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Price equilibrium and willingness to pay in a vertically differentiated mixed duopoly

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ABSTRACT

In the framework of a vertically differentiated mixed duopoly, with uncovered market and zero costs, we study the existence of a price equilibrium when a welfare-maximizing public firm producing low quality goods competes against a profit-maximizing private firm producing high quality goods. We show that a price equilibrium exists if the quality spectrum is wide enough *vis à vis* a measure of the convexity of the distribution of the consumers' willingness to pay, and that such equilibrium is unique if this sufficient condition is tightened. Logconcavity of the income distribution is inconsistent with the existence of equilibrium.

1. Introduction

Mixed oligopolies can be observed in many countries and sectors, as mixed industries in advanced economies became particularly relevant in the last decades, following extensive privatization programmes of public monopolies in the 80's and 90's.[1] In mixed industries (e.g., public utilities, transportation, telecommunication, energy, postal services, education, health care, etc.) public firms compete with private firms in price, quantity and the quality of goods. It is frequently argued that public firms supply goods or services, the quality of which is lower than that provided by private firms: e.g., such is allegedly the case in many countries for education and health care, or in transport and postal services. To be sure, the idea that public firms consistently supply lower quality can be challenged on empirical grounds – indeed, cases can even be found where the same industry is characterized by public firms supplying higher or lower quality, depending on the country or the sector one looks at (Epple and Romano, 1998; Jofre-Bonet, 2000; Sanjo, 2009; Cremer and Maldonado, 2013). However, cases where

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[1] In Europe several public utilities such as telecommunication, electricity, gas retailing, and postal services became mixed markets as private firms were allowed to compete with public firms. The same happened with many previously public industries, such as airlines, railways, energy, steel, banking, broadcasting, life insurance, health care, and education. On the main privatization programmes and the relevance of mixed industries see, e.g., Cuervo and Villalonga (2000) and Megginson and Netter (2001).

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public firms do offer lower quality are many, and the literature of mixed oligopolies usually relies on such an assumption (see, e.g., Ishibashi and Kaneko, 2008).[2]

A number of papers address the question of why this should be so, in the framework of a welfare-maximizing public firm competing with a profit-maximizing private one[3]; however, the answer they provide is usually sought by assuming away any role for the distribution of the willingness to pay across consumers: either because the crucial feature of uncovered market is ruled out, or because – while allowing for uncovered markets – the standard, uniform-distribution model of vertical differentiation is used.[4] This is somewhat surprising on at least two counts: at a very general level, most informal arguments justifying the very existence of public firms competing with private firms rely on distributional concerns about inequality and providing the poor with access to goods and services; and, more to the point at the analytical level, it is in general well known that the distribution of the willingness to pay affects the firms' equilibrium choices and can in principle affect the very existence of equilibria (Grandmont, 1993; Anderson et al., 1997).

In this paper we focus on the existence of a short-run price equilibrium in a vertically differentiated mixed duopoly with uncovered market, to confirm that the distribution of the willingness to pay affects equilibria. We assume costless production, which allows us to concentrate upon the relevant features of demand and hence the distribution of the willingness to pay; and we model a mixed duopoly as a case where a welfare-maximizing, low-quality producing public firm competes against a profit-maximizing, high-quality producing private firm – which in principle might provide a first step in addressing the important general question of comparing the overall performance of 'mixed' *vs* 'pure' oligopolies within vertically differentiated markets.[5] In this framework, we show that for a price equilibrium to exist the distribution of the willingness to pay cannot be logconcave, and that sufficient conditions for existence and uniqueness place a lower bound on the (given) quality spectrum – a lower bound which is higher, the higher the given convexity bound on the income distribution.

The paper is organized as follows. Section 2 presents the model and the general framework of mixed duopoly with vertical differentiation; Section 3 gives the solution for a market price equilibrium and discusses existence and uniqueness; Section 4 presents an example where the consumers' willingness to pay is supposed to be distributed as a Pareto distribution, while some concluding remarks are gathered in Section 5.

2. The model

We start from a standard model of duopoly competition with vertical differentiation, uncovered market and costless quality choice, as developed by Mussa and Rosen (1978), Shaked and Sutton (1982) and Tirole (1988). There are two competing firms, $i = H, L$, playing a non-cooperative game on price. Each firm i produces a good of quality $s_i \in \{s_H, s_L\}$, where $0 < s_L < s_H < \infty$ and $\Delta = s_H - s_L > 0$ denotes the quality differential. We crucially assume that L is a public firm producing low quality goods, while H is a profit-maximizing firm producing high quality goods; production costs are normalized to zero.[6] The firms' profits are $\Pi_i = p_i D_i$, where p_i and D_i, with $i = H, L$, denote prices and demands: higher quality s_H sells at a price p_H, and lower quality s_L at a price p_L.

Each consumer is identified by her marginal willingness to pay for quality, θ, and has a utility $U_i(\theta) = \theta s_i - p_i$ if she buys a unit of good from firm i, and 0 otherwise. The marginal consumer, who is indifferent between buying the high and the low quality, has utility $U_H(\theta) = U_L(\theta)$, and is accordingly identified by $\theta_H = (p_H - p_L)/\Delta$; the marginal consumer who is indifferent between purchasing the low quality commodity and nothing at all has utility $U_L(\theta) = 0$, and is identified by $\theta_L = p_L/s_L$.[7] Clearly, θ_L and θ_H denote the positions of these marginal consumers along the 'income' scale: for later reference, it is useful to derive the price elasticities of θ_L and θ_H, which are given by $\varepsilon_H = \frac{\partial \theta_H}{\partial p_H}\frac{p_H}{\theta_H} = \frac{p_H}{p_H - p_L} > 1$ and $\varepsilon_L = \frac{\partial \theta_H}{\partial p_L}\frac{p_L}{\theta_H} = \frac{-p_L}{p_H - p_L} < 0$, such that $\varepsilon_H + \varepsilon_L = 1$.

[2] Examples of mixed industries where public firms allegedly provide low quality are transport services (Dodgson and Katsoulacos, 1988), postal services (Mizutani and Uranishi, 2003), telecommunication (Ros, 1999), and financial services (Barros and Modesto, 1999). It should perhaps also be noticed that, according to Blackorby and Donaldson (1988) and Besley and Coate (1991), if the quality differential between public and private sectors is justified by a concern for accessibility, the quality offered by the public firm should be sufficiently low to make accessibility effective.

[3] For an overview of the theory of mixed oligopoly see De Fraja and Delbono (1990) and for standard models of mixed oligopoly see, e.g., Harris and Wiens (1980), De Fraja and Delbono (1989), Grilo (1994), Barros and Martinez-Giralt (2002), Cantos-Sánchez and Moner-Colonques (2006) and Cremer and Maldonado (2013).

[4] Thus, e.g., Ishibashi and Kaneko (2008) use the Hotelling model to argue that in a duopoly equilibrium the public firm would supply the lower quality, and the private firm the higher (in fact, higher than efficient) quality level. On the other hand, Delbono et al. (1996) use the standard uncovered market model to show that an equilibrium where the public (private) firm chooses the low (high) quality exists, though an equilibrium with inverted quality allocations also exists, and market segmentation is exogenous (also, this is a framework where it is problematic to find analytical solutions).

[5] As we argue in Section 3.2, the focus on short-run price equilibria with given qualities makes it easier to think of marginal costs as constant.

[6] This amounts to marginal costs being constant and independent of quality (see our discussion in Section 3.2). Notice that in this framework a high-quality producing public firm would serve the whole market at a price equal to marginal cost, and no profit maximizing firm could produce low-quality goods in equilibrium.

[7] These are the basic features of the standard vertical differentiation model (Mussa and Rosen, 1978); as is well known, the marginal willingness to pay θ can be looked at as a proxy for income (Gabszewicz and Thisse, 1979).