

COMPETITION CAN HARM CONSUMERS^{*}

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ABSTRACT—Duopolists selling differentiated products can generate less consumer surplus than a monopoly selling one of the products. In a Hotelling model where a monopoly supplies more than half of potential consumers, but not all, entry by a rival leads to a duopoly price that is higher than the monopoly price. Consumers in aggregate will be made worse off by such entry when the effect of the price increase outweighs the benefit of extra variety. When consumers have continuous demand functions and firms use two-part tariffs, duopoly can also result in lower aggregate consumer surplus than monopoly.

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1. INTRODUCTION

Can the introduction of competition reduce aggregate consumer surplus? When a market has two firms rather than one the usual result is some combination of lower prices, improved quality and enriched variety, all of which raise consumers' welfare. An exception is when consumers have imperfect information, because new entry can increase consumer search costs and firms take the opportunity to raise prices (see Stiglitz, 1989). Another exception is when capacity-constrained firms are in a repeated game. An increase in the number of firms raises overall industry capacity and can make punishment for cheating on the collusive outcome more severe, thus raising the likelihood of successful collusion (Brock and Scheinkman, 1985). This paper shows that competition can make consumers worse off when there is perfect information about products and prices and firms choose prices non-cooperatively. In the model a monopolist sells one product while in duopoly a rival firm sells an alternative, differentiated, product. Competition adds to variety, which directly increases aggregate consumer surplus. So a necessary condition for competition to cut consumer surplus is that the duopoly price exceeds the monopoly price. We find that under reasonable conditions the duopoly price is higher than the monopoly price, and moreover that there is a parameter range where the price increase is sufficient to outweigh the gains from extra variety and thus make consumers worse off in aggregate.

A simple discrete-choice Hotelling model is used. Consumers have a common reservation price and firms have fixed locations. The conditions under which entry causes (i) the price to rise and (ii) consumer surplus to fall can be completely characterized. A monopolist is located at one end of the Hotelling line but not the other. In duopoly the second firm is located at the opposite end of the line and the firms choose prices non-cooperatively. The duopoly price exceeds the monopoly price if the monopolist chooses to serve more than half of the consumers, but not all of them. A natural measure of product differentiation in a Hotelling model is the ratio of the unit

transport cost to the reservation price. The monopolist optimally serves more than half of the customers if this ratio exceeds 0.5, and chooses not to supply all the market if this ratio is below 1. Thus the price increases with competition when the product differentiation measure is in the range (0.5, 1).

The price rises with competition when each duopolist's own-price elasticity of demand, when both firms set the monopoly price, is below the monopolist's elasticity at the same price. The move from monopoly to duopoly creates two contrasting effects on the elasticity. First, the fact that the market is now shared means that the monopolist sells a smaller quantity, which increases the elasticity. Second, the entry of a competitor reduces the sensitivity of demand to price, which cuts the elasticity. A useful way to think of the monopolist's problem is that it is identical to that of a duopolist facing a rival setting a price equal to the consumer's reservation price and whose customers incur no transport costs. Demand falls as the price rises because the marginal customers choose not to buy. In the real duopoly the monopoly faces a competitor whose customers incur transport costs, which reduces their incentive to switch for any given price increase. Thus the sensitivity of demand to the price in duopolistic competition is lower than with monopoly (in fact it is halved). When the sensitivity effect outweighs the demand reduction effect the elasticity is reduced, and both firms want to raise their prices above the monopoly price. The resulting Nash equilibrium has a higher price than the initial monopoly price.

The effect on consumer surplus of entry under these conditions is a balance between three effects. Those who buy from the entrant but did not purchase from the monopolist are better off. Those who remain customers of the monopolist are worse off because of the higher price. The effect on consumers who switch from the original monopolist to its rival can go either way. In a small but not negligible range of the parameter space the negative effect of the higher price dominates and aggregate consumer surplus falls.

In independent work Chen and Riordan (2006) present a general framework for assessing when a duopoly results in an equilibrium price above the monopoly price. They derive several sufficient conditions for this effect to hold. Here the focus is on the effects of such price increases on consumers' welfare, and it is natural to use a Hotelling model to enable surplus calculations to be made. Moreover we extend the analysis to nonlinear pricing to show that competition can hurt consumers when firms set two-part tariffs.

The paper is organized as follows. Section 2 presents a numerical and graphical example. Section 3 presents the Hotelling model more formally and derives the necessary and sufficient conditions for duopolistic competition to raise the price and cut consumer surplus. Section 4 discusses some extensions and conclusions are in Section 5.

2. AN EXAMPLE

Assume that consumers are distributed uniformly along the Hotelling line $[0, 1]$, that their common reservation price is 1 and they bear a transport cost per unit of distance traveled of $2/3$. Firm 0 is located at 0 and initially acts as a monopolist facing the (inverse) demand function illustrated by the heavy lines in Figure 1. The demand function has the equation $p_0 = 1 - 2q_0/3$ for $p_0 \geq 1/3$ where p_0 and q_0 are firm 0's price and quantity respectively. For prices below $1/3$ demand is at its maximum level of 1, equal to the population of consumers. Marginal costs of production are zero. The profit-maximizing monopoly price for firm 0 is $1/2$, giving an interior solution for monopoly output of $3/4$.

In the duopoly firm 1 is located at 1. Both firms set prices non-cooperatively. The new demand function for firm 0 in Figure 1 is drawn under the assumption (to be justified) that firm 1's price is $2/3$. This demand function is kinked. It is the same as the monopoly demand function for prices above $2/3$, because then the firms do not compete

over marginal customers and instead act as local monopolists. For prices below $2/3$ the two firms compete over the consumers in the middle of the line and firm 0's direct demand function, given $p_1 = 2/3$, is $q_0 = 1 - 3p_0/4$ with inverse demand $p_0 = 4(1 - q_0)/3$. The slope of (inverse) demand is twice that of the monopoly demand function because a given price cut is less effective at attracting customers from firm 1 than it would be if there was no rival. Finally the Nash equilibrium price is $2/3$. Neither firm wants to raise price above $2/3$ along the elastic part of the monopoly demand function. A price cut of $\Delta > 0$ below $2/3$ gives extra output of $3\Delta/4$, but the effect on profit is $-3\Delta^2/4 < 0$, so the Nash equilibrium price is indeed $p_0 = p_1 = 2/3$. The interesting point is that the duopoly price is above the monopoly one. Under duopoly the demand for firm 0's product falls from $3/4$ to $1/2$, which by itself increases 0's price elasticity of demand. This is outweighed, however, by the fact that demand is now half as sensitive to a price change, so at the initial price of $1/2$ the price elasticity of demand, which equals $1/2$, is lower than with the monopoly (when it is 1) and both firms thus raise their prices.

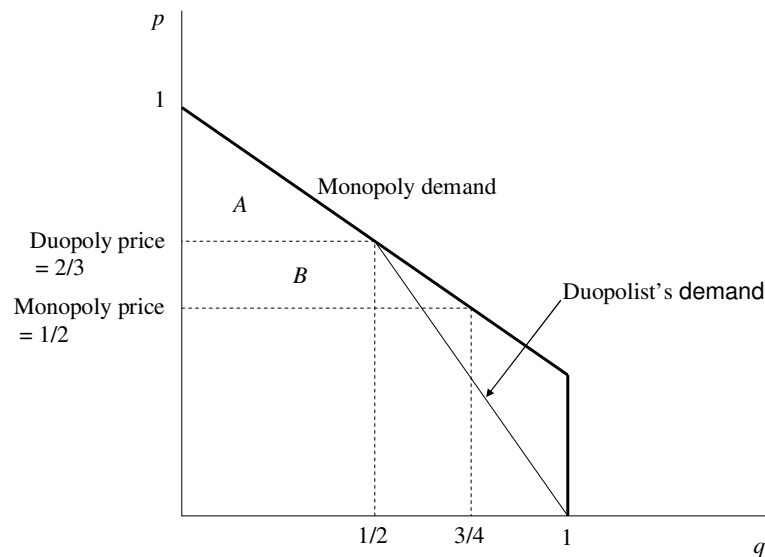


Figure 1

The effect on consumer surplus of two-product duopoly compared to single-product monopoly is as follows. With the monopoly consumer surplus is the triangle $A + B$, which is $\frac{1}{2}$ times $\frac{1}{2}$ times $\frac{3}{4}$, i.e. $\frac{3}{16}$. Under duopoly consumers surplus is twice area A . The triangle A is $\frac{1}{2}$ times $\frac{1}{3}$ times $\frac{1}{2}$, i.e. $\frac{1}{12}$, so total consumer surplus is $\frac{1}{6}$. It follows that consumer surplus with monopoly is higher than with duopoly.

The result depends on the transport cost (relative to the reservation value) being at an intermediate level. If there were no transport costs consumers would regard the products as identical, the Bertrand paradox would apply and the duopoly price would equal zero (or marginal cost). At the other extreme if the transport cost was much higher, say 1.5, then the Nash equilibrium would have each firm setting the monopoly price, $\frac{1}{2}$, and having market shares of $\frac{1}{3}$. The consumers in the middle third of the line would not be served. Entry would just lead to another local monopoly and there would be no effect on the price. The next section presents the general necessary and sufficient conditions for the price to rise, and for consumer surplus to fall, with duopoly.

3. THE MODEL

Consumers are uniformly distributed along a linear city of length one, i.e. $[0, 1]$, and each of them either buys one unit or nothing. Each consumer has reservation price $v > 0$.¹ A consumer who has to travel x units to buy the good pays a transport cost of tx where $t > 0$ is the unit transport cost. The marginal cost of production, $c < v$, is constant and without loss of generality is set to zero. The monopolist, firm 0, is located at 0. When there is duopoly firm 1 enters at 1. The model works in exactly the same way if there is a Salop (1979) circle with firms located at opposite points on the circle, so the location specification does not affect our main result. A key role is played by the ratio of the unit transport cost to the reservation price, t/v .

¹ For analyses of the Hotelling model with a reservation price that focus on location decisions see Economides (1984) and Hinlopen and van Marrewijk (1999).

Assumption 1. The unit transport cost-reservation price ratio satisfies $0.5 < t/v < 1$.

To see why this assumption is made consider what happens when it does not hold. Suppose first that $t/v \geq 1$. The location, x , of the marginal consumer, who is indifferent between buying from 0 and not purchasing, is defined by $v - tx - p = 0$, so firm 0's demand function is $x = (v - p)/t$. The monopoly price is $v/2$ and the associated quantity is $v/2t$, which is at most 0.5 when $t/v \geq 1$. In this case the entry of firm 1 at location 1 has no effect on firm 0 or its customers. Firm 1 will likewise price at $v/2$ and each firm acts as a local monopolist. The duopoly price equals the monopoly price and consumer surplus certainly increases with duopoly as the new customers of firm 1 obtain some surplus and there is no effect on the customers of firm 0.

Suppose now that $t/v \leq 0.5$. The monopolist will optimally serve the whole market because at the price $v - t$ the consumer at 1 is just willing to buy from firm 0 and $v - t \geq v/2$ if $t/v \leq 0.5$. When firm 1 enters, the location of the consumer who is indifferent between buying from firm 0 or firm 1 is defined by x such that $tx + p_0 = t(1 - x) + p_1$, where p_0 and p_1 are the prices. This indifference equation defines the demand functions. The unique pure-strategy Nash equilibrium in prices is standard. Prices are $p_0 = p_1 = t$ and each firm sells to half of the consumers. The equilibrium duopoly price, t , is below the monopoly price, $v - t$, since $t/v \leq 0.5$. In summary, the necessary condition for the price to rise in duopoly is that Assumption 1 holds.

Assumption 1 is also sufficient for the price to rise with duopoly. To prove this we need to characterize the duopoly equilibrium. For $0.5 < t/v \leq 2/3$ the equilibrium looks the same as when $t/v \leq 0.5$. Firm 0's demand function is defined by the indifferent customer and is $x = 0.5 + (p_1 - p_0)/2t$. The unique symmetric equilibrium is $p_0 = p_1 = t$. When $2/3 \leq t/v < 1$ the prices $p_0 = p_1 = v - t/2$ constitute an equilibrium.² The consumer located at 0.5 is indifferent between buying from either firm and not buying at all. Each

² This is what Economides (1984) calls a touching equilibrium.

firm is then a local monopolist for price increases and a duopolist for price reductions, and has a demand function with a kink at the price $v - t/2$. A rise in price of Δ would lead to a fall in sales of Δ/t as the monopoly part of the demand function applies. A price reduction of Δ would lead to an increase in sales of $\Delta/2t$ along the competitive part of the demand function. Neither move is profitable. In fact there is a continuum of Nash equilibria when t/v is in this range. Prices satisfying $p_0 + p_1 = 2v - t$ also yield an equilibrium. In this case the average price is $(p_0 + p_1)/2 = v - t/2$. For simplicity we assume that the symmetric equilibrium applies.³

Proposition 1. If $0.5 < t/v < 1$ the duopoly price is strictly greater than the monopoly price.

Proof. When $0.5 < t/v \leq 2/3$ the equilibrium duopoly price is t , which exceeds the monopoly price $v/2$. For $2/3 < t/v < 1$ the symmetric equilibrium has $p_0 = p_1 = v - t/2$ and this again exceeds the monopoly price. \square

The duopoly price rises because the introduction of competition causes the own-price elasticity of demand to fall at the monopoly price. The monopoly maximizes profit where the price-elasticity of demand is unity. The price elasticity of demand for each duopolist, when both price at the monopoly level of $v/2$, is $v/2t$, which is below 1 by Assumption 1.⁴ Thus each firm finds it profitable to raise the price above $v/2$. Another way to see this is to use the reaction functions. The equation of firm 1's reaction function in the relevant range is $p_1 = (t + p_0)/2$ and when $p_0 = v/2$ firm 1 sets $p_1 = t/2 + v/4 > v/2$.

³ If an asymmetric equilibrium holds then the negative effect on consumers is stronger. The total amount paid to the firms is the same, but the asymmetry increases aggregate transport costs.

⁴ This is the price, $v/2$, times the slope of direct demand, $1/2t$, divided by the quantity sold ($1/2$).

The surplus of a consumer is v minus the price paid less the transport cost incurred. Aggregate consumer surplus is found by integrating across all consumers who buy. It is straightforward to calculate the parameter range within which competition reduces aggregate consumer surplus.

Proposition 2. When $0.645 < t/v < 0.707$ consumer surplus is lower with duopoly than with competition.

Proof. Consumer surplus generated by the monopoly is $\int_0^{v/2t} [v - tx - 0.5v] dx = v^2 / 8t$.

Consumer surplus with duopoly when $t/v \leq 2/3$ is $v - 5t/4$, which is gross utility, v , less total expenditure, t , less aggregate transport costs, $t/4$. It follows that surplus with monopoly is higher than with duopoly if $5t^2/4v^2 - t/v + 1/8 > 0$. Solving for the value of t/v at which the quadratic equals zero gives the cut-off value of 0.645 (to three decimal places). Thus when $0.645 < t/v \leq 2/3$ consumer surplus is lower with duopoly. When $2/3 \leq t/v < 1$ the duopoly price is $v - t/2$ and duopoly consumer surplus is $t/4$, which is below the monopoly level $v^2/8t$ when $t/v < 2^{-0.5} = 0.707$. This gives the upper bound of the range in the proposition. \square

Competition ensures that the customers who were not served by firm 0 now obtain some surplus. Those who remain customers of firm 0 are worse off because they pay a higher price. There is an ambiguous overall effect on those who switch to firm 1. Those located close to firm 1 benefit, but those located just to the right of the mid-point lose as their lower transport costs are outweighed by the higher price. Proposition 2 shows that in just over 12 per cent of the relevant range (0.5, 1) the price increase with duopoly is sufficient to reduce consumer surplus.

4. EXTENSIONS

A natural extension of the model has prices being set sequentially. Suppose that firm 0, which is already in the market, sets its price before firm 1, who then responds according to its best-response function. The effect of this is to expand significantly at the bottom end the region within which consumer surplus falls. When $t/v \leq 0.5$ the subgame perfect equilibrium with sequential price-setting is $p_0 = 1.5t$ and $p_1 = 1.25t$.⁵ In this region prices are strategic complements and the effect of the sequential move order is to increase prices above the simultaneous-choice level, t . This reduces consumer surplus compared to that obtained with simultaneous choice. The direct effect of higher prices is reinforced by the increase in transport costs caused by the asymmetric market shares, which are $3/8$ for firm 0 and $5/8$ for firm 1. Consumer surplus, calculated as v less transport costs and aggregate expenditure, is $v - 103t/64$. Comparing this to consumer surplus with monopoly gives a quadratic equation, and consumer surplus is lower with duopoly when $t/v \geq 0.448$ (to three decimal places).

Another extension has consumers with continuous demand functions and firms using two-part tariffs. Suppose, following Yin (2004), that customers pay transport costs which are proportional to both the volume of goods bought and the distance that they are transported. Customers who are further away from the supplier demand less than those who are near. The utility function of a consumer at x , when buying from firm 0, is $u(q_0, x) = (b - q_0/2)q_0 - \delta x q_0$, $\delta > 0$, where $\delta x q_0$ is the shipping cost, which depends on δ , the cost of transporting one unit of the good one unit of distance. The direct demand function is $q_0 = b - p_0 - \delta x$, so more distant consumers have lower demands. Yin (2006) gives details of the model. Duopoly results in smaller net consumer surplus if and only if $0.412 < \delta b < 0.489$. Net consumer surplus falls in this region as the combination of the marginal price and the lump-sum fee results in a higher price index for consumers.

⁵ Firm 1's reaction function in this region is $p_1 = (t + p_0)/2$.

5. CONCLUDING REMARKS

As our analysis in Sections 3 and 4 showed, when transport costs are sufficiently high, or products are sufficiently differentiated, the duopolists do not compete over marginal customers and consumers benefit from greater supply by two local monopolies compared with a single monopolist. On the other hand, when product differentiation is sufficiently small, severe competition forces firms in duopoly to offer attractive deals to the consumers, and duopoly is unambiguously better than monopoly from a consumer's point of view. When, however, product differentiation is at an intermediate level and firms compete but the fight is not that tough, duopoly results in a higher price in the Hotelling model or a higher price index under two-part tariffs as firms have smaller incentives to increase their market sizes than the monopolist. In turn, duopolistic competition can make consumers worse off. While the result is in some sense unlikely it is not paradoxical and it does not depend on unusual assumptions.

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