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不確定性下產品品質選擇：先行承諾與後進彈性的抉擇

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研究計畫中文摘要：

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固定成本下垂直產品差異模型的市場涵蓋範圍

摘要

在品質成本為固定成本的假設下，本文發現消費者異質程度高過某一水準時，市場中有部份消費者未購買商品(即市場非全面涵蓋,uncovered market)。相反地，消費者異質程度低於此一水準時，市場中全部消費者皆會消費，購買高品質或低品質商品(即市場全面涵蓋,covered market)，但在賽局中的第二階段(即價格階段)，價格均衡解為邊角解，因此，文獻中在假設市場全面涵蓋下，價格均衡解為內解的有關研究與分析，似不恰當。然而，當消費者異質程度非常小時，此種市場全面涵蓋下價格均衡解為內解的競爭模式，相較於邊角解的競爭模式，所產生的社會福利較高，因此本文建議政府可採用品質管制政策，來影響廠商的競爭模式，以提高社會福利。

研究計畫英文摘要：

Keywords : Market coverage, Consumer heterogeneity, Quality competition

Market Coverage in Vertical Differentiation Models with Fixed Costs

Abstract

With fixed costs of quality improvement, we find that the market is uncovered when the degree of consumer heterogeneity is above a threshold value. Otherwise, the market is covered with a corner solution in the price stage. Thus, the analysis under a covered market with an interior solution in the price stage becomes inappropriate and irrelevant. However, such a market configuration would yield higher social welfare when the degree of consumer heterogeneity is small enough. It is suggested that government intervention, such as minimum quality standards, be used to raise social welfare.

I. Introduction

Since the classical works by Gabszewicz and Thisse (1979) and Shaked and Sutton (1982), the issue on quality competition between firms has been widely analyzed in the literature. The early works implicitly assume that the market is either covered or uncovered. Motta (1993) points out that Cournot case can be analyzed only under partial market coverage because the demand functions cannot be inverted under full market coverage. For example, Das and Donnenfeld (1989), Valletti (2000), and Herguera et al. (2000), analyze the effects of quantity (quota) and/or quality (minimum quality standard) restrictions on the duopolists with Cournot competition, and the market is uncovered in their models. Herguera et al. (2002) analyze the tariff policy in a Cournot duopoly model, and the market is uncovered. Motta (1993) also points out that, under the assumption that consumers are uniformly distributed on the interval $[0,1]$, the market is implicitly uncovered because some consumers will never buy the product.¹ Under such an assumption, the market is uncovered in Ronnen (1991), Motta (1993), Polavarapu and Vaidya (1996a, b), Aoki and Prusa (1996), Lehmann-Grube (1997), Lutz (2000), Lutz et al. (2000), Zhou et al. (2002), for example. Moorthy (1988) interprets “buying nothing” as the choice of a substitute of quality zero and price zero, or as buying other kind of product.² In his model, although consumers are assumed to be uniformly distributed on the interval $[a,b]$, $b > a > 0$, the market is uncovered with such an interpretation. On the other hand, some papers, for example, Crampes and Hollander (1995), Boom (1995), Ecchia and Lambertini (1997), Maxwell (1998), Wang and Yang (2001), Wang (2003), analyze

¹It is also the case for the models with consumers uniformly distributed on the interval $[0, b]$, $b > 0$.

²For example, a consumer buying nothing in an automobile market may buy a bicycle.

Bertrand case under the assumption that the market is covered.

Without assuming *ex ante* that the market is covered or uncovered, Wauthy (1996) shows that covered or uncovered market are endogenous outcomes of the quality game, and the market outcome depends on the degree of consumer heterogeneity. However, Wauthy (1996) typically assumes that the costs of improving quality are zero.³ Under the assumption of zero costs, it is costless to produce any quality level of a product. But in reality quality improvements do cost, and it is generally believed that it is more costly to produce a higher quality product. With the same (zero) cost, it is also hard to explain why the duopolists would produce differentiated goods, and why one firm chooses to be the high-quality firm and the other be the low-quality firm. Moreover, Wauthy (1996) imposes an arbitrary upper bound on quality, and thus the high-quality firm always chooses this highest feasible quality independently of the low-quality firm's choice. In this paper, we relax the assumption of zero costs and assume that firms incur fixed costs to improve quality, and a higher quality product costs more to produce than a lower one. Following Wauthy (1996), we reexamine the market outcome of the game in which the duopolists choose the quality levels in the first stage, and compete in prices in the second stage.⁴ Going beyond Wauthy (1996), we compare social welfare in different market configurations. We find that, when the degree of consumer heterogeneity is small enough, the duopolists do not want to compete in a covered market with an interior solution in the price stage. However, such a market configuration yields higher social welfare. It is suggested that the government use quality controls to

³The same is assumed as in Shaked and Sutton (1982), Choi and Shin (1992), and Wang and Yang (2001).

⁴The order of the moves is consistent with the assumption of fixed costs because the quality choice is irreversible. Moreover, we analyze Bertrand case here because Cournot case can be analyzed only in an uncovered market

change the firms' competition behavior and the market outcome in order to raise social welfare.

II. The Model

We use a vertical product differentiation model that was developed along the line of Gabszewicz and Thisse (1979), Shaked and Sutton (1982) and Tirole (1988). Two firms supply a vertically differentiated good, each with a quality denoted by s_i , $i \in H, L$, and $s_H > s_L > 0$. Each firm incurs a fixed cost which is quadratic in quality with the form $s_i^2/2$, $i = H, L$. There is a continuum of consumers indexed by θ , uniformly distributed in the interval $[\underline{\theta}, \bar{\theta}]$, $\bar{\theta} > \underline{\theta} \geq 0$.⁵ The parameter θ represents consumers' marginal willingness to pay for quality, or the reciprocal of the marginal utility of income. Consumer θ has unit demand for the good and his utility function is:

$$U = \begin{cases} \theta s_i - p_i & \text{if buying one unit of the good with quality } s_i \text{ at price } p_i, i = H, L. \\ 0 & \text{otherwise.} \end{cases}$$

We consider the following two-stage game. In stage one, the firms simultaneously determine the quality levels of their products. In stage two, they compete in prices. Consumers, perfectly informed about the products and prices of the two firms, purchase the product from the firm that generates a higher utility level. Let $\hat{\theta}_1$ be the consumer who is indifferent to the product produced by either firm, so $\hat{\theta}_1 = (p_H - p_L)/(s_H - s_L)$. Let $\hat{\theta}_2$ be the consumer who is indifferent between buying the low-quality good and buying nothing at all, so $\hat{\theta}_2 = p_L/s_L$. Consumer θ with $\theta \geq \hat{\theta}_1$ and $\hat{\theta}_1 > \theta \geq \hat{\theta}_2$ will purchase the high-quality good and the low-quality good,

⁵As mentioned before, if $\underline{\theta} = 0$, the market is implicitly uncovered.

respectively. Consumer θ with $\theta < \hat{\theta}_2$ will buy nothing at all. If $\hat{\theta}_2 > \underline{\theta}$, the market is uncovered because the portion of the market $[\underline{\theta}, \hat{\theta}_2)$ is not served by either firm. If $\hat{\theta}_2 \leq \underline{\theta}$, the market is covered in the sense that every consumer in the market consumes either good rather than nothing at all.

Without assuming *ex ante* that the market is covered or uncovered, Wauthy (1996) shows that covered or uncovered market are endogenous outcomes of the quality game. There are four possible cases at the price stage: uncovered market, covered market with a corner solution, covered market with an interior solution, and preempted market. Since we are interested in a duopoly model in which both firms supply a positive output and earn a non-negative profit, our analysis is limited to the first three cases.

III. Main Results

This paper examines the market coverage in a duopoly model of vertical product differentiation. Different from Wauthy (1996) assuming zero costs, we assume that firms incur fixed costs to improve quality, and the higher quality, the more costly to produce. We show that covered or uncovered market outcome depend on the degree of customer heterogeneity. The market is uncovered at equilibrium when the degree of consumer heterogeneity is above a threshold value, i.e., $\bar{\theta} / \underline{\theta} > 4.705$. Otherwise, the market is covered with a corner solution in the price stage. Thus, the analysis under a covered market with an interior solution in the price stage becomes inappropriate and irrelevant. However, in Wauthy (1996) with zero costs, all these three market outcomes would arise. Compared to Wauthy (1996), our results also show that an uncovered market outcome is more likely to occur, and the degree of product differentiation is greater with fixed costs of quality improvement.

Going beyond Wauthy (1996), we further examine the welfare consequence of each market configuration. When the degree of consumer heterogeneity is small enough, i.e., $2 < \bar{\theta}/\underline{\theta} \leq 2.9271$, a covered market outcome with an interior solution in the price stage yields higher consumer surplus and social welfare. Since the firms would rather compete in a covered market with a corner solution in the price stage, government intervention would be needed to resolve the conflict between consumer and producer surplus. Thus, it is suggested that some restrictions, such as minimum quality standards, be used to change the firms' competition behavior and the market outcome in order to raise social welfare.

IV. Self-Evaluation (計畫成果自評)

The content of this paper is not quite the same as “Product Quality Choice with Uncertainty: A Trade-Off between Commitment and Flexibility” in the original proposal. Before we can analyze the issue about firms' quality choices under uncertainty, one more basic problem which has to be solved is the market coverage in vertical product differentiation models. As we show in the paper, covered or uncovered market are endogenous outcomes of the quality game, so it seems inappropriate to assume exogenously and explicitly that the market is covered or uncovered as most of the papers do.

In this paper, we only examined the case of fixed quality costs because the model with variable quality costs is much more complicated. The model with variable quality costs is working on progress and it is in need of mathematical programming to get the solutions of the game. We think that our works provide good contributions to the theoretical model in vertical product differentiation.

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