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On the Nature of Equilibrium in Monopolistic Competition

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Abstract: This paper shows that product differentiation is compatible with perfect competition under free entry and exit and small firm size relative to size of market. Thus, monopolistic competition is a form of perfect competition. Although no product sold under monopolistic competition has a perfect substitute, each product has many close, albeit imperfect, substitutes, which have a cumulative effect on own-price elasticity of demand. With infinitely elastic demand, excess capacity and sub-optimal firm size disappear from monopolistic competition in equilibrium. The number of basic industrial structures is reduced to three—monopoly or single seller, oligopoly or competition among the few, and perfect competition or competition among the many. Perfect competition can be divided into perfect competition with homogeneous products and perfect competition with differentiated products. Advertising can pay off under the latter, since products have separate identities and price depends on quality, even though firms are price takers for any given quality. Under oligopoly, firms will behave like Chamberlin's monopolistic competitors when certain conditions are met, but there is no guarantee that these conditions ever will prevail. Finally, I ask how small a firm's share of industry output value must be if it is to be a *de facto* price taker.

Keywords: Monopolistic Competition, Perfect Competition, Product Differentiation

1. Introduction

This paper shows that product differentiation is compatible with perfect competition under free entry and exit and small firm size relative to size of market. Under the conditions given by Chamberlin in his classic treatise on monopolistic competition [5], firms will be price takers and perfect competition will prevail. Despite the widespread view in economics that monopolistic competitors face downward sloping demand and produce with excess capacity and sub-optimal firm size [9, 10, 11, 15], the existence of many imperfect substitutes for a product is enough to turn its supplier into a price taker, causing these problems to disappear. Other economists have derived similar results [7, 8, 13], using approaches that differ from the one taken here. However, the derivation here is shorter, more accessible, and freer of restrictive assumptions. It focuses on the key question of demand elasticity. This paper also complements an earlier paper [4], in which I approached monopolistic competition from the cost side.

Monopolistic competition implies many firms in an industry, with each supplying an infinitesimal share of industry output value, the result of free entry and exit and large market size relative to the output that minimizes average cost for any firm. Firms maximize profit and reach a Nash equilibrium. In these respects, monopolistic competition resembles perfect competition with homogeneous products. Under monopolistic competition, however, firms supply differentiated products that are close but not perfect substitutes. Nevertheless, I will show that if its share of industry output value is small enough, a firm's own-price elasticity of demand will be as large as desired; in this sense, its own-price elasticity is unbounded. At the end of the paper, I will ask how small such a share must be if a firm is to be a *de facto* price taker.

Other papers dealing with issues that arise under monopolistic competition include [2, 9, 12, 14]. Empirically, studies disagree on whether returns to scale in the U.S. economy are constant—suggesting optimal firm size and no excess capacity—or increasing, suggesting positive excess capacity and sub-optimal firm size. See for example [1, 3, 6]. Some U.S. industries are oligopolies, however, and there are incentives for oligopolistic firms to have excess capacity—eg., on order to deter entry—that disappear as market shares become small.

2. Method

2.1. Derivation of Basic Elasticities Equation

An own-price elasticity of demand reflects the availability of substitutes for a product. Thus there should be a link between a product's own-price elasticity and its cross-price elasticities with other products. Finding this link is the first step in showing that own-price elasticities are unbounded under monopolistic competition. Intuitively, a fall in the price of a product sold under monopolistic competition, with other prices constant, will transfer demand to that product from many close substitutes, because this is the only way buyers can profit from the outward shifts in their budget constraints caused by the fall in price.

Let X be a differentiated product that survives in long-run equilibrium in an industry called the X industry that operates under monopolistic competition. 'Survival' will mean that it produces at least one unit of output, and because firm size is small relative to size of market, I assume that equilibrium prices and quantities are bounded above regardless of product shares. Let P_x and x be the price and quantity demanded of X, and let ε_x be the own-price elasticity of demand for X, given by $\varepsilon_x = -(P_x x_{Px})/x$, where x_{Px} is the change in x per unit of a small increase in P_x, with all other prices held constant. Let I^* be the economy's total income, which is assumed to be independent of the price set by any single firm, and let E_x be the expenditure on all products that are neither substitutes for nor complements with X. If $I = I^* - E_x$, then I equals the sum of expenditures on X and on its substitutes and complements. Since changes in P_x do not change I^* or E_x, they do not change I.

Let products (Y_1, Y_2….) be all the substitutes for and complements with X that survive in long-run equilibrium, with prices (P_1, P_2….) and quantities demanded (y_1, y_2….). These quantities are assumed to be second-order continuous functions of prices and buyers' incomes. We have:

$$I = P_x x + \Sigma_k P_k y_k, \tag{1}$$

where the summation is over all products in I except X. Let P_x increase by a small amount, dP_x, with all other prices held constant. Since I does not change, we have the following when dP_x tends to zero:

$$0 = dI/dP_x = x + P_x x_{Px} + \Sigma_k P_k y_{kPx}, \tag{2}$$

where dI is the change in I, and y_{kPx} is the change in y_k per unit of dP_x. Here y_{kPx} is positive when Y_k is a substitute for X and negative when Y_k is complementary with X. Let $S_x = P_x x/I$ be the equilibrium share of X in I. Since $\varepsilon_x = -(P_x x_{Px})/x$, we have $(P_x/I)(x + P_x x_{Px}) = S_x(1 - \varepsilon_x)$. Note from (1) that $(\Sigma_k P_k y_k)/I = (1 - S_x)$, and let $\varepsilon_{kPx} = P_x y_{kPx}/y_k$ be the cross-price elasticity of demand between X and Y_k when P_x changes. Let ε_{Ax} be the share-weighted average of these cross-price elasticities over all products in I other than X when P_x changes. That is, $\varepsilon_{Ax} = \Sigma_k[(P_k y_k/I)(\varepsilon_{kPx})]/(1 - S_x)$, where this sum is over all products in I except X.

Because the sum of these weights equals $(1 - S_x)$, we can write $(1 - S_x)\varepsilon_{Ax}$ as the sum of product shares times cross-price elasticities over all Y_k in I. That is:

$$(1 - S_x)\varepsilon_{Ax} = \Sigma_k[(P_k y_k/I)(\varepsilon_{kPx})] = \Sigma_k[(P_k y_k/I)(P_x y_{kPx}/y_k)] = (P_x/I)[\Sigma_k P_k y_{kPx}], \tag{3}$$

Equation (2) becomes $S_x(1 - \varepsilon_x) + (1 - S_x)\varepsilon_{Ax} = 0$ if we multiply both sides by P_x/I. Re-arranging these terms gives the basic relation between the own-price elasticity, ε_x, and the share-weighted cross-price elasticity, ε_{Ax}:

$$\varepsilon_x = 1 + [(1 - S_x)/S_x]\varepsilon_{Ax}. \tag{4}$$

If S_x is small enough, $(1 - S_x)/S_x$ will be as large as desired. Thus, if ε_{Ax} remains above some positive lower bound, ε_x will be as large as desired if S_x is small enough. A profit-maximizing firm with a positive marginal cost will never produce where ε_{Ax} is negative, since $\varepsilon_x > 1$ must hold for such a firm, which implies $\varepsilon_{Ax} > 0$. Nevertheless, ε_{Ax} could be small when S_x is small, allowing the two to offset in their effects on ε_x, so that ε_x remains bounded. As we shall see, however, this does not happen.

2.2. Firms Inside and Firms Outside the X Industry

We next divide all products in I into those that are in the X industry and those that are outside. When this is done, let I_x be total expenditure on products in the X industry and I_{nx} be total expenditure on products outside, with $I = I_x + I_{nx}$. If $S^x_x = P_x x/I_x$ is the equilibrium share of X in industry output value, $S^x_x = S_x(I/I_x) \geq S_x$. Thus if S^x_x is quite small, as monopolistic competition requires, the same will be true of S_x.

As indicated above, the X industry consists of 'close' substitutes for X. By definition, one product is a substitute for another when an increase in the first product's price raises the quantity demanded of the second and a fall in the first product's quantity demanded raises the demand price of the second at each output. The 'demand price' is the price a buyer is willing to pay for any given quantity. In monopolistic competition, a change in the price of any product has a negligible income effect because any buyer spends a negligible share of his or her income on it. Thus, if X is a substitute for Y_k, then Y_k will be a substitute for X, if Y_k is in the X industry. I shall say that X is a 'close' substitute for Y_k in equilibrium if two conditions are met. First, the cross-price elasticity, ε_{kPx}, must have a positive lower bound, B. Second, a given percentage increase in x must cause at least some minimal percentage decrease, $-dP_k/P_k$, in P_k at any given y_k. That is, $[(-dP_k/P_k)/dx/x]$ must have a positive lower bound, b.

Given the above, the X industry is defined to consist of X and all products, Y_k, such that X is a 'close' substitute for Y_k and Y_k is a 'close' substitute for X. Thus, Y_k is in the X industry if and only if the following pairs of inequalities hold in equilibrium:

$$\varepsilon_{kPx} \geq B,\ \varepsilon_{xPk} \geq B;\ (-dP_k/P_k)/(dx/x) \geq b,\ (-dP_x/P_x)/dy_k/y_k \geq b, \tag{5}$$

where ε_{xPk} is the cross-price elasticity of demand between X and Y_k when P_k changes with all other prices held constant.

While B and b are not unique, they must be low enough that S^{α}_x can be made as small as desired. I shall also require that I_x/I be bounded below. That is, there must exist an A such that $I_x/I \geq A > 0$, where A can be any positive value. This prevents the structure of the X industry from being irrelevant to the value of ε_x.

Finally, suppose that A, B, and b have been chosen and that the boundaries of the X industry are therefore determined. From (3), we can write $\varepsilon_{Ax} = \varepsilon^x_{Ax} + \varepsilon^{nx}_{Ax}$, where $\varepsilon^x_{Ax} = \Sigma_k[(P_k y_k/I)(\varepsilon_{kPx})]/(1 - S_x)$, with summation over all products in the X industry, and ε^{nx}_{Ax} is the same sum over all substitutes for and complements with X that are outside the X industry. Since $\varepsilon_{kPx} \geq B$ for any product, Y_k, in the X industry, $(I/I_x)\varepsilon^x_{Ax} \geq B[(1 - S^{\alpha}_x)/(1 - S_x)]$, which is bounded away from zero as long as S^{α}_x is bounded away from one—that is, as long as the X industry is not a monopoly. This implies $\varepsilon^x_{Ax} \geq AB[(1 - S^{\alpha}_x)/(1 - S_x)]$. In addition, since $\varepsilon_{kPx} = P_x y_{kPx}/y_k$, we have $(1 - S_x)\varepsilon^{nx}_{Ax} = (P_x/I)\Sigma_k P_k y_{kPx} = (P_x/I)(dI_{nx}/dP_x)$.

3. Results

3.1. Proof That ε_x Is Unbounded

To show that ε_x is unbounded, I assume it to be bounded and show that a contradiction results. Starting from equilibrium, let P_x rise by a small amount, dP_x, with other prices fixed. This will cause changes of dI_x and dI_{nx} in I_x and I_{nx}, with $dI_x = -dI_{nx}$. Fix dP_x. Then $(1 - S_x)\varepsilon^{nx}_{Ax}$ equals $(P_x/I)(dI_{nx}/dP_x)$ to a close approximation, provided dP_x is small enough. Since $x \geq 1$, we have $(P_x/I) \leq S_x$. Thus, if dI_{nx}/dP_x is bounded over all S^{α}_x, ε^{nx}_{Ax} will be as small as desired for S^{α}_x (and S_x) small enough, and ε_{Ax} will be as close to ε^x_{Ax} as desired.

This gives two cases. In case I, dI_{nx}/dP_x is *un*bounded. If dI_x is then negative, a bounded ε_x implies that dI_x is bounded below, and $dI_{nx} = -dI_x$ is bounded above. Thus, dI_{nx} can only be unbounded if dI_x is positive and dI_{nx} is negative. In this sense, complements with X predominate in I_{nx}, and the unbounded increase in I_x results from an unbounded increase in the value of 'close' substitutes for X, owing to increases in the quantities demanded of these 'close' substitutes. That is, $\Sigma_k P_k dy_k$ is unbounded, where summation is over all products in the X industry except X. However, $\Sigma_k P_k dy_k$ can be written as $(y^A_k P^A_k)(\Sigma_k(dy_k/y_k))$, where y^A_k and P^A_k are averages of equilibrium y_k and P_k values and are therefore bounded above. Thus, $\Sigma_k(dy_k/y_k)$ is unbounded. From the last inequality in (5), this drives the demand price for X to zero at every x when S^{α}_x is small enough. Let P^e_x be the equilibrium value of P_x. For small enough S^{α}_x, the quantity of X demanded at $P^e_x + dP_x$ will be zero, regardless of how small dP_x is. It follows that ε_x can be made as large as desired in equilibrium by making S^{α}_x small enough.

Unless ε_{Ax} can be made as close to ε^x_{Ax} as desired by making S^{α}_x small enough, therefore, ε_x can be made as large as desired the same way. But if ε_{Ax} can be made as close as desired to ε^x_{Ax}, ε_x can again be made as large as desired. This is case II. Since $\varepsilon^x_{Ax} \geq AB[(1 - S^{\alpha}_x)/(1 - S_x)]$, which is bounded away from zero, ε_{Ax} will have a positive lower bound, and from (4), ε_x will be as large as desired if S^{α}_x is small enough. As in case I, ε_x is unbounded. Case II is probably more likely than I since a tiny increase in P_x is unlikely to cause a huge substitution of products that are substitutes for X for products that are complementary with X.

Finally, when X is a 'close' substitute for Y_k and Y_k is a 'close' substitute for Y_j, suppose that X is also a 'close' substitute for Y_j. Then the X industry will consist of all firms whose products are 'close' substitutes for X, and these products will also be 'close' substitutes for one another. Each product in the X industry, so defined, has an own-price elasticity that will be as large as desired when its share of industry output value is small enough.

3.2. When a Firm Is a de facto Price Taker

Finally, how small does S^{α}_x have to be for the supplier of X to be a *de facto* price taker? Suppose that S^{α}_x is an average share for the X industry, so that $n_x = 1/S^{\alpha}_x$, where n_x is the number of firms in this industry. Then we can ask how large n_x has to be for the supplier of X to be a *de facto* price taker. Let $\varepsilon^A_{kPx} = (I/I_x)\varepsilon^x_{Ax}$. When n_x is large, ε^A_{kPx} is approximately the share-weighted average of ε_{kPx} values across the X industry—in general, this average equals $\varepsilon^A_{kPx}[(1 - S_x)/(1 - S^{\alpha}_x)]$. We can rewrite (4) as:

$$n_x = (\varepsilon_x - 1)/\varepsilon^A_{kPx} + I_x/I, \tag{6}$$

assuming that ε^{nx}_{Ax} is small enough to ignore, so that $\varepsilon^x_{Ax} = \varepsilon_{Ax}$.

Suppose that $I_x/I = .7$ and that the supplier of X is a *de facto* price taker if $\varepsilon_x \geq 9$, in which case a 5% cut in P_x will lower x by 45% or more. If $\varepsilon^A_{kPx} = .3$, n_x will be between 27 and 28, S^{α}_x will be about .036, and S_x about .025, so that $(1 - S_x)/(1 - S^{\alpha}_x)$ is about.99. If ε^A_{kPx} is lower for these given values of ε_x and I_x/I, n_x will be larger, and if ε^A_{kPx} is higher, n_x will be smaller. Suppose that ε^A_{kPx} again equals .3, but that $n_x = 9$. Then ε_x is just under 4, and the supplier of X might well be a price maker instead of a price taker. However, with only nine firms in the industry, this is oligopoly. If $\varepsilon_x = 1.3$, $n_x = 2$, and we have duopoly.

Under oligopoly, firms may behave like Chamberlin's monopolistic competitors when cross-price elasticities within the industry are not too high—so that firms do not act strategically—and the number of competitors is not so large that each firm is a *de facto* price taker, but not so small that firms earn positive economic profit in equilibrium. There is no guarantee that such an industry will exist, however.

4. Conclusion

This paper has shown that Chamberlin's monopolistic competition is really a form of perfect competition in which firms are price takers despite the fact that their products are differentiated and no firm's product has a perfect substitute. The existence of many close—albeit imperfect—substitutes for a product has a cumulative effect on that product's own-price elasticity of demand, so that it becomes unbounded as the product's market share tends to zero. As a result, there are just three basic industrial structures in economics—monopoly or single seller, oligopoly or competition among the few, and perfect competition or competition among the many. In the latter case, marginal-cost pricing prevails.

There is a difference between perfect competition with differentiated products and perfect competition with homogeneous products, however. In the former, firms and products have separate identities and can be distinguished from one another. It is therefore possible to advertise a specific firm's product successfully if the advertising leads potential customers to believe that it has a higher quality than they had previously perceived. For that quality, the firm is still a price taker, however. While market failure can always result from too few competitors and entry barriers, it does not result from product differentiation with many competitors, provided customers are well informed.

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