Quality Options of Market Equilibrium

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The heterogeneity of products has become an issue in market equilibrium and consumer theory. The purpose of this paper is to discuss the equilibrium quality depending not only on market structure but also on the ability of quality identification of consumers. Under both the assumption of a perfectly competitive and a monopolistic product sales market, the market equilibrium is derived for a search good and an experience good separately. The analysis indicates that a monopolistic market structure may have the benefit of ensuring a higher quality if a good is a search good whereas a competitive market structure results in both a higher quantity and quality level for an experience good. The implication suggests that regulators need to address not only market structure when formulating policy, but also whether the good in question can be classified as a search or an experience good.

Keywords: *product heterogeneity, equilibrium quality, market structure, search goods, experience goods*

1. Introduction

The heterogeneity of agricultural commodities has resulted in products' characteristics becoming an issue in market equilibrium and in consumer theory. Lancaster's theory endogenizes characteristics and enriches the tra-

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ditional theory, but ignores the heterogeneity within "one" product. In the real world, consumers continually face non-homogeneity in the good markets. Producers and sellers are in an effort to sort the products and reduce trading uncertainty.

In classical economic analysis, products are assumed to be homogeneous so a comparison of competitive and monopolistic market equilibrium leads to the inescapable conclusion that monopoly causes allocative inefficiency and is less socially desirable than a competitive market. The models of monopolistic competition formulated by Robinson and Chamberlin attempted to deal with products being close substitutes but not completely homogeneous. Monopolistically competitive firms face demand curves that are less elastic than those faced by competitive firms. Accordingly, monopolistically competitive firms operate with allocative inefficiency but it is often argued that this is offset, at least in part, by the larger number of choices available to the consumer. The study of product differentiation, however, does not say much about product quality in monopolistic versus competitive markets unless the greater array of goods available to consumers can be interpreted as providing increased quality.

Agricultural markets abound with examples of goods with varying levels of quality being sold for the same price. For example, oranges in a bin at the supermarket sell for the same price per pound although there may be a considerable difference in quality between any two oranges. In this example, the price is effectively fixed and consumers determine the quality level of their purchase by their selection of oranges. Consumers might inspect products to select the one(s) with the desired characteristics, e.g., size, color, shape, length, texture, uniformity, degree of ripeness, tenderness, label, and price. This occurs because consumers have their own particular preference and

have the ability to inspect the quality. On the other hand, consumers might not be able to assess the actual quality and select products by the experience over time.

The distinction between search and experience goods was introduced by Nelson. Search goods are those for which the consumer is able to correctly evaluate quality prior to purchase simply by engaging in search activities. Fresh vegetables and fruits might be considered as search goods since the majority of consumers are able to inspect the desired quality. There is a cost associated with search activity that is inversely related to the probability of finding the desired level of quality; as this probability approaches one, search costs approach zero. Thus if there were no variance in quality, there would be no need for search.

In the case of experience goods, however, consumers are unable to correctly identify quality without actually purchasing and consuming the good. Consumers use past experience with the good to estimate the mean and variance of the quality distribution and end up selecting the good randomly, knowing they have a certain probability of selecting a good with the desired level of quality. Meat might be an example of experience goods. Given the difficulty in inspecting the quality of meat and poultry, consumers might abandon search activities and depend on previous experience as they purchase. Here consumers face an element of risk: they do not know a priori the level of quality they have chosen. The risk is a function of the variance of the quality distribution. Risk averse consumers are expected to associate higher quality with a higher mean level of quality and a lower quality variance.

The purpose of this paper is to discuss the equilibrium quality depending not only on market structure but also on the ability of quality identification

of consumers. It is argued here that the comparison between quality levels in competitive and less than competitive markets depends only in part on market structure. The equilibrium level of quality attained also depends on whether the good is a search or an experience good.

Although there are a variety of previous studies concerned with product heterogeneity in the market, there has been no existing theory to emphasize on the quality equilibrium. The product characteristics research classified into empirical studies (Waugh, 1928; Harrington and Gislason, 1956; Adrian and Daniel, 1976) having no underlying theoretical framework and theoretical models (Lancaster, 1966; Ladd and Suvannunt, 1976; Hanemann, 1982) deals with how product characteristics influence demand and supply. Quality competition implies non-price competition (White, 1972; Dixit, 1979), concerned with the degree of monopoly power and product differentiation (Spence, 1976; Grossman and Shapiro, 1984; Harrington, 1995). The literature of information centers on the problem due to imperfect information (Stigler, 1961; Nelson, 1970; Nagle, 1984; Bergin, 1995). Equilibrium quality was not interpreted clearly in the previous studies.

The following analysis derives the equilibrium quality and quantity under both the assumption of a perfectly competitive and a monopolistic product sales market. For a search good, the equilibrium quantity is larger given competition rather than a monopoly, but the quality level of the competitive equilibrium is lower. However, if an experience good is considered, competitive equilibrium again results in a larger quantity than the monopoly, but also in a higher quality level.

2. Equilibrium Quality of Search Goods

In this analysis we assume that there is a product characteristic, z, which is universally accepted as a proxy for product quality. Consumers could inspect the quality and purchase the good with exactly the desired quality if it is a search good. The firm selling a search good that has the quality characteristic z faces the inverse demand equation, $p = g(x, z)$, and cost function, $c(x, z)$. Consumers are willing to pay higher price for higher quality. On the other hand, the firm will expend more to improve the quality of its product.

Since consumers are able to inspect individual product characteristics, the quality may indicate the frequency with which the product with the desired characteristics is found, rather than the level of the products characteristics. The higher portion of the products with desired characteristics, the higher the quality is. Consumers are willing to pay higher price for higher quality to reduce search costs. On the other hand, it will cost more for both producers and sellers to sort agricultural products for higher quality.

The firm desires to maximize profit:

$$\begin{aligned} \pi &= px - c \\ &= g(x, z)x - c(x, z) \end{aligned} \tag{1}$$

where $g_x < 0, g_z > 0$

$c_x > 0, c_z > 0, c_{xx} > 0, c_{zz} > 0$

x : product quantity

p : product price

The first order conditions necessary for profit maximization are:

$$\begin{aligned}\pi_x &= g + g_x x - c_x \\ &= g(1 + \frac{\partial g}{\partial x} \cdot \frac{x}{g}) = g(1 + \frac{1}{\frac{\partial x}{\partial p} \cdot \frac{p}{x}}) \\ &= g(1 + \frac{1}{e}) - c_x = 0 \end{aligned} \tag{2}$$

$$\pi_z = g_z x - c_z = 0 \tag{3}$$

where e : the price elasticity of demand for the product.

The inverse of price elasticity of demand is labeled as the "Lerner Index of Monopoly" by economists of industrial organization to measure monopoly power. The monopoly power is at zero level for pure competition as elasticity rises toward infinity. Price elasticity faced by firms will be used as a tool to distinguish market structure later in this section.

The necessary second order conditions for maximization are:

$$\pi_{xx} < 0, \pi_{zz} < 0$$

$$\pi_{xx}\pi_{zz} - \pi_{xz}^2 > 0$$

where $\pi_{xz} = \pi_{zx}$

The intersection of the curves describes by the first order conditions determines the profit maximum for individual firm. To get more information about the shapes of these curves, we take the total derivative of the first order conditions and solve for dz/dx of (2) and (3) separately:

$$dz/dx = -\pi_{xx}/\pi_{xz} \tag{4}$$

$$dz/dx = -\pi_{zx}/\pi_{zz} \tag{5}$$

The signs of both π_{xx} and π_{zz} are negative according to the second order conditions. The sign of π_{xz} is not immediately apparent. For π_{xz} to be negative requires $g_{xz} < 0$ and/or $c_{xz} > 0$. If g_{xz} is rewritten as $\partial g_x/\partial z$, it becomes apparent that g_x is the slope of the demand curve and a negative g_{xz} means that as quality increases, consumer demand becomes less price elastic. Similarly, a positive c_{xz} means that the marginal cost will be higher for a higher quality good. It is reasonable to expect that it becomes less price elastic in demand and/or higher marginal cost for a higher quality good. Therefore, it is assumed here that π_{xz} is negative, resulting in negative sign for (4) and (5), and both (2) and (3) defining downward sloping curves in x, z space. A negative sign for π_{xz} combined with the second order conditions further assures that (2) is steeper than (3).

Finally, (2) does depend on the market structure in which the firm sells. If the market is competitive, the e approaches negative infinity and its inverse approaches zero. A competitive firm formulates (2) as $g - c_x = 0$ rather than $g - c_x = -g/e$, (2) for a less-than-perfectly-competitive firm. Assuming π_{zx} is negative and the second order conditions are met, then (2) for a competitive firm will lie to the right of where (2) would lie if the firm were a monopolist.

Figure 1 illustrates these results. The competitive firm and monopolist are denoted by the subscripts of C and M separately. The competitive market will result in a larger expected equilibrium quantity and also a lower equilibrium quality than that of a monopoly. This is a familiar result. In monopolistic competition, it may be argued that the allocative inefficiency caused by product differentiation is offset by the increased options (quality level) offered to the consumer.

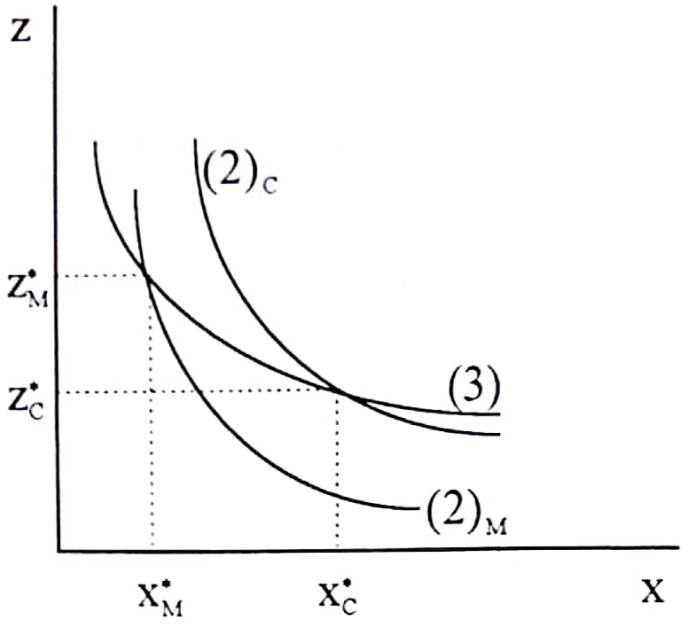

Figure 1. Market Equilibrium of Search Goods

3. Equilibrium Quality of Experience Goods

Now, consider the situation for a market in which the commodity being sold is an experience good. Here the firm will still maximize profit, but consumers cannot accurately evaluate the actual quality characteristic. Consumers of an experience good base their choice on the mean, μ , and the variance, σ , of the product characteristic that they have observed from experience over time. The inverse demand and cost are represented by $p = g(x, \mu, \sigma)$ and $c(x, \mu, \sigma)$ separately as before. It is assumed that consumers are risk averse and prefer a higher mean and a smaller variance. For cost function, producers and sellers will cost more to produce higher mean and/or to reduce quality uncertainty.

Thus, the profit function to be maximized is:

$$\pi = g(x, \mu, \sigma)x - c(x, \mu, \sigma) \tag{6}$$

where $g_x < 0, g_\mu > 0,$ and $g_\sigma < 0$

$c_x > 0, c_\mu > 0,$ and $c_\sigma < 0$

The necessary first order conditions are:

$$\pi_x = g(1 + \frac{1}{e}) - c_x = 0 \tag{7}$$

$$\pi_\mu = 0 \tag{8}$$

$$\pi_\sigma = 0 \tag{9}$$

And the second order conditions of:

$$\pi_{xx} < 0, \quad \pi_{\mu\mu} < 0, \quad \pi_{\sigma\sigma} < 0 \tag{10}$$

$$\begin{vmatrix} \pi_{xx} & \pi_{x\mu} \\ \pi_{\mu x} & \pi_{\mu\mu} \end{vmatrix} > 0, \quad \begin{vmatrix} \pi_{\mu\mu} & \pi_{\mu\sigma} \\ \pi_{\sigma\mu} & \pi_{\sigma\sigma} \end{vmatrix} > 0, \quad \begin{vmatrix} \pi_{xx} & \pi_{x\sigma} \\ \pi_{\sigma x} & \pi_{\sigma\sigma} \end{vmatrix} > 0 \tag{11}$$

$$\begin{vmatrix} \pi_{xx} & \pi_{x\mu} & \pi_{x\sigma} \\ \pi_{\mu x} & \pi_{\mu\mu} & \pi_{\mu\sigma} \\ \pi_{\sigma x} & \pi_{\sigma\mu} & \pi_{\sigma\sigma} \end{vmatrix} < 0 \tag{12}$$

The market equilibrium occurs at the intersection of (7), (8), and (9). To examine the equilibrium quality requires the derivation of these conditions in x ,μ space where μ is the mean level of the product characteristics. Accordingly, the total derivatives of the first order conditions are taken and solved for $d\mu/dx$, resulting in:

$$\frac{d\mu}{dx} = \frac{-\pi_{xx}\pi_{\sigma\sigma} + \pi_{x\sigma}^2}{\pi_{x\mu}\pi_{\sigma\sigma} - \pi_{\mu\sigma}\pi_{x\sigma}} \tag{13}$$

$$\frac{d\mu}{dx} = \frac{-\pi_{x\sigma}\pi_{\sigma\sigma} + \pi_{x\sigma}\pi_{\sigma\sigma}}{\pi_{\mu\mu}\pi_{\sigma\sigma} - \pi_{\mu\sigma}^2} \tag{14}$$

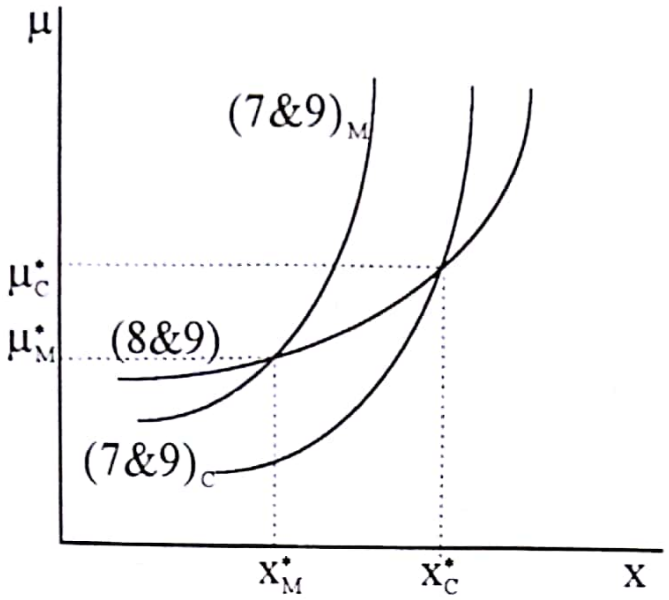

Figure 2. Market Equilibrium of Experience Goods in x, μ Space

(13) describes in x , μ space the slope of a curve which satisfies both (7) and (9), called curve (7&9) hereafter. (14) does the same for a curve which satisfies both (8) and (9), called curve (8&9) hereafter. The second order conditions of (11) indicate that (13) has a negative numerator and (14) has a positive denominator. Thus, the slope of these curves depends on the sign of $\pi_{x\mu}\pi_{\sigma\sigma} - \pi_{\mu\sigma}\pi_{x\sigma}$. This expression will be negative if $\pi_{x\mu} > 0$, $\pi_{x\sigma} < 0$, and $\pi_{\mu\sigma} \leq 0$. For $\pi_{x\mu}$ to be positive and $\pi_{x\sigma}$ to be negative means that product quality and quantity are complements in the profit function. If $\pi_{\mu\sigma} = 0$, then μ and σ are independent of one another, while $\pi_{\mu\sigma} < 0$ suggests that marginal profit of μ will fall if σ increases. We believe these signs to be reasonable and thus assume $\pi_{x\mu}\pi_{\sigma\sigma} - \pi_{\mu\sigma}\pi_{x\sigma}$ to be negative. Therefore, both fractions of (13) and (14) are positive and the fraction in (13) is greater than that in (14), according to the second order conditions.

This means that both (7&9) and (8&9) will be upward sloping with (7&9) steeper than (8&9) in x , μ space. Further, since e is greater for a

competitive firm than for a monopoly, (7&9) for a monopoly will lie to the left of that for a competitive firm in x , μ space.

Figure 2 illustrates the equilibrium quantity and mean quality level in a competitive and a monopolistic situation, denoted by the subscripts of C and M separately. As was the case with a search good, the competitive quantity for an experience good is greater than for a monopoly. The finding of interest, however, is that the mean quality level is also higher in a competitive market. This result is the opposite of the result found in the market for a search good where equilibrium quality was lower in the competitive market.

A similar procedure can be followed to examine the equilibrium variance of quality in the competitive and monopolistic situations by solving the first order conditions for $d\sigma/dx$. As before, it is assumed that $\pi_{x\mu} > 0$, $\pi_{x\sigma} < 0$, $\pi_{\mu\sigma} \leq 0$, and second order conditions hold. Since $\pi_{x\sigma}\pi_{\mu\mu} - \pi_{\mu\sigma}\pi_{x\mu}$ is positive, curve (7&8), which satisfies both (7) and (8), and curve (8&9), which satisfies both (8) and (9), are downward sloping. As previous reason, (7&8) for a monopoly is left to that for a competitive firm in x ,σ space. The resulting equilibrium in x , σ space is shown in Figure 3 for both monopoly and competitive markets. Equilibrium quantity is larger for the competitive equilibrium. Further, the equilibrium variance of the product characteristic, σ , is lower for the competitive market than in the monopoly market. Since product quality is inversely related to the variance of the product characteristic, this result provides further evidence that equilibrium quality is higher for an experience good if it is sold in a competitive market.

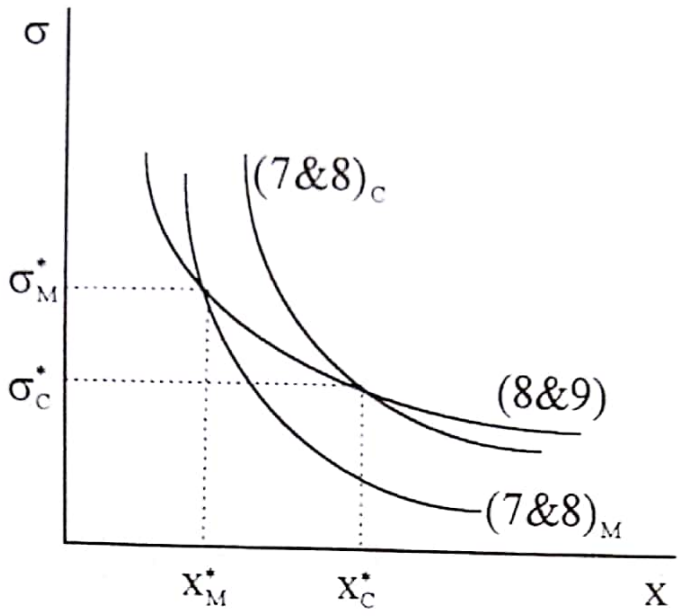

Figure 3. Market Equilibrium of Experience Goods in x, σ Space

4. Summary

This analysis compares the equilibrium quality of search and experience goods sold in competitive and monopolistic markets. The results indicate that monopoly power in the market results in a higher level of equilibrium quality than if goods were sold in a competitive market only if the commodity in question can be classified as a search good. For experience goods, a higher mean level of quality is attained if the good is sold in a competitive market.

As long as monopoly power could be measured by the inverse of price elasticity of demand, anything that reduces the elasticity of demand for the product might change market structure and cause an increase in the overall level of product quality for a search good. In some markets, this could happen due to government regulations restricting entry such as occur in agriculture when market orders are established. Other ways of reducing the price elasticity of demand include the implementation of brand labeling

schemes that differentiate the products of individual producers.

The social desirability of such elasticity reducing programs depends on the relative social values imparted to the allocative inefficiency caused by monopoly power and the social benefit derived from a higher equilibrium level of quality. This applies to search goods. The results for experience goods suggest that a competitive market structure may be more beneficial than a monopoly structure because the equilibrium quantity is greater (no allocative inefficiency) and the equilibrium product quality is also greater than for a monopoly. In the case of an experience good, the reduction of price elasticity by any of the means mentioned above will reduce both equilibrium quantity and quality.

A monopolistic market structure may have the benefit of ensuring a higher quality if a good is a search good whereas a competitive market structure results in both a higher quantity and quality level for an experience good. The implication suggests that regulators need to address not only market structure when formulating policy, but also whether the good in question can be classified as a search or an experience good. The results of policy on equilibrium quality may be quite different depending on the type of goods.

The results illustrated in this paper are derived from the assumption of signs of partial derivatives of profit function and the existence of maximum conditions in the model. Consumers are able to evaluate the quality of search goods prior to purchase, however, they are unable to identify the quality of experience goods without consuming. Since a consumer of search goods has the knowledge and realize the importance of quality, it is reasonable to assume that he/she might care the level of quality more and reduce the sensitivity on price as the quality level increases. It may not hold for the

consumer of experience goods. Therefore, different assumptions are implied for search goods and experience goods in this mathematical model. The issue raised from the different assumptions may be interesting in the further studies.

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市場均衡之品質選擇

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產品品質的不均一性，已成為市場均衡和消費者理論的重要議題。本文的目的在探討市場均衡的品質水準，不只決定於市場結構，也決定於消費者對品質認定的能力。本文在完全競爭和獨占市場的兩個假設下，分別推導尋覓產品（search goods）和經驗產品（experience goods）的市場均衡。研究的結果是：尋覓產品在獨占市場的產品品質水準將高於完全競爭市場的均衡品質水準；但是經驗產品則使完全競爭市場的均衡品質水準高於獨占市場的品質水準。這個政策涵意表示管理者在注意市場結構的同時，也不能忽略產品的特質種類。

關鍵字：品質不均一性、均衡品質、市場結構、尋覓產品、經驗產品