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Consumer Demand, Grades, Brands, and Margin Relationships

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CHAPTER 4

CONSUMER DEMAND, GRADES, BRANDS, AND MARGIN RELATIONSHIPS*

Peter Berck and Gordon C. Rausser†

1. *Introduction*

In addition to consumer demand and producer supply, the performance of the U. S. agriculture and food sector also depends on the structure and behavior of those agents which transfer, transform, transport, and distribute farm production to the ultimate consumer. These agents include the assemblers, food processors and manufacturers, wholesalers, and retail distributors. Most econometric investigations of the U. S. food and agricultural sector treat the behavior of this group of agents via constant or percentage margin relationships (Brandow, George and King, Waugh). None of these treatments examine the distinction between food grades and brands; they simply neglect variations in quality. From the standpoint of simplicity and the purposes for which such models were constructed, these treatments cannot be faulted. Nevertheless, to forecast the impact of many food policies, representations that extend beyond the purely competitive paradigm are required. These representations must recognize the importance of grading and branding in the U. S. food sector, must explicitly treat consumer uncertainty with respect to quality, and must reflect the dynamics of the economic structure that lies between farm production and retail consumption.

Although many agricultural commodities are produced in almost infinite variety, they are marketed as a small number of grades and brands. As a product moves from the grower to the first handler, it is often graded and sized. A number of grading schemes and grade classes are possible covering such dimensions as moisture, color, taste, tenderness, foreign matter, age, texture, sweetness, and numerous others. Grade classification schemes are

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viewed as socially desirable since they convey valuable information to the consumer and, thus, enhance pricing efficiency. This view provides the basis for the role of the U. S. government in grading of farm products which began as early as 1901 with the U. S. Department of Agriculture (USDA) investigation of complaints regarding nonuniformity of grades in both domestic and foreign markets for grains. These efforts culminated in the Cotton Futures Act of 1914, which provided official grades for all cotton traded on futures markets; the Grade Standards Act of 1960 establishing mandatory grading for all grains in interstate commerce; the Agricultural Marketing Act of 1946; and other legislation establishing USDA grade standards for other farm produce.

In addition to grading activities at the farm produce level, we find that, as a graded product moves through the vertical marketing chain, additional services and information is added to the product prior to its arrival in the hands of consumers. Products are often labeled or branded in order to provide the consumer with additional information regarding the extent of these associated services and the product's minimal quality. This identification is enhanced by advertising and promotional campaigns.

The resources that are allocated to the development of product brands suggest that substantial value or net benefits accrue from these activities. A number of agricultural cooperatives have also pursued such brand developments strategies, e.g., Sunkist, Sunsweet, Land O' Lakes, Pure Gold, etc. Most of the major distributors like Safeway, A&P, Lucky Stores, and the like do not promote national brands; instead, their products are often referred to as nonbranded products which simply carry the label of the distributor. In the parlance of businessmen, a distinction is often drawn between brands and commodities. Commodities simply refer to products whose quality dimensions are loosely defined, while brands refer to more tightly specified quality dimensions.

The definition of a grade, or the clever placing of the boundary between two grades, can alter the demand for the underlying commodity. Grades can be set to correspond to consumer taste or for the purpose of "commodity bundling," viz., forcing the purchase of two or more goods together rather than permitting their independent purchase (Adams and Yellen). Since the grading of agricultural products often provides less information than consumers find useful, many processors and distributors find it worthwhile to

undertake further differentiation by branding the graded commodity. By guaranteeing specific attributes in their brands, these firms increased the demand for their product over the demand they would face if only graded commodities were marketed. The increased demand comes from both certifying that on the average their product is better than the graded product and from resolving consumer uncertainty with respect to the quality of their products.

1.1 *Literature Review*

There are several advantages to the hedonic point of view reviewed extensively by Ladd and by Hanemann, both in this volume. Briefly, the advantages of hedonics are that it is possible to evaluate the market price for an attribute and treat both the quality and quantity choice simultaneously. Ladd concentrates on the first of these points. Hanemann concerns himself with systems of demand equations and with the simultaneous choice of both quantity and quality. The empirical simplification available from the hedonic point of view is that one may, under suitable specification, estimate the demands and supplies of the rather small number of attributes instead of the demands and supplies of the infinite number of commodities (Rosen).

A much earlier view of product quality was advanced by Zusman. Writing before the hedonic revival of the 1970s, Zusman specified his system as a utility function over a set of distinct commodities and one grade which contains a little of each of the commodities. Zusman was concerned with the conditions under which a grade rather than the component commodities would be purchased and, more generally, the effect of a change in the price of one of the commodities or of the grade on the demand for the others. Based on some strong assumptions about the substitution effects and the income effects, Zusman was able to show that the demand for the grade would indeed be downward sloping.

The recent agricultural economics literature that emphasizes the less than perfectly competitive nature of branded goods can be divided into three classes based on the views the authors hold regarding (i) the benefits of product diversification, (ii) the role of information, and (iii) the use of diversity to create barriers to entry. The best place to begin the process of sorting these divergent views is at the beginning which, in this case, is

the classic monopolistic competition literature. In the work of Chamberlain, each firm has one product and some market power which it exploits. These monopoly profits are, however, short lived because, seeing the profit opportunity, new firms produce new products that are near the old products and drive the pure profits to zero. This monopolistic competition equilibrium has more products and higher prices than the competitive equilibrium. Since Chamberlain gave no value to product diversity *per se*, the monopolistic competitive equilibrium is worse than the competitive equilibrium or, since product diversity is not a good, a market structure with brand proliferation implies social losses.

These conclusions are reversed when consumers value product diversity, a feature which appears in the recent contributions of Spence and of Dixit and Stiglitz. In these formulations, pure competition can generate less goods than monopolistic competition which produces less goods than the social optimum. Spence specifies utility as being a (generalized) constant elasticity of substitution (CES) function in the goods, so that the marginal utility of the first unit of some good could be very large (and possibly even infinite). However, Spence ignores second-order effects and, thus, the qualitative implications of his model are ambiguous. The rest of Spence's model is quite similar to Chamberlain's and includes fixed costs as the reason for less than perfect product diversity.

By relaxing the assumption that one firm produces one good, Schmalensee comes to a different conclusion. He examined product proliferation as a barrier to entry for the case of ready-to-eat-breakfast cereals. In Schmalensee's view, cereal industry firms may market more than one brand and they may collude to prevent entry from outside firms. The essential method of preventing entry is to leave no brands for the new entrant to assume. When the number of goods becomes a method of competition all by itself, the outcome may be a cartel.

Expanding on the Schmalensee view, Parker and Connor take the view that branding of products is part of the monopolization of the food industry by large firms. They show that consumers do indeed pay more for branded items than for the generic goods and that brand proliferation is positively associated with both the concentration of the industry and the level of advertising. To these authors brand proliferation (with advertising)

is a method of erecting barriers to entry, and it causes consumers large welfare losses.

Another thread in the analysis of imperfect competition relates to the role of information. In models with an information orientation, consumers care about the differences among marketed goods, but they find it very difficult to tell which good is actually being sold. Under these circumstances, Akerlof showed that a market for second-hand goods might not exist. Briefly, consider a single good that has a variation in quality (it has a single attribute that varies) and a set of agents that respond to the average level of quality in the market. For instance, consumers do not know the quality of used cars until they buy them. Hence, the consumer is willing to pay for the average quality, and producers can sell low quality as average. The market failure is obvious and may lead to market nonexistence. Agricultural grading is designed to avoid just such pathology as is reputable advertising.

In a piece broadly sympathetic to the practice of brand proliferation and reputable advertising, Padberg and Westgren tie successful innovation in the food industry to advertising or communicating to the consumer, placing little emphasis on product development. Taking a Schumpeterian point of view, the large enterprise has the advantage in the communication of the attributes of new products, partially because of actual economies of scale in distribution and partially because new products need to be near old products in terms of their attributes. In this setting, Padberg and Westgren view branding and advertising as a socially useful feature of the food system.

1.2 *Outline of Analysis*

The purpose of this paper is to investigate the markets for graded and branded products with less than perfect information and competition and with an emphasis on prediction. Section 2 presents the theory of demand under product uncertainty and grading. It finds that uncertainty has an ambiguous effect on demand so that provision of information through branding may or may not increase demand. Under grading without uncertainty, there are more definitive results: a grade boundary-sensitive, estimable, demand system is presented. Comparative statics in this system show that there are producer profit-maximizing grading schemes. Section 3 examines equilibrium in a

branded market with imperfect competition and uncertainty about consumers'
demand. This generalization of the Spence and of the Dixit-Stiglitz results
does not predict, as they do, a unique equilibrium characterized by a
survival coefficient and zero profits. The monopolistic model is also
generalized in another direction—that of learning by consuming. This
generalization predicts the market share of entrants as a function of
advertising and time. These monopolistic competition results are then
compared to competition. Section 4 spells out estimable equations that
result from a monopolistic competitive model. These equations are set out as
equations for predicting margins; they can be used to test for a difference
between pure and monopolistic competition.

2. *Demand for Brands and Grades*

Branding and grading are a natural outcome for commodities that exist in
an infinite variety because categorizing products conveys information and
eliminates the transaction costs inherent in an infinite number of markets.
Although it is easy to see when some grading will be desired by both
producers and consumers, the actual setting of grades in the United States is
a political process that determines the distribution of potential benefits to
producers and consumers. In these circumstances, the task of the
prediction-oriented econometrician is to set out the demand for grades as a
function of grade boundaries and of available information. These demands can
then be used to estimate producers' revenues and consumers' surpluses from
various grading schemes; and the estimates of these agents' gains can, in
turn, be used to predict the government's likely setting of grades. We
approach this task in two ways. First, we construct a very simple model in
which the role of information in consumer demand can be explored. We use it
to show that added information does not have a determinate effect on demand.
Then we construct an estimable demand system that is sensitive to the grade
boundaries but not to information *per se*.

We require some preliminary definitions before proceeding. A commodity
will be defined as an object unique in its attribute list. Using Debreu's
example, Red Winter Wheat, yielding 12 percent—neither more nor less—
protein, available on the first of January in Minneapolis, is what we shall
call a commodity. Wheat with a higher protein content or white wheat would
be a different commodity. Because of this very sharp definition for a

commodity, there certainly are an infinite number of them. We denote the quantity of ith commodity as x_i.

The definition of a grade is a set of commodities. For instance, hard red No. 2 wheat is a grade consisting of hard red wheat with varying protein contents and varying levels of impurities. One buys and pays for No. 2 wheat. Grades may be very wide; for instance, ice cream is almost any frozen dessert with the butterfat content in excess of some standard. In our definition, grades may be so narrow as to be a single commodity.

The definition of a grade, j, requires a set of included commodity indices

$$J = \{i \mid i \text{ is the index of a commodity}\}$$

and the frequency of the ith commodity in the jth grade is represented by f_{ij}. Letting G_j be the quantity of the jth grade (with index set J), then

(1)
$$x_i = \sum_j f_{ij} G_j$$

gives the amount of ith commodity that is obtained when grade G_j is purchased. When, as in the next section, there are only two commodities in one grade, it is more convenient to drop the superfluous subscripts and write

$$x_1 = fG \text{ and } x_2 = (1 - f) G.$$

A brand is a grade plus some associated information. It is usual for a brand to contain some subset of an otherwise marketed grade so that Del Monte peaches, while being U. S. No. 1, are also a very small set, presumably on average superior to U. S. No. 1 peaches. It is called a brand when some agency or firm informs (or for that matter, misleads) consumers about the exact set of commodities contained within the grade that is branded.

2.1 *Information and Demand*

In the markets for many products—fresh fruits, meats, and automobiles—the quality of the good purchased is not known until after the good is

purchased. In this section we present the demand for uncertain goods and show the effects of information (labeling, government standards, etc.) on this demand.

The model is very simple; there are three commodities—x_1, x_2, and x_3. The third, x_3, is a composite composed of all other goods. On visual inspection, x_1 and x_2 are indistinguishable and have the same price; one may be a sweet orange and the other a sour orange, one a ripe melon and the other an unripe melon, or one chocolate with a liquid center and the other chocolate with a solid center. The consumer samples with replacement a bin containing these two commodities sold together as the grade G, so that in the long run he consumes exactly the distribution of commodities present in the population. That is, since the consumer cannot discern the difference between x_1 and x^2, he consumes both of them together. Let the total quantity purchased be $G = x_1 + x_2$ and $f = x_1/G$ be the unknown proportion of x_1 in G. If on the ith trip to the bin the consumer purchases G units of the uncertain commodities, he gets utility

$$U[f^i G, (1 - f^i)G, x_3]$$

where f^i is the ith realization of the random variable f.[1]

The consumer choice problem is to allocate available income y to a composite good x_3 with price 1 or to selecting G units, composed of x_1 and x_2, from the bin and paying P per unit. This choice problem for an expected utility maximizer is

$$\max EU[fG, (1 - f)G, x_3]$$

subject to $P(x_1 + x_2) + x_3 = y$ where E is the expectation operator over the outcomes of many trips to the store.

Without more structure on U, consumer demand for the uncertain good may increase or decrease as f becomes less certain.[2] This proposition is easily seen graphically. In Figure 1, the line A-B is the locus of $x_1 + x_2$ constant or the possible outcomes for (x_1, x_2) if $(y - x_3^*)$ is available income. Assume that (G^*, x_3^*) solves the choice problem.

$$x_2 = \frac{(1-Ef)}{Ef} x_1$$
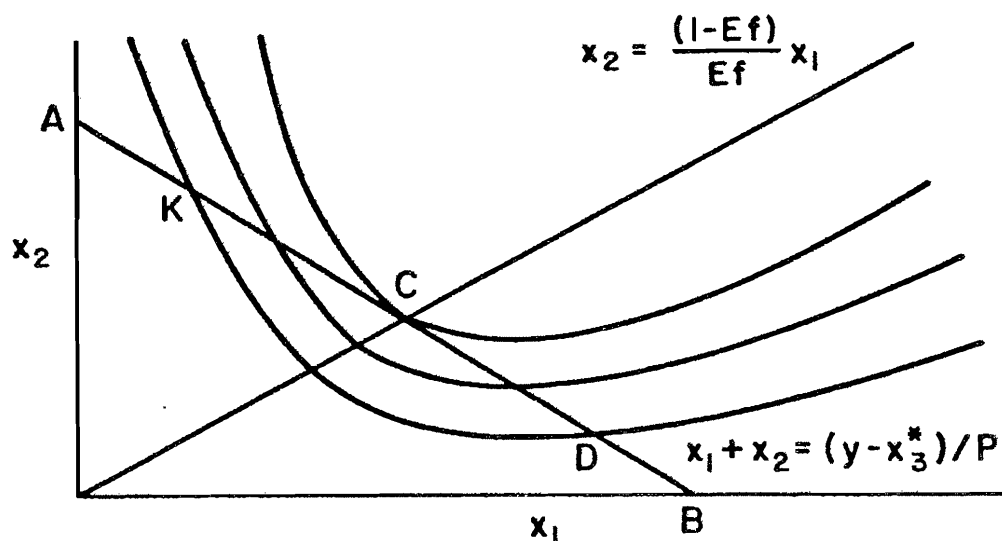
$$x_1 + x_2 = (y - x_3^*)/P$$

FIGURE I. Indifference Map and Quantity Constraint
for Demand-Decreasing Uncertainty

An example in which a mean-preserving spread in f decreases the demand for goods x is illustrated at point C, a tangency between an indifference curve and the line A-B also on the ray [GEf, G(1 - Ef)]. It corresponds to the case in which the consumer gets the same ratio of x_1 to x_2 on every trip to the store (f is Ef under no uncertainty) and that ratio makes his/her rate of commodity substitution of x_1 for x_2 equal to 1. As the diagram shows, any other distribution of f will make the consumer no better off on each trip to the store if he/she allocates $(y - x_3^*)/P$ to buy G. For small changes in the distribution of f, we can conclude that the expected marginal utility of buying x has decreased. There are utility functions that compensate for this decrease in marginal utility of a good by buying less of it.[3] An example that goes the opposite way is just as easy to construct. In Figure 2, point C' with certainty need not be preferred to a distribution between D' and K' because point D' can be better than K' or C' by an arbitrarily large amount. Thus, a mean-preserving decrease in f may not be preferred. The rest of the argument is as before, and one concludes that demand could decrease with information. These two examples are sufficient to show that theory does not predict that more information about a grade will make consumers better off or increase demand.
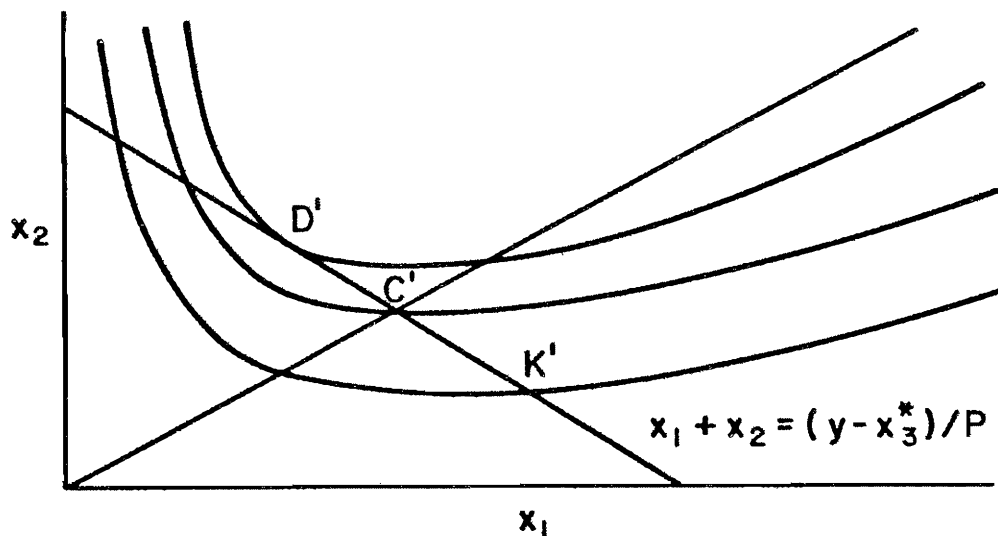
The graph shows indifference curves and the budget line labeled $x_1 + x_2 = (y - x_3^*)/P$, with points D', C', and K' marked, axes x_2 (vertical) and x_1 (horizontal).

FIGURE 2. Indifference Map and Quantity Constraint
for Demand-Increasing Uncertainty

An issue related to that of information increasing demand is the prediction of new private brand entry. In the context of our three-good model, a brand is simply one of the commodities with certainty. Entry is possible if the price at which the brand can be produced, P^b, is less than what a consumer would pay for it at the graded (uncertain) equilibrium. What the consumer would pay for a unit of the first good is its hedonic price, P^h. It is defined by the equality of the rate of commodity substitution of x_1 for x_3 and the ratio of P^h to 1, at the graded equilibrium.

The Cobb-Douglas form provides an example. Let

$$U = x_3^{1-a_1-a_2} \, x_1^{a_1} \, x_2^{a_2}$$

and all other symbols as before. The demands are

(2) $\qquad G = (a_1 + a_2) \dfrac{y}{P}, \qquad x_3 = (1 - a_1 - a_2) \, y$

and they are completely independent of f.

The hedonic price for x_1, P^h is $D_{x_1}EU/D_yEU$, or

$$(3) \quad P^h = \frac{a_1 \, E \, f^{a_1-1} \, (1-f)^{a_2} \, G^{a_1+a_2-1} \, x_3^{1-a_1-a_2}}{D_y \, EU}$$

where $G = (a_1 + a_2) \, y/P$, $x_3 = (1 - a_1 - a_2) \, y$, and $x_1 = 0$. This hedonic price can be compared to the price P for the grade, viz.,

$$(4) \quad P = \frac{(a_1 + a_2) \, E \, f^{a_1} \, (1-f)^{a_2} \, G^{a_1+a_2-1} \, x_3^{1-a_1-a_2}}{D_y \, EU}$$

where G, x_3, and x_1 are as defined above. The bid or hedonic price for x_1 will exceed what the producer is paid if a_1 is much larger than a_2, since

$$(5) \quad E\left[f^{a_1} (1-f)^{a_2}\right] < E\left[f^{a_1-1} (1-f)^{a_2}\right].$$

Letting $a_1 = a_2 = 1/2$ and $f = \bar{f}$ gives

$$(6) \quad \begin{aligned} P &\propto \sqrt{\bar{f} - \bar{f}^2} \\ P^h &\propto 1/2 \, \frac{\sqrt{1 - \bar{f}}}{\sqrt{\bar{f}}} \end{aligned}$$

so if $\bar{f} = 3/4$, for instance, $P = .43 > P^h = .29$. Letting $f = \bar{f} = 1/2$ will make $P = P^h$ and letting $f \to 0$ will obviously make P^h much larger than P.

The above example illustrates that the sign of $P^h - P$ is not *a priori* known and depends on the distribution of f. On the reasonable assumption that the cost of producing x_1 alone is related to P (the price of the grade), then, as $P^h - P$ becomes large, one would predict that the graded equilibrium would break down. The private profit motive would provide the brand x_1 and the information necessary to differentiate it from the grade.

In conclusion, even in the simplest models of graded goods, there are no strong theoretical predictions about the effects of information on demand or the likelihood of the entry of brands where previously there were only graded goods.

2.2 *Demand for Grades*

The demand for a grade depends upon which commodities are included in the grade as well as income and prices. Under the assumption of certainty so that each consumer always receives exactly the proportion f_{ij}, this section provides an estimable demand system for nonoverlapping grades that is a function of which commodities they contain.

The standard consumer problem is different from the grading problem because it is a finite number of grades, G, not a continuum of commodities, x, over which the choices are made. Substituting from the identity (1), one gets the consumer problem recast in terms of grades[4]

$$\max_G U(f_{ij} \; G_j)$$

subject to $G'P = y$. Solving this problem will yield the demand for grades. There is at least one case which can be solved, that of U as a CES function and the nonoverlapping grades, $f_{ij} \cdot f_{ik} = 0$ if $j \neq k$. The utility in terms of commodities is

$$(7) \qquad U(x) = \left[\int_{i \in J} (a_i x_i)^\rho \; di \right]^{1/\rho}$$

where a_i and ρ are parameters, and the integration is carried out over the commodity space. Substituting $\Sigma_j \; G_j \; f_{ij}$ for x_i and making use of the nonoverlapping grades assumption to break the integral into a sum gives

$$(8) \qquad U(G) = \left(\sum_j A_j^\rho \; G_j^\rho \right)^{1/\rho}$$

where

$$A_j = \left[\int_{i \in J} (a_i \; f_{ij})^\rho \; di \right]^{1/\rho} .$$

The new parameter, A_j, is the grade utility weight, and it is the mean of order ρ of the commodity utility weights times their frequency in the grade. Note also that the problem is reduced in dimension from infinite to finite.

Applying standard maximization technique yields the demand for grades:

$$(9) \qquad G_j = \frac{y \, P_j^{r-1} \, A_j^{-r}}{\sum_i \left(\frac{P_i}{A_i}\right)^r}$$

where $r = \rho/(\rho - 1)$. Substituting into equation (7) gives the indirect utility function

$$(10) \qquad v(P, y) = y \left[\sum_j \left(\frac{P_j}{A_j}\right)^r \right]^{1/r} .$$

The usual treatment of demand for grades is to estimate A_j and r in the demand equation (9) which take the grade definitions as fixed. If the makeup of the grades is of interest, then one could also recover some of the microparameters, a_i. To do so requires that there be some within-grade variation in the sample. Either the frequency of certain commodities (f_{ij}) must vary, good years produce sweeter oranges, or some commodity must be assigned to a new grade—a change in grade standards. Given the variation in the data and observations on f_{ij}, one proceeds by parameterizing the weights a_i: $a_i = a(n, m)$. Then one writes

$$(11) \qquad A_j = \left\{ \int_{i \in J} [a(n, m) \, f_{ij}]^\rho \right\}^{1/\rho} .$$

Equation (11) is substituted into equation (9) and the parameters n, m, ρ, and the macroparameters A_k ($k \neq j$) that appear in the denominator of (9) are estimated. For instance, $a_i = n + mi$ leads to

$$(12) \qquad G_j = \frac{y \rho^{r-1} \left[n^\rho \int_{i \in J} f_{ij}^\rho \, di + m^\rho \int_{i \in J} i^\rho \, f_{ij}^\rho \, di \right]^{1/\rho}}{\sum_k \left(\frac{P_k}{A_k}\right)^r} .$$

This is a nonlinear regression with parameters A_k, ρ, n, m. An observation is G_j, y, P_k, $\int_{i \in J} f_{ij}^{\rho}$, and $\int_{i \in J} (if_{ij})^{\rho} \, di$, the latter two terms capturing the intragrade variation.

Determining the effects of changing grade definitions upon various performance measures is formally a problem of comparative statics. If the product mix is fixed, the effect of changes in grade can be determined easily. Letting the first grade be those goods with indices less than b and the second grade be those with indices b or greater, the supply of the first grade may be represented as:

$$(13) \qquad\qquad G_1^S = \int_{-\infty}^{b} x_i \, d_i$$

and the supply of the second grade can be represented as:

$$(14) \qquad\qquad G_2^S = \int_{b}^{\infty} x_i d_i .$$

Hence, $\partial G_1^S / \partial b = x_b$ and $\partial G_2^S / \partial b = -x_b$. Combining these results with equation (9) for the demand, it is a simple matter to show that the expenditure on the two grades is invariant with respect to b for this particular functional form.[5] Hence, a producer-dominated trading authority cannot alter profits after the quality distribution is determined, e.g., in the postharvest period.

Prior to the harvest, the story is quite different. During these periods, price changes resulting from changes in grade can be represented by the inverse of the Jacobian matrix of the excess demand functions times the vector, $[x_b, -x_b]'$, i.e.,

$$(15) \qquad\qquad \begin{bmatrix} \dfrac{dP_1}{db} \\[2ex] \dfrac{dP_2}{db} \end{bmatrix} = [DG^d - DG^S]^{-1} \begin{pmatrix} x_b \\ -x_b \end{pmatrix} .$$

where G^d denotes grade demand, i.e., equation (9), and D is the differentiation operator. Under these circumstances, the change in producer profits, Π, is

(16)
$$\frac{d\Pi}{db} = \frac{\partial \Pi}{\partial P_1} \frac{dP_1}{db} + \frac{\partial \Pi}{\partial P_2} \frac{dP_2}{db} ;$$

or, by Hotelling's lemma,

$$\frac{d\Pi}{db} = G_1^s \frac{dP_1}{db} + G_2^s \frac{dP_2}{db} ,$$

and the producer-oriented marketing board will set this last expression to zero. For the postharvest example, we know that, if supply response is limited (near zero), then revenue will not change with grade. For this case, the profit-maximizing grade choice must result in minimum production and handling costs. This outcome may imply no grading whatsoever.

3. Product Supply and Industry Equilibrium

As previously noted, in the new monopolistic competition literature (Dixit and Stiglitz or Spence), the results of the Chamberlain formulation are reversed. No longer is monopolistic competition seen as an impediment to marginal cost pricing. Now monopolistic competition is a fortuitous organization form that values product diversity without a lump-sum subsidy. When the firms are capable of anticipating perfectly the demand for their products, the monopolistic equilibrium is unique; but when product uncertainty exists, many equilibria are possible. Here, we explore the monopolistic competition equilibria under product uncertainty and develop an empirical formulation for predicting product brand and grade entry. The contrast with a competitive equilibria is briefly drawn in Appendix A, and the role of consumer learning is investigated in Appendix B.

3.1 Monopolistic Competition Formulation

The most tractable yet complete monopolistic competition model (Dixit and Stiglitz) is composed of firms with constant marginal costs, c, and positive fixed costs, FC, in a Bertrand (price-setting) equilibrium. In this formulation, demand is derived from a CES indirect utility function

(17)
$$V(p, y) = y K(P)^{1/r},$$

where

(18)
$$K = \sum_i a_i P_i^r,$$

with P_i denoting prices and a_i denoting their associated weights. Implicitly, we assume that y, the amount of income dedicated to the monopolistically competitive sector, is constant.[6] Note that, for $V(\cdot)$ to be an indirect utility function, $r < 0$.

The demand for the ith product, prices of other products taken as given, is

(19)
$$Q_i(P_i) = a_i P_i^{r-1} K^{-1} y,$$

with an elasticity of demand, $r - 1$. Hence, each product's own demand must be elastic. The problem for the ith firm is to

(20)
$$\max_{P_i} \Pi = P_i Q_i(P_i) - c_i Q_i(P_i) - FC.$$

Setting $\Pi_{P_i} = 0$ to find the equilibrium price of the ith firm yields the surprising result

(21)
$$P_i^* = \frac{c_i(r-1)}{r}$$

given the plausible approximation that $D_{P_i} Q_i = (r - 1) Q_i/P_i$.[7] Note that this result is independent of the number of firms. Letting all firms have the same marginal costs, c, there is a common price, P^*. Hence, K can be explicitly evaluated as $P^{*r} \sum_I a_i$, where I is the set of indexes of produced grades and brands and is sufficient to describe the state of the economy. Nonproduced products have an infinite price and thus do not contribute to K. Given P^* and K, it is a simple matter to compute

(22)
$$\Pi^i = \frac{a_i}{\sum_I a_i} y \left(1 - \frac{c}{P^*}\right) - FC$$

or

$$(23) \qquad \Pi^i = y \left(\frac{a_i}{\Sigma_I \, a_i} \right) \left(\frac{1}{1 - r} \right) - FC \, .$$

3.2 *Industry Equilibrium*

A state of the economy, I, is a Bertrand equilibrium if there are no additional firms that can profitably enter production and every firm currently in production generates profits. Since margins depend only on P* and c and are the same for all firms, once a firm has entered, it will never exit. All existing firms cover their variable costs. Thus, Bertrand equilibria are sets I with

$$(24) \qquad \forall_j \notin I, \qquad a_j \leq \frac{FC}{y} \, (1 - r) \, \Sigma_I \, a_i \, .$$

For example, with all fixed costs and for even-numbered goods $a_i = 1/8$ while for odd-numbered goods $a_i = 1/4$, the Bertrand equilibria could be characterized by sets that have their sums of a_i equal to some constant ω:

$$(25) \qquad \hat{B} = \left\{ I \, \bigg| \, \overset{\Sigma}{\underset{I}{}} \, a_i = \omega \right\}$$

and letting m be the number of included evens and n the included odds,

$$(26) \qquad \hat{B} = \left\{ I(m, \, n) \, \bigg| \, m \, \frac{1}{8} + n \, \frac{1}{4} = \omega \right\} \, .$$

The constant ω is determined from $\omega \leq 1/8FC \, [1/(1 - r)]$, small firms make a profit, and $\omega \geq 1/4FC \, [1/(1 - r)] - 1/4$, no further large firms can enter.

There could be very many of these equilibria and which one is reached depends on chance. Potential entrant firms hope to be profitable, but they do not know the market share they will garner nor the profits they will receive. Market share, S_i, for brand i is

$$(27) \qquad S_i = \left(\frac{a_i}{\sum\limits_{j \in J} a_j} \right)$$

while profits are

$$(28) \qquad \Pi_i = (1 - r)^{-1} y S_i - FC.$$

On the assumption that entry happens very quickly, relative to the stream of discounted profits, firms can be viewed as sequentially attempting entry if

$$(29) \qquad E \left\{ (1 - r)^{-1} y S_i - FC \right\} > 0,$$

where E is the expectation operator over the uncertain market share of the potential entrant firm. The firm's market share is uncertain because the firm does not know the consumer's demand for the firm's good or, in formal terms, the level of its a_i; and the firm does not know which, if any, firms will enter after it.

To keep things simple imagine that there are very many a_i's so the profitability of drawing a good product (high a_i) is unaltered by previous drawings. Under these circumstances, entry is attempted if

$$(30) \qquad E \left\{ \frac{a_i}{\omega} \right\} > \frac{(1 - r) FC}{y}$$

and will not be attempted if

$$(31) \qquad E \left\{ \frac{a_i}{\omega + a_i} \right\} < \frac{(1 - r) FC}{y} .$$

Solving these two inequalities for ω yields the set of Bertrand equilibria, and the likelihood of each equilibrium is the same as that of drawing numbered balls from an urn, with replacement, until the sum of the numbers is ω. Note that, since $(E_J \ a_i < \max_{i \in J} \ a_i)$ the expected outcome is worse than the best outcome, uncertainty decreases the number of products in an equilibrium.

Another, and more complicated view, is that, if it is known that there are very few good firms, then the model is akin to drawing without replacement; and ω is not known independently of the sequence of drawings. This problem we leave to the statisticians. Following the Bayesian prescription, potential entrants may be viewed as having a prior distribution on the a_i which is updated from the experience of previous entrants. Thus, a drawing of a high a_i increases both Ea_i and Σa_i so the effect on entry is ambiguous.

3.3 *Branding and Advertising*

An important extension of the above model relates to endogenous taste. Advertising, for example, can influence the evolution of consumer tastes. When a firm decides to brand a product, it combines its reputation with the physical attributes of the product. It does this by expending Z_i dollars on advertising. The advertising expenditure changes the weights, a_i, the consumer uses in deciding how much of the product to purchase. This relationship is specified as a_i (Z_i); it is presumed to be an increasing function.

If the advertiser or brander takes his rival's advertising budgets as given, his profit—maximizing problem is

$$(32) \qquad \Pi^Z = \max_Z \frac{a_i\ (Z_i)}{\sum\limits_I a_i\ (Z_i)}\ y\ \left(1 - \frac{c}{P^*}\right) - FC - Z_i.$$

This maximization problem is known to have a solution for Z since Z lies in the closed interval between 0 and y. The shape of the function $a(Z)$ determines whether or not there will be any advertising expenditure and consequent branding. For instance, if the first several hundred thousand dollars·in expenditure are needed to set up an advertising department with no effect on consumer demand, and the total demand for this class of goods is at most several hundred thousand dollars, then the goods will not be branded. To the contrary, if the fixed costs of advertising are small and the marginal benefit of the first advertising dollar is very large ($\lim_{Z \to 0} \partial a/\partial Z = \infty$), then there will be advertising.

Branding (and advertising) are purely a matter of comparing (maximized) profits in equation (32) with profits without advertising. The first-order conditions for equation (32) are easily obtained; and they imply that, *ceteris paribus*, more advertising should be carried out earlier in the development of a branded product. This is because the marginal benefit of advertising is proportional to $a_i'(Z)/\Sigma_I\ a_i(Z_i)$ where $a'(Z)$ denotes the partial of a with respect to Z. This term is large before the industry has reached its equilibrium and because earlier advertising serves to raise the market share and deter other firms' entry [through raising $\Sigma_I\ a_i(Z_i)$].

4. *Margin Relationship*

Margins or the difference between consumers and farm prices or raw material costs, CR, are composed of quasi rents and the services and materials, CP, needed to turn raw goods into grades or brands. Decomposing the constant marginal costs into two components, CR(s) and CP(s), i.e.,

$$(33) \qquad\qquad c = CR(s) + CP(s)$$

where s is a vector of all input prices (Gardner), margins, M_i, can be represented as

$$(34) \qquad\qquad M_i = P_i - CR_i(s).$$

Using the monopolistic competition solution for P_i from Section 3, i.e., equation (21), M_i can be rewritten as

$$(35) \qquad\qquad M_i = CP(s) - r^{-1}\ [CP(s) + CR(s)]$$

where, as previously noted, $r - 1$ is the demand elasticity. As a special case, the pure competitive structure obtains when $r \rightarrow -\infty$. The margin relationship for a pure competitive structure does not include CR(s) while a monopolistic margin structure requires the inclusion of this factor. Hence, an obvious distinction between the monopolistic and pure competitive margin structures centers on the influence of CR(s).

4.1 *Pure vs. Monopolistic Competitive Margins*

To test for monopolistic competition, a regression of M_i on CP and CR is not possible since both CP and CR are functions of the same s. It is possible, however, to regress M_i on CP and CR and regress CR on s, constraining the coefficients across the two regressions and testing to determine whether $-1/r = 0$. For example, given available times series data on margins (determined from observed consumer and farm prices) and raw product costs, it is possible to empirically conduct such a test. In particular, suppose s is composed of two factors, s_1 and s_2, and that both relationships are translog with parameters β^P and β^R. That is

$$
M_i = \frac{(r-1)}{r} \left(\beta_1^P \ln s_1 + \beta_2^P \ln s_2 + \beta_{12}^P \ln s_1 \ln s_2 + \beta_{11}^P \ln s_1 \ln s_1 \right.
$$

$$
(36) \qquad \left. + \beta_{22} \ln s_2 \ln s_2 \right) + \frac{1}{r} \left(\beta_1^R \ln s_1 + \beta_1^R \ln s_2 + \beta_{12}^R \ln s_1 \ln s_2 \right.
$$

$$
\left. + \beta_{11}^R \ln s_1 \ln s_1 + \beta_{22}^R \ln s_2 \ln s_2 \right)
$$

$$
(37) \quad CR = \beta_1^R \ln s_1 + \beta_2^R \ln s_2 + \beta_{12}^R \ln s_1 \ln s_2 + \beta_{11}^R (\ln s_1)^2 + \beta_{22}^R (\ln s_2)^2
$$

are two linear regressions to be jointly estimated by an appropriate Aitken estimator. A likelihood ratio test is then used to determine whether $\beta_1^R/r = \beta_2^R/r = \beta_{12}^R/r = \beta_{11}^R/r = \beta_{22}^R/r = 0$ and whether β_1^R, β_2^R, β_{12}^R, β_{11}^R, $\beta_{12}^R \neq 0$.

In addition to the above test, other influences can be examined to distinguish a monopolistic from a pure competitive margin structure. For the competitive margin structure, the comparative static formulation advanced by Gardner reveals positive effects of demand increases, no effects of raw product prices, positive effects of food processing input prices, and no effects of advertising on margins. In contrast, for monopolistic margins, raw product prices are expected to have a negative effect; for advertising, a positive effect; for food processing input prices, a positive effect (since 1 $- r^{-1}$ is positive); and for demand growth, an ambiguous effect.

The distinguishing effect of raw product prices on competitive and monopolistic margins is the basis for the test outlined above. An additional test relates to the effects of demand growth. For competitive margins, the effect is positive, while in. a monopolistically competitive market, increases in demand may decrease the margin. The logic behind the competitive story is that the margin represents the costs of processing and grading the commodity and those costs must increase as the amount of commodity graded increases. In the monopolistically competitive case, the cost structure is different; fixed costs matter, and these fixed costs are spread over a larger volume of products. Hence, for large enough increases in demand, the average cost of processing and grading may decrease. The zero-profit condition in a monopolistically competitive equilibrium then assumes that the margin decreases along with the average cost. As a result, the effects of a demand growth increase may be startingly different in the competitive and monopolistic models. Thus, a significant negative effect of demand growth on margin would favor a monopolistic rather than a competitive margin structure.

4.2 Entry Conditions and Market Shares

The tests outlined in the previous section distinguish only between monopolistic and competitive margin structures. They are powerless in determining the no-entry condition of a Bertrand equilibrium. To capture the no-entry condition, the market share relationships must be specified. Using the monopolistically determined price, P_i^*, represented in equation (21), there is no longer a simple expression for G. However, G can be readily computed; it will be represented as $G(a_i, c_i, r_i)$. Given this result, value shares are:

$$(38) \quad \overset{v}{S}_i = a_i\, G^{-1}\, (a_i\, \ldots\, a_n,\, c_1\, \ldots\, c_n,\, r_1\, \ldots\, r_n) \left[\frac{c_i(r_i-1)}{r_i}\right]^{r_i}$$

and quantity shares are

$$(39) \quad S_i = a_i \left[\frac{c_i(r_i-1)}{r_i}\right]^{r_i-1} \Bigg/ \Sigma a_i \left[\frac{c_i(r_i-1)}{r_i}\right]^{r_i-1} \quad .$$

The complete model composed of equations (36)-(39) can be tested by estimating the nonlinear regression equations (38) and (39) jointly with the

margin equations (36) and (37) and testing the equality of the r's across equations. Besides the use of these models to predict shares and margins which are substantially different from the competitive results, the shares equations (38) and (39), along with the assumption that a potential entrant has an equal likelihood of achieving the performance of any current producing firm, allow prediction of entry. Hence, given input and output prices, market shares, and <u>any</u> component of cost (not necessarily all costs), it is possible to (a) test for the monopolistically competitive Bertrand equilibrium and (b) predict shares, prices, margins, and entry.

5. *Concluding Remarks*

Modeling the structure between the farm and retail level has historically emphasized simplicity. A number of recent conceptual developments, however, motivated by the hedonic point of view and summarized in this volume by Ladd and Hanemann, provides us with the means to extend current formulations. These extensions allow us to investigate the role of quality, grades, brands, and margin relationships between the retail and wholesale levels. Moreover, recent literature on food structure and performance which emphasizes the benefits of product diversification, the role of information, and the use of diversity to create barriers to entry can be investigated by a richer set of quantifiable relationships.

We have advanced conceptual frameworks for graded and branded product markets in which information is less than perfect and competition is less than pure. We have found that uncertainty has an ambiguous effect on demand; hence, information associated with branding may or may not increase demand. However, for the case of no uncertainty, there are more definitive results. Here we have derived a grade boundary-sensitive estimable demand system. In a market equilibrium context, we have generalized the earlier work of Spence and also of Dixit and Stiglitz. We have shown that a unique equilibrium characterized by a survival coefficient and zero profits does not necessarily follow. This monopolistic formulation is extended to include consumer learning. This extension predicts the market share of entrants as a function of advertising and time. Finally, we have derived an estimable set of equations that result from a monopolistically competitive model. These equations are advanced for estimating margin relationships and, thus,

predicting the difference between farm and retail prices. This formulation is compared and contrasted with the typically employed purely competitive structure for margin relationships.

The assumption often underlying agricultural sector models is that the entities or agents between the farm and retail level (e.g., assemblers, processors, and distributers) have little or no perceptible influence on market prices. For many commodity systems, this assumption should be seriously assessed to determine its validity. The formulation that we have advanced in Section 4 could be empirically investigated for a number of agricultural products and food items. The empirical tests that were discussed in Section 4 can be used to select from among the two principal margin structures, namely, the monopolistic versus the pure competition formulations. If the monopolistic competitive structure proves superior for some products in commodity systems, the implications for agricultural sector forecasting models are obvious.

The above recommendations for new directions in modeling margin relationships in agricultural sector models can be combined with the hedonic view of consumer or retail demand. For markets in which grades and brands play a major role, quality uncertainty can and should be explicitly modeled and included in sectorial forecasting systems. Until empirical work along these lines begins to emerge, we have little or no basis to determine its value in improving forecasting accuracy of agricultural sector models. Even so, the potential value in regulatory or policy impact evaluations suggest that such empirical efforts are worthwhile. Such regulatory policies include antitrust, consumer protection, advertising, grading schemes, and the like.

Appendix A

Branding and Pure Competition

In pure competition, the branding decision is much less complex than in the monopolistic competition case (analyzed in Section 3.2). For simplicity, consider the case of two goods marketed together as a grade. These goods are assumed to be so similar in appearance that a firm would have to expend advertising dollars, Z, to separate them and allow consumers to purchase them individually as a brand. In accordance with the competitive model, let the cost of branding, c, be proportional to the quantity branded; hence, there are no fixed costs of branding.[8]

The initial state of the economy is that consumers purchase the two goods for the same price P* for each of them even though they may prefer the first good to the second. The two goods are not discernible to consumers, the suppliers provide them as if their prices were the same, and the proportion of the first good to the second, f, is the intersection of the budget line, $\overline{ML}$, and the proportion line, $\overline{Of}$ on Figure 3. Branding is the opportunity to deviate from this initial equilibrium by trading the good at a price of P* per unit for the preferred brand at a price of P* + ξ per unit.

With the addition of a brand, the consumers' choice set expands from the line Oθ to the area OθNO. The indifference curve we have superimposed on this figure shows that at least some branding will be supported in a competitive equilibria. In words, branding will be supported in a competitive equilibrium if the rate of commodity substitution in the graded equilibria exceeds P*/(P* + c).

Even with constant elasticity of substitution, we have shown in Section 3.2 that the Bertrand monopolistic competition equilibria are not unique. Prices depend only on costs and the elasticity of substitutes—not on consumer weights a_i or market shares. With uncertainty, there are fewer products than otherwise, and exactly which products are marketed is random. By comparison, in pure competition branding depends simply on a comparison of the (expectation of) the rate commodity substitution to P*/(P* + ξ) and is independent of market share, entry, and the like.
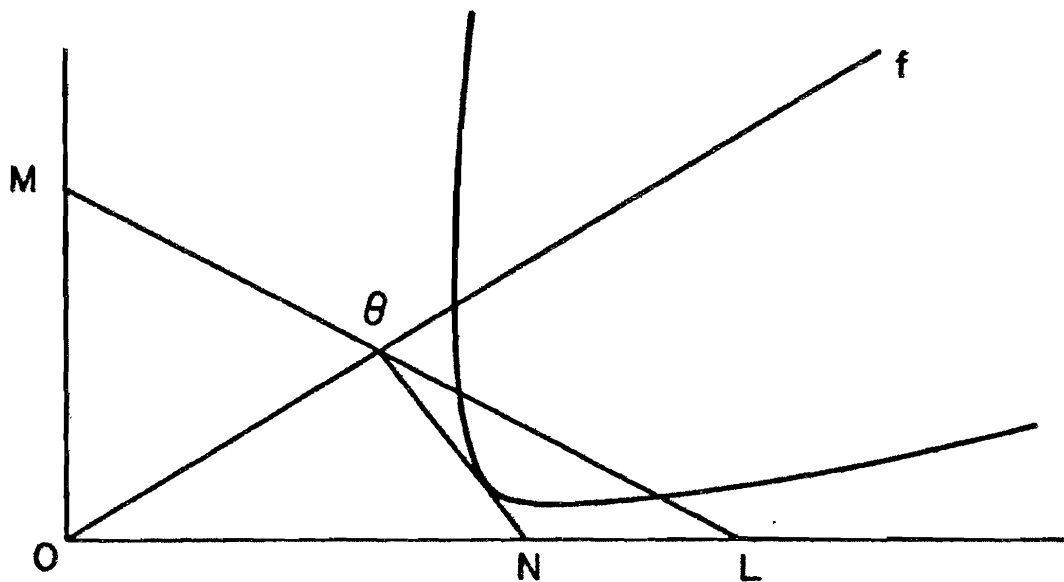
FIGURE 3. Branding in Pure Competition

Appendix B

Branding and Consumer Learning

The observations of Section 3.3 can be extended by allowing consumers to learn. In this setting, each brand has a "true" a* that is not the same as the consumer's initial conception of the value of the good, R^0. Consumers learn about the quality of the brand through actual consumption or as a result of information associated with the brand. Specifically, the consumers' *ex ante* utility function is

(B.1) $V(P_0, P, y; R)$.

This function is stated in terms of the price vector of grades, P_0; the price vector of brands, P; income, y; and the perceived vector of parameters, R, associated with the various brands. One possible form of $V(\cdot)$ is the constant elasticity of substitution utility function, i.e.,

(B.2) $V = y \left[\Sigma (R_i P_i)^\rho + (a_0 P_0)^\rho \right]^{1/\rho}$.

For this form, note that R is not generally the "true" parameter, a_i. The true parameter, a_i, is determined by the attributes of the branded product. Such attributes are unknown, but they can be estimated by consuming the branded product and/or collecting information related to its quality. Information can possibly be misleading and hereafter will be referred to as advertising, Z. The estimates of the true a_i, represented by reputation parameter, R, may be revised through consumer learning. Formally,

$$(B.3) \qquad\qquad \dot{R} = f(R, a, Z, x)$$

where x refers to the amount of the product purchased by consumers and is a vector composed of both graded and branded products.

By Roy's identity,

$$(B.4) \qquad\qquad x = \frac{-V_p}{V_y} .$$

In addition, if V is CES or the generalized Leontif as well as a number of other possible forms,

$$(B.5) \qquad\qquad x_i = H(P_i) \, K(P_0, P) \, y.$$

Moreover, if a branded product x_i represents a small portion of the consumption bundle, it follows that

$$(B.6) \qquad\qquad D_{p_i} x_i \sim H'(\cdot) \, K(\cdot) \, y.$$

In the case of graded products, the attribute list is presumed to be known; thus, there is no consumer uncertainty. Readily available public information and past consumption of grades results in an equivalence between reputation parameter, R_0, and the true parameter, a_0.

In the case of branded products, the situation is fundamentally different depending upon whether initial expectations are over- or underestimates of

the true attribute list. That is, the outcomes depend critically upon whether $R_i > a_i$ or $R_i < a_i$. For the former, it is expected that a monopolist would reap some gains from misinformed consumers. For the case in which consumers are skeptical about the attributes of a branded product, intuition suggests that the firm will tend to sell more than the static profit-maximizing level. This is simply due to the fact that $f(\cdot)$ implies that more sales today shift out the demand function tomorrow.[9]

If the brand is widely consumed, then R^0 converges to $a*$. The role of a firm's reputation, which is made by advertising (including possible creditable performance with other brands), is to speed (or retard) the convergence process. If brands are generally undervalued by consumers at their introduction, then the timing of firm entry is quite important because earlier firms have their (short-run) profits determined in part as a positive affine function of $1/\Sigma_I \ a_i^0$ while the later entrants must contend with the smaller $1/\Sigma_I \ a_i^*$.

Footnotes

*Giannini Foundation Paper No. 607 (reprint identification only).

[1]The difference between this model and that of Akerlof is mostly in the restrictions placed on U. In Akerlof's view, one of the goods (say, x_1) is always better than the other good, x_2; and only one unit of the commodity is purchased. In our view neither good dominates the other, and U represents preferences that have closed, convex-upper contour sets. Thus, both of our commodities are desirable.

[2]See Heal for the opposite result in a more restrictive model.

[3]This is the case one expects, but see Fisher.

[4]Zusman has derived the first-order conditions for this problem and interpreted them as pricing equations.

[5]If U is CES and the quantity of each good x_i is fixed, then the amount spent on the branded goods is invariant with respect to the grade cutoff.

Proof.

$$U^\rho = a_0 x_0^\rho + \int_{[o,b)} (a_i x_i)^\rho + \int_{[b,1)} (a_i x_i)^\rho.$$

The consumer problem is max U subject to $x_0 + G_1 P_1 + G_2 P_2 = y$ where x_0 is the numeraire, G_i is quantity of grade, and P is price.

$$G_1 \equiv \int_{(o,b)} x_i, \; G_2 \equiv \int_{(b,1)} x_i, \; A_1 = \int_{(o,b)} f_i a_i^\rho, \; A_2 = \int_{(b,1)} f_i a_i^\rho.$$

Set the marginal rate of substitution (MRS) of G_1 for G_2 equal to its price ratio and substitute into the budget constraint to obtain

$$y = x_0 + P_1 x_1 \left[\left(\frac{A_2}{A_1} \right)^\rho \right] + 1$$

where $F = G_2/G_1$. Set the MRS of G_1 for x_0 equal to P_1 (since $P_0 \equiv 1$) and substitute out P_1 to obtain

$$y = x_0 + x_0^{1-\rho} a_0^{-\rho} G_1^\rho \left[A_1^\rho + (A_2 F)^\rho \right].$$

Note that x_0 will be constant with respect to b, provided $G_1^\rho [A_1^\rho + (A_2 F)^\rho]$ is constant with respect to b. But this is

$$G_1^\rho A_1^\rho + G_2^\rho A_2^\rho = \int_{[o,b)} (a_i x_i)^\rho + \int_{(b,1)} (a_i x_i)^\rho$$

which is obviously invariant with respect to b.

Since $dx_0/db = 0$ and $P_0 \equiv 1$, the amount of income spent on the numeraire is constant; and since the amount spent on the graded good is $y - P_0 x_0$, that amount is constant also. Note that this result depends on the special properties of the CES function and does not necessarily hold for other utility functions.

[6]In the Spence formulation, the marginal utility of income is assumed constant.

[7]This neglects a term that is of the order of magnitude of the reciprocal of the number of firms. For further details, see Dixit and Stiglitz or Spence.

[8]Technically, all that is needed is that costs be nondecreasing.

[9]While this might represent a welfare gain, it must be balanced against the fact that consumers are less likely to buy, simply because they underestimate its value.

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