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TWO ESSENTIAL CHARACTERISTICS OF RETAIL MARKETS AND THEIR ECONOMIC CONSEQUENCES

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Two essential characteristics of retail markets and their economic consequences*

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Retail firms provide customers with a variety of distribution services. Higher levels of these services cost the firms more to produce but reduce costs for their customers; these distribution services are usually not priced separately from the products purchased; in addition, some distribution services are available to all items in an assortment (common) and others are available to a few (specific). Incorporation of these characteristics into the analysis of retail markets generates novel results on the nature of pricing policies, on their interaction with the provision of distribution services, and on the effects of competitive behavior.

1. Introduction

One characteristic of retail enterprises, which is shared to some extent by virtually all business firms, is the bundling of distribution services with whatever goods or services the firm offers. This paper presents an economic analysis of a price setting multiproduct retailer that also chooses levels of distribution services. Hence, it generalizes our earlier work on single product

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retailing [Betancourt and Gautschi (1988)] and also that of Bliss (1988) on multiproduct firms with an exogenously given level of a distribution service.

A second characteristic of retail enterprises is their ability to shift distribution costs between consumers and retailers [Bucklin (1966), Ingene (1984)]. In our earlier study [Betancourt and Gautschi (1988)] we incorporated this characteristic by treating distribution services as outputs, which in turn become inputs that lower distribution costs in a household production model of the consumer. We show here that this capacity has important welfare consequences.

Our results are especially relevant for two different strands of literature on retail enterprises. First, there is an older strand that focuses on the practice of market basket pricing [Preston (1962), Bailey (1954) and Holdren (1960) made early contributions and Nagle (1987) provides an example of a textbook treatment of the topic]. We generalize the analysis of this practice here by allowing explicitly for the role of distribution services. Secondly, there is a more recent strand that seeks to explain retail margins in terms of the practice of mark-up pricing [Nooteboom (1982) and Nooteboom and Thurik (1985)]. Econometric studies in this tradition, for example Bode (1990), reveal a wide variety of associations between retail margins and the levels of distribution services. In this paper we identify mechanisms that lead to these different patterns of association.

We proceed as follows: in section 2, we specify the demand and cost characteristics of retailing. In section 3 we analyze the profit maximizing behavior of the retail firm, in particular the interactions between distribution services and pricing policies. Finally, in section 4, we analyze competition in retail markets, in particular its effect on the levels of prices and distribution services offered by retailers and on the welfare consequences for consumers of bundling and distribution cost shifting.

2. Components of the model

The demand side follows from assuming a household production model in which utility is maximized subject to the constraint that the household's full income (W) be sufficient to cover the costs of producing the optimal levels of the commodities that yield satisfaction (Z^0). This optimization yields

$$Q_k = h_k(p^*, \bar{p}, D, Z^0(p^*, \bar{p}, D, W)) = g_k(p^*, \bar{p}, D, W), \qquad k = 1, \ldots, K, \tag{1}$$

where (1) is the Marshallian demand function derived in Betancourt and Gautschi (1992). p^* represents a vector of retail prices; $\bar{p}$ represents a vector of other prices, including the opportunity cost of time; and D is a vector of distribution services.

In the subsequent sections we use: the price elasticity of demand,

$\varepsilon_{kl}=(\partial Q_k/\partial p_l^*)(p_l^*/Q_k)$, and the distribution services elasticity of demand, $\varepsilon_{kj}=(\partial Q_k/\partial D_j)(D_j/Q_k)$. Betancourt and Gautschi (1992) demonstrate that there exists a tendency toward gross complementary ($\varepsilon_{kl}<0$) between items in the assortment of a given retailer as well as between the distribution services of a retailer and the items in his or her assortment ($\varepsilon_{kj}>0$).

Associated with the optimization problem generating (1) is the following expenditure function

$$E=E(p^*,\bar{p},D,Z^0). \tag{2}$$

Because distribution services provided by a retailer act as fixed inputs into the household's consumption and purchasing activities, this expenditure function is nonincreasing in distribution services (since a restricted cost function is nonincreasing in the restricted input). This characteristic provides the demand side mechanism for cost shifting and yields a shadow price for distribution services (r_j), namely

$$r_j=-(\partial E/\partial D_j)\geqq 0. \tag{3}$$

As the level of a distribution service increases, the consumer's expenditure needed to attain a given optimal level of utility is reduced; the absolute value of this reduction represents what the consumer should be willing to pay for a unit of the service in the market if it were available at an explicit price.

Just as any other firm in the economy, the retail firm's problem can be formulated as the production of given levels of outputs demanded by its customers at the lowest possible cost. Cost minimization subject to technologial restrictions results in the following cost function for retailing

$$C=C(V,Q,D), \tag{4}$$

where V are input prices,[1] Q is a vector of outputs or retail items and D is a vector of distribution services. This function is nondecreasing, linear homogeneous and concave in prices, increasing in at least one price, the levels of outputs and in the level of distribution services. The latter are treated as outputs of the retail firms, which provides the supply side mechanism for shifting costs between consumers and retailers. To illustrate, if in a given market area a retailer provides two stores instead of one that retailer is providing much higher levels of accessibility of location, one of the most important elements of the D vector, but this decision will entail much higher levels of costs, i.e. $C_j\equiv\partial C/\partial D_j\geqq 0$.

Jointness in supply between distribution services and items in the assort-

[1]Namely, prices of capital services, labor services, etc. It does not contain wholesale or retail prices of items for sale.

ment is one reason for distinguishing between common and specific distribution services. Common and specific distribution services are distinguished as follows: a common one is available to all the items in an assortment, for example accessibility of location; a specific one is available to a particular item, or a subset of items, in an assortment, for example in formation on the price of an item.

If the level of a common distribution service is increased, it becomes available to all the items provided by a retailer and the cost savings are likely to lead toward multiproduct natural monopoly over some output ranges. For example, increasing accessibility of location by expanding a parking lot provides this higher level of the distribution service to all the items in the assortment and generates cost savings over the alternative of increasing it for every item under stand-alone production, for example contracting for delivery of specific items with different delivery services. By contrast increasing a specific distribution service such as providing a better description of an item will not furnish strong monopoly incentives.

Jointness in supply within distribution services can also be a source of cost savings driving a retailer toward natural monopoly over some output ranges. For instance, if a retailer increases the depth of assortment by adding one line of products closely related to another one already in the assortment the assurance of product delivery in the desired form also increases, since consumers will view both lines as close or perfect net substitutes.

It is convenient at this point to introduce some notation to distinguish between common and specific distribution services in terms of the concept of multiproduct returns to scale. We will apply the definition used by Laitinen and Theil (1978). That is, multiproduct returns to scale, SE, can be defined as

$$SE=\sum_{k=1}^{K} S_k+\sum_{k=1}^{K} \eta_k+\sum_{j=1}^{J} \eta_j, \qquad (5)$$

where $SE=(\mathrm{d}C/C)/\mathrm{d}x/x$ and $\mathrm{d}x/x$ represents the same proportionate increase in all outputs, including distribution services. The term $S_k=(\partial C/\partial Q_k)Q_k/C$ can be interpreted as the proportionate contribution of the kth type of retail item to total marginal costs, or the elasticity of costs with respect to the kth item. Similarly, $\eta_k=(\partial C/\partial D_k)D_k/C$, where we have defined D_k as the level of a specific distribution service that affects only the kth item.[2] $\eta_j=(\partial C/\partial D_j)D_j/C$ and it represents the elasticity of costs with respect to the jth common distribution service.

[2]In general one can have a specific distribution service that affects several items, but not all of them, and more than one specific distribution service affecting the same item, but to simplify the notation we are assuming there is only one specific distribution service per item and that it affects only that item.

3. Pricing implications

In this section we develop the implications of the prior specification of the demand and cost side for a profit-maximizing retail firm. Profits will be given by

$$\pi = p^*Q - C(V, Q, D) - pQ, \tag{6}$$

where p is a vector of prices at which the retailer purchases the items from suppliers.

Maximization of (6) by choosing prices (p_l^*), specific distribution services (D_k) and common distribution services (D_j) leads to three different sets of first-order conditions which, after manipulation, can be written as

$$\alpha_l = \sum_k \alpha_k M_k(-\varepsilon_{kl}) \qquad l = 1, \ldots, K \tag{7}$$

$$\eta_k = \alpha_k^* M_k(\varepsilon_{ks}) \qquad k = 1, \ldots, K \tag{8}$$

$$\eta_j = \sum_j \alpha_k^* M_k(\varepsilon_{kj}) \qquad j = 1, \ldots, J. \tag{9}$$

Most of the terms have been defined in the previous section. The ones that have not are: $\alpha_k = p_k^* Q_k / \sum p_k^* Q_k$, the share of the kth item in total revenues; $M_k = [p_k^* - C_k - p_k]/p_k^*$, the profit margin on the kth item; $\alpha_k^* = p_k^* Q_k / C$, the share of revenues from the kth product in the costs of retailing (notice that $\sum_k \alpha_k^* > 1$); ε_{ks} is the distribution services elasticity of demand with respect to the specific distribution service that affects the kth item in the assortment (D_k).

An important although straightforward consequence of these conditions is that, in general, the optimal pricing policy of a retailer affects and is affected by the optimal levels of specific and common distribution services provided to customers. Below we will develop a number of propositions that bring out several aspects of this result in terms of (7) through (9). Due to the multiproduct nature of the problem, however, general results are subject to qualifications. Therefore, we will proceed by deriving the basic results rigorously through a comparative statics analysis of a simpler model in the appendix. This procedure yields four theorems that provide the basis for general tendencies that are summarized in terms of propositions. In general, these tendencies will be stronger the greater the number of items in a given assortment that are gross complements ($-\varepsilon_{kl} > 0$).

It is useful to state explicitly the main assumptions underlying the results: marginal costs are nondecreasing in output and distribution services; the responsiveness of demand to changes in distribution services is nonincreasing in distribution services; these same two assumptions hold in terms of elasticities; finally, all distribution services elasticities are assumed to be positive.

Our first result is summarized in the following theorem.

Theorem 1. An exogenous increase in the responsiveness of demand to price changes lowers the retail price and the level of distribution services.

The proof is in the appendix but the intuition underlying the result is as follows: the greater responsiveness to price changes leads the firm to lower prices, which increases the quantity demanded of retail items; the consequent increase in marginal costs leads the firm to lower distribution services in order to lower costs and increase profits.

This result underlies the following proposition for the general case described by (7)–(9).

Proposition 1. Retailers that sell items with high (absolute) values of the own price elasticity of demand and/or that are gross complements will tend to offer lower prices and lower levels of distribution services than retailers without these characteristics.

The association between high price elasticities of demand and gross complementarity with lower prices is embedded in the market basket pricing literature cited in the introduction.[3] Indeed, eq. (7) is similar in form to Preston's basic equation. What is new here is first the precise identification of the source of this result in Theorem 1 and second that the same mechanism leads to lower levels of distribution services. This proposition supports the commonplace observation that retailers that cater to price sensitive segments of the market tend to offer low levels of distribution services.

A second result from the simple model is in the following theorem.

Theorem 2. An exogenous increase in the responsiveness of demand to changes in distribution services leads to a higher retail price and a higher level of distribution services.

Once again the proof is in the appendix but the intuition underlying the result is as follows: the greater responsiveness to changes in distribution services leads the firm to provide higher levels of these services which increases the quantity demanded of retail items; the consequent increases in marginal costs in both dimensions leads the firm to raise prices and, thus, to lower the quantity demanded of retail items in order to increase profits.

[3]Since the retail price and the retail or gross margin will always move in the same direction, the same association holds for retail margins.

This result underlies the following proposition for the general case described by (7)–(9).

Proposition 2. Retailers that face high distribution services elasticities of demand will tend to charge higher prices and offer higher levels of distribution services than retailers without this characteristic.

This proposition is what one would expect if distribution services are viewed as a proxy for quality. In the product quality literature, higher quality is associated with a higher price due to the consumer's greater willingness to pay, e.g. Shaked and Sutton (1982). An important economic implication of this result, however, is in the precise identification of one of the conditions that lead to the association between higher prices and higher levels of distribution services. That is, Theorem 2 indicates that this association will be generated by differences in the responsiveness of demand to distribution services as created, for example, by a high opportunity cost of time.

A third result is the following theorem.

Theorem 3. An exogenous decrease in the responsiveness of marginal costs to changes in distribution services leads to higher prices and higher levels of distribution services.

Just as before the proof is in the appendix but the intuition is as follows: the lower responsiveness of marginal costs to increases in distribution services leads to an increase in these services which in turn increases the quantity demanded of retail items; the consequent increase in marginal costs along both dimensions leads the firm to raise prices in order to increase profits.

This result underlies the following proposition for the general case described by (7)–(9).

Proposition 3. Retailers that face low elasticities of costs with respect to distribution services will tend to charge higher prices and offer higher levels of distribution services than retailers without this characteristic.

This proposition is somewhat surprising because in the quality literature higher costs of producing higher levels of quality are associated with higher prices, e.g., Moorthy (1988). Our results shows that this is not the case when the higher costs are the result of a change in the slope of the marginal cost function for distribution services as opposed to, for example, a change in the slope of the marginal cost function for quantity of retail items.[4] An

[4]See the appendix.

economic implication of this result is that an association between high prices and high levels of distribution services can be generated by differences in the responsiveness of the marginal cost function to distribution services which are created by differences in cost conditions, for example differences in wages of night-time workers.

The last theorem derived from the model in the appendix is the following:

Theorem 4. An exogenous increase in demand increases prices at a given level of distribution services and lowers the levels of distribution services at a given level of prices.

The proof is also in the appendix but the intuition is as follows: a shift in demand allows the firm to charge higher prices at the old level of distribution services or to provide lower levels of distribution services at the old prices. While the normal range of responses by the firm would be to charge higher prices and offer lower levels of distribution services, it is possible for the firm to increase prices by so much that it can increase the levels of distribution services or to lower the levels of distribution services by so much that it can lower prices.

This result underlies the following proposition for the general case described by (7)–(9).

Proposition 4. Retailers that operate in markets with high levels of demand for their given assortments will tend to charge higher prices and offer lower levels of distribution services than those that operate in markets with lower levels of demand for the same assortments.

These four propositions identify different exogenous characteristics of demand and cost which generate different patterns of association between levels of prices and distribution services that can be observed in retail markets. These patterns arise as a result of the possibilities for cost shifting introduced in the demand and cost side of the model and the jointness in supply between distribution services and the quantities of retail items specified in the retailing cost function.

Since the previous results are based on the simple model of the appendix, they do not bring out the jointness in supply within distribution services or the distinction between common and specific distribution services. In order to bring out these features we put forth an additional proposition and illustrate its validity in a simple setting. Thus, we have

Proposition 5. Retailers who provide common *distribution services and find it profitable to expand their assortments are likely to increase the levels of these common distribution services and/or lower prices; the opposite tendencies exist* *for retailers who provide specific distribution services and find it profitable to expand their assortments.*

While all previous propositions are also of the other things equal variety, this one requires special notice since the objective function leading to (7)–(9) assumes assortment to be given. The conceptual experiment to be considered is one involving two situations where profits are maximized with the property that $\pi^*(K+1)>\pi^*(K)$ for each of two firms, i.e., for one that provides only common distribution services (A) and for one that provides only specific distribution services (B).

Taking the situation for firm A first, comparison of (9) for $\pi^*(K+1)$ with (9) for $\pi^*(K)$ provides the basis for the first part of Proposition 5. Consider (9) for $\pi^*(K+1)$.

$$\eta_j=\sum \alpha_k^* M_k \varepsilon_{kj}+\alpha_{K+1}^* M_{K+1} \varepsilon_{(K+1)j}. \tag{9'}$$

Assume initially that prices are given in both situations and that the marginal cost of providing the kth item is not affected by the change in assortment. Then the first term in (9′) will be smaller than the corresponding term in (9), because $\alpha_k^*=p_k^* Q_k/C$ and C must be higher in (9′) than in (9) as a result of the increase in assortment. Nevertheless, the second term in (9′) will be positive and the magnitude of this term will be larger the more profitable it is to expand the assortment, i.e., the larger M_{K+1}. Therefore, the more profitable it is to expand assortment, the more likely is the second term in (9′) to dominate the first and thus to require an increase in common distribution services so that the two sides of (9′) can be equated. Alternatively, let us now assume distribution services are given in both situations and everything else is as before, except prices can adjust. If the second term in (9′) dominates, in order to equate the two sides of (9′), as required in equilibrium, it would be necessary to lower retail prices, which in turn would lead to lower levels of M_k and thus restore equilibrium. In general, of course, adjustments to the assortment expansion will rely on both instruments.[5]

Consider now the situation for firm B. The expansion of assortment will change eq. (8) as follows:

$$\eta_k=\alpha_k^* M_k \varepsilon_{ks} \quad k=1,\ldots,K+1. \tag{8'}$$

[5]Incidentally, note that these changes in either prices or distribution services will also need to equilibrate eq. (7) after the expansion in assortment. That is, consider (7′)

$$\alpha_l=\sum_k \alpha_k M_k(-\varepsilon_{kl})+\alpha_{K+1} M_{K+1}[-\varepsilon_{(K+1)l}] \quad k=1,\ldots,K+1. \tag{7'}$$

Since all shares decrease, i.e., $\alpha_k=p_k^* Q_k/\sum_{k=1}^{K+1} p_k^* Q_k$, we are simply assuming that the necessary changes to bring (7′) in equilibrium will not be strong enough to eliminate the direction of changes identified on the basis of eq. (9′). That is why the proposition is stated in terms of tendencies.

With prices and C_k given, at the old level of distribution services (8′) would not be an equilibrium because $\alpha_k^* = p_k^* Q_k / C$ decreases as a result of the increase in C due to the new item in the assortment; hence, specific distribution services must decrease in order to restore equilibrium, no matter how profitable the addition of the $K+1$ item. If instead distribution services are given at the old level and prices are allowed to adjust, they must increase in order to bring the two sides of (8′) into equilibrium. The same qualification as in footnote 5 applies here.

Proposition 5 is useful in explaining trends in certain characteristics of retail institutions as well as differences between retail institutions. For instance, expansions in assortment are an important feature in the rise of supermarkets and in the demise of the corner grocery store. Moreover, a similar process has been continuing in the 1980s with superstores expanding rapidly at the expense of conventional supermarkets.[6] The former are differentiated from the latter in that they contain a greater variety of products and considerable nonfood products, i.e. broader and deeper assortments. Proposition 5 suggests that the ability of superstores to increase market share and accessibility of location provided in the 1980s, while competing with the low prices of conventional supermarkets, is intimately related to their broader and deeper assortments.

This proposition also helps explain a well known characteristic of retailing as well as challenging one piece of conventional wisdom that purports to explain this characteristic. It is a fact that supermarkets have low retail margins and department stores have high retail margins.[7] Both types of institutions have broad assortments and in the retailing literature the high retail margins of department stores are commonly attributed to their providing many 'services'. Proposition 5 suggests that supermarkets can provide very high levels of accessibility of location and maintain low prices and retail margins because accessibility of location is a *common* distribution service and supermarkets do not offer high levels of specific distribution services. In contrast, department stores provide high levels of *specific* distribution services for each item or subsets of items in their assortments through their sales personnel, who provide information services and assurance of product delivery in the desired form; consequently, department stores must charge high prices and operate at high retail margins in order to provide these *specific* distribution services. Thus, the difference in retail margins is mainly due to the different nature of the services that are

[6]For instance, sales of conventional supermarkets in the U.S. decreased from 73.1 percent in 1980 to 42.6 percent in 1985, at the same time sales of superstores went from 17.7 percent in 1980 to 30.6 percent in 1989. Similar changes occurred in the number of establishments. U.S. Statistical Abstract, 1991 (table 1364).

[7]For example, in the 1982 U.S. Census of Retail Trades the average retail margins of grocery stores and department stores were 0.23 and 0.35, respectively.

provided. In fact, in comparison to supermarkets there are some services that department stores offer at fairly low levels, for example the common distribution service accessibility of location.[8]

4. Competition and welfare[9]

One form of competition in retail markets, characterized by Bliss (1988), is that the firm must offer the consumer as equally good value for money as any other firm. Bliss interprets this condition in terms of an indirect utility function, so that the firm's optimization problem is subject to the constraint that the utility a consumer receives while patronizing a retailer, $V(p^*, \bar{p}, D, W)$ in our notation, must be the greater than or equal to the maximum level of utility he or she can attain from any other retail firm, $\bar{V}$. For our purposes, it is convenient to express this constraint in terms of the expenditure function. Thus, the firm's optimization problem is subject to the constraint that the expenditures of a consumer to attain her maximum level of utility while patronizing a retailer $E(p^*, \bar{p}, D, Z^0)$ be less than or equal to the lowest cost from attaining this maximum level of utility at any other firm, $\bar{E}$. Imposing this constraint on the optimization problem of the previous section allows us to evaluate the effect of this aspect of competition in retail markets on equilibrium prices and distribution services and, thus, on welfare.

Formally, we have as the objective function

$$L = p^*Q - C(V, Q, D) - pQ + \mu[\bar{E} - E(p^*, \bar{p}, D, Z^0)], \tag{10}$$

where μ is the Lagrange multiplier. The necessary conditions for an optimum solution to this problem generate the equilibrium levels of prices and distribution services for the retail firm. These are given in (11)–(14) after some manipulation to facilitate comparisons with the literature and section 3. That is, at the solution values we must have

$$\alpha_l(1-\mu) = \sum_k \alpha_k M_k(-\varepsilon_{kl}) \quad l = 1, \ldots, K \tag{11}$$

$$\eta_k = \mu r_k[D_k/C] + \alpha_k^* M_k \varepsilon_{ks} \quad k = 1, \ldots, K \tag{12}$$

$$\eta_j = \mu(r_j D_j/C) + \sum_k \alpha_k^* M_k \varepsilon_{kj} \qquad j = 1, \ldots, J \tag{13}$$

[8]For instance, using number of establishments as a measure of accessibility of location, the 1982 U.S. Census of Retail Trade shows grocery stores with 128,494 units and department stores with 9,981 units.

[9]We analyse the role of competition by comparing two situations with dfferent exogenously determined levels of competition. H. Röller has suggested to us the use of a game theoretic framework to allow an endogenous determination of the level of competition. Clearly, this is an important area for future research.

$$\bar{E}=E(p^*,\bar{p},D,Z^0). \tag{14}$$

A comparison of (11)–(13) with (7)–(9) reveals that, for any given degree of competition ($\mu>0$ and $\bar{E}$ given), the first-order conditions are modified by the introduction of an additive term in each of the three equations. Therefore, the same tendencies established in the previous section will continue to hold but they will be amplified or dampened by the changes in this new term due to changes in the exogenous demand and cost characteristics. Since no novel insight arises from a detailed discussion of these changes, we proceed instead to the main topic of this section.[10]

Our principal concern in this context is to ascertain the welfare effects of this aspect of competition in retail markets. To do so note the interpretation of the Lagrange multiplier: it represents the marginal contribution to profits of lowering the competitive standard that the firm must meet, since a higher value of $\bar{E}$ makes it easier for the firm to maximize profits while meeting the consumer's best alternative situation. Note that $\mu \geqq 1$ is not feasible as it would require prices to be negative or equal to marginal cost in the presence of downward sloping demand curves. Hence, the analysis here only considers situations where $0 \leqq \mu < 1$.

We will analyze the role of competition by comparing a situation in which the constraint is not binding, $\bar{E}_1 > E(p_1^*,\bar{p},D_1,Z_1^0)$ and $\mu=0$, to one where the constraint is binding, $\bar{E}_0=E(p_0^*,\bar{p},D_0,Z_0^0)$ and $\mu>0$. In going from the former situation to the latter, we have an increase in competition and $\bar{E}_1-\bar{E}_0>0$, but we don't know if $U(Z_1^0) \gtreqless U(Z_0^0)$. In general, if equilibrium prices decrease (increase) and equilibrium distribution services increase (decrease) in going from the former situation to the latter, the bottom (top) inequality prevails and consumers are better (worse) off, because with the same full income they can attain a higher (lower) level of utility at the new prices and distribution services, and we say that competition is beneficial (detrimental). If equilibrium prices increase (decrease) but equilibrium distribution services increase (decrease) in going from the former situation to the latter, one cannot tell in general whether competition is beneficial or detrimental, as it would depend on the offsetting effects of these two tendencies on the expenditure function of the consumer. With specific functional forms, however, the question could be answered.

Proceeding to the comparison directly, we have

Proposition 6A. Competition in retail markets tends to be beneficial to consumers in the sense of lowering prices and it can but need not be beneficial to consumers in the sense of raising distribution services.

[10]Incidentally, eq. (11) is a generalization of eq. (14) in Bliss (1988) expressed in terms of elasticities.

To establish this proposition compare (7)–(9) with (11)–(14). This comparison reveals that competition ($\mu > 0$) operates in (11) as an increase in the absolute value of the price elasticities; hence, the statement in Proposition 1 with respect to prices is applicable, which establishes that competition tends to lower prices. The situation with respect to distribution services, however, is a bit more complex. The logic of Proposition 1 suggests a lowering of the level of distribution services but this tendency will now be counteracted by the term $(\mu r_j D_j / C)$ in (13) and the corresponding term in (12). Whether this tendency is sufficient to lead to an increase in distribution services will obviously be determined by the magnitude of this term.

Our previous discussion naturally leads to an additional proposition.

Proposition 6B. Other things equal, competition in retail markets is more likely to be beneficial, in the sense of raising distribution services, the higher is the shadow price of distribution services (r_j) and the lower is the average cost of providing a unit of distribution services (C/D_j).

This proposition follows logically from the previous discussion, as it merely identifies the two independent economic factors that make the term $(\mu r_j D_j / C)$ large in magnitude (μ makes this term large but it also makes the decrease in margins large in absolute value). Its economic significance is the following. One of the main determinants of the price consumers are willing to pay for distribution services is the opportunity cost of their time. From our analysis of the demand side [Betancourt and Gautschi (1992)] almost all distribution services are to be viewed as substitutes for the household's time. Therefore, the higher the opportunity cost of time for households, as in high wage countries with multiple income earners, the higher the shadow price of distribution services and the more likely is competition to be beneficial by raising the level of distribution services. On the cost side, this proposition suggests, for example, that competition is more likely to be beneficial by raising distribution services in small, densely populated and easily traversed regions than in expansive, thinly populated regions or in those with difficult topographies, since the average costs of providing accessibility of location would be larger in the latter case.

By considering the special case of exogenously given prices we obtain a result which is useful in relating our findings to those available in the literature. That is,

Theorem 5A. Under the assumptions of section 3, if prices are given the introduction of competition is always beneficial to consumers.

Proof. The hypothesis that prices are given makes eq. (11) irrelevant. The introduction of competition requires, under the assumptions of section 3, an increase in distribution services to increase the term on the LHS and/or to decrease the second term on the RHS of (12) and (13). Therefore, the introduction of competition is always beneficial in this case. Q.E.D.

An important aspect of this finding is that it contradicts one standand result of the Hotelling (1929) model which is highlighted in the literature, e.g., Sharkey (1982, ch. 4). There, it is argued that competition on location is always detrimental to consumers. The explanation for this difference in results brings out the importance of one of the two essential characteristics of retail markets that we have been emphasizing, namely the shifting of distribution costs between consumers and retailers. In the spatial literature the result is obtained by assuming that the marginal costs of providing accessibility of location are zero; hence, there can be no cost shifting.

We conclude our discussion by summarizing the implications of making a similar assumption in our model. That is,

Theorem 5B. If the marginal costs of providing a distribution service are assumed constant at the zero level, a monopolist will provide the highest level of the distribution service consistent with a nonnegative distribution services elasticity of demand and competition is not feasible.

Proof. To establish this result, note that if the marginal cost of providing distribution services is zero, then the LHS of (13) must be zero under both competition ($\mu > 0$) and monopoly ($\mu = 0$). Under monopoly and the assumption of nonincreasing ε_{kj}, the only way to bring the RHS into equilibrium with the LHS is to increase, for example, the level of accessibility of location until $\sum_k \alpha_k M_k \varepsilon_{kj}$ is down to zero. Hence, the highest feasible level of accessibility of location is being provided and competition is not feasible because it requires higher levels of accessibility of location in order to make the second term in (13) negative.[11] Q.E.D.

Appendix: Comparative statics results

In this appendix, we perform a comparative statics analysis on a simplified version of the model that highlights the basic insights to be derived from the model.

Consider the single product, single distribution service situation, profits will be given by

[11]This result is similar to one obtained in the product quality literature. As Moorthy (1988, p. 164) points out when 'quality' is costless the monopolist chooses the highest feasible quality and if there is competition both firms (Moorthy provides a game theoretic analysis of a duopoly) cannot be at this point.

$$\pi = p^*Q - C(v, Q, D) - pQ. \tag{A.1}$$

The first-order conditions are

$$\pi_{p^*} = Q + [p^* - C_Q - p)\,\partial Q/\partial p^* = 0 \tag{A.2}$$

$$\pi_D = -C_D + [p^* - C_Q - p]\,\partial Q/\partial D = 0. \tag{A.3}$$

For simplicity we will consider first two types of exogenous changes on the demand side: one that shifts only the intercept (I) in the demand function and another type that shifts only the slope of the demand function with respect to the retail price (S_{p^*}) or the slope of the demand function with respect to distribution services (SD). Recall from the text that demand is given by $Q_k = g_k[p^*, \bar{p}, D, W]$.

Allowing for these changes and expressing the total differentials of (A.2) and (A.3) in matrix form, we have

$$\underset{2\times 2}{H}\begin{bmatrix} \mathrm{d}p^* \\ \mathrm{d}D \end{bmatrix} = \underset{2\times 3}{a}\begin{bmatrix} \mathrm{d}I \\ \mathrm{d}(S_{p^*}) \\ \mathrm{d}(SD) \end{bmatrix}, \tag{A.4}$$

where

$$h_{11} = \{2\,\partial Q/\partial p^* - C_{QQ}(\partial Q/\partial p^*)^2 + N\,\partial^2 Q/\partial (p^*)^2\} < 0,$$

$$h_{12} = \{\partial Q/\partial D - C_{QQ}(\partial Q/\partial D)(\partial Q/\partial p^*) - C_{QD}(\partial Q/\partial p^*)$$
$$+ N\,\partial^2 Q/\partial p^*\,\partial D\} > 0,$$

$$h_{21} = \{-C_{DQ}\,\partial Q/\partial p^* - C_{QQ}\,\partial Q/\partial p^*\,\partial Q/\partial D + N\,\partial^2 Q/\partial D\,\partial p^*\} > 0,$$

$$h_{22} = \{-C_{DD}(1 + \partial Q/\partial D) - C_{DQ}\,\partial Q/\partial D - C_{QQ}(\partial Q/\partial D)^2$$
$$+ N\,\partial^2 Q/\partial D^2\} < 0, \quad \text{and} \quad N = (p^* - p - C_Q) > 0.$$

The signs of h_{11} and h_{22} follow from the seond-order conditions, which also ensure that $|H| > 0$. The signs of h_{12} and h_{21} follow from the standard assumptions on the cost function ($C_{DQ} \geqq 0$ and $C_{QQ} \geqq 0$) and the assumption that $\partial^2 Q/\partial p^*\,\partial D > 0$. That is, as distribution services increase the responsiveness to price decreases and this means a higher algebraic value of $\partial Q/\partial p^*$.

Continuing with an identification of the terms in (A.4).

$$a_{11} = -(\partial Q/\partial I) + C_{QQ}(\partial Q/\partial p^*)(\partial Q/\partial I) < 0,$$

$$a_{12} = -N\,\partial^2 Q/\partial p^*\,\partial(Sp^*) > 0,$$

$$a_{13}=0,$$

$$a_{21}=C_{DQ}(\partial Q/\partial I)+C_{QQ}\,\partial Q/\partial D(\partial Q/\partial I)>0,$$

$$a_{22}=0$$

$$a_{23}=-N\,\partial^2 Q/\partial D\,\partial(SD)<0.$$

These signs follow from the same assumptions as before and the definition of the exogenous changes in positive terms so that $\partial Q/\partial I>0$, $\partial^2 Q/\partial D\,\partial(SD)>0$ and $\partial^2 Q/\partial p^*\,\partial(Sp^*)<0$. Again the last sign follows because an increase in price responsiveness implies an algebraic decrease in $(\partial Q/\partial p^*)$. $a_{13}=a_{22}=0$ by assuming that the change in the slope with respect to price does not affect the slope with respect to distribution services and vice versa.

We can now obtain the results of interest, i.e.

Proof of Theorem 1. By the hypotheses of the theorem $\mathrm{d}I=\mathrm{d}SD=0$, hence the solution of (A.4) leads to

$$\partial p^*/\partial S_{p^*}=h_{22}a_{12}/|H|<0 \qquad \text{(A.5)}$$

$$\partial D/\partial Sp^*=-h_{21}a_{12}/|H|<0 \qquad \text{Q.E.D.} \qquad \text{(A.6)}$$

Proof of Theorem 2. By the hypotheses of the theorem $\mathrm{d}I=\mathrm{d}SP^*=0$, hence the solution of (A.4) leads to

$$\partial p^*/\partial SD=-h_{12}a_{23}/|H|>0 \qquad \text{(A.7)}$$

$$\partial D/\partial SD=h_{11}a_{23}/|H|>0. \qquad \text{Q.E.D.} \qquad \text{(A.8)}$$

Proof of Theorem 4. By the hypotheses of the theorem $\mathrm{d}Sp^*=\mathrm{d}SD=0$, hence the solution of (A.4). leads to

$$\partial p^*/\partial I=(h_{22}a_{11}-h_{12}a_{21})/|H|\gtrless 0 \qquad \text{(A.9)}$$

$$\partial D/\partial I=(-h_{21}a_{11}+h_{11}a_{21})/|H|\gtrless 0 \qquad \text{(A.10)}$$

If we now assume that distribution services are given, (A.10) is irrelevant and (A.9) becomes

$$\partial p^*/\partial I\,|\,(\mathrm{d}D=0)=a_{11}/h_{11}>0 \qquad \text{(A.9')}$$

Similarly, if we assume instead that prices are given (A.9) becomes irrelevant and (A.10) becomes

$$\partial D/\partial I\,|\,(\mathrm{d}p^*=0)=a_{21}/h_{22}<0. \qquad \text{Q.E.D.} \qquad \text{(A.10')}$$

The proof of Theorem 4 is a simple illustration of the Le Chatelier principle. Namely, when the constraints in (A.9′) and A.10′) are relaxed the range of responses of the endogenous variables increases, which means in this case that they can reverse signs.

We will now consider two types of exogenous changes on the cost side: one that shifts only the slope of the cost function for distribution services (*SDD*) and one that shifts only the slope of this cost function for the quantity of retail items (*SCQ*). Allowing for these changes and expressing the total differentials of A.2 and A.3 in matrix form leads to a new version of (A.4), namely

$$H\begin{bmatrix} dp^* \\ dD \end{bmatrix} - a_{2\times 2}\begin{bmatrix} d(SCQ) \\ d(SCD) \end{bmatrix} \tag{A.4'}$$

The elements of H are exactly the same as before but the elements of a differ. That is,

$$a_{11} = (\partial^2 C/\partial Q\, \partial SCQ)\, \partial Q/\partial p^* > 0$$

$$a_{12} = 0$$

$$a_{21} = (\partial^2 C/\partial Q\, \partial SCQ)\, \partial Q/\partial D < 0$$

$$a_{22} = \partial^2 C/\partial D\, \partial SCD < 0.$$

These signs follow from defining the exogenous changes in terms of decreases in the slope of the function and from assuming that they do not interact with each other.

We now have

Proof of Theorem 3. By the hypothesis of the theorem $dSCQ = 0$, hence the solution of (A.4′) implies

$$\partial p^*/\partial SCD = -h_{12}a_{22}/|H| > 0 \tag{A.11}$$

$$\partial D/\partial SCD = h_{11}a_{22}/|H| > 0. \qquad \text{Q.E.D.} \tag{A.12}$$

The same procedure allows us to show that a decrease in the slope of the marginal cost function with respect to Q leads to ambiguous results, i.e.,

$$\partial p^*/\partial SCQ = (h_{22}a_{11} - h_{12}a_{21})/|H| \gtrless 0 \tag{A.13}$$

$$\partial D^*/\partial SCQ = (-h_{12}a_{11} + h_{11}a_{21})/|H| \gtrless 0. \tag{A.14}$$

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