

DEMAND COMPLEMENTARITIES, HOUSEHOLD PRODUCTION, AND RETAIL ASSORTMENTS

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This paper presents a formal model of retail demand, based upon a household production framework, that permits rigorous analysis of retail assortments. The model captures the essential shifting of distribution costs between retailers and consumers that manifests itself in retailers' provision of distribution services for consumers. We apply the model to define rigorously conventional retailing concepts, such as assortment breadth and depth, and to explain the appearance of certain well-known phenomena such as market-basket pricing, nonprice retail competition, and the incentives for retail agglomerations to form. Throughout, distribution services play a critical role in binding together the analytical model and the diverse reality giving rise to retail assortments.

(Retail Assortments; Distribution Services; Consumption Activities; Demand Complementarities)

1. Introduction

The primary motivation for this paper might best be explained as an attempt to address formally the "assortment problem" in retailing. Why is it that one retailer may offer to his customers a choice of quantities of gasoline and groceries, while another may offer only gasoline, and still another only groceries? Apparently, the combination of these market goods (i.e. gasoline and groceries) into a retail assortment must be demanded by some customers sometimes; hence, the rise of what is often called "one-stop shopping". The fact of retail life is that the retailer provides, usually, a set of market goods, that is, an assortment of more than one market good. Within this set, some of the items may appear to be substitutes in consumption, some may appear to be complements in consumption, and some may be independent in terms of consumption. Yet in their desire for "one-stop shopping" consumers inevitably purchase baskets of market goods that may include substitutes, as well as goods that are independent in the conventional sense.

Conventional measures of cross price elasticities, reflecting demand side relationships among different products, are almost always articulated in terms of consumption and not in terms of the individual consumer's transactions within the marketing (retailing) system. This means that the conventional way of looking at substitutes (coffee and tea, for example) and complements (coffee and sugar, for example) does not help the retail manager to determine how best to assemble or modify his assortment. The conventional representation of product demand interdependencies in the economic theory of the consumer lends little insight into how one should formally represent the consumer's choice

of a market basket that may include such goods as gasoline and milk, which are, hopefully, independent in terms of consumption, though apparently complementary in terms of transacting with the marketing system.

We present in this paper a formal examination of retail demand that captures, conceptually, the nature of the relationship among items in a retail assortment and which, we think, is a necessary step to permit further development of managerially relevant and usable retail assortment models. As we do not address formally the supply side of retailing, we cannot claim that our approach is sufficient in explaining relationships among items in a retail assortment, yet an interesting feature of our approach is that it is compatible with Bucklin's (1966) definition of the "product" of distribution as a mix of market goods in conjunction with an array of services resulting from the struggle to minimize costs among economic agents at adjacent levels in the marketing channel. Our formulation, moreover, permits a rigorous treatment of the shifting of distribution costs among retailers and consumers and comprehensive analysis of cross product effects in a retail setting.

This paper is organized as follows. First, we briefly review the relevant literature. Subsequently, we present a formalization of the demand side of the retailer's operation that is based upon a household production framework. This formulation allows a novel and precise definition of the concepts of depth and breadth of an assortment, as well as the establishment of properties of the demand functions in terms of net and gross demand relationships which are useful in the analysis of retail assortments. The bulk of the paper, however, considers the implications of the analytical results of the model for retailing theory and management, paying particular attention to the role of consumption activities of the household, the role of the nonmarket services of the retailer (distribution services), the presence of gross substitutes and the characteristics of traffic building items in the retail assortment, and the nature of retail competition and agglomeration effects.

2. Review of the Literature

The rationale for the appearance of retail assortments has been eloquently argued by "classical" marketing scholars. For instance, Alderson (1950, 1957) argued that the points at which assortments appear in the marketing system are determined by the principle of postponement. That is, the marketing system will delay the creation of an assortment to the last possible link in the channel. To Alderson's argument Bucklin (1963) later added a refinement: that the appearance of assortments in the marketing system is determined by the balance of the tendencies to delay (principle of postponement) and to risk (early creation (principle of speculation) of an assortment. These arguments are useful as a first step in structuring one's thinking about the complex problem of assortment creation and modification within the marketing system, but these arguments are difficult to apply in a managerial sense.

A related stream of the marketing literature deals with the classification of goods and the classification of retailing, e.g. Aspinwall (1958). Yet there is no generally recognized classification system that can guide the retail manager to select items for inclusion in (or deletion from) an assortment on the basis of their demand or cost interdependencies.

In an early paper, Baumol and Ide (1956) presented a model of the demand for a retailer that was based on the countervailing influences of the consumer's desire to search the market and the full cost of searching. The prescriptive result is that retail assortments would not expand unchecked, even if there were no (supply) costs to doing so because beyond some point the cost of continued searching for the consumer is more to him than its benefits. The argument is appealing because it points to an essential aspect of the shifting of (distribution) costs between the retailer and the consumer, but it does not explicitly model the interdependencies between items in the assortment.

Perhaps the most fruitful research tradition for the analysis of demand interdependencies among goods in the context of retail assortments is applied price theory. Several recent attempts to model aspects of product line pricing are presented in Moorthy (1984), Katz (1984), and Oren, Smith, and Wilson (1984). In each of these examples, items in the product line are assumed to be substitutes, such that the principal managerial issue is product cannibalization.

Retail assortments may indeed contain substitutes, but their principal characteristic in allowing "one-stop shopping" is to permit the consumer to purchase a basket of goods that are complements, at least in some sense. Telser (1979) analyzes the case of the multi-product monopolist who sells complementary goods, and creates different bundles of these goods for different market segments. Another relevant argument for the analysis of retail assortments is Preston's (1962) model of market basket pricing. The models of Telser and Preston, however, ignore an important additional aspect of retail assortments, namely, that they are collections of market goods and services and nonmarket services. The presence of the nonmarket services in the assortments, many of which patrons of the retail establishment cannot help but consume in a bundle with the market goods, and some of which patrons of the retail establishment consume even if they purchase no market goods, makes the retail manager's merchandising task all the more difficult.

In the next section of the paper we present a formal explanation of retail demand that permits a rich analysis of the relatively complex interdependencies within and between the market goods and services and nonmarket services in the retail assortment.

3. Formalization of Retail Demand

The consumer's patronage of retail establishments entails a variety of costs which usually can be shifted between the consumer and the retailer, at least to some degree (cf. Bucklin 1966; Ingene 1984). Recognizing the existence of these costs, any given retailer can offer a variety of services in order to reduce the level of these costs borne by the consumer and, thereby, generate demand for his establishment.¹ As the retailer does not typically unbundle these distribution services (i.e. offer them to the market at explicit prices), many of these services constitute what we previously referred to as the "non-market" services of the retail assortment.

We formalize the demand for the market goods and services provided by the retailer by using the concept of household production developed in the economic literature by Becker (1965), Lancaster (1966) and Muth (1966). Briefly, we depict the representative household as producing a variety of outputs or commodities (denoted Z) that yield it satisfaction or utility. These consumption activities generating the Z s are undertaken with a household technology that uses among other inputs (1) "the household" time, (2) capital services from the fixed stock of durables available within the household, (3) market goods and services, and (4) distribution services provided by the retailers it patronizes. Various environmental characteristics may also be relevant to the production process, such as the availability of electricity or refrigeration.

The optimization in which the household engages may be depicted as though it were to follow a two-stage process (Deaton and Muellbauer 1980, pp. 245-254). For the analysis of the demand facing any given retailer, this decomposition of the optimization into two stages permits a useful interpretation of two categories of effects, namely, direct (household) production and (household) consumption effects (Betancourt and Gautschi (1988)).

¹ As will become clear in the more detailed discussion of §4B, the distribution services are defined in such a way that the retailer, in almost all cases, must produce some nonzero level of each service and that the retailer bears a nonzero cost in the production of each given service.

The direct production effects arise from the minimization, in the final stage, of the costs of attaining given levels of the commodities that yield satisfaction, while satisfying the restrictions imposed by the nature of household production activities. This optimization results in a cost function

$$C = C(p, D, Z) \tag{1}$$

that is nondecreasing, concave, and linear homogeneous in prices (the elements of p), increasing in outputs (the elements of Z), and nonincreasing in distribution services (the elements of D). The last property follows from assuming that the distribution services provided by a retailer act as fixed inputs into the household production activities. It is in this manner that the shifting of distribution costs between households and retailers is captured formally in the model. It follows from Shephard's Lemma that the conditional (Hicksian) demand function, g , for an item purchased from a particular retailer will be given by

$$Q_k = C_k = \partial C / \partial p_k = g_k(p, D, Z), \quad k = 1, \dots, K. \tag{2}$$

In the second stage the household maximizes utility, by choosing the optimal levels of the commodities that yield satisfaction, subject to the constraint that the household's full income (W) be sufficient to cover the costs of producing these levels of the commodities. The solution yields the demand functions for the commodities,

$$Z_i = f_i(p, D, W), \quad i = 1, \dots, I. \tag{3}$$

Substitution of (3) into (2) yields the Marshallian or uncompensated demand functions for any item purchased from a retailer

$$Q_k = g_k[p, D, f(p, D, W)], \quad k = 1, \dots, K, \tag{4}$$

where $f(\cdot)$ denotes the vector of demand functions as represented in (3).

Using (4) one may express the effects of a change in the price of an item in the retail assortment in a manner reminiscent of the Slutsky decomposition of the standard economic theory of the consumer. The own price elasticity for a retail item, k , is obtained by differentiating (4) with respect to price and manipulating, which results in the following:

$$\begin{aligned} \epsilon_{kk} &= \epsilon_{kk}^* + \sum_i \omega_{ki} \eta_{ik} \quad \text{where} \\ \epsilon_{kk} &= \frac{\partial Q_k}{\partial P_k} \frac{P_k}{Q_k}, \quad \epsilon_{kk}^* = [(\partial Q_k / \partial P_k) | Z] (P_k / Q_k), \\ \omega_{ki} &= \frac{\partial Q_k}{\partial Z_i} \frac{Z_i}{Q_k} \quad \text{and} \quad \eta_{ik} = \frac{\partial Z_i}{\partial P_k} \frac{P_k}{Z_i}. \end{aligned} \tag{5}$$

The first term on the right-hand side, ϵ_{kk}^* , is the percentage change in the quantity demanded of the k th item in the assortment for a percentage change in the price of the k th item, given levels of the household's production of the commodities (Z) that yield satisfaction. We refer to ϵ_{kk}^* as the *direct production effect* of a price change, and we note that it must always be *nonpositive* by the concavity of the cost function (equation (2)). We refer to the second term on the right as the *consumption effect*. It is the percentage change in demand for an item in the assortment resulting from a change in demand for the commodities (ω_{ki}) times the percentage change in the demand for commodities induced by a percentage change in the cost of producing the commodities η_{ik} . Unlike the production effect, the consumption effect can be either positive or negative. However, we have shown elsewhere (cf. Betancourt and Gautschi 1987a) that the sufficient con-

ditions for $\sum \omega_{ki}\eta_{ik}$ to be nonpositive are likely to be satisfied in the large majority of cases.²

The consumption effect plays an especially important role in the analysis of (demand side) relationships among different items in a retail assortment. From the Marshallian demand function in (4), we may derive the cross-price elasticity between two different items (k, l) in the assortment as follows:

$$\epsilon_{kl} = \epsilon_{kl}^* + \sum_i \omega_{ki}\eta_{il}. \quad (6)$$

Here again we have decomposed the effect on the demand for item k from a change in the price of item l into a direct production effect

$$\epsilon_{kl}^* = \left(\frac{\partial Q_k}{\partial P_l} \middle| Z \right) \left(\frac{P_l}{Q_k} \right)$$

and a consumption effect

$$\sum \omega_{ki}\eta_{il} = \sum \left(\frac{\partial Q_k}{\partial Z_i} \frac{Z_i}{Q_k} \right) \left(\frac{\partial Z_i}{\partial P_l} \frac{P_l}{Z_i} \right).$$

Equation (7) provides us with the grounds on which to present two important definitions.

DEFINITION 1. Two items (k, l) in an assortment are *net* substitutes, independent, or complements as the production effect (ϵ_{kl}^*) is positive, zero, or negative, respectively.

DEFINITION 2. Two items (k, l) in an assortment are *gross* substitutes, independent, or complements as the *sum* (ϵ_{kl}) of the production effect (ϵ_{kl}^*) and the consumption effect ($\sum \omega_{ki}\eta_{il}$) is positive, zero, or negative, respectively.

We note that it is with respect to the *net* effect of the *first* definition that the literature has formally addressed cross item relationships (e.g. Preston 1962). Yet it is with respect to the *gross* effect of the second definition that relationships among items in complex assortments can be described. Invoking the example of gasoline and milk, as cited in the introduction to the paper, one can argue that these two items are *net* independents (i.e. the production effect is zero) but over some set of relevant consumption activities (Z), the consumption effect must be negative such that gasoline and milk are *gross complements*.³ If, for example, Z_1 is "having a picnic" and Z_2 is "driving to the country", then because gasoline and milk are gross complements for (Z_1, Z_2) a retailer could include both items in his assortment. The negativity of the consumption effect is a force that drives all items in a retail assortment *toward* gross complementarity, even when two items are net substitutes (production effect is positive: lamb chops and hamburger).

Given the tendency for items in a retail assortment to be gross complements, we now apply the decomposition of the cross price elasticity of equation (6) to define rigorously the two dimensions commonly used to describe retail assortments, namely, *depth* and *breadth*.

DEFINITION 3. The extent to which items in a retail assortment are *net substitutes* is the *depth* of the assortment from the point of view of a representative household.

DEFINITION 4. The extent to which items in a retail assortment are *net independents* is the *breadth* of the assortment from the point of view of a representative household.⁴

² For instance, this result always holds for any two items used in the production of every commodity or for any two items used exclusively in the production of a commodity with a positive income effect. For other cases, it is possible but not likely that negativity is violated.

³ Once again, in our earlier work (Betancourt and Gautschi 1987a), we showed that the consumption effect in equation (6) is negative in the vast majority of situations.

⁴ The value of the definition lies in its conceptual rigor. For instance, one finds occasion to argue for net

Applying these definitions to any empirical situation will depend normally on how the set of consumption activities (Z) is defined. Before discussing the issues surrounding the application of these definitions, we consider formally another set of forces that binds the items of a retail assortment together as complements, namely, the distribution services (D_j) provided by a retailer.

From the uncompensated demand function (4), we can obtain the service elasticity of demand for any item in a particular retailer's assortment. Namely,

$$\begin{aligned} \epsilon_{kj} &= \epsilon_{kj}^* + \sum_i \omega_{ki} \eta_{ij}, & k = 1, \dots, K, & \quad j = 1, \dots, J, & \quad \text{where} \\ \epsilon_{kj} &= (\partial Q_k / \partial D_j) (D_j / Q_k), & \epsilon_{kj}^* &= (\partial Q_k / \partial D_j | Z) D_j / Q_k, \\ \omega_{ki} &= (\partial Q_k / \partial Z_i) \frac{Z_i}{Q_k} & \text{and} & \quad \eta_{ij} = (\partial Z_i / \partial D_j) D_j / Z_i. \end{aligned} \quad (7)$$

Equation (7) suggests the following definition.

DEFINITION 5. A distribution service of a retailer and an item in this retailer's assortment that may be purchased by the household are *net* complements, independent or substitutes as the production effect (ϵ_{kj}^*) is positive, zero or negative, respectively.⁵ This definition is consistent with Definition 1. The reason for the difference in sign is that here the elasticity is defined with respect to a change in a quantity rather than in a price.

Equation (7) also suggests the following definition.

DEFINITION 6. A distribution service of a retailer and any item in this retailer's assortment that may be purchased by the household are *gross* complements, independent or substitutes as the sum (ϵ_{kj}) of the production effect and the consumption effect is positive, zero or negative, respectively.

We have shown elsewhere (cf. Betancourt and Gautschi 1987a) that the distribution services provided by a retailer will tend to be gross complements with every item in the retailer's assortment that may be purchased by the household.⁶

4. Managerial Implications of the Household Production Formulation of Retail Demand

To illustrate the application to the retail environment of the analytical framework of the preceding section, we discuss four central issues that follow immediately from the model, namely, the role of consumption activities, the role of the distribution services, the appearance of gross substitutes in an assortment and the characteristics of traffic building products, and the nature of competition and retail agglomerations.

independence on conceptual grounds when confronted with ladies' nightgowns and spark plugs in the assortment of Sears.

⁵ While one would expect the distribution services of a retailer normally to be *net* independent or complementary with the items in the retailer's assortment that the household may purchase, *net* substitutability will also arise. Among the distribution services offered by the retailer is assortment, itself, and the clearest example of net substitutability involving a distribution service is in the case of the depth of the assortment, as defined in Definition 3. If a retailer who sells one kind of meat, Q_k (hamburger), increases the depth of his assortment (D_j) by providing another kind of meat (lamb chops), households then have a greater range of choice. The result is that some households, at least, will now choose lamb chops instead of hamburger for given levels of the relevant consumption activities (dinner). That is, with manipulations of the depth of the assortment, ϵ_{kj}^* will be negative for at least some Q_k .

⁶ Even in situations where an item (hamburger) and a distribution service (depth of assortment) may be *net* substitutes, the consumption effect is likely to dominate the production effect. Thus, for example, increased depth may encourage the household to use a given item in the retailer's assortment as an input into more consumption activities (dinner, lunch, picnics, etc.).

A. *The Role of Consumption Activities (Z)*

As the demand for any item in the assortment of a retailer is *derived* from a more basic demand of the household for a consumption activity, it is the identification of *Z* that represents the most difficult task in the formulation of managerial strategy. This is not so new. In the tradition of Drucker (1954) and Levitt (1964) we know that it is not simply relevant, but that it is essential for the manager to ask himself occasionally “what market or business am I really in?” What is not so apparent is how the manager should ever *begin* to answer the question. In the context of the household production framework of the preceding section, it is apparent that the answer to the basic question of market definition for the retail manager should be structured, *in large part*, in terms of a response to another question, namely, “to which *Z*s do I cater?” That is, the retailer must identify among the many different possible *aims* of household production those that he intends to serve.

By determining which set of *Z*'s to serve and for which households, the retailer expresses his positioning objectives at a fairly general level. This suggests that different retailers selling items in the same general product categories may not be competitors because they each define the *Z*'s that they serve in different ways.

Consider the case of a supermarket and a delicatessen. Both are food stores, but clearly the delicatessen is a specialty food store and the supermarket is a general food store. Assume that the two stores are equidistant from some representative household. The decision of the household to patronize the delicatessen may be determined by its pursuit of a rather disaggregated consumption activity, for example, “nutrition from a specific kind of meal or for a specific type of occasion” over a given interval of time (Christmas dinner with members of the extended family and close friends). If the household were to pursue a more aggregated consumption activity, such as “nutrition from meals served at home” over the same interval of time (dinner on the 25th of December), then the product choice offered by the delicatessen could be irrelevant for the household.⁷

This example suggests that the way a retailer positions himself in the market depends, to some extent, on the level at which he presumes his target clientele to aggregate the consumption activities that they pursue. The extent to which the retailer caters to scrutinizing customers (i.e. customers who pursue disaggregated *Z*s over a given interval of time) will, in large part, determine the degree to which the retailer is a specialist. Conversely, a retailer is more of a generalist, the more he caters to customers who pursue aggregated consumption activities.

Finally, the example also illustrates that the retailer's positioning depends to a great extent on the distribution services provided by the retailer which lower costs incurred by relevant representative households in the undertaking of their consumption activities. That is, the assortment of the delicatessen is not likely to be simply a subset of the assortment of the supermarket. For a given set of consumption activities and for a given interval of time the assortments are likely to differ in terms of depth, freshness, and information provided as well.

B. *The Role of the Distribution Services (D)*

If the definition of the relevant set of *Z*'s at an appropriate level of aggregation is a most challenging aspect of retail management, a basic relationship to know on the demand side is the demand for *Z*. In reference to equation (3), one notes that the demand for any Z_i is a function of a host of arguments, namely, the prices of the items in the retailer's

⁷ Incidentally, this suggests that the vendor who provides high degrees of product choice (specialization) for a clientele who define the relevant consumption activity at aggregate levels commits the same error as the industrial goods manufacturer who *over-engineers* his product.

TABLE 1^(a)

Distribution-related Costs	Distribution Services
Direct Transportation	Product Assortment
Direct Time	Accessibility of Location
Storage	Ambiance
Adjustment	Availability of Information
Information Acquisition	Assurance of Product Delivery
Psychic	(a) in desired form
	(b) at desired time

^(a) It must be stressed that the distribution costs on the left-hand side of the table often map into more than one of the distribution services on the right-hand side of the table.

assortment and of items in the assortments of other retailers (p), the distribution services offered by the retailers (D), and other environmental variables. Thus, fundamentally, the distribution services provided by retailers in conjunction with the items in the retail assortment are among the various *means* with which the household achieves its consumption *aims* (i.e. Z).

The distribution services are means to the ends of household production because they are provided in order to reduce certain costs that the household incurs in interacting with the marketing system. We identify six categories of distribution costs in Table 1. These costs require little explanation except, perhaps, for psychic costs and adjustment costs. *Psychic costs* stem from what the consumer considers disagreeable in the retail environment, such as disagreeable social interactions, loud music, unpleasant odors, etc. Adjustment costs could result from a stockout or, generally, whenever the consumer must either *substitute* a different form for the exact form of the product that he desires, *abstain* from consuming the product, *wait* until the desired form is available or, possibly, *patronize another retailer* who has the exact form of the product he desires.

The distribution services that the retailer provides are listed in Table 1.⁸ Every retailer provides *some* level of each of these services, and any retailer can only produce nonzero levels of any of the services by deploying his resources (i.e. they are not free). A number of aspects of these services, as we have defined them, need to be emphasized. First, there is not necessarily a one-to-one mapping from a given distribution service to any given distribution cost. For example, increasing the depth of assortment in a product category by stocking several package sizes of a product could reduce both adjustment and storage costs for the consumer. Secondly, some of the distribution services are produced *jointly*. For example, increasing the depth of an assortment also increases the assurance of product delivery, and, depending on the nature of the item, could improve the ambience of the retail establishment. Third, some distribution services are *common*, meaning that the effect of altering a service, accessibility of location, for example, is distributed *over all* (or almost all) *items* in the retail assortment. Other distribution services are *specific to certain items* in the retail assortment, such as information on the specifications of a particular model of personal computer. Fourth, the five services identified are intended as general categories under which specific services may be classified. For example, liquidity cost is a form of adjustment cost as the retailer may find that in order to have an item purchased he would have to extend credit to his customers, thereby achieving high levels of assurance of product delivery at the desired time. Fifth, it is important to recognize

⁸ For illustrations of the distribution costs and services, see Betancourt and Gautschi (1987b).

that these categories of distribution services permit a fuller explanation of retail demand than can be rendered by general appeals to uncertainty or to the economics of information (Salop and Stiglitz 1982). Finally, distribution services are most conveniently viewed as net complements with items in the retail assortment, but by definition most distribution services⁹ are net *substitutes* for the household's time.

Consider the association between distribution services and the aggregation of consumption activities in the context of Bucklin's (1963) method of retail classification.¹⁰ A household pursuing a very *disaggregated* consumption activity at a specific point in time (special dinner for one's boss on Friday night) desires low adjustment costs in purchasing inputs. So the *specialty* store responds by providing high levels of *depth* of assortment, thereby assuring product delivery in the desired form at the desired time. Alternatively, the household that pursues an *aggregated* consumption activity that is highly disaggregated with respect to time (quenching one's thirst on a very hot day) desires low adjustment costs primarily in terms of delay. The *convenience* store responds by providing an assortment satisfying many of those consumption objectives for which product delivery at the desired time is more important to the household than desired form (availability of something wet and cold). This suggests that the assortment of the convenience store is likely to be shallow, its opening hours are likely to be long, and its accessibility to the market is likely to be high. Finally, the household that pursues a vaguely defined consumption activity that is aggregated because the household is unfamiliar with the extent of product choice on the market (home entertainment) will be served by a *shopping* goods store. The shopping goods store provides high levels of information by means of a broad and deep assortment, advertising, and the distribution of catalogues, for example.

The application of our framework preserves the essence of Bucklin's earlier argument by shifting the discussion from assertions about the nature of preference orderings to assertions about the nature of the *Z*'s and their levels of aggregation. Moreover, it offers considerable conceptual progress by relating these assertions to specific types of distribution services, which are in principle measurable.

Choice among different kinds of retailers highlights an important aspect of the demand for *Z*'s. That is, the household can decide to provide itself higher or lower levels of different distribution services. Hence, for example, one reason for the rise of large-scale food stores in France (supermarkets and hypermarkets) and the attrition of traditional, small-scale food retailers (*épiceries*) is that the opportunity cost of time for the French household is rising with its income. This means that more French households now willingly incur relatively higher transportation, adjustment, information, and even psychic costs as compared to ten years ago *in order to conserve time costs*.¹¹ By offering extensive assortments, credit, and central locations, large scale retailers permit significant time savings for consumption activities undertaken during extended time intervals. Moreover,

⁹ Ambiance, for example, is not necessarily related to time.

¹⁰ Bucklin's argument is actually more extreme than ours, as he classified retailing activities as specialty, convenience, or shopping stores depending on the nature of the consumer's preference for *items* in an assortment *before* the act of patronage.

¹¹ Presumably, there are not so many French households now that demand traditionally high levels of assurance of product delivery in the desired form; hence, many small scale specialists have left the market. Because those households that have below average demands for assurance of product delivery in the desired *form* are more likely to be patrons of the supermarket, those specialist retailers (e.g. *boulangeries*) that remain cater to a customer base demanding a higher average standard of product form. The result is that competition among the small-scale specialty retailers themselves could conceivably be fiercer now as compared to the level of competition when the supermarkets first emerged. This would only foster further structural change. Notwithstanding this particular example, our view of general merchants versus specialists does not require specialists to operate at small scales or generalists at large scales.

the *shifting* of storage costs for time costs *within* the household, as indicated by the increased use of refrigerators in French households, has further hastened structural changes in French retailing.

C. Gross Substitutes, Traffic Building Products, and Distribution Services

In this section of the paper we address the conditions under which items in a given retail assortment can be gross substitutes; we explore the issue of items that are gross complements with many other items in the assortment, thereby serving as traffic builders; and we discuss the traffic building role of distribution services.

By Definition 2 an item, k , is a gross substitute with other items in the assortment if $\epsilon_{kl} > 0$, for $l = 1, \dots, L$. Assuming, as usual, that the consumption effect is negative, it follows directly from equation (6) that an item can be a gross substitute for another item only if the net production effect dominates the consumption effect. This is most likely to occur for assortments that are extremely deep and not at all broad. An extreme case is that of a “pure” specialist who sells only two items, each used as an input in the same highly disaggregated consumption activity. Consider, for example, the pushcart vendor of apples and pears who appears on some corner of Wall Street during the lunch hour every Monday through Friday. This vendor may be said to cater to Z_i : light, nonfat, healthful nutrition for the quick midday meal. The typical pushcart customer may be the busy office worker who eats lunch on the run, procuring main dish (e.g. quiche), drink (e.g. orange juice), and fruit from various street vendors. So, for the pushcart vendor the cross price elasticity between the only two items in his assortment can be expressed as from equation (6) or $\epsilon_{kl} = \epsilon_{kl}^* + \omega_{kl}\eta_{il}$. In this case, for those customers with very inelastic demands for the commodity (Z_i) the consumption effect is likely to be small and as $\eta_{il} \rightarrow 0$ gross substitutability will arise.

Other possibilities for the existence of gross substitutes in a given assortment require that the commodities or outputs of the consumption activities by substitutes in consumption for the household *and* that the substitution effect dominates the income effect or that the income effect be negative.¹² If the length of the decision interval relevant for the household encompasses a week, and the consumption activities are defined at specific points in time, such as a meal on a particular day of the week, then conditions for gross substitutability are not likely to be satisfied because most consumption activities within the decision interval are not likely to be substitutes in consumption. That is, a meal on Monday is not a substitute for a meal on Friday. Thus, regular coffee and ground roast coffee at the grocery would not be even *net* substitutes for a household if the former was an input into the daily breakfast meal and the latter was an input into a weekend entertainment meal.

It is intuitive to think of items in a retail assortment as complements in some sense. In this regard, an issue that attends merchandising decisions is which items in an assortment should the retailer promote to generate patronage and, hopefully, encourage the representative consumer to consolidate his diverse (intended) purchases in pursuit of a given set of consumption activities (Z) in a single transaction with the retailer. Such product promotions often take place in the manner of what is commonly—if, perhaps, imprecisely—called “loss leader” pricing. Our purpose in this section is to highlight the characteristics of items in an assortment that would be good candidates for traffic building.

In general the retailer will designate as traffic builders those items viewed by a representative household as gross complements with many items in the assortment and that have high absolute values of the cross-price elasticity ($\epsilon_{kl} < 0$). Obviously, the most direct

¹² A detailed algebraic statement of this condition is provided in an appendix available from the authors upon request.

way of finding these items is through a survey of households designed for this purpose, which would allow estimation of the demand functions for the items. Such a survey could be very expensive, and its results would be sensitive to some factors, such as the clientele of the retailer not being stable, a move by the retailer to a new location, or the addition of a set of items not available at the time of the survey. Therefore, it would be useful to have as an alternative some conceptual guidelines as to which items are likely to be good traffic builders.

Recently, the literature on retailing has stressed what it calls "one way cross-price elasticity of demand", for example Albion (1983, p. 9). This notion in terms of our model is that the uncompensated cross-price elasticity of demand for an item is not symmetric ($\epsilon_{kl} \neq \epsilon_{lk}$) and that some items or products enjoy high (absolute) values of these elasticities, i.e. they are good traffic builders. Albion argues that products with these high elasticities are important because they act as traffic builders and that these high values for the elasticities are due to "product salience: the degree to which consumers notice and care about the terms of sale of a product" (p. 11). Subsequently, the example of meat and meat sauce, where meat has product salience, is mentioned (p. 103) without elaboration.

Our analysis provides various avenues in which "one-way cross-price elasticities" arise, as well as a way of identifying items or products having this characteristic, that is more precise than an appeal to "product salience". To illustrate, consider the example of meat and meat sauce provided by Albion. Both of these items can be viewed as inputs used exclusively in the production of a commodity, a tasty (red) meal. An analysis of equation (6) for this situation explains why meat has a much higher "one-way cross-price elasticity of demand" than meat sauce, namely meat constitutes a much larger share of the budget than meat sauce, and a change in its price increases the marginal costs of producing a tasty (red) meal substantially more than a change in the price of meat sauce.¹³ Moreover, many of the other inputs used in the production of a tasty (red) meal, for example peppers, onions, salt, etc., can be viewed as inputs used in the production of every commodity or activity associated with the broad category nutrition-food. Therefore, an analysis of equation (6) for this alternative situation shows that meat will also have a high one-way cross-price elasticity with these items because it constitutes a large share of the budget for this broad category, whereas any of the other items mentioned will have a small share of the budget for this category. Finally, an analysis of equation (6) for a situation in which items are used exclusively in the production of other commodities that are a large share of the food budget or have high income elasticities of demand, for example fresh shrimp or lobster in the production of tasty (white) meals, also reveals meat to have a high value of one-way cross-price elasticity of demand because meat constitutes a large share of the food budget.

Our framework is useful at the conceptual level because it provides a systematic way of searching for the characteristics of traffic building products or the determinants of "product salience". Moreover, as the preceding discussion illustrates, this search generates at least one very specific result: an item's share in the consumer's budget is one of the main determinants of "product salience". In turn, this result can lead to testable hypotheses in specific contexts. For instance, the preceding example suggests that, since meat constitutes a large share of the food budget, a given percentage change in the price of meat by a food retailer should generate larger percentage changes in the quantities of other items purchased by the patrons of the retailer than, for example, a change in the price of onions or other items with small shares in the consumer's budget. Perhaps more

¹³ An algebraic explanation of these conditions and the ones applying to the two cases below is provided in an appendix available from the authors on request.

importantly, this result also suggests that market research which provides information on the share that various items in an assortment have in consumer's budgets is extremely valuable in the design of a traffic building strategy. This information would be less costly to acquire than conducting a full-scale survey designed to estimate the elasticities directly.

To conclude this section, it is useful to note briefly another type of traffic building relationship: namely, the one between the distribution services of the previous section and the items in a retail assortment. We have shown, through a detailed analysis of equation (7) in Betancourt and Gautschi (1987a), that the distribution services of a retailer will tend to exhibit a relationship of gross complementarity ($\epsilon_{kj} > 0$) with every item in the retailer's assortment. Here, we merely summarize the characteristics that generate the strongest degree of complementarity, i.e. either a greater number of items with positive values of ϵ_{kj} or a larger positive value for any one item. These characteristics are (a) the distribution service (j) is a fixed input in all the household production activities; (b) the percentage reduction in the household's costs as a result of an increase in the distribution service (j) is large; (c) the consumption activities (Z) in which the items (k) in the retail assortment are used have *high* marginal budget shares or high income elasticities of demand; (d) the *items* (k) sold by the retailer constitute a *small* share in the household's budget. Therefore, the first two characteristics suggest that common distribution services that save time, e.g. breadth of assortment and accessibility of location, will be especially powerful sources of gross complementarity in a representative household's demand for the retail products of general merchants. Similarly, the second and the fourth characteristics suggest that depth of assortment may be an important source of gross complementarity in the household's demand for the retail products of most specialists.

D. Retail Competition and Agglomeration Effects

Consider the situation of two retailers, A and B , where the items in the assortment of A would constitute a subset of the items in the assortment of B . How would a price reduction in an item in the assortment of B influence the demand for any given item in the assortment of A ?

The most expedient way to investigate the effects of a price change in an item of one retailer on the patronage of another retailer is in terms of a slight modification of equation (6).

$$\epsilon_{kl}(A, B) = \epsilon_{kl}^*(A, B) + \sum_i \omega_{ki}(A) \eta_{il}(B). \quad (8)$$

If item k is Brand X in retailer A 's assortment and item l is Brand X in retailer B 's assortment, it is entirely possible that reductions in the price of l will not cause consumers to buy less of k . That is, even if k and l are *net* substitutes, $\epsilon_{kl}(A, B)$ can still be nonpositive because of the consumption effect where $\eta_{il}(B) < 0$. The reduction of the price of the input l from B reduces the total cost to the household of pursuing relevant consumption activity Z_i . Therefore, the following holds:

PROPOSITION (A). *The household not only continues to use k from A , it could even maintain its usage of k from A as a result of the decrease in the price of l from B if as households increase their pursuit of Z_i the distribution services of retailer A continue to draw households to his store.*

Thus, to analyze the nature of competition among retailers it is necessary to consider the influence of distribution services. We accomplish this by modifying slightly equation (7).

$$\epsilon_{kj}(A, B) = \epsilon_{kj}^*(A, B) + \sum_i \omega_{ki}(a) \eta_{ij}(B). \quad (9)$$

If distribution service j from B is a common service, manipulations of its level will influence the demand for all items in the assortment of retailer B . Thus, if retailer B expands his parking facilities, households will be more inclined to buy more of all items in his store. What does this mean for the demand for items in the assortment of retailer A ? The result depends fundamentally on whether items in the assortment of A are *net complements*, *net substitutes*, or *net independent* in relation to items in the assortment of B . For example, if they are net substitutes $\epsilon_{kl}^*(A, B) > 0$, for some k and l , then $\epsilon_{kj}^*(A, B) < 0$ when j^B is a common distribution service. However, whether j from B is a *gross complement* with any k from A will ultimately depend on the strength of the consumption effect ($\sum \omega_{ki}(A)\eta_{ij}(B)$) which must be positive. If the consumption effect dominates the production effect [$\epsilon_{kj}^*(A, B)$] when k and l are net substitutes or if k and l are *net complements* or *net independent*, then increases in the levels of common distribution services provided by retailer B will increase the demand for items in the assortments of *both* retailers. Therefore, the following holds:

PROPOSITION (B). *When distribution services of one retailer, j from B , are gross complements with items in the assortment of another retailer, k from A , there is a demand side incentive for the retailers to form an agglomeration.*¹⁴

This proposition provides a formal justification for the retail specialist to locate within an agglomeration, but an agglomeration that he chooses judiciously.

Conversely, if a distribution service of one retailer is a *gross substitute* with items in the assortment of another retailer, then there is no demand side incentive for the two retailers to coexist in one agglomeration. In this situation the two retailers are clearly competitors. One should note the following

PROPOSITION (C). *It is only possible for a common distribution service of one retailer to be a gross substitute with items in the assortment of another retailer if items in the assortments of the two retailers are net substitutes in production.*

If common distribution services of, say, retailer B are gross substitutes with items in the assortment of retailer A , then retailer B may also have a strong incentive to compete on price. That is, if the production effect in equation (8) dominates the consumption effect [$\sum \omega_{ki}(A)\eta_{il}(B)$], then for repeated reductions in the price of l from B , $\omega_{ki}(A)$ becomes smaller and smaller. In the limit $\omega_{ki}(A)$ approaches zero so that the consumption effect ceases to temper the forces toward substitution in the production effect [$\epsilon_{kl}^*(A, B)$]. Hence, when k in A and l in B are gross substitutes, price leading of l in B could eventually drive item k out of the assortment of retailer A , and this event would be hastened if retailer B simultaneously increased the levels of the *common* distribution services he or she provides.

One implication of Proposition (C) is that, other things equal, competition among specialists is likely to be more effective and intense than among general merchants, in the sense of being able to draw patronage from each other by undertaking a specific move. The rationale is that a necessary condition for price competition between retailers is that items in their assortments be net substitutes, but specialists by providing depth of assortments stock more net substitute items relative to the total number of items than general merchants. Additionally, a necessary condition for effective non-price competition through the provision of distribution services is also that items in different assortments be net substitutes; otherwise, gross complementarity tends to prevail between the distri-

¹⁴ An agglomeration is any concentration of retail activities, such as a central business district, shopping mall, etc. The determinants of agglomeration are obviously a mixture of demand and supply conditions. We address only demand conditions here.

bution services of one retailer and the items in the assortment of other retailers. As a consequence the following holds:

PROPOSITION (D). *Specialists must be careful in their participation in retail agglomerations, favoring those in which other specialists provide different product lines and avoiding those in which other specialists provide the same product line. Moreover, they are also likely to face stiff competition if a general merchant in an agglomeration happens to provide unusually deep assortments in their product line due to, for example, historical reasons. By contrast the competition between two general merchants in an agglomeration will be far more diffuse, since one of the effects of competitive tools, such as lower prices in a product line, may be to increase demand for the items of the competitor that are net complements or independent with the items experiencing the price decrease.*

An interesting feature of competition in retailing follows from our model as summarized in the following

PROPOSITION (E). *Namely, the provision of distribution services at no explicit prices leads to a free rider problem in some cases.*

Consider a situation of gross substitutes, $\epsilon_{kl}(A, B) \geq 0$. For example, k in A could be a given model of a 35mm camera sold by retailer A , a mail order house, l in B could be the same model of cameras sold by a photographic equipment shop. If retailer B provides high levels of information on l (via advertising, in-store demonstrations, documentation, etc.) a consumer can reduce his information acquisition costs and certain adjustment costs by, first, obtaining the information services that retailer B provides to the market at no explicit price and, secondly, purchasing the camera from retailer A who prices it significantly below B , in part because retailer A provides lower levels of most distribution services and information, in particular, than does retailer B .

5. Concluding Remarks

Identification of relevant consumption activities at appropriate levels of aggregation is the clearest way for the retailer to define his market, but it is a difficult task which includes two dimensions (over commodities and over time) and does not yield easily to systematization. Part of the progress made here, however, lies in bringing out the relation between the consumption activities of the household and the distribution services provided by retailers. The latter are more amenable to measurement. By definition most distribution services are gross complements with items in the retailer's assortment. What is, perhaps, most interesting about the distribution services is that the manipulation of these services by the retailer influences the demand for items in other retailers' assortments in complex but systematic ways. Having a precise definition of depth and breadth of assortment allows many of these processes to be identified in the paper, particularly in §4.D where five important implications of the analysis are summarized in terms of Propositions (A) through (E). More generally, the conceptual distinction between net and gross demand relationships is instrumental in the derivation of most of our results. Specifically, these relationships allow us to identify important characteristics of traffic building products and distribution services in §4C.

One advantage of the framework presented in this paper is that it suggests a number of potentially fruitful lines of empirical work. First, consider the analysis of the productivity of retailing. Rather than using gross margins or retail margins, for example, as proxies for retail output, this framework suggests a set of retail outputs in the form of distribution services. A second area of potentially interesting empirical work would be the analysis of cross-national or cross-regional differences among retail institutions. This framework

suggests that households in different environments will have systematically different demands for distribution services. Indeed, the formal model of demand provides the basis for a well designed market survey of households. A third area of potential empirical work is a temporal analysis of institutional change. As the valuation and usage of the household's time is central in determining the levels of most distribution services, the rising valuation of time in growing economies can only mean that households will demand more distribution services that conserve time. This process will be reflected in institutional change.

An appropriate conclusion to this paper is at least to begin to answer one of the questions raised in the opening paragraph. Why is it that a retailer offers his customers a choice of quantities of gasoline and groceries? A grocer in a village offers gasoline as simply another item in an expanded assortment due to the gross complementarity that exists because the items are net independents and accessibility of location is a valued common distribution service. Similarly, a gasoline station on a highway offers a limited assortment of groceries due to gross complementarities generated by the same factors as well as by assurance of product delivery at the desired time, for example, at the time one realizes that an item wanted on the trip was left behind. Of course, a gasoline station in an urban area will offer, if anything, soft drinks and cigarettes and often through vending machines because cost and strategic considerations are also important.¹⁵

Acknowledgements. Earlier versions of this paper were presented at the TIMS/ORSA Marketing Science Conference at Jouy-en-Josas, France, June 24–27, 1987 and in the Business Economics Seminar at INSEAD in December 1987. We gratefully acknowledge financial support for this project provided by the Research and Development Department of INSEAD. We have appreciated the constructive criticisms from participants in these seminars and from three anonymous reviewers of this journal.

¹⁵ This paper was received in August 1987 and has been with the authors 7 months for 3 revisions. Accepted by Subrata K. Sen.

References

- Albion, M. (1983), *Advertising Hidden Effects: Manufacturer's Advertising and Retail Pricing*, Boston: Auburn House Publishing, Inc.
- Alderson, W. (1950), "Marketing Efficiency and the Principle of Postponement," *Cost and Profit Outlook*, 4, 3 (September).
- (1957), *Marketing Behavior and Executive Action*, Homewood, IL: R. D. Irwin.
- Aspinwall, L. (1958), "Characteristics of Goods and Parallel Systems Theories," in E. Kelley and W. Lazer (Eds.), *Managerial Marketing*, Homewood, IL: R. D. Irwin, 434–450.
- Baumol, W. and W. Ide. (1956), "Variety in Retailing," *Management Science*, 3, 1 (October), 93–101.
- Becker, G. S. (1965), "A Theory of the Allocation of Time," *Economic Journal*, 75 (September), 493–517.
- Betancourt, R. and D. Gautschi (1988), "The Economics of Retail Firms," *Managerial and Decision Economics*, 9 (June), 133–144.
- and ——— (1987a), "The Demand for Retail Products and the Household Production Model: New Views on Complementarity and Substitutability," working paper.
- and ——— (1987b), "The Evolution of Retailing: A Suggested Economic Interpretation," *International Journal of Research in Marketing*, 3 (April), 217–232.
- Bucklin, L. P. (1963), "Retail Strategy and the Classification of Consumer Goods," *Journal of Marketing*, 27, 1, 50–58.
- (1965), "Postponement, Speculation, and the Structure of Distribution Channels," *Journal of Marketing Research*, 2, 26–31.
- (1966), *A Theory of Distribution Channel Structure*, Berkeley: Institute of Business and Economic Research, University of California.
- Deaton, A. and J. Muellbauer (1980), *Economics and Consumer Behavior*, Cambridge: Cambridge University Press.
- Drucker, P. (1954), *The Practice of Management*, New York: Harper and Brothers, Inc.
- Ingene, C. (1984), "Productivity and Functional Shifting in Spatial Retailing: Private and Social Perspectives," *Journal of Retailing*, 60 (Fall), 1536.

- Katz, M. (1984), "Firm Specific Differentiation and Competition Among Multiproduct Firms," *Journal of Business*, 57, 1, 2, S149-S160.
- Lancaster, K. (1966), "A New Approach to Consumer Theory," *Journal of Political Economy*, 74 (April), 132-157.
- Levitt, T. (1964), "Marketing Myopia" in *Modern Marketing Strategy*, E. Bursk and J. Chapman (Eds.), Cambridge, MA: Harvard University Press.
- Moorthy, S. (1984), "Market Segmentation, Self-Selection, and Product Line Design," *Marketing Science*, 3, 4 (Fall), 288-307.
- Muth, R. (1966), "Household Production and Consumer Demand Functions," *Econometrica*, 34 (July), 699-708.
- Oren, S., S. Smith and R. Wilson (1984), "Pricing a Product Line," *Journal of Business*, 57, 1, 2, S73-S100.
- Preston, L. (1962), "Markups, Leaders, and Discrimination in Retail Pricing," *Journal of Farm Economics*, 44 (May), 291-302.
- Salop, S. and J. Stiglitz (1982), "A Theory of Sales: A Simple Model of Equilibrium Price Dispersion with Identical Agents," *American Economic Review*, 72, 1121-1130.
- Telser, L. (1979), "A Theory of Monopoly of Complementary Goods," *Journal of Business*, 52, 2, 211-230.