Economic Modelling 50 (2015) 130–137

Contents lists available at ScienceDirect

Economic Modelling

journal homepage: www.elsevier.com/locate/ecmod

On the efficiency of private and state-owned enterprises in mixed markets☆

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ARTICLE INFO

Article history:
Accepted 8 June 2015
Available online 6 July 2015

Keywords:
Mixed oligopoly
Product differentiation
Quality
State-owned enterprises
Welfare

ABSTRACT

We examine oligopoly models of vertical product differentiation in which producing firms face variable costs of quality development. We show that comparing to private oligopoly, mixed oligopoly – whereby state-owned enterprises (SOEs) and private firms coexist – enhances social welfare but reduces firms' profitability. We also demonstrate that Bertrand competition makes firms better off under mixed oligopoly but it makes firms worse off under private oligopoly compared with Cournot competition. These findings help to justify both the existence of SOEs and the efficiency of SOEs and private firms in mixed markets in transitional economies.

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1. Introduction

Mixed markets – whereby state-owned enterprises (SOEs) and private firms coexist – are often observed in reality, especially in transitional economies. In these markets, the issue of whether or not SOEs should be retained in the economy and – if yes – how to maximize their efficiency remains hotly debated, at least from a policy standpoint. A number of theoretical studies have paid attention to this issue by focusing on government's regulations in mixed markets (market structure, mode of competition, ownership, and subsidies) under the approach of horizontal product differentiation (Cremer et al., 1991; Donder and Roemer, 2009; Ghosh and Mitra, 2010; Ghosh and Sen, 2012; Matsumura and Ogawa, 2012; Scrimitore, 2014; Nakamura, 2015). The general findings are that mixed oligopoly enhances social welfare comparing to private oligopoly and there is usually a way to achieve social optimum under mixed oligopoly (such as through a subsidy). Furthermore, under mixed oligopoly, price (Bertrand) competition yields larger profits for firms than quantity (Cournot) competition. However, under the approach of horizontal product differentiation, in most cases, not only is the product quality assumed to be exogenous, or even ignored, but also consumers are homogeneous with respect to product quality and/or prices.

In practice, however, competing firms often attempt to make their product qualitatively different from their competitors. That is, firms often choose their product quality endogenously. At the same time, consumers are also heterogeneous with respect to quality and/or prices, and they are willing to pay more for products with a higher quality. In other words, we usually observe vertical markets in reality. In these vertical markets, clearly the conclusions of the horizontal product differentiation models do not have an immediate application and, therefore, the question of whether mixed oligopoly or private oligopoly is better for social welfare and firms' profitability deserves some further theoretical justifications.

Despite the popularity of the vertical product differentiation model proposed by Mussa and Rosen (1978) and Shaked and Sutton (1982), there have been a limited number of studies that adopt this approach to analyse mixed markets. Grilo (1994)'s and Delbono et al. (1996)'s papers, to the best of our knowledge, were the first that examine welfare implications of mixed oligopoly for the case of fully covered and uncovered markets, respectively. However, Delbono et al.'s analysis is based entirely on Bertrand competition and relies on some numerical solutions only, whereas Grilo's analysis focuses on socially optimum solutions rather than comparing between mixed and private oligopoly. Lutz and Pezzino (2014), on the other hand, study mixed oligopoly with quality-dependent fixed costs and show that when the mode of competition (price or quantity) is fixed, mixed oligopoly not only enhances social welfare but also might make the private firm better off comparing to private oligopoly.[1]

In this paper, we fill the gap in the literature by considering a vertical product differentiation model with variable costs of quality development.[2] We aim to compare firms' profitability and social welfare

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☆ I would like to thank John Asker, Jay Pil Choi, Arghya Ghosh, Sushanta Mallick (the editor), Hodaka Morita, Massimo Motta, and anonymous referees for their insightful comments and suggestions.

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[1] Jofre-Bonet (2000) adopts the framework with quality-dependent fixed costs to analyse mixed oligopoly in the case of the health care market where consumers are segmented into low- and high-income groups.

[2] Industries in which inputs are expensive are typically captured by this set up (Motta, 1993).

http://dx.doi.org/10.1016/j.econmod.2015.06.011
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between mixed oligopoly and private oligopoly under this setting. We also extend the analysis to compare outcomes between Bertrand competition and Cournot competition under both private and mixed oligopoly, some of the neglected aspects in the vertical product differentiation literature.

Our main results can be summarized as follows. First, comparing to private oligopoly, mixed oligopoly is found to enhance social welfare regardless of the modes of competition (price or quantity). This result is consistent with that in Lutz and Pezzino (2014)'s paper and also the horizontal product differentiation literature. Second, in contrast to Lutz and Pezzino (2014), it is found that mixed oligopoly always reduces firms' profitability comparing to private oligopoly. Finally, we find that Bertrand competition yields larger social welfare, and it also yields larger profits under mixed oligopoly but lower profits under private oligopoly, than Cournot competition, which are similar to findings under the horizontal product differentiation literature, despite fundamental differences in modelling structure (Singh and Vives, 1984; Vives, 1985; Qiu, 1997; Hackner, 2000; Ghosh and Mitra, 2010; Matsumura and Ogawa, 2012).[3] These findings help to justify both the existence and efficiency of SOEs in transitional economies.[4]

It should be noted that Motta (1993) compares outcomes between Bertrand and Cournot competition under private oligopoly in which competing firms face either fixed costs or variable costs of quality development. He shows that firms' profits are larger but social welfare is smaller in Cournot competition than in Bertrand competition. However, Motta only introduces a numerical example for the case of variable costs of quality. Meanwhile, although the comparison between Bertrand and Cournot competition under both private and mixed oligopoly using the approach of horizontal product differentiation has been well explored, there are a number of limitations with this approach: the degree of product substitutability is often given exogenously, firms' marginal costs are mostly symmetric and independent of quality, and a representative consumer framework is usually adopted. Our results, therefore, complement these earlier studies.

The paper will proceed as follows. Section 2 introduces the model, followed by an analysis of private oligopoly in Section 3. Section 4 explores mixed oligopoly. Discussions of the main results are provided in Section 5. Finally, Section 6 offers some concluding remarks.

2. The model

Consider a duopoly model of vertical product differentiation with two producing firms, 1 and 2, who each supplies a unique product to the market. Let u_i denote the quality level of firm i's product ($i = 1, 2$). Without loss of generality, assume that when the quality levels are different, $u_1 > u_2$ holds so that firm 1 is the producer of the high-quality product whereas firm 2 is the producer of the low-quality product. Production requires quality development costs, which are assumed to be increasing in quality level. For tractability, assume that firm i's total cost function is $TC(u_i) = \frac{1}{2}u_i^2 d_i$, where d_i is the demand for firm i's product (see a similar set-up in Motta, 1993).[5]

On the demand side, there are a continuum of consumers who differ in their tastes (or preferences), described by the parameter v that is continuously distributed with unit density over $[\underline{v}, \bar{v}]$. We focus on the case in which $\underline{v}$ is low enough and $\bar{v}$ is high enough so that interior solutions arise in equilibrium. Note that Motta (1993) assumes $\bar{v} = 5$ to derive numerical results. In this paper, we consider any value of $\bar{v}$. Each consumer is endowed with a utility equal to zero and can buy at most one unit of the products. If the consumer purchases the product of quality u_i at the price p_i from firm i, she obtains an indirect utility equal to $vu_i - p_i$. It is popular in the vertical product differentiation literature that the demand for firm 1's product and firm 2's product are $d_1 = \bar{v} - v_{12}$ and $d_2 = v_{12} - v_{\phi 2}$, respectively, where $v_{12} = (p_1 - p_2)/(u_1 - u_2)$ and $v_{\phi 2} = p_2/u_2$.[6]

We consider a two-stage game played by firms 1 and 2. In the first stage, they simultaneously choose the quality level for their product. In the second stage, they compete in either prices (Bertrand competition) or quantities (Cournot competition). More specifically, in the second stage, in Bertrand competition, firms 1 and 2 simultaneously set the price level for their product, whereas in Cournot competition, firms 1 and 2 simultaneously set the quantity (or sales) level.

In what follows, we examine two different cases. The first case is private oligopoly in which both firms 1 and 2 are private firms, whose objective is to maximize their absolute profit. The second case is mixed oligopoly in which one of the firms is an SOE, whose objective is to maximize social welfare, whereas the other firm is still a private firm. For each of these cases, we solve the game described above by backward induction. We then compare outcomes between the two cases as well as between Bertrand and Cournot competition within each of these cases.

3. Bertrand and Cournot competition under private oligopoly

In this section, we explore implications of Bertrand and Cournot competition on producing firms' profitability and social welfare under private oligopoly. We will show that Motta's (1993) numerical results for the case of variable costs of quality can be generalized. Some unexplored aspects in Motta's (1993) paper such as quality gap and market coverage will also be discussed.

Based on the model set-up, the profits of firms 1 and 2 are respectively given by:

$$\pi_1 = d_1(p_1 - u_1^2/2) = (\bar{v} - v_{12})\left(p_1 - \frac{u_1^2}{2}\right), \tag{1}$$

$$\pi_2 = d_2(p_2 - u_2^2/2) = (v_{12} - v_{\phi 2})\left(p_2 - \frac{u_2^2}{2}\right). \tag{2}$$

Consider Bertrand competition. Firm 1's and firm 2's problems in stage 2 are respectively stated as follows:

$$\underset{p_1}{\operatorname{Max}}\, \pi_1 = (\bar{v} - v_{12})\left(p_1 - \frac{u_1^2}{2}\right) = \left(\bar{v} - \frac{p_1 - p_2}{u_1 - u_2}\right)\left(p_1 - \frac{u_1^2}{2}\right),$$
$$\underset{p_2}{\operatorname{Max}}\, \pi_2 = (v_{12} - v_{\phi 2})\left(p_2 - \frac{u_2^2}{2}\right) = \left(\frac{p_1 - p_2}{u_1 - u_2} - \frac{p_2}{u_2}\right)\left(p_2 - \frac{u_2^2}{2}\right).$$

First order conditions yield the following solutions:

$$p_1 = u_1(2u_1^2 + 4u_1\bar{v} - 4u_2\bar{v} + u_2^2)/(8u_1 - 2u_2), \tag{3}$$

$$p_2 = u_2(u_1^2 + 2u_1\bar{v} - 2u_2\bar{v} + 2u_1u_2)/(8u_1 - 2u_2). \tag{4}$$

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[3] Reisinger and Ressner (2009) extend the model of Singh and Vives (1984) and Vives (1985) to show that firms prefer quantity competition when demand is certain, or when their products are highly substitutable. Using examples of the liquor industry and the audio tapes and disks industry in the United States as explored by de Jong et al. (2008), Reisinger and Ressner demonstrate that in these industries, competing firms possess a high level of product substitutability so that they prefer quantity competition to price competition. As will be shown in what follows, Reisinger and Ressner's explanations are basically consistent with our results.

[4] Contrasting to a large number of studies comparing Bertrand and Cournot competition under horizontal product differentiation, the comparison between Bertrand and Cournot competition under vertical product differentiation is a relatively new research topic. For some recent contributions, see Lambertini (2000)'s comparison of cartel stability between Bertrand and Cournot competition, Andaluz (2010)'s comparison of outcomes between price collusion and quantity collusion, and Nguyen et al. (2014)'s comparison of outcomes between Bertrand and Cournot competition in the presence of technology licensing.

[5] Nguyen (2014) adopts a similar framework to analyse monopolistic third-degree price discrimination.

[6] The threshold $v_{\phi 2}$ characterizes the marginal consumer who is indifferent between purchasing firm 2's (low-quality) product and not purchasing any product, i.e. $v_{\phi 2}u_2 - p_2 = 0 \rightarrow v_{\phi 2} = p_2/u_2$. The threshold v_{12} characterizes the marginal consumer who is indifferent between purchasing firm 1's (high-quality) product and firm 2's product, i.e. $v_{12}u_1 - p_1 = v_{12}u_2 - p_2 \rightarrow v_{12} = (p_1 - p_2)/(u_1 - u_2)$.

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