

O.R. Applications

# A note on price and quality competition between asymmetric firms

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## Abstract

This paper analyzes the impact of asymmetry between firms on the outcome of price and quality competition from a microeconomic viewpoint. Consumers purchase a product based on not only its price but also its quality level; therefore, two firms compete in determining their prices and quality levels to maximize their profits. The asymmetry arises from the difference in consumers' loyalty to each firm; that asymmetry then determines a character of differentiation between firms. Our purpose is to show how asymmetry influences competition under varying consumers' price- and quality-sensitivity. In doing so, we extend earlier work in the area of price and quality competition. We show that in both the moderately quality-sensitive and price-sensitive markets, higher consumers' sensitivity as well as lower consumers' loyalty to any firm leads to intense competition, resulting in a decrease of both firms' equilibrium profits. On the other hand, in highly quality-sensitive market, asymmetry compels the smaller firm to change its competitive strategy. In general, this is more beneficial to the larger firm, as the smaller firm's profit tends to decline. In the worst case, the smaller firm is driven out of business under equilibrium.

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## 1. Introduction

In this paper, we consider a price and quality-based competition between two firms. Consumers buy a product in consideration of not only its price but also its quality level, which is a measurable value exhibiting a "more is better" property. Under this demand structure, firms compete with each other in determining their prices and quality levels to maximize profits. Using a game theoretic approach, we investigate this competition

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theoretically by looking at the asymmetry between two firms that arises from differences in their consumers' loyalty. The purpose of this paper is to analyze the competition in terms of the welfare of both firms and consumers from a microeconomic viewpoint.

From MPHPT (2003) and Matsubayashi (2007), we can see an example of price and quality competition in the real world, where Internet service providers (ISPs) compete in the emerging broadband Internet market in Japan. We recognize that in offering broadband Internet services, competing firms may employ different mechanisms from "natural" price competition. That is, consumers may very well require not only an acceptable price (user's fee), but also a level of quality necessary for comfortable downloading of broadband contents (e.g. movies, voice, etc). This is confirmed by the results of a consumer questionnaire conducted by MPHPT (2004) in which they state that consumers consider some factors of quality level (e.g. the maximum circuit speed rate, connection rate, etc.) in making their choice of ISP. Such firms should thus consider, i.e. optimize at least two factors – price and quality level in generating profits. This action will create a "price and quality competition."

We develop our analysis in a microeconomic framework. Specifically, our model depends on and extends that of Shaffer and Zhang (2002). They consider an asymmetry arising from a consumers' loyalty which is defined as the minimum price differential to induce his/her from the less preferred firm. However, their work focuses on promotion strategy under price competition, and so does not consider quality – the key factor in our study.

There are a number of the microeconomic literatures in existence, which focus on price and quality competition. Specifically, the spatial competition model originated by Hotelling (1929) is one that is widely used as a model for a price–quality decision, where a customer's "location" can be interpreted by an "ideal-point" of the consumer's taste preference. However, the quality decision in much of the marketing literature based on the Hotelling model (e.g. Tyagi, 2000; Syam et al., 2005) is assumed to have no direct cost implications. In contrast, Banker et al. (1998) and Matsubayashi (2007) investigate a price and quality competition under a duopolistic setting, where the consumers' demand is modeled as a linear function of price and quality levels, and the cost as a quadratic function of the quality level. Banker et al. (1998) also explore the impact of asymmetry in demand/cost structure between firms on their competition. However, since their model focuses on competition only in the highly quality-sensitive market (in terms of our paper), it is not clear how the price- and quality-sensitivity influences firms' decisions and the resulting competition. On the other hand, Matsubayashi (2007) characterizes price and quality competition by focusing on the degree of horizontal differentiation between symmetric firms. The topics of interest here are thus asymmetry between firms due to the difference in degrees of loyalty to each firm, and the impact of it on competition under varying degrees of consumers' sensitivity.

As previously noted, we herein extend the model of Shaffer and Zhang (2002) to a price and quality competition. That is, we consider consumers' loyalty, which is defined as the minimum perceived price (weighted combination of the price and quality levels) able to induce them to purchase from their less preferred firm. If the degrees of consumers' loyalty are similar between both firms, then they are symmetric and horizontally differentiated. In contrast, if they are different, then the firms are asymmetric and vertically differentiated.

With this demand structure, and the quadratical cost impact of quality-improving, we formulate a non-cooperative game, where two firms compete with each other in determining their prices and quality levels simultaneously.<sup>2</sup> Although the timing and sequence of decisions depend on circumstances, we here concentrate our focus on a one-shot decision as a short-term strategy of both price and quality. Under varying levels of price- and quality-sensitivity of the market, the outcome of the game is characterized and the impacts of the asymmetry between the two firms on the outcome are analyzed in terms of the welfare of each firm and the consumers, i.e., the profits and the perceived price.

To understand our model, we imagine an example of a service launch by two incumbent ISPs. Both ISPs have already succeeded in creating their loyal customers by their existing services and thus they know their brand loyalties almost exactly. In such a circumstance, the demand for the new service is likely to be affected

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<sup>2</sup> Our one-shot setting is contrast to the sequential setting in Banker et al. (1998), where each firm first determines quality level and then determines price.

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