Quality with Saturation Goods*

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1. Introduction

During recent years, a variety of approaches joining quality and market power have been proposed (to mention only a few, see Dixit 1979, Shaked and Sutton 1983, 1987, Sutton 1991, Ungern-Sternberg 1988, and Judd and Riordan 1994, Kehoe 1996 for imperfect information). The purpose of the present paper is to contribute a novel argument to this literature. We claim that quality is most important in the context of saturation goods, in particular when a quality improvement shifts out the saturation level. In this setting, a quality improvement enhances the firms degree of market power both in terms of the Lerner-index, and in terms of profits.

In fact, many goods are characterized by the existence of a saturation level that can be shifted out if quality is improved. In this case, quantity and quality are complements: Only if higher quality can be provided, more quantity will be consumed. Lancasters characteristic approach to consumer theory is used to offer an appropriate definition of quality. Accordingly, the saturation level can be pushed out if the amount of positive characteristics per unit of consumption is increased, or if the amount of negative characteristics is reduced. In the latter case, a quality improvement can be thought of as removing negative side effects of consumption.

We show that with this specification, a quality improvement increases demand elasticity. This result is interesting for two reasons. Firstly, it allows a natural interpretation of the conditions which lead a monopolist to oversupply or undersupply quality relatively to a social planner. An adequate interpretation has not been provided by the literature, where in locational-type models the saturation level usually has been taken exogenous (see Spence 1975, 1976).

Secondly, a simple model of the choice of quality and quantity with saturation goods is set out. We investigate individual firm behavior and aggregate market equilibrium both in an imperfect competitive output market, and in oligopoly. We find that from the firms point of view, the decisive strategic variable is the cost of quality: If it succeeds in producing quality more economically than its competitors, it gets a higher mark-up of prices above marginal costs, and sells a larger amount of output. Thus, by improving quality, the firm can increase market power both in terms of the Lerner-index, and in terms of market shares and hence profits.

The paper proceeds as follows. Section 2. investigates the necessary conditions for a quality improvement to reduce demand elasticity. Section 3. discusses the importance of saturation effects, and presents a definition of quality of saturation goods in terms of the Lancaster characteristics approach. Section 4. addresses the question of the choice of quality in a monopolistic competition model, where the behavior of the individual firm (section 4.1.) as well as the outcome in the aggregate market (section 4.2.) is formalized. Section 5. is dealing with firm behavior in an oligopolistic output market. Finally, some conclusions are drawn in section VI.

2. Necessary Conditions for Quality to Increase Demand Elasticity

In the literature, it has long been debated whether pushing up (perceived) quality (by advertising or otherwise) is best modeled as an outward shift in demand, or by a change in demand elasticity. While the former property is general, the latter seems to depend on very special assumptions (as the present paper shows). Moreover, if demand elasticity is affected, it is not a priori clear whether it should be decreased or increased by a quality improvement.

At a first sight, one might expect that firms benefit if higher quality reduces demand elasticity. In contrast, Spence (1976) has pointed out that firms should favor a reduction in demand elasticity as quality is improved, because this allows them to capture a larger share of net surplus as profits. Still he concedes that "this conclusion runs counter the intuition of countless students of microeconomics that low elasticities are nice for sellers, because they permit higher mark-ups. I dont wish to try to overturn this truth, but rather to point out nevertheless that the surplus is harder to capture with the price system for low elasticity products" (Spence 1976, p. 409). The present paper backs Spences position by showing that a quality improvement is most valuable for firms when it decreases demand elasticity.

The link between quality and demand elasticity has also been recognized as being essential for the quality choice by a monopolist (see Spence 1975, 1976). This topic has been investigated in locational-type models of product differentiation, which assume that consumers differ in their willingness to pay for quality. In addition, it is mostly required that each consumer buys at most one unit of the good[2]. In these models, the main finding roughly states that ceteris paribus a monopolist produces socially suboptimal quality if a quality improvement renders the demand curve more elastic. Conversely, if demand gets less elastic if quality is increased, too little quality will be produced from a social point of view. More precisely, the bias of the choice of quality depends on the sign of the second derivative of the output price with respect to quantity and quality. Quality will be oversupplied by private agents if the cross derivative is positive, and vice versa. Accordingly, monopolists will oversupply or undersupply quality depending on whether the marginal or the intramarginal consumer values a quality improvement most (see Spence 1975, 1976). Yet it has been considered hard to provide a clear economic interpretation of this condition (see Beath and Katsoulacos 1991)[3] as it seems unlikely that goods could be grouped according to the second derivative of the demand function.

The present paper shows that this difficulty is removed if the "buy zero or one units" assumption is dropped, and downward sloping demand functions (of a representative consumer) are used. We find that improved quality decreases demand elasticity if better quality mitigates saturation effects in consumption, and hence shifts out the saturation level. Of course, in locational-type models, where the saturation level is given exogenously, no such interpretation is possible.

This section is dealing with the general conditions for quality to increase demand elasticity. Let a representative consumer's utility function depend on consumption of the saturation good x (the price of which is p), its quality index Θ, and a composite commodity z. For simplicity, the price of z is normalized to 1. Hence, $U = U(x, \Theta, z)$. We assume that marginal utility of x is a

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[2] Of course, an exogenous saturation level is not assumed in models of monopolistic competition following Chamberlin (1933) and Dixit and Stiglitz (1977), where general demand functions are allowed. In this specification, however, no interesting link between demand elasticity and quality has been derived. The reason is that with the usual isoelastic utility functions, demand elasticity is independent of quality. A synthesis of the two diverse approaches has been presented by Perloff and Salop (1985). Still the assumption that every buyer has only one "best buy" is retained in their model.

[3] An exception from this is Ungern-Sternberg's (1988) model for general purpose products. It provides a link between quality and market power in a geographical circle type of product differentiation. Firms can build up market power (decrease demand elasticity) by investing in a more general specification of their product, so that consumers' costs of deviating from the most preferred brand are reduced, which allows them to serve a larger share of the market.

decreasing function of the quantity consumed, and an increasing function of quality, $U_{xx} < 0$, and $U_{x_\theta} > 0$. Of course, marginal utility U_x must be positive in the relevant economic range; it becomes zero when the saturation level is reached, and is negative beyond this point.

The consumer's problem consists of choosing the amount of x by maximizing:

$$(1) \qquad \text{Max} U(x, \Theta, z) - \lambda[px + z - M]$$

where λ is the shadow price of income M. Necessary first-order conditions for x and z yield:

$$(2) \qquad x\colon U_x(x, \Theta, z) = \lambda p \,.$$

$$(3) \qquad z\colon U_z(x, \Theta, z) = \lambda \,.$$

If we assume that good x captures only a small amount of the budget, so that U_z and hence λ are constant, it follows:

$$(4) \qquad \mu = 1 + \frac{x U_{xx}}{U_x}$$

where $\mu = (\varepsilon - 1)/\varepsilon$, and $\varepsilon = -1/(p_x x / p)$ stands for demand elasticity. Of course, μ is positively correlated to ε. Then we find that demand elasticity will be increasing in θ if:

$$(5) \qquad \frac{U_{xx_\theta} x}{U_{x_\theta}} > \frac{U_{xx} x}{U_x}$$

According to (5), the condition for quality to increase demand elasticity requires that the elasticity of U_{x_θ} with respect to output be larger than the elasticity of U_x with respect to output. Since x, U_x, and $U_{x_\theta} > 0$, a sufficient condition for (5) to hold is $U_{xx_\theta} \geq 0$.

We can now turn to an interpretation of this result. $U_{xx_\theta} \geq 0$ says that an increase in quality leads to a higher U_{xx}. Since $U_{xx} < 0$, a quality improvement retards the decline of marginal utility as a larger quantity of the good is being consumed. Hence, if condition (5) holds, saturation effects from consumption are mitigated if a better quality is provided.

It is useful to make clear the impact of quality on U_{xx} graphically. In fig. 1 a - c, three cases are distinguished according to whether U_{xxx} is negative, zero or positive.

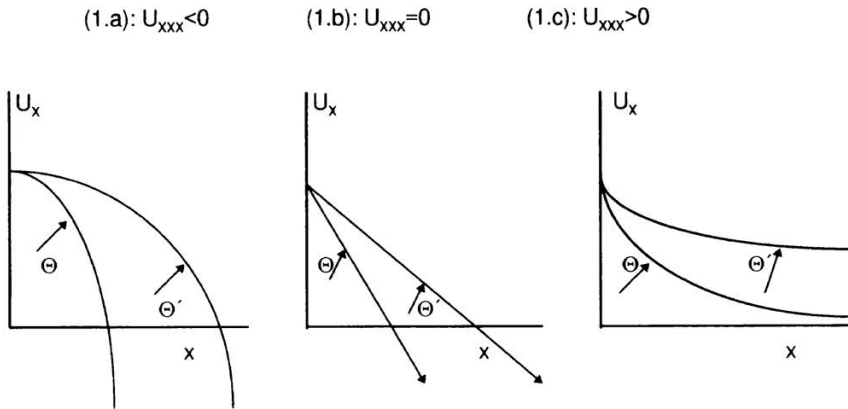(1.a): $U_{xxx}<0$ (1.b): $U_{xxx}=0$ (1.c): $U_{xxx}>0$

Figure 1

Since $U_{x_\theta} > 0$, a quality improvement (from θ to θ') shifts out marginal utility independent of the sign of U_{xx_θ}. If $U_{xx_\theta} > 0$, however, the vertical distance between the two curves increases as a function of output. Roughly spoken, if $U_{xx_\theta} > 0$, consumers are primarily ready to pay more for a quality improvement of *additional* units of output, whereas consumers value quality most at the original output level if $U_{xx_\theta} < 0$. [Compare fig. 2 a - b for the case $U_{xxx} = 0$]. Again, this suggest that improved quality mitigates saturation effects of consumption.

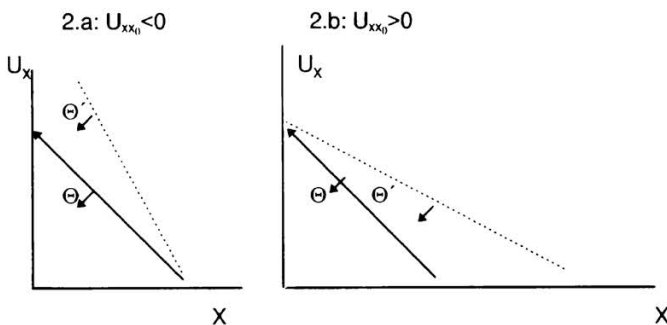2.a: $U_{xx_\theta}<0$ 2.b: $U_{xx_\theta}>0$

Figure 2

We believe that saturation effects are relevant for many types of goods. In fact, if defined in a way narrowly enough, every good has a saturation level that is independent of the limitations of a consumer's resources. The satura-

tion level can plausibly be explained by the existence of a "bad" characteristic (in Lancaster's 1975 terminology), which diminishes marginal utility until it falls below zero as consumption is increased.

If the saturation level is approached, consumers do not want more goods, but better goods. Accordingly, firms seek to improve quality by redesigning the good in a way to reduce the amount of negative characteristics. If consumption was originally limited by the negative side-effects, the quality improvement increases marginal utility and shifts out the saturation level of the good, relaxing the physical limitation of consumption.

A few examples are useful to show this point more clearly. One can drink more of good wine than a bad wine without getting a headache, and eat more "light" than fatty food without putting on a lot of weight. Similarly, one might have enough of listening to bad music after one hour, but only after a couple of hours when listening to good music. People typically are willing to travel a longer distance in a Mercedes Benz than in a Daihatsu because it provides more safety, higher speed, and higher traveling comfort. Along similar lines, working time spent at a personal computer may be limited by the quality of the screen. Also the applicability of pharmaceutical products is limited by the negative side-effects. The transformation of different type of blood groups into a single type (zero), which has recently become possible, is considered as a major breakthrough in medicine. Of course, also in this case, negative side effect of specific blood groups (when combined with the blood group of the patient) are removed.

It is exactly this case where the above arguments are particularly important, since a quality improvement shifts out the saturation level and allows to sell a larger quantity of the good.

The above considerations suggest a natural and straightforward interpretation of a well-known result of the product differentiation literature. Spence (1975, 1976) has established that a monopolist will produce too large a quality level as compared to the choice of a social planner if $p_{x_\theta} > 0$ (and vice versa). Now recall that for $U_{xx} = \lambda p_x$, and λ constant, $U_{xx_\theta} = \lambda p_{x_\theta}$ follows. Hence, from the above arguments it follows that p_{x_θ} implies that a quality improvement increases demand elasticity. The demand function underlying this analysis, however, differs significantly from the demand function of the present model. While in Spence (1975) each of heterogeneous consumers buys at most one unit of the good, a representative consumer's willingness to pay is positive over a lager product space in our model. Now, while $U_{xx_\theta} > 0$ can be given a natural interpretation in the present version, the sign of p_{x_θ} in Spence (1975) is difficult to interpret (see also Beath and Katsoulacos 1991, p. 80 / 1). Indeed, it seems hard to imagine important classes of products which are distinguished by whether the marginal or the

intramarginal consumer places a higher weight on a quality improvement. Hence, any assumption about the sign of p_{x_θ} seems arbitrary and lacks economic interpretation. In contrast, the presence of a saturation level yields an straightforward concept for understanding the significance of the sign of U_{xx_θ}. Accordingly, a monopolist would produce too high a quality level from a social point of view if quantity and quality are complements, so that a quality improvement shifts out the saturation level and allows to sell a larger amount of output. Conversely, if quantity and quality are substitutes for one another, the monopolist chooses too low a quality since otherwise his revenues would fall below the profitmaximizing level.

To derive the most simple utility function where a quality improvement decreases demand elasticity, let $U_{xxx} = 0$. Then by integrating twice, and taking account of $U_{xx} < 0$, and $U_{x_\theta} > 0$, we obtain: $U = a(\Theta)x - b(\Theta)x^2$, where $a'(\Theta) - 2xb'(\Theta) > 0$ must hold. To keep things as simple as possible, let $a(\Theta) = a\Theta$, and $b(\Theta) = $ const., so that

(6) $$U = a\Theta x - bx^2 \ .$$

With this specification, consumption reaches a saturation level for $x = a\Theta/2b$, which is clearly an increasing function of quality. Then a quality improvement increases marginal utility without affecting U_{xx}. More general, $U = ax^\alpha - bx^\beta/\theta$ where $0 < \alpha < 1$ and $\beta > 1$, (so that $U_{xx_\Theta} > 0$). Clearly, as long as $\alpha < \beta$, a saturation level exists.

The following section provides a microfoundation of this type of utility function in terms of the Lancaster consumption technology.

3. Quality and Characteristics of Goods

In his approach to consumer theory, Lancaster (1979) considers goods "not as entities in a gestalt sense but as bundles of properties of characteristics" (p 17). Utility is not directly derived from goods, but from the characteristics that goods possess. Accordingly, a quality improvement of the good is equivalent to an increase in the amount of good characteristics or a reduction of the amount of bad characteristics per unit of consumption. In his approach, Lancaster does not pay further attention to bad characteristics, which "only require appropriate modifications" (Lancaster 1979, p. 19). In contrast, bad characteristics are taken account of explicitly in the present paper. The reason is that it is typically the existence of bad characteristics which leads to saturation effects in consumption.

Assume that goods contain two characteristics, good and bad, and define quality as a weighted ratio of the two characteristics. Accordingly, a quality improvement must either increase the amount of good, or decrease the amount of bad characteristics. Now, as long as marginal utility derived from the good characteristic outweighs marginal disutility associated with the bad one, marginal utility is positive. As soon as marginal disutility from the bad characteristic dominates (which may or may not occur), a saturation level is reached. Then by increasing the marginal utility for all levels of consumption, a quality improvement shifts out the saturation level. With a more favorable package of characteristics, larger amounts of the good can be consumed.

To formalize these ideas in a most simple way, we follow Lancaster (1979) in using a linear consumption technology. Hence, a quantity x of a good contains x times as much of every characteristic as a unit quantity. Let the good (bad) characteristic be contained in an amount a_1 (a_2) per unit of consumption. A simple consumption production function linking characteristics and utility is:

$$(7) \qquad\qquad U = (k_1 a_1 x)^{\beta_1} - (k_2 a_2 x)^{\beta_2} \, ,$$

where k_1 and k_2 are efficiency parameters, and $\beta_1, \beta_2 > 0$. Now two cases appear possible. Firstly, if $\beta_1 > \beta_2$, marginal utility of x strictly increases at declining rates if consumption of x exceeds a threshold level:

$$(8) \qquad\qquad x > \left[\frac{\beta_2 (k_2 a_2)^{\beta_2},}{\beta_1 (k_1 a_1)^{\beta_1},}\right]^{1/(\beta_1 - \beta_2)}$$

Rational consumers never buying less than the threshold level, it is not relevant from an economic point of view. Hence, for $\beta_1 > \beta_2$, the relevant qualities of the utility function are captured by the usual nonsatiation assumption.

For many types of goods, however, $\beta_1 < \beta_2$ will hold. In this setting, a saturation level in consumption must exist. Beyond this level, marginal utility becomes negative and consumption reduces utility, so that the relevant economic range is restricted to:

$$(9) \qquad\qquad x < \left[\frac{\beta_1 (k_1 a_1)^{\beta_1},}{\beta_2 (k_2 a_2)^{\beta_2},}\right]^{1/(\beta_2 - \beta_1)}$$

Now define quality Θ as:

(10) $$\Theta = a1^{\beta 1}/a2^{\beta 2}.$$

According to (10), quality is measured by the ratio of good and bad characteristics provided per unit of consumption. The reflects the insight that quality should not be defined exclusively in technological terms (concerning the relationship between consumption and characteristics), but depends on the parameters of consumers' utility functions, too. Indeed, this agrees with much of the 'folcloristic' management literature, which has outlined that a definition of quality must take account of the "conformance to requirements of consumers . . . In this case it is a question of fitting the mould in the customers' mind" (Wille, p. 5).

This definition implies that a quality improvement either reduces the amount of bad characteristics, or increases the amount of good characteristics[4]. Using our quality definition (10) in (7), utility for the two cases can be rewritten as:

(i) $\beta_1 > \beta_2$: $U = c\tau x^h$, where $h = \alpha - \beta > 0$. Here $c = k_1^{\beta 1}/k_2^{\beta 2}$ stands for the efficiency parameter, and quality is given by $\tau = a_1^{\beta 1}/a_2^{\beta 2}$. The relevant economic range for consumption of good x starts off above the threshold level indicated by (8).

(ii) $\beta_1 < \beta_2$: $U = a\Theta x^{\beta 1} - bx^{2'}$ with $a = k_1^{\beta 1}$ and $b = k_2^{\beta 2}$. In this case the second term in the utility function is essential. To keep the analysis as simple as possible, in what follows we set $\beta_1 = 1$ and $\beta_2 = 2$, so that utility can be written as: $U = a\Theta x - bx^2$. This expression coincides with utility given by (6).

The economic implications of a quality improvement are different in the two cases. If $\beta_1 > \beta_2$, a quality improvement increases the threshold level as well as marginal utility of consumption. There are no new insights beyond those easily obtained from standard consumer theory. If $\beta_1 < \beta_2$, however, a higher quality not only enhances marginal utility, but also shifts outward the saturation level (see fig. 3). In this case, a quality improvement lessens the physical limitations to consumption.

Before turning to the implication of saturation goods for the firms' behavior and for the output market equilibrium, we firstly investigate utility with several saturation goods. Assuming that agents have a "taste for variety", utility is given by:

(11) $$U = \Sigma[a_i\Theta_i x_i - b_i x_i^2], \quad i = 1 \ldots n,$$

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[4] It can be shown that the inclusion of two types of qualities does not yield additional insights. It is only the existence of a saturation level that is relevant for results obtained in this model.

where n is the number of saturation goods. Fig. 4 shows the resulting indifference curves for two brands. In the relevant economic range, indifference curves are 'well behaved'. In particular, note that the size of the nonsatiation region (indicated by negatively sloped indifference curves) depends on quality as the elasticity of substitution between brands is a function of their quality levels, too.
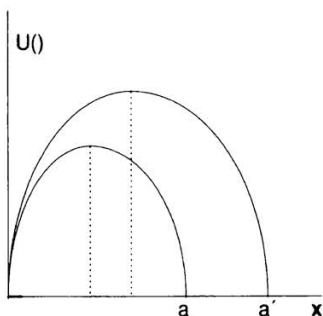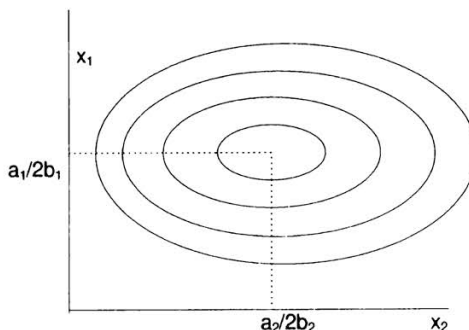

Figure 3

Figure 4

4. Monopolistic Competition with Saturation Goods

This section investigates the economic implications of saturation goods in an imperfectly competitive output market. Let there be n firms in the industry, each of which is producing another saturation brand. For consumers, different brands as close but imperfect substitutes for one another. Following Dixit and Stiglitz (1977), we assume that production of each brand requires a set-up cost k, which are leading to increasing returns of scale and hence limit the number of firms sustainable in the market.

For the case of an individual brand, in section 2 we have taken the shadow price of income as given exogenously when deriving the necessary conditions for quality to increase demand elasticity. This assumption, however, cannot be carried over to a whole industry. Instead, we assume that utility is Cobb Douglas in the saturation good industry, and in another industry y. Therefore, consumers will spend a constant amount of income (m) on the saturation brands.

Before setting up the model, it is useful to consider the effect of quality in the Dixit and Stiglitz (1977) approach to product differentiation which assumes isoelastic demand functions, so that quality does not affect demand elasticity. The analysis being straightforward, we only summarize results that are interesting in the present context. In Dixit and Stiglitz (1977), de-

mand elasticity of each firm depends on the elasticity of substitution among brands, which is exogenously fixed by consumers' preferences. In particular, with the usual isoelastic utility functions, demand elasticity is independent of quality. As one might expect, firms choose a higher quality level if demand is less elastic. Moreover, the mark-up of prices above marginal costs is determined by demand elasticity only. Hence, the driving force determining both the mark-up of prices over marginal costs as well as quality is exogenous at the level of the individual firm. In particular, it is not influenced by the firms' choice of quality.

Next we turn to the behavior of firms in a monopolistic competitive output market with saturation goods. At first, demand functions have to be derived. Having assumed a Cobb-Douglas type of utility function, the budget constraint for this problem is given by:

$$(12) \qquad m = \Sigma p_i x_i , \quad i = 1, \ldots n .$$

where m indicates income spent on the saturation industry, and $m + y = M$ holds. Denote the shadow price of the budget restraint of the corresponding Lagrangian as μ. It is derived as:

$$(13) \qquad \mu = \frac{\frac{\Sigma p_i a_i \Theta_i}{(2b_1)} - m}{\frac{\Sigma p_i^2}{(2b_i)}} .$$

Then demand functions and demand elasticities ε_ι of firm i are obtained as:

$$(14) \qquad p_i = \frac{a_i \Theta_i - 2bx_i}{\mu} .$$

$$(15) \qquad \varepsilon_\iota = \frac{a_i \Theta_i - 2bx_i}{2bx_i} .$$

According to (14) and (15), firms offering higher quality face a higher demand elasticity, and set higher prices that firms producing less quality. In other words, we find that market power becomes endogenous if quality considerations are used in the context of saturation goods.

4.1 The Behavior of the Individual Firm

As the present paper is not concerned with the relation between scale and quality choice, but instead between market structure and quality, we assume constant returns to scale (apart from set-up costs). Hence, unit vari-

able costs depend only on the level of quality: $C(x, \theta) = c(\theta)x + k$, where $C(x, \theta)$ shows total production costs, and $c(\theta)x$ stands for unit variable costs. Let $c_\theta > 0, c_{\theta\theta} > 0$, and define $\sigma = c_\theta \theta / c$. It is assumed that marginal costs of quality are increasing "sufficiently" strong, so that $\sigma_\theta \geq 0$, or $c_{\theta\theta}\theta/c_\theta > \sigma - 1$. We believe that this assumption is most plausible in a context where quality removes saturation effects. Then it is realistic to assume that the main burden of improved quality falls on marginal costs of production. In contrast to advertising expenditures, where marginal production costs of higher quality are zero, marginal costs that are necessary to improve the mix between good and bad characteristics, and to shift out the saturation level, are typically large.

Using (14), profits of an individual firm become:

$$(16) \qquad \Pi_i = \frac{a\theta_i x_i - 2bx_i^2}{\mu} - c(\theta_i)x_i - k \;.$$

Since there are many firms in the market, each one takes μ as given when maximizing its profits. Firms choose output and quality according to the following first-order conditions:

$$(17) \qquad x_i: a\theta_i - 4bx_i - \mu c(\theta_i) = 0 \;,$$

$$(18) \qquad \theta_i: a - \mu c_\Theta = 0 \;.$$

Second-order conditions require $b > 0$, and $c_{\Theta\Theta} > 0$, which we assume to hold. Then from (18) it follows:

$$(19) \qquad \theta_i = c'^{-1}(a/\mu) \;,$$

$$(20) \qquad x_i = \mu c(\theta_i)[\sigma - 1]/(4b) \;,$$

$$(21) \qquad p_i = c(\theta_i)(\sigma + 1)/2 \;,$$

$$(22) \qquad \frac{p_i - c(\theta_i)}{p_i} = \frac{\sigma - 1}{\sigma + 1} \;,$$

and finally

$$(23) \qquad \Pi_i = (\mu/8b)\big[c(\theta_i) \cdot (\sigma - 1)\big]^2 - k \;.$$

Taking into account the definition of μ given by (13), equation (19) states that quality depends on the shadow price of income, and on parameter a. According to (22), the mark-up of prices above marginal costs is not influ-

enced by demand elasticity, but only depends on the cost-elasticity of quality.

All solutions being expressed only implicitly, it is useful to consider comparative static results which are summarized in tab. 1. We investigate the impact of a shock in a, b and μ on the endogenous variables of the model. Additionally, for the special case of isoelastic cost functions $\left[c(\theta) = \theta^\gamma, \gamma > 1\right]$, comparative static results are obtained for a shift in γ too.

Table 1

Comparative Static Results – Behavior of the Individual Firm

	a	μ	b	γ
θ_i	+	–	0	–
p_i	+	–	0	–
x_i	+	–	–	–
$\left(p_i - c(\theta_i)\right)/p_i$	0 if $\sigma_\theta = 0$ + if $\sigma_\theta > 0$	0 if $\sigma_\theta = 0$ – if $\sigma_\theta > 0$	0	+
Π_i	+	–	–	–

Comparative static results show that parameter a (which is negatively correlated to aggregate demand, and positively to prices and qualities of other brands in the industry) affects quality, quantity, prices and hence profits in the same direction. While a positive shock in a increases all these variables, they are lowered if a positive shock in μ takes place (for instance because of a reduction in aggregate demand). Moreover, as long as the cost elasticity of quality is not constant, a shift in aggregate demand increases the mark-up of prices above marginal costs, while improved quality of other products will dampen this term. A similar arguments holds for a shock in a.

Finally, if the demand curve gets steeper (a shock in b occurs), fewer amounts of output are sold, and profits are reduced in the present model. The choice of quality and the mark-up rule, however, are not affected by this variable.

Using a most simple isoelastic cost-function allows to work out the impact of the cost elasticity of quality. The model predicts that a firm that succeeds in reducing the costs of quality (by reducing γ) succeeds in producing improved quality, charging higher prices, and selling a larger amount of output. Accordingly, profits must be raised, too. Tab. 1 shows that in the profit-optimum, the firm is able to increase prices and quantities at the same time only at the cost of lowering the mark-up of prices above marginal costs.

To sum up, we find that in contrast to models of imperfect competition where quality does not affect demand elasticity, the present model predicts that a firm which produces quality more economically than its competitors will raise its market share and the price mark-up above marginal costs relatively to other firms by selling improved quality. It will also end up with larger sales and higher profits. Therefore, in this model, the firms degree of market power can finally be traced back to its ability to produce high quality more economically than its competitors.

4.2 Aggregate Market Equilibrium

In this section the long-run market equilibrium is investigated. We assume that all firms are identical. In the short-run equilibrium (when the number of firms operating in the market is given exogenously), output and quality will be chosen according to (17) and (18), and economic profits will be made. This, however, will attract new entrants until profits of incumbent firms are driven down to zero in the long-run equilibrium.

The system is characterized by the following equations. Each individual firm continues to choose output and quality to maximize profits, so that the first-order conditions for output and quality (17) and (18) remain active. Moreover, the number of firms will be determined by the zero-profit condition, which implies:

$$(24) \qquad\qquad x(p - c) = k .$$

From now on, the index i is omitted since all firms produce the same level of output and quality in our model. Aggregate industry demand is found by using the budget constraint for the symmetric case, yielding:

$$(25) \qquad\qquad m = npx .$$

Finally, we must take account of the shadow price of consumers budget, which is endogenous at the aggregate level. For n identical firms, this yields:

$$(26) \qquad\qquad \mu = \frac{nap\Theta - 2bM}{np^2} .$$

Equations (18) - (19) and (24) - (26) implicitly determine the long-run market outcome. While the solutions for prices and the mark-up of prices above marginal costs continue to be given by (21) and (22), quality, output

(per firm), the number of firms and the shadow price of income μ are implicitly established as:

(27)
$$\Theta = \frac{8b\sigma k}{ac(\sigma - 1)^2} \, ,$$

(28)
$$x = \frac{2k}{c(\sigma - 1)} \, ,$$

(29)
$$n = \frac{m(\sigma - 1)}{k(\sigma + 1)} \, ,$$

(30)
$$\mu = 8bk / \left[c(\sigma - 1)^2 \right] .$$

Tab. 2 summarizes the following comparative statics results:

Table 2

	a	b	k	m
Θ	$-$	$+$	$+$	0
p	$-$	$+$	$+$	0
x	$+$	$-$	$+$	0
n	0 if $\sigma_\theta = 0$ $-$ if $\sigma_\theta > 0$	0 if $\sigma_\theta = 0$ $+$ if $\sigma_\theta > 0$	$-$	$+$
$(p - c)/p$	0 if $\sigma_\theta = 0$ $-$ if $\sigma_\theta > 0$	0 if $\sigma_\theta = 0$ $+$ if $\sigma_\theta > 0$	0 if $\sigma_\theta = 0$ $+$ if $\sigma_\theta > 0$	0

If a positive shock in fixed costs k occurs, the number of firms operating in the market, and hence variety, are diminished. Then each firm sells a larger output at a higher price, which is sustainable since a higher quality is chosen. If the cost elasticity of quality is not constant, the mark-up of prices above marginal costs is positively correlated to fixed costs, too.

The impact of a shock in m (which reflects the size of the market or aggregate demand) only works by increasing the number of firms in the long-run equilibrium, while optimal firm-size and an individual firm's decisions concerning quality, quantity, and prices remain unaffected. The reason behind is that in the present model, the impact of m on the shadow price of income is neutralized by changing the number of active firms because of constant variable unit costs. Hence, a firms individual decisions are independent of the level of aggregate demand.

Comparing the comparative statics results of tables 1 and 2, we find that what holds for a single firm, does not necessarily carry over to the aggregate market outcome. In the aggregate output market, a positive shock in a decreases (rather than increases) quality. At the same time, the firm will lower the output price and sell a larger amount of output. In general, the mark-up of prices above marginal cost will decrease, and so will the number of firms sustainable in the long-run equilibrium. A positive shock in b works exactly opposite to a shock in a: While higher quality is offered at a higher price, less output is sold. The mark-up of prices above marginal costs is increased, and higher variety is obtained in this setting.

5. Oligopoly

This section is dealing with the choice of prices and qualities in an oligopolistic output market. As a solution concept, the Nash-Cournot solution is adopted. For simplicity, we assume that there are only two firms in the market, producing goods x and z with the quality levels θ and γ, respectively. Prices of the goods are given by p and q.

To derive demand functions, let a representative consumer's utility function be given by:

$$(31) \qquad U = a\theta x - bx^2 + a\gamma z - bz^2.$$

Agents seek to maximize (31) subject to the budget constraint:

$$(32) \qquad px + qz = m.$$

Let λ stand for the shadow price of the income. First-order conditions for x and z yield:

$$(33) \qquad x: a\theta - 2bx - \lambda p = 0 \,,$$

$$(34) \qquad z: a\gamma - 2bz - \lambda q = 0 \,.$$

Equations (33) and (34) appear identical to the respective demand functions of the monopolistic competitive market. In the present context, however, neither firm can ignore repercussions of the other firms behavior to its decisions. In the above model, these repercussions operate through affecting the shadow price of income. Hence λ has to be eliminated in (33) and (34). Using (32), leads to:

$$(35) \qquad p = \frac{m(a\theta - 2bx)}{x(a\theta - 2bx) + z(a\gamma - 2bz)} \, ,$$

$$(36) \qquad q = \frac{m(a\gamma - 2bz)}{x(a\theta - 2bx) + z(a\gamma - 2bz)} \, ,$$

$$(37) \qquad \lambda = \frac{x(a\theta - 2bx) + z(a\gamma - 2bz)}{m} \, .$$

Equations (35) and (36) yield demand curves of the duopolists. Then profits of firm x can be expressed as:

$$(38) \qquad \Pi_x = x \left[\frac{m(a\theta - -2bx)}{x(a\theta - 2bx) + z(a\gamma - 2bz)} - c(\theta) \right]$$

With demand curves given by (33) and (34), the two firms face symmetric output market conditions in the present model. Still the firms are allowed to differ with respect to the costs of producing their respective quality levels θ and γ. The Nash-Cournot solution concept requires that each firms chooses its level of output and quality, where it takes the strategy of the other firm as given. Profitmaximizing choices of firm x lead to:

$$(39) \qquad x: (a\theta - 2bx)z(a\gamma - 2bz) = cN^2/m \, ,$$

$$(40) \qquad \theta: az(a\gamma - 2bz) = c_\theta N^2/m \, ,$$

where $N = \left[x(a\theta - 2bx) + z(a\gamma - 2bz) \right]$. The argument of the cost function has been omitted for simplicity. Dividing (39) and (40), yields:

$$(41) \qquad x = \frac{a\theta(\sigma - 1)}{4b\sigma} \, .$$

Similarly, from the analogous problem of firm z we obtain:

$$(42) \qquad z = \frac{a\gamma(\phi - 1)}{4b\phi} \, ,$$

where ϕ stands for the cost elasticity of quality γ. Using (41) and (42), quality, prices, the mark-up of prices above marginal costs, and profits of firm x are implicitly determined by:

(43)
$$c(\theta) = \frac{8bmk_2}{a(k_1 + k_2)^2} ,$$

where $k_1 = \theta^2(\sigma^2 - 1/\sigma^2)$, and $k_2 = \gamma^2(\phi^2 - 1/\phi^2)$. Furthermore, we obtain:

(44)
$$p = \frac{c(\theta)(k_1 + k_2)(1 + \sigma)}{2k_2} ,$$

(45)
$$\frac{p - c}{p} = 1 - \frac{2k_2}{(k_1 + k_2)(1 + \sigma)} ,$$

(46)
$$\Pi_x = \left[\frac{c(\theta)\left[(k_1 + k_2)(1 + \sigma) - 2k_2\right]}{2k_2} \right] \frac{a\theta(\sigma - 1)}{4b\sigma} .$$

Similar expressions can be derived for quality and output of firm z. From these results, the following conclusions can be drawn.

Total differentiation of (43) shows that quality θ is positively correlated to $2b/a$, the inverse of the saturation level of good x. Hence quality will be larger if the saturation level is lower. The intuition behind this finding is that a quality improvement increases demand elasticity in the present model. If the firm is prevented from selling a large amount of output due to saturation effects, it is forced to produce a higher quality level. The effect of quality γ on the choice of quality θ is ambiguous: As long as $\theta > \gamma$, firm x will raise its quality level if quality of firm z is increased. The contrary holds for $\theta < \gamma$. Finally, quality of both firms will be positively correlated to aggregate demand.

Moreover, (45) states that the mark-up of prices above marginal costs will be an increasing function of quality θ, and a decreasing function of quality γ. Hence the model predicts that the high quality firm will set a higher mark-up of prices above marginal costs. In the present model, it is the firm that has lower costs of quality that produces better higher quality. Therefore, the firms degree of market power as measured by the Lerner-index can be traced back to its technological competence to produce high quality.

Using (41), it can be shown that output x in an increasing function of the parameters m and a. Further, it is negatively correlated to b. Hence, if aggregate demand goes up, both quantity and quality of output are increasing. If the saturation level is increased (as a consequence of a shift in a or b), a lower quality and a larger amount of physical output will be produced. Conversely, if the saturation level falls, the firm improves quality and chooses to sell less output for a higher price. It is this effect which is responsible for the positive correlation between quality θ and the mark-up of prices above

marginal costs: In spite of the fact that a quality improvement increases demand elasticity, quality and the mark-up of prices above marginal costs are positively correlated since high-quality firms still choose to produce less output. Finally it can be shown that the it is the high quality firm that obtains higher profits in the present model.

6. Conclusions

In the industrial organization literature, a variety of links between quality and market power have been discerned. The present paper contributes an additional argument to this debate: It is emphasized that quality is particularly important in the context of saturation goods, if a quality improvement is able to mitigate saturation effects from consumption. If defined in a way narrowly enough, every good has a saturation level. Hence we believe that this aspect is worthwhile to be investigated. Indeed, many characteristics of quality improvements can be understood best as removing negative side effects that arise from consumption. The present paper departs from much of the product differentiation literature by modeling the saturation level not as being exogenous, but as a function of quality. We show that this concept allows a natural interpretation of the bias of the quality choice of an individual firm from a social point of view. Accordingly, a monopolist produces too high a quality from a social point of view if quantity and quality are complements, so that a quality improvement shifts out the saturation level and allows to sell a larger amount of output. Furthermore, analyzing the behavior of firms operating in an imperfectly competitive output market, and in oligopoly, the model predicts that a firms degree of market power both in terms of the Lerner index, and in terms of market shares and hence profits, is based on its capability to produce quality more efficiently than its competitors. In other words, the production of high quality becomes the most important strategic variable for firms in a setting where saturation goods are sold.

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Zusammenfassung

Das vorliegende Papier untersucht einen Aspekt des Zusammenhangs von Qualität und Marktmacht. Wir betonen darin die Bedeutung von Qualität insbesondere bei Sättigungsgütern. Soferne eine Qualitätsverbesserung das Sättigungsniveau erhöht, steigert diese auch die Nachfrageelastizität. Wir führen eine entsprechende Definition von Qualität gemäß Lancasters Charakteristikaansatz ein. Diese Spezifikation erlaubt eine einfache Interpretation der Qualitätsentscheidung eines Monopolisten. Ferner zeigt das Modell für Firmenverhalten bei monopolistischer Konkurrenz bzw. im Oligopol, daß die entscheidende strategische Größe zur Gewinnung von Marktmacht bzw. zur Erhöhung von Profiten darin besteht, Qualität effizienter als die Konkurrenz zu produzieren.

Abstract

The present paper is dealing with the link between quality and market power in the context of saturation goods. Investigating the conditions of a quality improvement to increase demand elasticity, the findings suggest the existence of a saturation level which depends on quality. Following Lancasters approach to consumer theory, an appropriate definition of quality is proposed. This specification allows a natural interpretation of the bias of the quality choice by a monopolist. Furthermore, we investigate firm behavior both in an imperfect competitive output market, and in oligopoly to find that firms can build up market power and increase profits by improving quality. Thus a firm's competitiveness can be traced back to its ability to produce quality more efficiently than its competitors.