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 independent of the price set by any single firm, and let \( x \) be the price and quantity demanded of \( X \), given by \( \varepsilon_x = -(P_x x_p)/x \), where \( x_p \) 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 \( E \) 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 \( (Y_1, Y_2, \ldots) \) be all the substitutes for and complements with \( X \) that survive in long-run equilibrium, with prices \( (P_1, P_2, \ldots) \) and quantities demanded \( (y_1, y_2, \ldots) \). These quantities are assumed to be second-order continuous functions of prices and buyers’ incomes. We have:

\[
I = P_x x + \Sigma y k Px k, \tag{1}
\]

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:

\[
0 = dI/dP_x = x + P_x x_p + \Sigma P_k y k, \tag{2}
\]

where \( dI \) is the change in \( I \), and \( y k \) is the change in \( y_k \) per unit of \( dP_x \). Here \( y k \) is positive when \( Y_k \) is a substitute for \( Y \) and negative when \( Y_k \) is complementary with \( X \). Let \( S_k = P_k/I \) be the equilibrium share of \( X \) in \( I \). Since \( \varepsilon_x = -(P_x x_p)/x \), we have \( (P_x/I)(x + P_x x_p) = S_x(1 - \varepsilon_x) \). Note from (1) that \( \Sigma(S y k)/I = (1 - S_x) \), and let \( \varepsilon x_p = \Sigma y k / y_k \) be the cross-price elasticity of demand between \( X \) and \( Y_k \) when \( P_x \) changes. Let \( \varepsilon x \) be the share-weighted average of these cross-price elasticities over all products in \( I \) other than \( X \) when \( P_x \) changes. That is, \( \varepsilon x = \Sigma((P y k)(y k)/y_k)/(1 - S_k) \), where this sum is over all products in \( I \) except \( X \).

Because the sum of these weights equals \((1 - S_k)\), we can write \((1 - S_k)\varepsilon x \) as the sum of product shares times cross-price elasticities over all \( Y_k \) in \( I \). That is:

\[
(1 - S_k)\varepsilon x = \Sigma((P y k)(y k)/y_k) = \Sigma(P y_k y_k / y_k) = (P y / I)(\Sigma P y y k), \tag{3}
\]

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

\[
\varepsilon_x = 1 + [(1 - S_x)/S_x]\varepsilon x. \tag{4}
\]

If \( S_x \) is small enough, \((1 - S_x)/S_x\) will be as large as desired. Thus, if \( \varepsilon x \) remains above some positive lower bound, \( \varepsilon_x \) 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 \( \varepsilon x \) is negative, since \( \varepsilon_x > 1 \) must hold for such a firm, which implies \( \varepsilon x > 0 \). Nevertheless, \( \varepsilon x \) could be small when \( S_x \) is small, allowing the two to offset in their effects on \( \varepsilon_x \), so that \( \varepsilon_x \) 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 \( I_{x^*} \) be total expenditure on products outside, with \( I = I_x + I_{x^*} \). If \( S_x = P_x/I \) is the equilibrium share of \( X \) in \( I \) output value, \( S_x = S_x(I/I_x) \geq S_x \). Thus if \( S_x \) 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 \( Y \), then \( Y \) will be a substitute for \( X \), if \( Y \) is in the \( X \) industry. I shall say that \( X \) is a ‘close’ substitute for \( Y \) in equilibrium if two conditions are met. First, the cross-price elasticity, \( \varepsilon x y \), must have a positive lower bound, \( B \). Second, a given percentage increase in \( x \) must cause at least some minimal percentage decrease, \(-dP_x/P_x \), in \( P_x \) at any given \( y_k \). That is, \([-dP_x/P_x]/y_k \) must have a positive lower bound, \( B \).

Given the above, the \( X \) industry is defined to consist of \( X \) and all products, \( Y \), such that \( X \) is a ‘close’ substitute for \( Y \) and \( Y \) is a ‘close’ substitute for \( X \). Thus, \( Y \) is in the \( X \) industry if and only if the following pairs of inequalities hold in equilibrium:

\[
\varepsilon x y \geq B, \varepsilon y x \geq B; (-dP_x/P_x)(y_k)/y_k \geq b, (-dP_x/P_y)(dy_k/y_k) \geq b, \tag{5}
\]

where \( \varepsilon x y \) is the cross-price elasticity of demand between \( X \) and \( Y \) when \( P_x \) changes with all other prices held constant.
While \( B \) and \( b \) are not unique, they must be low enough that \( S^A \) can be made as small as desired. I shall also require that \( I/I \geq 1 \geq 0 \), where \( A \) can be any positive value. This prevents the structure of the \( X \) industry from being irrelevant to the value of \( x \).

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 \( \varepsilon_{Ax} = \varepsilon_{Ax} + \varepsilon_{Ax} \), where \( \varepsilon_{Ax} = \sum([P_{xy}]/I(\varepsilon_{xy}))/1 - S_x \), with summation over all products in the \( X \) industry, and \( \varepsilon_{Ax} \) is the sum over all substitutes for and complements with \( X \) that are outside the \( X \) industry. Since \( \varepsilon_{Ax} \geq B \) for any product, \( Y_x \), in the \( X \) industry, \( (I/\varepsilon_{Ax}) \geq B(1 - S_x)/(1 - S_x) \), which is bounded away from zero as long as \( S^A \) is bounded away from one—that is, as long as the \( X \) industry is not a monopoly. This implies \( \varepsilon_{Ax} \geq AB[(1 - S_x)/(1 - S_x)] \). In addition, since \( \varepsilon_{Ax} = P_{xy}y_x \), we have \( (1 - S_x)\varepsilon_{Ax} = (P_{xy}/I)\sum P_{xy}y_x = (P_{xy}/I)(dW/dP_x) \).

3. Results

3.1. Proof That \( \varepsilon_x \) Is Unbounded

To show that \( \varepsilon_x \) is unbounded, I assume it to be bounded and show that a contradiction results. Starting from equilibrium, let \( P_x \) be a small amount, \( dP_x \), with other prices fixed. This will cause changes of \( dl_x \) and \( dl_{ax} \) in \( I_x \) and \( I_{ax} \), with \( dl_x = -dl_{ax} \). Fix \( dP_x \). Then \( (1 - S_x)\varepsilon_{ax} \) equals \( (P_x/I)(dW/dP_x) \) to a close approximation, provided \( dP_x \) is small enough. Since \( x \geq 1 \), we have \( (P_x/I) \leq S_x \). Thus, if \( dW/dP_x \) is bounded over all \( S_x, \varepsilon_{ax} \) will be as small as desired for \( S^A \) and \( S_x \) small enough, and \( \varepsilon_{ax} \) will be as close as desired.

This gives two cases. In case I, \( dW/dP_x \) is unbounded. If \( dl_x \) is then negative, a bounded \( \varepsilon_x \) implies that \( dl_x \) is bounded below, and \( dl_{ax} = -dl_x \) is bounded above. Thus, \( dl_{ax} \) can only be unbounded if \( dl_x \) is positive and \( dl_{ax} \) is negative. In this sense, complements with \( X \) predominate in \( I_{ax} \) 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, \( \sum P_x dy_x \) is unbounded, where summation is over all products in the \( X \) industry except \( X \). However, \( \sum P_x dy_x \) can be written as \( \varepsilon_x(P_{xy})(\sum_y dy_x y_x) \), where \( y_x \) and \( P_{xy} \) are averages of equilibrium \( y_x \) and \( P_{xy} \) values and are therefore bounded above. Thus, \( \sum P_x dy_x y_x \) is unbounded. From the last inequality in (3), this drives the demand price for \( X \) to zero at every \( x \) when \( S^A \) is small enough. Let \( P_x \) be the equilibrium value of \( P_x \). For small enough \( S^A \), the quantity of \( X \) demanded at \( P_x + dP_x \) will be zero, regardless of how small \( dP_x \) is. It follows that \( \varepsilon_x \) can be made as large as desired in equilibrium by making \( S^A \) small enough.

Unless \( \varepsilon_{ax} \) can be made as close to \( \varepsilon_{ax} \) as desired by making \( S^A \) small enough, therefore, \( \varepsilon_x \) can be made as large as desired the same way. But if \( \varepsilon_{ax} \) can be made as close as desired to \( \varepsilon_{ax} \), \( \varepsilon_x \) can again be made as large as desired. This is case II. Since \( \varepsilon_{ax} \geq AB[(1 - S_x)/(1 - S_x)] \), which is bounded away from zero, \( \varepsilon_{ax} \) will have a positive lower bound, and from (4), \( \varepsilon_x \) will be as large as desired if \( S^A \) is small enough. As in case I, \( \varepsilon_x \) 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 \( Y_x \), \( Y_x \) is a ‘close’ substitute for \( Y_x \). 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 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 \( S_x \) have to be for the supplier of \( X \) to be a de facto price taker? Suppose that \( S_x \) is an average share for the \( X \) industry, so that \( n_x = 1/S_x \), 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 \( \varepsilon_{ax} = (1/I)\varepsilon_{ax} \). When \( n_x \) is large, \( \varepsilon_{ax} \) is approximately the share-weighted average of \( \varepsilon_{ax} \) values across the \( X \) industry—in general, this average equals \( \varepsilon_{ax}[(1 - S_x)/(1 - S_x)] \). We can rewrite (4) as:

\[
\varepsilon_x = (\varepsilon_x - 1)\varepsilon_{ax} + I/I,
\]

assuming that \( \varepsilon_{ax} \) is small enough to ignore, so that \( \varepsilon_{ax} = \varepsilon_{ax} \).

Suppose that \( I/I = 7 \) 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 \( I \) by 45% or more. If \( \varepsilon_{ax} = 0.3, n_x \) will be between 27 and 28, \( S_x \) will be about 0.036, and \( S_x \) about 0.025, so that \( (1 - S_x)/(1 - S_x) \) is about 99. If \( \varepsilon_{ax} \) is lower for these given values of \( \varepsilon_x \) and \( I/I \), \( n_x \) will be larger, and if \( \varepsilon_{ax} \) is higher, \( n_x \) will be smaller. Suppose that \( \varepsilon_{ax} \) again equals 0.3, but that \( n_x = 9 \). Then \( \varepsilon_x \) 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.

References