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HEDONIC ANALYSIS OF GASOLINE RETAILING

by

SOLEMAN A. AL-BASSIR

**A dissertation submitted in partial fulfillment of the
requirements for the degree of**

**DOCTOR OF PHILOSOPHY
in
URBAN STUDIES**

Portland State University

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TO THE OFFICE OF GRADUATE STUDIES:

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AN ABSTRACT OF THE DISSERTATION OF Soleman A. Al-Bassir for the Doctor of
Philosophy in Urban Studies presented June 14, 1988.

Title: Hedonic Analysis of Gasoline Retailing.

APPROVED BY MEMBERS OF THE DISSERTATION COMMITTEE:

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Researchers have difficulty modeling the influence of retailing attributes on consumer choice. The literature of retailing that has dealt with this issue has conventionally used experimental data for estimating the influence of retailing attributes on consumer behavior.

The present research applies hedonic analysis to the measurement of the value of retailing attributes. This is accomplished by applying hedonic specifications to supply and demand models for the retail sales of unleaded gasoline for the purpose of estimating the influence of specified retailing attributes on retail prices.

Four retailing attributes--accessibility, convenience, service, and competition--were expected to have a determinable value that was measurable through hedonic specifications. Spatial competition was expected to influence retail prices by lowering them. The value of retailing attributes was expected to be variable relative to household income.

It was found that the value of the specified retailing attributes could be isolated and determined. The application of hedonic analysis to the supply and demand of unleaded gasoline provided a relatively precise and consistent market value, which was represented by the "ask" and "bid" implicit prices of these retailing attributes. Spatial competition was seen to exert an important influence on retailing, tending to lower retail prices. The value of retailing attributes was found to be variable relative to household income.

The relative consistency and precision of hedonic analysis in the measurement of the value of retailing attribute was reinforced insofar as the findings were consistent with generally accepted notions of retail marketing and consumer behavior as represented in the literature in the field.

DEDICATION

This work is dedicated to my father, Sheik Abdullah I. Al-Bassir, my mother, and to the memory of His Excellency, Prince Ibrahim Al-Ibrahim. Without their help, patience, and encouragement this endeavor would not have been possible.

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CHAPTER I

INTRODUCTION

Determining the true value of retail commodities requires a complex analysis of not only the commodity's product attributes (that is, the objective physical characteristics of the product itself and its status relative to supply and demand), but also an analysis of the implicit value of the complex bundle of what the present study terms retailing attributes. As the term implies, retailing attributes are multidimensional and discretionary attributes which retailers assess in the interest of creating a marketing edge. These retailing attributes—categorized here as accessibility, convenience, service, and competition—are variable, and the relative level of the presence of these retailing attributes is proportional to the retail price of a given commodity.

That retailing attributes have a significant influence on consumer behavior is well documented in the literature of retailing and consumer preference, spatial competition, and movement interaction. Important treatments of the topic may be found in the work of Hotelling (1929), Christaller (1933), Rich and Portis (1964), Lessing (1973), and a great many others (see Chapter II). However, despite the well documented influence of retailing attributes on consumer behavior, there remains no clear precedent for ascertaining precise explicit and implicit values for retailing attributes, and therefore no clear indication of their relative value in determining a given commodity's transactional cost, which may reflect markups of from three to forty percent. It is the purpose of the present study to measure, ascertain, and then analyze the influence of these implicit and explicit values.

Central to the present study of the effects of the value of retailing attribute bundles on consumer preference is hedonic theory and its attendant methods of analysis. In the past

numerous researchers have employed hedonic analysis to evaluate the influence of product attributes (as distinct from retailing attributes) on pricing and consumer behavior. Several studies have applied hedonic analysis to studying price variability in automobiles (Court, 1939; Fischer, Griliches, and Kaysen, 1962; Griliches, 1964; Cagen, 1965; Cramer, 1966; Triplett, 1966; Dhrymes, 1967). Hedonic analysis of price variability in electric appliances was conducted by Dean and DePodwin (1961), and Dhrymes (1967) studied the pricing of refrigerators. Fetting (1963) applied these methods to studying the pricing of tractors, and Gavett (1967) used it to study the pricing of carpets and washing machines. Chow (1967) did the same for the pricing of computers. In each case cited here, findings resulted in the formulation of competition-hedonic models, and each therefore supports the viability of hedonic analysis insofar as it measures the implicit value of specific product attributes (size, shape, power, etc.). However, in none of the studies cited here are retailing attributes included in the analysis. In fact, classical hedonic analysis, and the resulting competition-hedonic models, routinely ignore retailing attributes (and by association, transactional costs) and their necessarily significant influence on pricing and, hence, consumer preference. This failure lies at the base of the present study and its analytical methodology.

It is assumed that in a climate of "perfect" competition, exchange requires no effort and entails no cost, and that there is no shopping and, hence, no transactional cost. However, in reality the process of the transaction itself, which encompasses space, information, advertising, convenience, service, and other factors, not only facilitates these transactions, but also influences consumer preferences regarding them. Hence, these transactional processes have a determinable value. Furthermore, because these transactional processes encompass retailing attributes, these attributes may also be considered to possess determinable values. Moreover, consumers perceive this value, and these perceived values influence consumer preference and, in turn, purchase decisions. On the basis of these postulates, the present study shall apply hedonic analysis to retailing

the basis of these postulates, the present study shall apply hedonic analysis to retailing attributes in order to measure its value (price), and by extension the value of attribute bundles, and from this base analyze consumer behavior in relation to these aggregate values.

THE TOPIC AND SCOPE OF THE PRESENT STUDY

The present study employs hedonic analysis to examine the influence of specified retailing attributes on retail pricing and consumer preference in the retail sales of gasoline in the metropolitan area of Vancouver, Washington. Gasoline retail sales were selected for study for several reasons. First, few studies have analyzed retail gas pricing in relation to retailing attributes. Even for the issue of retail pricing mechanisms operating on retail gasoline sales there exist few studies. One exception is found in Chamberlain (1956), who examined pricing among competing gas stations and then proposed the principle of "chain-linked" submarkets. He describes the phenomenon as follows:

Retail establishments scattered throughout an urban area are an instance of . . . a "chain" linking of markets. Gasoline filling stations are another. In either of these cases the market of each seller is most closely linked (having regard only to the spatial factor) to the one nearest him, and the degree of connection lessens quickly with distance until it becomes zero Where this is the case, considerations relative to small numbers hold even though the "group" be large. (pp. 103-104)

Chamberlain goes on to explain that variations in the chain-linked effects of pricing may exist. For example, a price cut by one retailer might be met by a somewhat smaller cut by a nearby retailer, and a cut even smaller than that by the retailer next along the "chain." In this way, price reductions may tend to dissipate over a short distance. On the other hand, should a nearby retailer meet a price cut in full, it might force others along the chain to do the same, thereby extending the price cuts throughout the chained submarkets.

A second reason for selecting this commodity for analysis is that gasoline is a homogeneous product (Haining, 1986), enjoying little in the way of customer loyalty to

brand name (Shaw, 1974). This homogeneity provides a high degree of experimental control in testing for the value of retailing attributes. Consequently, retail price variations among commodities with similar product attributes will indicate the relative influence of various retailing attributes.

Finally, gasoline is an intrinsically important commodity in highly mobile, present-day America. Gasoline purchases are frequent and price consciousness at a high level. As expressed by Haining (1986):

Consumers are highly mobile, usually purchasing petrol as part of a journey to shop, work, or leisure The consequence of this is that consumers can compare prices at several sites and at low cost. The potential for consumers to be very aware of price differences is accentuated by the existence of clear and usually unambiguous price posting. (p. 145)

The majority of gas stations in the U.S. are owned by major oil companies, and the corporations determine most of the locational and pricing strategies. However, oil companies are reluctant to reveal the formulae they employ for evaluating locational (or retailing) attributes for proposed stations (Smith, 1971:292). Smith adds, however, that most oil companies locate as near as possible to highway ramps on interurban thoroughfares, and near major intersections at urban locations. Beaton and Hall (1968:560) lists other attributes oil companies tend to consider in making pricing and siting decisions, among them the type or nature of the trading area; the accessibility of the site to customers; the visibility of the station signs; the property's size and shape; the traffic count on the adjacent thoroughfares; and utilities available at the site. Beaton and Hall goes on to say that, regarding marketing strategies, oil companies take into account many of the more subjective retailing attributes that are central to the present study, among them the level and quality of service, competition at a given site, dealer personnel, acceptability to the consumer of the product (image), the structure and design of the station, and other factors. In a similar vein, Globerman (1978), in a study of Canadian self-service gasoline stations, concluded that the level of price competition in retail markets "has the largest quantitative

impact upon the probability of innovation-adoption," adding that, "the degree of retail price competition is also positively related to the intrafirm rate of diffusion" (p. 85-86).

Focusing on the issue of competition, Haining (1986) studied price variation in gasoline retailing as it relates to competition in Sheffield, England. He found that competitive pricing in gasoline markets were influenced by several factors, including the pricing latitude allowed to individual retailers, the corporate (market shares) policy, and the overall sectoral structure (that is, the "coexistence and competitive relationships" among retailers of different brands of the same commodity—i.e., gasoline—within a limited geographic area). He concluded that competition results in a degree of spatial price regularity.

Haining goes on to say that very little exists in the way of conclusive findings on the nature of intersite competition. However, competition among retail gasoline distributors is largely local. Given the high degree of overlapping retail coverage that results from the tendency for gas retailing to agglomerate in high-traffic zones, pricing latitude at the local (retail) level is important insofar as it allows for price adjustments needed to maintain sales under prevailing local conditions. There is on the corporate level, however, an influence on spatial price variation which stems from corporate decisions to either maintain, increase, or decrease market share within a specific geographic area. Furthermore, a corporation might dictate prices within a limited geographic area (a kind of extended local adjustment). Haining sums up by admitting a "considerable scope for different types of price response patterns given some pressure on prices to change initiated in part of the urban area" (p. 146).

In conclusion, analysis of retail gasoline sales is thoroughly congruent with marketing analysis of retailing more generally. Specifically, the focal attributes of retailing to be addressed in the present study (accessibility, convenience, service, and competition) are marketing variables that cross most, if not all, retail sectors.

THE RESEARCH PROPOSITION

Given this context, the present study will test the ability of hedonic analysis to measure the influence of specific retailing attributes on consumer behavior.

Consumer purchase decisions are influenced by a combination of product and retailing attributes. The value of retailing attributes can be estimated by differentiating the retail prices of a homogeneous product. Retail prices will be associated with the level of the specified retailing attributes. A homogeneous product is used to control for product influence. Through the application of hedonic specification to the supply and demand models of the product under study, it is possible to isolate a scale of values for these retailing attributes. These values are represented in the implicit ask and bid prices for the retailing attributes.

The present research isolates, measures, and determines the market value of specified retailing attributes (accessibility, convenience, service, and competition) for a homogenous product at different retailing outlets. These were related to demand findings, which were estimated from actual observed consumer behavior.

On the basis of field observations and questionnaires, the study will formulate hedonic regression models for the variables as they relate to retail prices of gasoline in the study area. The analysis will determine the implicit value of specified retailing attributes and will estimate an inverse-demand function for each. Derived findings will be evaluated for the degree to which they substantiate, or controvert, the research proposition.

DEFINITIONS OF KEY TERMS

Following is a list of terms that are focal to the present study. Each is defined in accordance with usage that is conventional in the field of market research and analysis.

Brand

A brand is a logo or name that identifies a certain product, or group of products, and certain associated retailing attributes.

Competitive Prices

Competitive prices are those which are characteristically relatively low due to the influence of high levels of competition as well as variable levels of retailing attributes among competing retailers.

Convenience

Convenience encompasses a host of factors, some subjective, which pertain largely to consumer perception of a store's image. Among the factors considered are shopping ease (location), product assortment (variety), merchandise (quality), styling and fashion, and reputation on adjustments.

Explicit Prices

Explicit prices express the value of the visible portion of retailing attribute bundles.

Household Accessibility

Household accessibility is the measurable distance in miles and/or travel time from a given household to a given retail outlet.

Household Income

Household income is the pre-tax amount in dollars per year earned by individuals in a given household.

Implicit Price

The implicit price is the hedonic value associated with retail goods or services, which is a measure of the assigned implicit value of retailing attributes associate with a

given retail outlet, and by extension to that outlet's goods or services.

Multipurpose Capability

Multipurpose capability is the advantage of providing an agglomeration of retail outlets at a single site.

One-Stop Shopping

One-stop shopping is a retail outlet's capacity for providing a conglomeration of retail products at a single site.

Overall Price

The overall price is the sum of the explicit, the implicit, and the return on retail investment (wholesale price, overhead, and profit margin) of goods or services. Same as retail selling price.

Product Attributes

Product attributes are the dimensions, properties, and/or characteristics of goods and services which distinguish them objectively from similar goods and services.

(Compare "Retailing Attributes.")

Retail Bundle

The retail bundle is the quantitative measure of the retailing attributes at a given retail outlet.

Retail Price

The retail price is the posted or marked retail selling price of a given product or service.

Retailer

The retailer is the person or entity selling goods and services directly to the consumer for profit.

Retailer Accessibility

Retailer accessibility is the relative physical availability of a retail outlet to a given population concentration. It is measured by (a) the distance of the outlet from the nearest freeway exit, (b) the distance by existing roads to the proximate central business district (CBD), and (c) by traffic counts on the primary thoroughfare along which the retail store is located.

Retailing Attributes

Retailing attributes are factors external to the product itself, or accessory to its marketing, which the retailer provides in the context of offering the product for sale, or which market pressure imposes as a result of multiple retailers offering the same or similar products in the same market (competition). In the present study these retailing attributes are categorized as accessibility, convenience, service, and competition. Retailing attributes may be either explicit or implicit. Explicit attributes are easily untied from the retail bundle.

Service

Service includes several factors that pertain to levels of customer satisfactions. Factors to be included here include quality of service personnel, sales service, speed of service, multipurpose capability, and the availability of one-stop shopping.

METHODOLOGY

Phase One

In order to test the research proposition, the implicit (hedonic) value of selected

retailing attributes must be established. This will be accomplished by relating the dependent variable (cash price for unleaded gasoline) to data gathered for a sequence of independent variables. The independent variables listed below consist of several binary (B) and some continuous (C) variables:

- Traffic count on the thoroughfare most proximate to the outlet (C).
- Proximity to a freeway exit (within 2000 feet or less) (B).
- Distance in feet from Vancouver CBD (C).
- Presence of a convenience store on the premises (B).
- Size of station in number of gasoline pumps (C).
- Hours open for business daily (C).
- Level of service (full-serve or self-serve) (B).
- Presence of car wash facilities on the premises (B).
- Credit card use option (B).
- Distance from the Vancouver Mall (absolute distance) (C).
- Number of other gas stations within 90,000 square feet (C).
- Brand name of product (major or "off" brand) (B).
- Discount for cash payment (B).

By subjecting these independent variables to hedonic analysis and relating each with the dependent variable, the study will ascertain the precise implicit value for each, and, by extension, the proportional value of various combinations of attribute bundles. With this, it is hoped, the resulting model will provide the means for analyzing consumer preferences relative to the level of the attribute bundles present at a given retail outlet. A major portion of service attributes (e.g., washing windows, pumping gas, etc.) are estimated through the differentiation of the cash price of self-serve unleaded gasoline from the cash price of full-service unleaded gasoline at each gas station offering full-service islands. Then an average

differentiation is estimated, which is considered an explicit price. In the same way, a major portion of the price of credit is subjected to a similar process of differentiation within each station offering credit. In this way the findings and the resulting model will address the research propositions postulating a direct influence of attribute bundles on transactional costs. Although this was accomplished satisfactorily, the next step, that of extending the analysis to estimating the influence of transactional costs on consumer purchase decisions (the demand function) fell short of its desired aim. The statistical fit in the supply equation was best in the linear function, a finding which precludes the estimation of an inverse demand function for the continuous variables. The binary variables, which do not offer relative variability, may not be used to estimate the inverse demand function. Accordingly, it was necessary to turn in Phase Two of the analysis to an alternative approach in which the price of unleaded gas was treated as a dependent variable in relation to consumer characteristics like income and frequency of use.

Phase Two

There are certain inherent weaknesses with hedonic methodology (see Chapter III). In short, hedonic analysis provides less than perfectly reliable measurements of human behavior. This is so because it tends to simplify human behavior, and requires that restrictive assumptions be made about the function of utility. However, it is assumed in the present study that these shortcomings are offset by the considerable advantage offered in the study of consumer behavior by assigning on the basis of actual data implicit values to retailing attributes.

Although hedonic analysis allows us to ascribe precise implicit values to each retailing attribute, it falls short of providing means for estimating the inverse demand function—that is, the relative influence of the retailing attributes on consumer purchase decisions. This is so because the model's function was found to be linear, so that marginal

prices and quantities could not be estimated. As previously stated, this precludes the estimation of an inverse demand function on the basis of data for the independent continuous variables, resulting in a hedonic model with a non-curvelinear relationship between the dependent and the independent variables. In short, though implicit values of the retailing attributes may be reasonably estimated, no demand curves emerge.

In Phase Two, the analysis established for a dependent variable the variable retail price of gasoline at any given service station in the study area (in other words, the actual price paid by each consumer as established in a geographically stratified scientific sample of 300 households surveyed in the three statistical regions of the urban Vancouver, Washington area). This actual price was then regressed against the multi-independent variables listed below:

- Household income (continuous)
- Distance in feet of household to most frequently patronized station (continuous).
- Quantity of unleaded gas purchased per week (continuous).
- Utilization of convenience store on station premises (binary).
- Exercise of credit card option where available (binary).
- Exercise of full-service option where available (binary).
- Quality of service rated by consumer perception (continuous).
- Utilization of car wash if present on station premises (binary).
- Utilization of garage/mechanic services if present on premises (binary).
- Time of purchase (daylight or night hours) (binary).
- Purpose of trip on which gas was purchased (binary).
- Size of car engine (in number of cylinders) (continuous).
- Age of consumer (continuous).
- Gender of consumer (binary).

- Number of people residing in household (continuous).
- Length of time consumer has lived in area (continuous).
- Election to patronize major brand station (binary).

On this analytical foundation the findings for Phase Two of the analysis provide a model showing the relationship between the actual cash price for unleaded gasoline and the stated characteristics of consumer households (income and frequency of use). This relationship, when compared with the model resulting from Phase One of the analysis (which regressed prices against retailing attributes), will complete the overall picture. Together, the two phases of the analysis will show a relation of the retail price with the level of retailing attributes (that is, the extent of the attribute bundle), therefore enabling estimates of the influence of attributes on consumer preference.

PREVIEW OF FINDINGS

Findings from the supplier model are expected to support the proposition that the implicit value of retailing attributes may be realistically measured and their implicit prices estimated, and that in general implicit costs represent a measurable value that influence consumer choices. It is further expected that competition results in lower prices. The application in the present study of hedonic analysis to retailing attributes is expected to result in the estimation of the relative importance of the actual market values of retailing attributes. A gas station with a lower level of retailing attributes will be expected generally to offer lower prices.

The finding for the consumer demand function is expected to support the proposition that consumers differentiate between retailing attributes (accessibility, convenience, service, and competition). It is expected that lower income households will purchase at stations offering lower levels of attributes as a trade-off for generally lower prices at the pump, while higher income consumer will be expected to show the opposite

trend.

The research findings are expected to be consistent with the literature in the field of retailing, and will establish specific values for specified retailing attributes.

Chapter II will present a review of the literature in the field of retail marketing and price analysis, and will establish the relevance of the present research effort in the context of prior research. Chapter III will present the conceptual framework for hedonic analysis, and will present the rationale for its application to a study of retail pricing and consumer behavior. Chapter IV will detail the methodology of hedonic analysis as applied in the present research. Chapter V will present the findings of the present research. Chapter VI will present the analysis of the supply and demand findings, and Chapter VII will present the interpretation of the findings for supply and demand.

CHAPTER II

THE THEORETICAL BASIS FOR THE ATTRIBUTES OF RETAILING: A REVIEW OF THE LITERATURE

IDENTIFYING THE ATTRIBUTES OF RETAILING

This chapter will present a review and analysis of literature in the field and will establish the importance of retailing attributes. The discussion will not only define retailing attributes, but will survey their treatment in previous research and discuss several conclusions and conceptualizations that have been established regarding them. The chapter will further examine the relationship between retailing attributes and consumer preference, which is the subject of central-place, spatial-competition, and movement-interaction theories.

Christaller's central-place theory (1933) assumes that the attributes of goods and those of services are identical, and that in fact only two factors influence consumer behavior: the distance to a point of purchase, and the order of goods that exist in the near space. As indicated in Christaller's multipurpose-trip postulate, consumers consistently prefer shorter distances and larger places regardless of other potentially influential attributes. In Christaller's view, retailers attempt to furnish products at the closest possible distance from their patrons while at the same time providing optimum demand satisfaction.

Lately, though, Christaller's assumptions have been relaxed and more attributes have been added to the list those thought to influence consumer behavior. Adding such attributes as the level of competition among retail stores, the elasticity of supply and demand on retail products, and even retailing attributes such as the availability of parking (convenience) and the prices and assortment of merchandise (retailer image), have

combined to provide a more realistic analysis of consumer behavior.

The impact of competition on price variation and consumer behavior was advanced in the work of Fetter (1924), Hotelling (1929), and Lerner and Singer (1937). This vein of research was continued in the work of Isard (1956), Lancaster (1966, 1979), Eaton and Lipsey (1975, 1979), Hay (1976), Shaw (1982), and in that of Haining (1983, 1984, 1986). Studies of elasticity of supply and demand as an influence on prices and consumer preference is to be found in the work of Smithies (1941), Hay (1976), and Shaw (1982). Only more recently have studies of attributes generally termed "store image" been conducted, most notably in the work of May (1971, 1972, 1973), Kunkel and Berry (1968), Kelly and Stephenson (1967). In fact, the Winter 1974 issue of The Journal of Retailing was given over entirely to the topic of store attributes or image.

Although studies analyzing attributes of a store's image and their influence on consumer behavior were not conclusive, they nonetheless expanded and clarified the list, or bundle, of attributes thought to influence consumer behavior, subsequently making such analyses more realistic and viable. Although these studies included among their attributes retail prices, they took no account of hedonic (implicit) prices; neither did they evaluate or differentiate among these implicit prices relative to the existing level of retailing attributes. Consequently, studies dealing with consumer behavior remain equivocal on the specific influences of a store's image on consumer preferences.

Studies of store image began with the work of Martineau (1958). His study found that the image, or personality, of a store is communicated through functional characteristics which act as cues for both retailer and consumer. These functional characteristics include such things as size, location, and store hours. Further, Martineau asserts that a store's personality consists of four ingredients: personnel, symbols and color (i.e., logo), architecture and layout, and advertising. Later, Fisk (1961) identified what he termed the six attributes of image: (a) merchandise, quality, assortment, and pricing; (b) service and

sales clerks; (c) social class appeal; (d) store layout and shopping ease; (e) parking convenience; and (f) promotion. Kelly and Stephenson (1967) advanced eight "dimensions" of store image, which do not differ significantly from Fisk's six attributes. Kunkel and Berry (1968) conceptualized men's behavior relative to store image. Applying the principles of content analysis, they categorized consumer comments on twelve attributes as they were applied to three retail stores. Their twelve attributes were these: (a) quantity of merchandise, (b) quality of merchandise, (c) assortment of merchandise, (d) fashion of merchandise, (e) sales personnel, (f) locational convenience, (g) other convenience factors, (h) service sales promotion, (i) advertising, (j) store atmosphere, and (k) reputation on adjustments (p. 26). All of these studies attest to the growing importance of a broad view of identifying factors which influence the behavior of consumers.

In an attempt to find a common theme in the literature on retailing, Lindquist (1974) reviewed the published findings of 26 previous studies that dealt with the topic of store image. He synthesized their frameworks and divided them into the following nine categories, which he termed image/attitude attributes: (a) merchandise, (b) service, (c) clientele, (d) physical facility, (e) convenience, (f) promotion, (g) store atmosphere, (h) institutional factors, and (i) post-transactional satisfaction. Among the 26 studies examined, Lindquist found that, regarding common retailing themes, 42 percent of the studies mentioned merchandise selection and assortment, 38 percent mentioned merchandise quality, 38 percent merchandise pricing, 35 percent locational convenience, 27 percent merchandise styling and fashion, 27 percent general service, and another 27 percent sales service. Lindquist found that a quarter of the studies either established conclusively or hypothesized that when identifying the significant components of a consumer's image of a store, the attributes merchandise, service, and location are uppermost in importance. He adds that the dominance of merchandise deserves special note, and that the image/attitude attributes had considerable empirical support (except for "guarantee," "shopping ease," and

"post-transaction satisfaction"). One may generalize from Lindquist's findings that factors contributing to a store's image are multiple in nature.

The major methodological theme found in store-image studies is reflected in consumer ratings of certain attributes (McDougall and Fry, 1974; James et al., 1976). Accordingly, stores are differentiated on the basis of variations in the ratings of their characteristics (Kelly and Stephenson, 1967; Lessing, 1973; May, 1972; Lindquist, 1974).

Researchers report a wide variety of retailing attributes which they find to be indicative of a store's image, and this variety is due primarily to differences in defining store image. As stated by Kunkel and Berry (1968): "Retail store image is an alluring yet uncrystallized concept. Part of the problem stems from the difficulty encountered by some researchers in defining image" (p. 21). Pierre Martineau (1958) defines store image as "the way in which the store is defined in the shopper's mind, partly by its functional qualities and partly by an aura of psychological attributes" (p. 47). Important in Martineau's definition are two key terms—"functional qualities" and "psychological attributes." By the former he means such things as price range, credit policies, merchandise selection, store layout, location, and other attributes that may be compared objectively with those of other stores. The latter term, the psychological attributes, include such things as friendliness, a sense of belonging, comfort, and excitement. These two sets of attributes, the objective and the psychological, interact with one another in the consumer's mind, producing either a positive or negative store image, which then influences consumer shopping behavior.

Arons (1961) studied the influence of television viewing on perceived store image and shopping frequency, and from that foundation defined store image as "a complex of meaning and relationship serving to characterize the store for people" (p. 2). Kunkel and Berry (1968), on the other hand, define store image as "discriminative stimuli for an action's expected reinforcement. Specifically, 'retail store image' is the total conceptualized

or expected reinforcement that a person associates with shopping at a particular store" (p. 24). Their view is that consumers acquire an image of a store by weighing the sum of all his or her shopping experience there. The general form that this image will take hinges on the value that the consumer places on store convenience, fashionability and selection of merchandise, quality and quantity of selection, sales personnel, and/or other attributes, including the extent of "reward and/or damage" incurred in connection with these attributes.

In summary, it is clear that the matter of store image is not only complex, but involves intangible and subjective as well as objective variables, since store image is inherently a perceived quality. Consequently, any study that purports to analyze in depth consumer behavior in the context of retail shopping must take into account these subjective factors as fully as the more common objective ones. The present study attempts to do just this.

The studies discussed above used direct questionnaires and nominal measures for the evaluation of store attributes. Despite the complications of concurrent validity and other problems with nominal measures (see Kasulis and Lusch, 1981; Doyle and Fenwick, 1974:42-43), research on store image provides valuable information on consumer behavior which is particularly of use to marketing and retail professionals. The studies also show that retail prices in themselves play a less important role than previously thought, heightening even more the importance of analyzing the influence of retailing attributes. Furthermore, in none of these studies is there any account of either explicit retail prices or hedonic (implicit) prices—i.e., the value of these retailing attributes. Knowing both the explicit and the hedonic value of retailing attributes would indeed be a valuable tool in structuring the optimal bundle of attributes to most positively influence consumer behavior.

While agreeing that the attributes of store image are important, the present research takes for its focus the attributes outlined by Lindquist (1974), which are accepted by the majority of researchers in the field of retail marketing and consumer behavior. These

retailing attributes are categorized as accessibility, convenience, and service, which are considered to be major factors influencing consumer behavior. Furthermore, this influence may be tested by relating the level to which the attributes are present to retail prices in order to determine the explicit and implicit values of these attributes. These values may also be differentiated by consumer attributes such as level of household income.

Hedonic analysis (applied in Chapter III) identifies the implicit prices of these attributes and examines them in relation to consumer income and taste. Hedonic analysis has not previously been applied to the study of consumer behavior in retailing, and it is hoped that doing so here may provide a model for directly measuring the consumer's willingness to pay for a given retail attribute, therefore providing a more formal and realistic picture of the outcome of the process of consumer shopping.

Upon reviewing and identifying the attributes of retailing, it is necessary to analyze these attributes to determine the extent to which the implicit value of each one influences consumer behavior. Clearly, consumer behavior is highly variable, with a great many factors affecting purchasing decisions. Among these are the matters of cultural status (Thomas, 1974; Potter, 1977a), social class (Davies, 1969; Nader, 1969; Schiller, 1972; Thomas, 1974; Potter, 1977b), car ownership (Thomas, 1974; Potter, 1977a), and age and family size (Potter, 1977a), personal perceptions of the retailing environment (Potter, 1977a). The studies and findings of these and other researchers on the subject of the spatial behavior strongly supports the view that retailing attributes influence consumer behavior.

The works to be reviewed here advance two primary theoretical views. The first focuses on spatial competition, which directly influences pricing, and hence consumer preference. This view originated in the work of Fetter (1924), was advanced in Hotelling's (1929) conception of "spatial competition," and appears more recently in Lancaster's (1966, 1979) "consumer theory." The second view is grounded more in classical theory,

deriving from Proudfoot's (1938) research and his advancing of the "central place" theory. Proudfoot's view was furthered by several later researchers, among them Berry (1962, 1964, 1967), Simmons (1964), and Garner (1967). Central to the work of these theorists were conceptions such as the study of movement patterns within cities (including the formulation of gravity models), the "revealed preference" approach, the behavioral approach, and the learned or dynamic approach.

SPATIAL COMPETITION AND CONSUMER BEHAVIOR

The Views of the Spatial Economists

Spatial competition is that which exists between and among firms in a definable retailing sector. It results in differentiated retail products and varied prices for like products, and is exacerbated by several spatial considerations. The principles of spatial competition are prevalent in both classic and contemporary literature in the field, and following is a review of many of the more prominent studies and findings.

Lösch (1944), and his "interurban model" for explaining the effect of distance-to-producer is useful for explaining retail consumer behavior. Adapting Lösch's views to retailing, then, one might argue that in the interests of competition retailers price their products by taking into account the consumer's preference for accessibility—that is, the shortest distance. Regardless, the portion of Lösch's theory that is most applicable to the present study is his formulation of the interurban spatial monopoly and its applicability to competition among retail stores. When a given store is the sole provider of specific goods in a definable market area, that store enjoys a monopoly and the pricing advantages this affords, which then translate into added profits. However, these very added profits act as an inducement to other retailers to move in to the same retail market. As competition increases, the relative value of the retailing attributes is distributed among all competing retailers. The principles of spatial competition come into play, then, as competing retailers

attempt to increase their market by manipulating both prices and the level (or value) of their retailing attributes. Ultimately, competing retailers may reach a state of relative equilibrium, which may take the form either of a degree of competition, a monopolistic competition, or an oligopoly.

Hotelling (1929) advances the principles of market competition to explain firms clustering on the one hand (e.g., near highways or certain neighborhood centers), or on the other hand scattering. In his view, firms attempt to maximize market share by locating near the center of population concentrations or in high density traffic areas. Further, from Hotelling's view of linear market analysis, consumer demand is inelastic and evenly distributed. Consequently, Hotelling's landscape maximizes the aggregate transportation cost incurred by consumers in the area since his view is that consumers will be insensitive to the influence of transportation costs and product prices. Hotelling extends his theory to include what he terms "doupoly." If a single firm occupies a given market it will serve that total market; further, Hotelling asserts, if a second firm enters that same market equilibrium can be reached when the two firms are back-to-back. Since both firms are "back-to-back" both firms will maximize market coverage by clustering at the market center. Accordingly, each will secure half of the market.

A great many researchers have extended Hotelling's work in analyzing the influence of spatial competition on pricing. The majority of this research focuses on three areas: (a) increases in the number of competing firms; (b) understanding spatial competition in specific geographic areas; and (c) reviewing and improving Hotelling's assumptions about the inelasticity of consumer demand. The last of these will be discussed in a later section entitled "The Elasticity of Supply and Demand," but the two former are discussed below.

First is the issue of increasing numbers of competitors in a linear market segment. This subject was studied by Chamberlain (1956), and by Lerner and Singer (1937). The latter concluded that increased numbers of competitors would lead, beyond a certain point,

to disequilibrium, since firms would tend to jump one another, competing for a finite market share and limited consumer demand.

Eaton and Lipsey (1975) took a somewhat different approach, extending Hotelling's one-dimensional to a two-dimensional market model, as well as increasing the number of competing firms included in the analysis. As a result, they found that no specific generalization could be made about competitors in a given market area, since competition is a function of far too many variables. Among other things, their analysis depends on the specific number of competitors and their retailing behavior, the size of the market and its nature, customer distribution, and several other factors. According to Hay (1976), Eaton and Lipsey tentatively agreed that in one-dimensional models firms will be paired in a wide range of equilibrium and disequilibrium situations, and that in two-dimensional models firms may be either scattered or clustered, depending on any number of the factors mentioned above. Eaton and Lipsey later concluded (1979) that businesses may cluster in order to be in close proximity to their competitors so as to provide comparison shopping.

The second area of extended research focuses on understanding spatial competition within a specific geographic area. Findings in this branch of the research are similar to the findings discussed above, which pertained to increasing numbers of competitors. It was found that to maximize market share firms are inclined to scatter as much as to cluster, since scattering allows some competitors to serve localized market subsectors. Moreover, firms operating in a two-dimensional area are inclined to increase market coverage not only to increase profitability and extend the market's range, but also to deter entry of other competitors (Scherer, 1979; Schmalensee, 1978).

Spatial Competition and Product Differentiation

The relationship between spatial competition and product differentiation and its

influence on consumer behavior occupies a large share of the work of Lancaster (1966, 1979). In fact, though, Lancaster's views were derived largely from the work of Houthakker (1952), who addressed consumer behavior in relation to variations in product quality. In Lancaster's view, consumers are less apt to respond to products per se, but instead to attributes, including spatial attributes. Accordingly, Lancaster holds that products are in reality bundles of highly variable characteristics, many of which are attributes that are external to the products themselves (e.g., accessibility), but all of which influence consumer behavior. This view is highly supportive of the views advanced in the present study, since Lancaster supports the position that such spatial characteristics as accessibility exert an influence on consumer behavior. In short, a retail store is not necessarily desirable (or undesirable) in itself, but rather for the combined effect of both its product offerings and the retailing attributes it offers consumers. Consequently, consumer preferences ultimately determine the relative levels of each facet of the attribute bundle each retailer offers, in effect ascribing to each its real value. This is so because in the course of competing with one another retailers manipulate various elements of the bundle of retail attributes in response to consumer preference.

Fetter (1924) also studied the influence of levels of spatial characteristics on pricing, doing so in a two-dimensional market analysis. By adapting Fetter's analysis to retailing, two competing retailers may be expressed as overlapping hyperbolic curves. The shape and size of each curve is dependent on the level of accessibility—that is, the more accessible a retail store, the wider its market coverage (with all else being equal).

Hyson and Hyson (1950) expanded on Fetter's conception of the hyperbolic, two-dimensional market, but in their case distinguish between the cost and the mode of transportation. To illustrate, they developed what they termed "hypercircles," whose relative sizes depend on two factors: the cost of transportation (i.e., accessibility) and prices. Adapting their analysis to retailing, they found that retailers offering lower prices

and greater accessibility enjoyed a larger market area.

Isard (1956) discusses Hoover's formulation (1937) that firms having lower marginal costs will cover a wider market area than competing firms with higher marginal costs. Extending this concept to competing retail stores, one may conclude that retailers providing a greater volume of retailing attributes will enjoy a larger market share, since the quantity of retailing attributes sold offsets marginal costs (in effect lowering them), resulting in lower prices and, hence, a wider market base.

Chamberlain (1956) advanced the concept of the spatial monopoly, arguing that large groups of firms in monopolistic competing markets may be thought of as comprising numerous "chain-linked" submarkets. Given this, competition's effect on pricing could take two forms. First, a given firm's price cut might result in his competition's making a smaller cut (in some cases relying on other attributes to offset the differential). However, competition in this case would be limited. On the other hand, one firm's price cuts might force nearby competitors to meet the price cut in full, thereby spreading the competition over a wider area via a rippling effect through the chain-linked submarkets.

Along similar lines, Haining (1986) addresses the influence of competition and accessibility on retail pricing in intraurban markets. His view is that it is necessary to differentiate between corporate and individual retail sites when considering intraurban price variations. The chief consideration in pricing is maintenance of market share, since competition at the corporate level generally occurs in the form of oligopolistic means. Hence, the effect of a corporation's alteration of its price structure depends largely on the reactions of its competitors. Since corporate sales in urban markets is generally divided over several retail sites, corporate retailers may enjoy some latitude in establishing prices. At the local level, however, the level of competition is apt to be influenced more by the distribution of proximate retail sites, since competition is generally greatest where retail sites are densest. This may lead to a weakened "local monopoly" (Haining, 1986:144).

Spatial Competition and Brand Loyalty

Among other variables that influence spatial competition and consumer choice are promotional campaigns attempt to differentiate a product to increase and maintain sales by creating a loyal following. In general, brand loyalty influences retail pricing and quantity of sales. This is due largely to certain brand attributes that marketers identify as characteristic of their product, and which they promote as advantageous to the consumer. This, in turn, influences price and sales. In economic terms, differentiating a product through brand loyalty leads to both a shift outward and a steepening of the producer/advertiser's demand curve, all other factors remaining equal. As argued by Caves and Porter (1977): "Advertising outlays are made not only to raise the limit price and shift outward the advertiser's own demand curve, but also to decrease the elasticity of demand facing the firm" (P. 246). The threat from competitors will decrease as the demand curve steepens, and in such cases the seller will enjoy wider market coverage. Brand loyalty created through advertising, then, is used not only to maintain consumer loyalty and to expand market coverage, but also to maintain existing levels by deterring new entry (Scherer, 1979; Schmalensee, 1978). Sometimes, however, brand loyalty will distort the influence retailing attributes and product attributes.

Import to the present study, however, is that in the case of homogeneous products brand loyalty has a minimal influence on consumer behavior. Consequently, when analyzing homogeneous products, the influence of retailing attributes on retail prices will be highlighted.

In summary, firms tend to agglomerate in certain areas because they may offer greater potential for higher sales volume. This may be influenced by many factors, including corporate policies, the elasticity of supply and demand, shifts in supply and demand, the type of product, the level of retailing attributes, the level of promotion, and the level of competition in that area. To understand how these factors operate, it is necessary

to distinguish homogeneous from differentiated products. For differentiated products, agglomeration will relate positively with sales. A good example of this is comparison shopping afforded by so-called "auto rows." However, for homogeneous products, this may not be the case. Assuming supply is constant or elastic (as is the case with homogeneous products), then quantity demanded and demand may be the crucial factor in determining the level of spatial competition. Since spatial competition influences prices and, hence, sales volume, areas with normally high quantity demanded and demand (e.g., highly accessible locations) one would expect firms to enjoy high sales volumes and low marginal costs. Under these conditions the pressure to cut retail prices is minimal. In areas with relatively low quantity demanded and demand, on the other hand, one would expect to find a smaller number of firms. In these areas the tendency for competitive price cutting would be greater, particularly among firms selling homogeneous products. In the case of wide fluctuations of quantity of supply and supply and quantity demanded and demand, the situation can be a combination of various scenarios.

The Methodology of Spatial Competition

The methods most common to analyses of spatial competition include various forms of mapping, correlation regression, multilinear regressions, econometric modeling (with the simultaneous equation and model function estimations for statistically the best fitting functional forms), and "nearest-neighbor" analysis, which measures the degree of clustering of firms.

Nearest-neighbor analyses result in scatter graphs of firm locations as a statistical expression of relative distances between these firms. The resulting array of scatter points will show degrees of concentration and whether or not these concentrations are random. Each point is considered either an i or a j point, and the nearest neighbor to a given i point is the j point closest to it. All such distances are measured and an average distance of the

nearest neighbor is determined. Specific instances of relative distance are then correlated with the average, and in this way the degree of concentration is established. Total or complete concentration would be indicated with a correlation of 0.00, implying that all competitors are spatially concentrated in a single location. The opposite extreme is a correlation of 2.12, and the middle of the range indicates random distribution of firms. Recently Haining (1983, 1984), building on these nearest-neighbor concepts, applied this model to a study of intraurban price variation among gas stations in Sheffield, England, finding that retail sites did not tend to cluster in similar ways in all areas.

Most notable in the work of Hoover (1937), Isard (1956), and Lösch (1944), spatial competition models reveal the concerted attempts to add spatial dimensions to economic theory. Hoover is particularly empirical in his approach to this matter, emphasizing discussions of retail area structures in terms of maps of early trading areas and commentary on transportation's role in "channeling consumer patronage into certain observed patterns" (Thompson, 1966:10). According to Thompson, both Isard and Lösch are oriented toward determining what he terms "spatial equilibria" based on economic models that are amended to account for transportation factors, which they see as substituting for certain production factors. Furthermore, both insist on adding "spatial dimension to economic theory largely through their consideration of the revenue possibilities of spatially separate markets . . . [by] monetizing the costs of transportation" (Thompson, *op. cit.*). This is similar to methods used in the present research, which attempts to estimate precise implicit and explicit values for specified retailing attributes (i.e., monetize these attributes). Thompson summarizes this approach to analyzing spatial competition in the following terms:

In all these efforts the basic assumption is that the decision maker corresponds to the "economic man" in that an objective analysis of revenues and costs, satisfactions and dissatisfactions, utilities and disutilities, and the maximization of the difference between the two, lies at the heart of any decision to patronize one retail store rather than another. (p. 11)

In short, then, fundamental analysis of consumer behavior must take into account the implicit value of the prominent retailing attributes every bit as much so as the more objective variables of transportation and production. However, contrary to the trend for analysts to empirically estimate the value of the variables, it is essential to place such estimates on a firm theoretical and analytical footing, which hedonic analysis provides.

ELASTICITY AND CONSUMER BEHAVIOR

The elasticity of product supply directly influences the elasticity of retail attributes, which in turn influences pricing, quantity sold, and consumer behavior. Conversely, if the supply of the product is inelastic, then either product demand or any upward shift in demand will lead to a rise in the price of both the product attributes and retailing attributes, or else quantity demanded will increase. However, due to the competitive nature of retailing as an industry, retail products and retailing attributes are in most cases assumed to be supply-elastic. The changes in price can be attributed mainly to the level of retailing attributes and their elasticity.

Recent interest in the subject of demand-elasticity and its relation to spatial competition stems largely from Hotelling's (1929) assumption that demand is inelastic. Later research relaxed this assumption, taking into account the ability of firms to make trade-offs between maximum market coverage and potential loss of distant customers. Smithies (1941) was among the first to study elasticity of demand in relation to space, finding that, allowing pricing to be demand-elastic, distances between sellers is a function of the elasticity of their goods. That is, when demand is inelastic, sellers will tend to be closer together; conversely, when demand is elastic, they tend to separate. Smithies' formulation may be applicable to analogous conditions of elasticity and inelasticity among retailers.

Hay (1976), on the other hand, analyzed competing firms in a more practical

situation, wherein the cost of one retailer relocating or jumping another was unrealistic. His analysis allowed for new firms entering a given market, but the outcome indicated that firms tended to be evenly distributed throughout the market. This finding counters the research of Eaton and Lipsey (1975), which found that firms tended to cluster in markets where demand was spread evenly over the market area. According to Hay, though, demand that is distributed unevenly in a market area will result in firms tending to cluster in the proximity of the areas of higher demand, and to scatter in areas of lower density demand. However, Shaw (1982) found limits in Hay's analysis of product competition, specifically in Hay's assumption that a given distribution of demand undermines the impact of advertising and marketing.

Demand elasticity on a product will also influence the elasticity of retailing attributes such as accessibility, distance, convenience, service, and competition. If the consumer is not particularly sensitive to product prices, it is assumed he will also not be particularly sensitive to the hedonic value of the retailing attributes provided by the retailer. In this vein, Witte et al. (1979) studied implicit attributes of housing and found that they do not exist in and of themselves, but instead serve merely to shift both offers and bid curves. By extension, then, one might conclude that elasticity is constant, and that it only shifts the supply-demand curve upward or downward without altering its slope. However, Witte did not elaborate on this point—that is, whether the slope of the supply-demand curve is altered or merely shifted up or down.

Although elasticity of product attributes is crucial in determining the quantity demanded of retail product, the elasticity of the retailing attributes can influence quantity sold. This leads to an overall elasticity that differently influences consumer demand and quantity sold. It seems the influence on the overall elasticity of the retail product is a function of retailing attribute levels and quantity demanded, all other factors being equal.

MOVEMENT-INTERACTION AND CONSUMER BEHAVIOR

Movement interaction analysis is founded on the Newtonian theory of gravitation, in which the degree to which two bodies (objects) attract one another is proportional to their mass (size) and distance from one another. In adapting Newtonian theory to analyzing market behavior, physical objects are represented by population groups, and on that basis the principles relative size (mass) and distance are analyzed along Newtonian lines.

A crude version of this method was adapted to a study of market areas and retailing behavior by Reilly (1931), and on the basis of this analysis he determined market threshold and breaking points. Over time this method has become more specialized (see Huff, 1960), evolving to consider the influence of more specific retailing attributes, among them distance, accessibility, size of the shopping area, availability of parking, the assortment of merchandise, and other attributes. According to the principles of movement interaction analysis, then, a researcher may derive a gravity model representing the probability of a consumer shopping at a certain store as a function of the ratio of benefits or attractiveness of one store's attributes over similar attributes at another store. The store possessing the greater relative number of attributes will be proportionally more frequently patronized.

The concept of gravity modeling has been improved to include more retailing attributes, therefore depicting a more realistic picture of consumer and retailing behavior. These improvements are based largely on the isolating of more representative and reliable exponents, largely through employing techniques such as revealed preference and consumer demand theory, attitude/attribute measurements, and other forecasting methods. Consequently, gravity models can provide reliable profiles of market areas and reveal the attractive function of specific store attributes, as well as identifying the probable influence of a given attribute on specific consumer populations.

Central to both movement-interaction analysis and gravity concepts is the "central

place" theory (Christaller, 1933), which holds that retailing behavior is built upon two sets of behavioral postulates, one pertaining to concrete or objective attributes of goods and services, and the other to more subjective attributes of retailing. Among the latter accessibility (distance or space) is the primary variable. Christaller assumed that each product possesses a fixed range of objective attributes. However, his discussion identifies actual differences, noting that consumer preference respond to differentials in retailing attributes such as consumer mobility, price, and consumer preference (Murdie, 1965). The former set of behavioral postulates—that pertaining to attributes of the goods—describe consumer behavior that responds to retailers offering goods under conditions where purchasing power is equal to or greater than the threshold of the goods sold (Lösch, 1944). Conversely, retailers cease offering these products when purchasing power becomes less than this threshold. Christaller's view of the conditions under which a retailer withdraws products or services is similar to the above offered by Lösch (see Clark and Rushton, 1970:486). Similarly, both Christaller and Lösch assume that the retail attribute accessibility (distance) is variable, while all other attributes of the products and the retail store remain equal.

The second set of postulates describes consumer behavior in relation to space; that is, consumers will tend to patronize the nearest establishment that offers the desired goods (Clark and Rushton, 1970; Dent, 1972). The only attribute that is seen to significantly influence consumer preference, all else being equal, is distance. In studies designed to test this hypothesis, Clark and Rushton found that in fact their assumption varied from one retail product to another. Milk and vegetable products showed the highest percentage of consumers patronizing the nearest retail center (62.8%). Grocery shoppers used the nearest retail center 57.4 percent of the time, while meat shoppers did so only 46.8 percent of the time (Clark and Rushton, 1970:488).

Although central place theory proves reasonably reliable when applied to consumer

preference for convenience goods, Rushton cautions that "central place theory is only one of many areas of human geography where assumptions about spatial patterns of individuals are incorporated into explanations of spatial structure" (Rushton, 1969:391). He adds that the pattern of central place theory represents just one dimension of consumer preference, and that consumers readily adjust to prevalent patterns. The weakness, then, in central place theory in explaining consumer and retailer behavior lies in its tendency to rationalize given spatial structures while ignoring consumers' tendency to adjust to prevailing circumstances (Rushton, 1969:391). This conclusion, that central place theory is simplistic and normative in the analysis of consumer preference, are shared by other researchers (see Craig et al, 1984).

GRAVITY CONCEPTS

Gravity concepts describe the attractive (or inductive) influence of specific retailing attributes on consumer behavior, leading, then, to a principle of relative location by combining measures of relative scale, size, and price with parallel measurements of relative accessibility (Dent, 1972; Haynes and Fotheringham, 1984; Ingene, 1984; Goodchild, 1984; Eagle, 1984). The first mathematical formulation of gravity concepts was advanced by Reilly (1931); however, not until the work of Huff (1964) were retail and commodity attributes clearly specified. With this background, then, one could determine the ratio of the utility (or attractiveness) of a give store's attributes and with that ratio ascertain the probability of a given consumer's patronizing that store. The higher the ratio of utility attributes to total store attributes the greater the probability that the consumer would patronize that particular retail outlet.

Huff (1960, 1962, 1963a, 1963b, 1964, 1966) formulated a pragmatic model of this process by replacing a gravity model's population factor with the more realistic retailing attributes, such as store size, pricing, and parking convenience. Huff was also the

first to employ in his analyses the "revealed preference" concept, which ultimately developed into a theoretical approach of its own (Dent, 1972).

Gravity models have been used repeatedly over the past three decades, and the list of research efforts that have employed this approach is very long. This popularity testifies to its pragmatic utility in conducting research in the field of retailing (see among others Weisbrod et al., 1984; Houston and Stanton, 1984; Haynes and Fotheringham, 1984; Ingene, 1984; Eagle, 1984; Goodchild, 1984). Although these and many other studies do succeed at adding more attributes to their analyses, alter the distance or accessibility exponents, and classify households in a realistic fashion, they still fail to indicate the influence of hedonic values in their calculation of gravitational influence.

REVEALED PREFERENCE ANALYSIS

In the attempt to better explain retailer and consumer preference, to advance the theoretical work of Huff, and to better understand the difficulties of selecting an exponents for the attribute and accessibility variables in the gravity model, there emerged a "revealed preference" approach for more accurately and realistically modeling spatial choice (Timmerman and Rushton, 1979). As a result, revealed preference modeling has been used extensively in analyses of consumer demand. The method is based on consumer statements of intent. On the basis of this method, it is theoretically possible to identify an order or hierarchy of consumer intent from any consistent statement of consumer preferences derived from the paired comparisons of those intents (Samuelson, 1948). Any such order may then be illustrated graphically in such a way that that an "indifference surface" appears, highlighting combinations of goods about which the consumer is indifferent. In short, then, revealed preference analysis attempts to derive an indifference curve empirically from observed behavior. In this way the trade-off between different combinations of variables under a given set of conditions will emerge (Rushton, 1969).

However, there a problem with revealed preference analysis is that it is difficult to know the degree to which observed behavior reflects true preference. Some researchers have attempted to design experiments that allow attribute values to be manipulated in such a way that various combinations may be artificially constructed, in this way identifying a set of hypothetical options that are independent of any specific spatial structure. The most common example of this is the information integration theory. Employing the technique of "functional measurement," this method has been used to explain diversity of behavior by testing algebraic models of human behavior (with retailing attributes used for modeling variables) and than analyzing variances between models (Louviere and Norman, 1977; Louviere and Henley, 1977). The difficulty with this approach, however, is the subjective nature of applying levels of significance to the different retailing attributes.

Integration theory specifically studies choice behavior relative to various stimuli (attributes). Therefore, it can provide important information on human preferences in relation to a wide assortment of retailing attributes (e.g., accessibility, assortment of merchandise, service, etc.), even in cases when there is neither a market nor a clear value for these attributes. Integration theory and its analytical methodology (conjoint measurement) was developed by Anderson and his associates (Anderson, 1970, 1971, 1972a, 1972b, 1974a, 1974b; Anderson and Shanteau, 1970; Anderson and Weiss, 1971).

Using conjoint measurement to generate data on certain human behaviors, integration theory uses experimental and analytical methods based on collected data. The experimental portion employs factorial analysis, while the analytical portion rests on an algebraic approach to parameter estimation and goodness-of-fit analysis (Louviere and Norman, 1977). On the experimental level, however, a weakness rests experimenters selecting the attributes to study. Consequently, the threshold level will not always be typical of attributes which the subject encounters or internalizes (Cadwallader, 1984).

Revealed preference analysis may incorporate hedonic prices into a study of store

attributes. For example, a consumer could be asked to choose between attributes of convenience and service or to express his perception of the value of the level of convenience and service in his preferences. Invariably, the consumer will prefer the highest level of attributes having the lowest implicit value or price.

In Figure 1, below, it is shown how Rushton (1969:391) compares revealed preference with Reilly's gravity model (1931) and central place theory. The figure illustrates the trade-off that consumer's make between distance (accessibility) and other retailing attributes, showing that consumers prefer to be on the highest indifference line, which indicates outlets having the most desirable retailing attributes as well as offering the shortest distance for the consumer to travel.

SOURCE: Rushton (1969)

Figure 1. Revealed preference model as formulated by Rushton (1969).

Reilly's gravity model (1931), as Rushton (1969) illustrated, differs somewhat in that it squares the distance. This results in the series of indifference curves shown in Figure 2. Using an exponent greater than one, the gravity model shows that greater distances have a relatively more significant influence than do shorter distances on the resulting preference structure.

SOURCE: Rushton (1969)

Figure 2. Reilly's Gravity model as illustrated by Rushton (1969).

Also notable is that central place theory simplifies the setting up of indifference lines, as is shown in Figure 3. In Figure 3 the lines portray consumers concerned with the distance attribute only, remaining completely indifferent to variations in all other attributes. Rushton (1969) illustrates these relationships using size as a measurement for all other

store attributes.

SOURCE: Rushton (1969)

Figure 3. Central Place theory as illustrated by Rushton (1969).

Figure 4, on the other hand, illustrates the focus of the present study, showing that the consumer chooses between retailing attributes and the implicit value. As convenience increases, so does its implicit (hedonic) value. This rise is reflected in the retail selling price. Consumer will most often choose the highest level of service attributes that maximize utility (within budgetary constraints) that also offers the lowest implicit value.

SOURCE: Author

Figure 4. Correlation of attribute level with implicit value.

Timmerman (1979) further refined the concept of revealed preference by building on earlier studies which had established that the true area of preference is delimited by two factors: reasonable travel time, and what Loyd (1977) terms "the personal range of the good" (p. 15). Like most behavioral analyses, revealed preference examines a great many attributes of retail destinations (Pipkin, 1981:149). However, implicit prices as a measure of the influence of retailing attributes on consumers was left unexamined by human behaviorists. Implicit prices might reflect the gravitation parameter and its exponent. Regardless, revealed preference analysis more accurately accounts for gravity model exponents and parameters, particularly by including interval measures and by virtue of its being a multiplicative variable. However, there are problems with the gravity models when interpreting the results: first, there is difficulty relating one level of aggregation to another;

second, due to the multiplicative form, no parameters can be zero. This is a potential difficulty to be watched for carefully.

Gravity models indicate no implicit values and are incapable of identifying the influence of some independent variables (e.g., store attributes on retail prices). Hedonic multivariate regression analysis does provide implicit values of attributes, as well as indicating retail price variations in relation to each attribute. Accordingly, the implicit value of each retail attribute is expected to differentiate relative to household income. A multiplicative specification of the MLR model will isolate the interaction effect among pairs of attributes, as described in the discussion of the multi-attribute approach of Lindquist and others.

ATTITUDE/ATTRIBUTE BEHAVIORAL CONCEPTS

The multi-attribute attribute assumes that spatial behavior exhibits regularities that remain constant across spatial structures. In this respect it is similar to revealed preference analysis in that it postulates inherent rules of spatial behavior regardless of structure. However, these assumptions have created some dissenting views that focus on the need to distinguish specific behavior postulates instead of simply interpreting behavior in a generalized manner, that is, merely in terms of the structure in which it functions. Increasingly dissatisfied with the simplistic assumptions of equal attributes and the generalized distance of the consuming individual, marketing researchers and behavioral geographers have begun to adopt more realistic research methodology (Kunkel and Berry, 1968; Clauss et al., 1972; Pipkin, 1981; Olson, 1977; Harvey, 1979; Golledge, 1981).

Following the work of Simon (1957), researchers began adopting more pragmatic methods for analyzing consumer behavior, which resulted in findings that did not always conform with expectations of customer satisfaction ("satisfaction principle") or reasoned purchasing decisions ("bounded rationality"). Instead, findings indicated that consumers

will often be adequately satisfied with less than optimal savings and/or attribute values, and that purchase decisions are frequently made in a state of uncertainty and with an incomplete knowledge of rewards and risks. Unfortunately, though, the satisfaction principle poses problems for the researcher in that it is difficult to operationalize (Harvey, 1981). Although the concept of bounded rationality does incorporate "economic man" into its analytic viewpoint, it is realistic and feasible dealing with "him" as a consuming pattern or role instead of in terms of optimal behavior (Cadwallader, 1984:220).

Behavioral geography has contributed significantly to the study of consumer behavior. Researchers such as Harvey (1979, 1981), Cox (1981), Golledge (1981), Pred (1981), Rushton (1969), and Cadwallader (1984) have insisted that the behavioral approach to consumer analysis is founded on the postulate that consumers shop in a given store because of the interaction of several factors, including information, attraction of specific store attributes, and the store's accessibility. In fact, behavioral (or multi-attribute attribute) analysis of consumer preference admits the significance of a great many more attributes influencing human behavior than did previous approaches, which overemphasized spatial preference.

The multi-attribute attribute approach is a combination or synthetic research methodology in that it analyzes attributes that are assumed to be a weighted total of a given item's perceived attribute value. A store, then, may be viewed as a bundle of attributes, and the overall consumer posture toward a given store may be assumed to be the consumer's net conclusion as to the extent to which it possesses the desired attributes, as weighted by the importance the consumer assigns to each attribute (Wilkie and Pessemier, 1973). The result is a weighted additive model, which enjoys the advantage of offsetting a relatively low rating for one attribute by supplementing a relatively high rating for another. Among other things, these models may be used to indicate varying preferences by income level (Lloyd and Jennings, 1978).

ATTITUDE/ATTRIBUTE BEHAVIORAL METHODOLOGY

Multi-attitude attribute studies, and more specifically store-image studies, employ a battery of methods for measuring the influence of retailing attributes on consumer behavior. A list of these methods includes the following: semantic differential modeling (McDougall and Fry, 1974; Evans, 1980; Swan and Futrell, 1980); staple scaling (Lusk, 1973; Upah and Cosmas, 1980); the Fishbein model (Fishbein and Raven, 1962; Fishbein, 1963; Lessing, 1973; Sampson and Harris, 1970); and more recently, multidimensional scaling (Doyle and Fenwick, 1974; Green, 1974; Green and Rao, 1972, Singson, 1975); and conjoint measurement (Green, 1974; Green and Scrivivasan, 1978; Fenwick, 1978; Catlin and Wittink, 1982; Green and Tull, 1978; Assael and Lipstein, 1978; Blackston and Vandu Zanden, 1980). Each is discussed in detail below.

The Semantic Differential Model

Semantic differential model has been a generally accepted method for measuring store attributes (store image) for some time. By way of definition, McDougall and Fry (1974) describe the technique as consisting of "bipolar adjectives separated by a scale, often of five or seven intervals" (p. 53). The respondent rates his subjective response to these bipolar adjectives by marking point best representing his attitude's placement on the scale between them. The data is then analyzed in two ways. First is aggregate analysis, which totals responses for each store for all adjective pairs for each respondent. Second is profile analysis, which calculates the mean value for each adjective pair as applied to given object (store) by a defined group of respondents (Holmes, 1974; Albaum et al., 1977).

McDougall and Fry list four major advantages to using semantic scale analysis: its ease of execution, the resulting supply of quantifiable data, the low skill level required, and a relatively high reliability. However, this method does possess one major flaw in that the researchers choice of store attributes is forced on the consumer (Peterson and Kerin,

1981). This problem has been addressed in the development of testing instruments that provide open-ended questions to which the consumer is free to respond with whatever attributes he deems important. However, this method requires stronger verbal skills on the part of the respondents (McDougall and Fry, 1974). McDougal and Fry (1974) assert that these two methods are congruous and complementary, with each one's flaws minimized by the other's strengths, and suggest that both be used in tandem.

The Staple Model

Staple scaling is a simplistic form of semantic differential scaling. A typical staple scale is unipolar and consists of ten rating intervals, each having values that range from -5 to +5. Subject respondents are asked to rate the accuracy of set statements from "most accurate" (+5) to "not at all accurate" (-5) (Crespi, 1961; Evans, 1980; Swan and Futrell, 1980).

Staple scaling is notable for its ease of administration and for the fact that it circumvents the possibility that tester-provided adjectives might color the results (Lusk, 1973). Furthermore, this test may be administered in the form of a telephone survey (Hawkins et. al, 1974; Upah and Cosmas, 1980). In most cases responses are analyzed using factor analysis (Doyle and Fenwick, 1974).

As noted, semantic differential and staple scales present the researcher with many difficulties. They require precise verbal descriptions and may contain attribute categories which may not be particularly relevant. They also require that the researcher be familiar with all relevant store attributes, some of which may not be important to the respondent. Furthermore, in all cases dealing with store attributes, there are no clear means of isolating factors that are most important to consumers, nor for establishing any kind of hierarchy of importance. Consequently, an extremely important attribute might not necessarily have a correspondingly significant influence on the outcome. Another weakness is that factor

analysis itself is incapable of simultaneously comparing consumer groups and store attributes, since it is two-dimensional. Multidimensional attribute measures and the Fishbein technique attempt to correct this weakness (Doyle and Fenwick, 1974).

The Fishbein Model

Because the issue of store image is multidimensional, researchers have adopted the techniques of Fishbein modeling as a means of measuring these attributes. The Fishbein technique for modeling overcomes many of the shortcomings of the methods previously described, which provide only two-dimensional models. Fishbein modeling, on the other hand, allows the researcher to differentially weight multiple store attributes (variables), thereby providing a more reliable comparative analysis. Although the premises of Fishbein modeling are widely acknowledged in the field, empirical studies employing the techniques have frequently deviated somewhat from Fishbein's original theoretical premises (Doyle and Fenwick, 1974).

A Fishbein model is based on "belief" and on a subsequent assessment of a matrix of beliefs, thereby measuring the probability of a given limited set of consumer beliefs (perceptions). For example, to assess a given store's quality of service, subject respondents are asked to react to a probability scale instead of merely rating the store on a bipolar scale ranging from adequate to inadequate. According to Fishbein's methods, however, the researcher estimates belief by using a five-point semantic scale (Fishbein and Raven, 1962) which addresses or rates not the attributes per se, but instead beliefs regarding them. These five semantic points are likely/unlikely, possible/impossible, true/false, existent/nonexistent, and probable/improbable. Considering again the example of the service attribute, consumers would be asked to respond to specific beliefs, for example does poor service equate to long lines? Does it equate with inefficiency, or rude treatment by service personnel? In this way, the consumer's rating is not dependent on the

belief in the strict sense (that is, in the researcher-provided sense), but in terms of how these beliefs translate into actual retailer behavior. Implicit, too, is a measure of the relative strengths of the consumers' perceptions.

Unfortunately, adapting Fishbein modeling to marketing and retail analysis has not always proved reliable (Doyle and Fenwick, 1974). The measurement of store attributes tends to lack a conceptual base and fails to identify more salient attributes. Furthermore, Fishbein models have proven to deal inconsistently with varying household groups. As Sampson and Harris concluded (1970), the Fishbein model cannot predict value where consumer groups differ widely in their perceptions.

The Multidimensional Model

Multidimensional modeling is a mathematical method for deriving specific conclusions about consumer attitudes and perceptions about certain objects or stimuli. Singson (1975) defines multidimensional scaling as "an attempt to represent individuals' perception of n objects or stimuli in geometric space of M dimensions" (p. 39). In short, multidimensional scaling reduces data in a way comparable to that for factor analysis,

since the attempt is to represent a set of stimuli within a multidimensional space with the minimum number of dimensions that fit a set of observed similarities judged about the stimuli under study. The dimensions are assumed to represent the salient attributes along which the set of stimuli in question are perceived and compared. (Singson, 1975:39)

In this way the investigator avoids the likelihood of imposing on the respondent his own opinions about the stimuli being examined, since he does not begin with predesignated attributes. Multidimensional space, therefore, depicts a low-profile method for ascertaining consumers' attitudes.

Researchers analyze data acquired via multidimensional scaling through either of three computer routines—M-D-SCAL, TORSCA, or INDSCAL. All three provide similar results (Whipple, 1976). In each, the goal is to isolate a representation of the coordinates

of each object on a multidimensional map. The assumption is that the relative spatial array of the coordinates on this map (i.e., the Euclidean distance between them) will represent the rank order of similarities between the pairs of objects as they are perceived by the subject respondents. Accordingly, coordinates for paired objects perceived as most similar by respondents will lie closest together on them map, with proportionally greater distance reflecting proportionally dissimilar perceptions.

Multidimensional scaling has become increasingly popular, particularly for conducting store-image studies. However, it remains an imperfect method for determining the influence of retailing attributes on consumer behavior. Inherent weaknesses in the method include questions about the reliability and validity of the means of acquiring data and predictive validity uncertainties (Assael and Lispstein, 1978). Furthermore, multidimensional scaling does not offer the necessary precision when identifying the market value of retailing attributes.

The Conjoint Model

Conjoint measurement, another mathematical method of analysis, provides a computer-based and generally monotonic analysis of variance. To determine the relative importance of specific attributes or combinations of attributes, the experiment is designed and attribute combinations selected in such a way that multi-independent attributes are balanced. Furthermore, in the interest of simplification, researchers tend to focus on the most important attribute combinations (Green, 1974).

However, a great many weaknesses attend conjoint measurement as an analytical tool. Among these are the subjectivity in choosing attributes for study, the necessity of simplifying long lists of attribute combinations, and the use of nonactual data, all of which weaken the validity and reliability of the method (Green and Tull, 1978).

DYNAMIC AND LEARNING MODELS AND CONSUMER BEHAVIOR

Dynamic and learning concepts pertain to the often complex sequence of considerations and decisions which a consumer entertains in the course of establishing a preference. The probability of a consumer's exercising a given preference is related to the probability of making that same choice on a previous trial. Thus, the probability of selecting an alternative preference—or a store with a somewhat different bundle of attributes—is reduced at a decreasing rate. Focal to this method is implementation of the Markov chain and learning model for analyzing the dynamics of consumer behavior, which significantly expands the capabilities of market analysis.

The Markov Model

The Markov model is a technique for analyzing the decision sequence in consumer purchase choices. Each choice in such a sequence is assumed to be dependent on a preceding choice (Golledge and Brown, 1967), and the sum sequence may in most cases be represented as a series of probabilities. In turn, these probabilities may be expressed as a transition probability matrix. Since the decision sequence is order-dependent, specific conditions control these transition probability matrices. At any given time, for example, no element of analysis may exist in more than one stage of the sequence. Furthermore, all possible options or potential choices at a given stage must be identified, and the the sum of all elements in a sequence must equal one. Finally, any given element may move only in constant intervals within a stage, or from one stage to another.

Either of two stages may occur in a given transition probability matrix. First is the absorbing stage, where the value of the diagonal matrix is equal to one. In this case no element may leave the stage. Second is the inaccessible stage, where all elements of the related column are zero. Transition probabilities may then be determined by means either of empirical or theoretical analysis applied to the identified elements and their relative

placement in stages (Stokey and Zeckhauser, 1978).

The Markov model is simplistic insofar as it specifies transition probabilities as constant. Actually, consumers' positive or negative encounters with given retailers causes the transition probabilities to fluctuate. Since the time required for the consumer to progress from the search stage to the habitual stage is influenced by the learning rate, it lends itself to learning-technique analysis.

Learning Model

Learning parameters vary considerably across consumer groups and their diverse behaviors. The speed with which a consumer advances from search behavior to habitual behavior is determined to a large degree by the extent of these learning parameters. A high learning parameter results in a consumer's relatively speedy advancement to habitual behavior, and a low learning parameter results in the converse.

Habitual behavior is achieved when a consumer regularly patronizes a specific retailer. According to Amedeo and Golledge (1975), this will occur when an individual's decision-making inclination has been sufficiently influenced by immediacy of action, implicit learning, and preceding experience. Although extended search behavior is associated with a low learning parameter, it may in some cases be due to an unusually great number of alternatives. Golledge (1981) offers a number of learning models that are useful for analyzing learning parameters and consumer behavior, particularly in cases where the probability of choosing a given option is dependent on the probability of the consumer's electing the same option in a preceding attempt. This concept was presented earlier in the work of Hull (1964), Spencer (1960), Burke and Estes (1957), and Pred (1967). However, such models possess a weakness insofar as practical problems accompany attempts to apply them to retailing.

In reviewing the literature of retailing attributes and the methods used to measure

their influence on consumer behavior, four functional and psychological (retailing) attributes were defined: accessibility, convenience, service, and level of competition. These four are multi-independent variables which interact to influence retail prices, and ultimately produce the desire to purchase (or not to). In order to determine a consumer's willingness to pay for a given product, it is necessary to determine the prices of these retailing attributes.

Prices can provide a measurement of the importance of retailing attributes to the consumer. By differentiating the retail prices at a given firm with respect to the level of retailing attributes provided by that firm, one may determine the implicit value that may be assigned to those retailing attributes. This can be accomplished by differentiating homogeneous products, or the same product, at different retail stores.

THE RESEARCH PROPOSITION

It is in accordance with the views above the present study will apply hedonic analysis to measure the influence of specific retailing attributes on consumer behavior.

Consumer purchase decisions are influenced by a combination of product and retailing attributes. The value of retailing attributes is estimated by comparing a homogeneous product so that retailing attributes, which are variable, may be isolated from product attributes, which remain constant. Through the application of hedonic specification to the supply and demand models of the product under study, it is possible to isolate a scale of values for these retailing attributes. These values are represented in the implicit ask and bid prices for the retailing attributes.

The present research isolates, measures, and determines the market value of specified retailing attributes (accessibility, convenience, service, and competition) for a homogeneous product at different retailing outlets. These were related to demand findings, which were estimated from actual observed consumer behavior.

CHAPTER III

THE CONCEPTUAL BASIS OF HEDONIC ANALYSIS

APPLIED TO RETAIL MARKETING

The present chapter will review the methodology of hedonic analysis as it applies to a study of retail attributes and consumer behavior and will establish the conceptual basis for applying hedonic analysis to estimating the implicit value of selected retail attributes (accessibility, convenience, service, and competition).

Because it makes use of actual data, hedonic analysis is far more precise than methods that are conventionally used to measure the relative importance of retailing attributes. These other methods, which were discussed in Chapter II, include attitude/attribute analysis, integration theory, and movement interaction. Because these methods use experimental data, they sometimes lack precision and fall short supporting definite conclusions. Nonetheless, these methods are justified in cases where data is limited and inconsistent, and under circumstances where market equilibrium is difficult to maintain (Brookshire et al., 1982). In cases where there is market equilibrium, the researcher may introduce hedonic analysis to determine the implicit value of retailing attributes to supplement data gathered by these other, more conventional means. In short, hedonic analysis is the best available method for estimating the implicit value of retailing attributes, therefore making it ideal for isolating patterns of shopper behavior.

By comparing price differentials among identical or homogeneous retail commodities (i.e., gasoline) one may establish the implicit value of the retailing attributes and may also estimate a hierarchy of attribute importance. In this way one may postulate a pattern of consumer behavior and approximate relative demand for specific retailing

attributes.

Literature in the field widely supports the validity and reliability of hedonic analysis. It has reliably measured the retail attributes of home sales in hundreds of studies (Miller, 1982), and its consistency, validity, and reliability as a tool for market and consumer behavior analysis has been demonstrated in studies of numerous commodities (see among others Court, 1939; Fisher, Griliches and Kaysen, 1962; Griliches, 1964; Cagen, 1965; Dean and DePodwin, 1961; Dhrymes, 1967; Fetting, 1963; Gavett, 1967; Chow, 1967).

Price-method techniques may be subdivided into subordinate categories: single-cue studies, which measure prices in relation to retail attributes, and hedonic analysis, which employs hedonic specifications. Single-cue studies tend to have difficulties similar to those mentioned above (e.g., experimental and insufficient data), since they are based on experimentation and rely on conventional attitude measurements. Hedonic analysis of consumer goods, on the other hand, deals with objective product attributes (e.g., size, shape, length, power, etc.) and ignores retailing attributes altogether. However, a thorough analysis requires a comprehensive study of both product and retailing attributes.

HEDONIC ANALYSIS

Price Analysis

As a measure of both product quality and consumer preference, price analysis has developed two primary approaches. First is the single-cue approach, which analyzes explicit prices in relation to product quality, although in itself it provides no indication of implicit prices. The second approach is the price/quality study, which fails to consider the implicit value of retailing attributes. However, the researcher may identify the implicit value of retailing attributes by applying hedonic theory and analysis.

As an attribute in its own right, price has received a great deal of scholarly attention

over the past four decades. Early studies investigated the influence of price alone (independent of other attributes) on consumer behavior (Scitovsky, 1944; Leavitt, 1954; Tull et al., 1964). Haines (1974) and Bettman (1979) both suggest using price as a tool for screening decision-making in consumer behavior. Further, Jacoby and Olson (1977), and Olson (1980), promoted the importance of prices in consumer choices. Monroe (1971, 1973) verified the concepts of acceptable and unacceptable prices as screening devices in purchase decisions. However, these studies include no account of the influence of implicit prices (i.e., the value of retailing attributes). Accordingly, behavioral methods such as the multiple-cue or multiple-attribute techniques is more commonly used for analyzing consumer and retailer preferences.

Price studies which have attempted to determine the implicit value of product attributes have not then gone on to consider the implicit values of retailing attributes. Even those which employ hedonic analysis concentrate only on determining implicit values for goods and services, ignoring the bundle of retailing attributes altogether. This shortsighted approach overlooks the fact that without these essential retailing attributes goods would not be exchanged in the market.

The Rationale for Hedonic Analysis

Hedonic analysis is capable of measuring the influence of defined retailing attributes, of isolating a hierarchy of the relative importance of a closed set of attributes, and of determining their effect on consumer preference. This is indicated clearly in the work of Rosen (1974) which led to the formulation of his "general framework." Rosen's work is grounded in the earlier work of Houthakker (1952), which addresses the question of consumer behavior in relation to variations in product quality. Houthakker found that consumers tend to purchase negligible fractions of all available products regardless of the many corner solutions common to conventional economic theory. Houthakker's work was

followed up and extended by other researchers, among them Becker (1965), Muth (1966), and Lancaster (1966), who formalized the principle of product differentiation.

Rosen's theoretical approach to analyzing consumer behavior has been applied to a great many commodities by numerous researchers and has been subsequently supported by more than 105 housing studies analyzing several explicit as well as implicit attributes, including physical, quantitative, qualitative, locational, financial, transactional, economic, and other attributes (Miller, 1982; Witte et. al, 1979; Nelson, 1978; Harrison and Rubinfeld 1978a, 1978b; Bender, Gronberge, and Hwang, 1980). Blackley (1984), in a study that applied hedonic theory to the decentralization of manufacturing, even added site attributes, concluding that "not only have individual attributes proven to be significant in determination of site prices, but the results also suggest important differences between renters and owners in evaluating sites" (p. 549).

It is postulated in the present research that the influence of retailing attributes on consumer behavior will operate in a similar fashion, and as authority for this assertion the author cites Blackley's and Rosen's research, as well as studies by Freeman (1979a, 1979b), Bailey, et. al, (1963), Brown (1964), and Musgrave (1969). In doing so, the author contends that isolating a structure of hedonic prices will prove to be a valuable tool for determining the implicit value of retailing attributes, as well as defining a hierarchy of attribute values that will provide a useful picture of desirable attribute bundles. Relevant here are Rosen's comments (1974) on the significance of hedonic analysis and implicit pricing: "A theory of hedonic prices is formulated as a problem in the economies of spatial equilibrium in which the entire set of implicit prices guides both consumer and producer locational decision in characteristics space" (p. 34).

The rationale for applying Rosen's concept of analyzing retailer and consumer preferences hinges on the belief that both are guided by the implicit value of retailing attributes. That a consumer shops for a given, widely available product at a specific retail

outlet indicates the prominent role of retailing attributes in determining consumer preference. On the other hand, the retailer also chooses the level of the retailing attributes he wishes to offer according to the store's objectives (marketing) and constraints (costs). Consequently, failing to identify the implicit value of retailing attributes limits the validity of consumer behavior and price/preference analysis.

At the same time, retailing attributes have a direct influence on retail prices; increased levels of retailing attributes lead to increases in retail prices. Accordingly, hedonic analysis may be seen as complementary to other methods, such as behavioral attitude/attribute analysis, movement interaction, integration theory, and single-cue price studies, as it provides a dependable measure of consumer willingness to pay for given retailing attributes that is independent of the retail prices themselves.

Overview of Hedonic Theory

According to Griliches (1971) "overall prices" are the sum of the implicit price (hedonic value of retailing attributes) and the explicit price (dollar retail value determined by the market). Griliches summarizes hedonic theory as follows:

Hedonic theory is a characteristic approach to the construction of price indexes . . . based on the empirical hypothesis (or research strategy) which asserts that the multitude of models and varieties of a particular commodity can be comprehended in terms of a much smaller number of characteristics or basic attributes of a commodity. If one views the commodity as an aggregate of individual components or characteristics, there is no reason to expect that this relationship between the overall price of the bundle and the level or quantity of various characteristics will remain constant. (p. 4)

Furthermore, hedonic studies of consumer goods and behavior may be extended to considerations of primary retailing attributes (i.e., accessibility, convenience, service, and competition). For example, by adapting to retailing studies the assumptions of hedonic analysis adopted in the Harrison and Rubinfeld housing study (1978a, b), it may be asserted that the variations of the primary retailing attributes are capitalized in the form of retail prices, reflecting both retailer and consumer decision-making. This is seen to be

feasible by noting several parallels, among them that short-run equilibrium is maintained in the market and that there exists sufficient retail price variation. In short, a variety of retail product prices may be observed in relation to the level of retailing attributes present in a given set of stores. Hence, the implicit value-per-unit of a selected retailing attribute may be derived in relation to the overall level of retailing attributes, which then provides a marginal quantity and marginal price.

Implicit prices may then be used to characterize the overall price at a given store with respect to a specified bundle of both product and retailing attributes. In other words, the overall price of a given item may be seen as a function of its total attribute bundle, which is the sum of its product attributes and its retailing attributes. For example, any retail product or service that constitutes a class in itself (for example, S), then any unit of S (e.g., S_J) may be fully described by a vector of its characteristics. In the following illustration, R_N is a product attribute; A_Z is the retailing attribute accessibility; C_V is the retailing attribute service; O_X is the retailing attribute convenience; and T_M is the retailing attribute competition. Hence, the retail price, P_{S_J}, is a function of the bundle of these attributes.

$$P_{S_J} = P_S (R_{J1} \dots R_{JN}, A_{J1} \dots A_{JZ}, C_{J1} \dots C_{JV}, O_{J1} \dots O_{JX}, T_{J1} \dots T_{JM})$$

In the above, P_S is the implicit price function for retailed goods and services. A product's overall price, then, may be deduced from the sum of its attributes.

The marginal implicit price of a commodity's product attributes may be determined by differentiating the hedonic price function with respect to its attributes. For example, for the retailing attribute service, the equation would be as follows:

$$\frac{\Delta P_S}{\Delta C_V} = P_{C_V} (C_V)$$

This gives the increase in price of S that is associated with one added unit of C_V ceteris

paribus (see Figure 5).

SOURCE: Adapted from Freeman (1979a)

Figure 5. Marginal implicit prices plotted against quantity of attributes.

A second stage combines the implicit price data with an attribute's specified quantity, in this way identifying the inverse demand function. The consumer achieves maximum utility when the marginal price equals marginal willingness to pay. However, in hedonic studies, the consumer's willingness to pay for an attribute is a function of the sum of the level of retailing attributes, the consumer's income, and other factors that motivate his preferences and taste.

SOURCE: Adapted from Freeman (1979a)

Figure 6. Inverse demand function.

In Figure 6, consumer 1 consumed C_{V_1} level, while consumer 2 consumed at a level of C_{V_2} (assuming two consumers with different demands and different levels of income). In the case of consumer 1:

$$P_{C_{V_1}} = P_{C_V}(C_{V_1}, Y_1, Z_1), \text{ where}$$

$$P_{C_{V_1}} = \text{price or willingness to pay of consumer 1}$$

$$P_{C_V} = \text{implicit price of attribute service } C_V$$

$$Y_1 = \text{income of consumer 1}$$

$$Z_1 = \text{taste of consumer 1}$$

$$C_{V_1} = \text{quantity of attribute service } C_V$$

If the hedonic equation is linear, the inverse demand functions cannot be identified. However, if the buyer's utility function and income are identical, then the second equation

will represent the inverse demand function. If neither case is applicable, then the supply side of the product or service must be examined. In this event, there are three possible outcomes. First, if the supply of the bundle of retailing attributes is perfectly elastic (see Figure 7, then the implicit price function may be considered to be exogenous to the consumer. A regression of evaluated quantities CV against the observed implicit prices—as defined by the consumer's income and other factors—must be checked as follows:

$$PCV_1 = CV_1 (PCV, Y_1, Z_1)$$

Figure 7. Elastic supply curve.

The second possible outcome occurs when supply is inelastic (see Figure 8), in which case consumers bid the price upward, and the inverse demand function is then identified by implicit prices in relation to the available quantity of CV, taste, and income, as follows:

$$PCV_1 = PCV (CV_1, Y_1, Z_1)$$

The third and final outcome occurs when both the quantity of supply and the quantity of demand of the specified retailing attributes are functions of price. In this case a simultaneous equation procedure may be used.

SOURCE: Author

Figure 8. Inelastic supply curve.

These outcomes may also apply to consumer 2, and may be aggregated to include market demand for the specified attribute. Further, this market demand may be further segmented for analyzing a specific consumer group's income, taste, or preference (Freeman, 1979a:157; 1979b:81).

Some Difficulties With Hedonic Analysis

Having conceptualized the application of hedonic analysis to retailing, it is necessary to point out some expected difficulties. As stated by Freeman (1979a), hedonic analysis is neither better nor worse than any other conceptual economic empirical model once put into practice. In that sense, it shares some of the pragmatic difficulties which beset demand-function and product-function models—that is, it may be laced with unrealistic assumptions, inadequate measurements, problems with data collection, and imprecise definitions. Accordingly, when applying hedonic analysis careful attention must be paid to the issues of equilibrium, utility function (Rosen, 1974; Freeman, 1979a), and model-function estimation (Cropper et al., 1987).

Short-term equilibrium is also a potential problem, and it should be maintained

throughout the application of hedonic estimation. Further, close attention should be paid to the accuracy of price data, in that the actual data should accurately represent the market. Inaccurate data could result in the over- or underestimation of the consumer's true willingness to pay for a given commodity. Failure to closely monitor these factors may result in a maladjustment of supply and demand; accordingly, the research should be constructed in such a way that it is capable of determining biases. An estimate of the marginal willingness to pay, or the benefits derived from such studies, should be labeled as a bias (upper or lower bound) in their analysis and estimation (Freeman, 1979a).

A shortage in the supply of a demand-market attribute is another potential problem (Freeman, 1979a). In this event, Utility maximization would not be possible due to the unavailability of an adequate supply of the desired attribute. For example, in retailing a person demanding a store with a high level of attributes would have to shop at a low-attribute store because of the shortage of the desired high-attribute store, all else remaining constant.

Utility Function

The price of a retail unit is a function of its attribute level. Differences in utility are reflected in price differentials among attribute levels. Buyer characteristics should not enter into the equation, since the characteristics of potential gasoline buyers are assumed to be constant, implying that for this commodity people's tastes are the same. In the words of Stigler and Becker (1977), "widespread and/or persistent human behavior can be explained by a generalized calculus of utility-maximizing behavior" (p. 76).

It should be noted that consumer perception misspecification of product characteristics are problematic issues that cloud hedonic analysis when determining utility function. Consumer perception is an important issue in that consumers should be able to perceive and evaluate attributes. If there are no differences in perception, the demand curve

could not be identified, since utility would be identical for all consumers. In the case of misspecification of product characteristics, if a given characteristic is omitted from the hedonic price estimation, the coefficient for the other characteristics may then be biased.

Hedonic analysis requires a sensitive and prudent model-function estimate and very close measurements of dependent and independent variables. As indicated by Cropper et al. (1987), there is a need for an accurate estimation of marginal attribute prices, which are used to measure consumers' marginal willingness to pay for these attributes. Furthermore, the marginal prices become the dependent variables in the phase-two equation, which estimates the demand function of the attributes in cases where the model is nonlinear. The assumption measurement of the dependent variable, being continuous, should be strictly maintained. However, the independent variable may be measured by use of binary variables. In this case, the inverse-demand function for this binary variable cannot be estimated because of the nonavailability of variation among the binary variables. (For more details on these problems, see Freeman, 1979a, 1979b; Rosen, 1974; Miller, 1982. For a discussion of difficulties with estimation, see Cropper et. al, 1987.)

Hedonic analysis, then, is a superior measurement tool because it is built on economic utility-maximization theory and because it makes use of actual data for making precise measurements, therefore providing a relatively accurate valuation of retailing attributes. Compared with the problems seen in other methods for measuring retailing attributes, the potential problems with hedonic analysis appear relatively insignificant.

To summarize, isolating the implicit price structure of bundled retailing attributes by analyzing hedonic prices and inverse demand functions allows the researcher to measure the implicit value consumer's ascribe to various attribute bundles. In this way a realistic picture of consumer behavior may be derived.

CHAPTER IV

METHODOLOGY

GENERAL CHARACTERISTICS OF THE STUDY AREA

The study area for the present research consists of the city of Vancouver, Washington, and its suburbs (Burton, Cascade Park, East Vancouver, Evergreen, Hazel Dell, Minnehaha, Orchards, Salmon Creek, St. Johns, and Walnut Grove) (see map, Figures 7 and 8). Vancouver is the center and major city in Clark County, in the southwestern portion of Washington state, and the urban area makes up the northeast quadrant of the Portland, Oregon, metropolitan area. Situated approximately 70 miles from the Pacific Ocean, Vancouver is situated on navigable portions of the Columbia River, providing Clark County with approximately 41 miles of river frontage (see map, Figure 7). The Vancouver area lends itself to a study of this kind because the state of Washington has no law prohibiting self-service gasoline stations. This factor allows for good control in a minimum-service comparison.

The population of the Vancouver urban area is 134,420 (1980 census). The median income of the urban area and its surrounding suburbs is the following: urban area (14 census tracts [see map, Figure 9]) \$12,959; Burton \$19,816; Cascade Park \$23,297; East Vancouver (four census tracts) \$19,760; Evergreen \$21,128; Hazel Dell \$19,455; Minnehaha \$13,187; Orchards \$17,401; Salmon Creek (three census tracts) \$21,219; St. Johns \$21,921; and Walnut Grove \$12,203.

Figure 2. Map of Vancouver, Washington, and surrounding suburbs.

Figure 10. Map of census tracts for Vancouver, Washington, and surrounding suburbs.

Figure 11. Map of census tracts for Vancouver, Washington, urban area.

TABLE I
POPULATION DISTRIBUTION IN THE VANCOUVER
URBAN AREA, 1980 AND 1990 PROJECTED

AREA	1980	1990 (projected)
Salmon Creek	5,793	14,013
Hazel Dell	16,092	23,355
Minnehaha	8,552	9,794
St. Johns	7,356	15,519
Walnut Grove	5,793	12,807
Orchards	14,712	24,108
Burton	12,598	18,081
East Vancouver	7,908	9,794
Evergreen	6,805	11,150
Cascade Park	5,977	12,054
Population outside Vancouver	91,586	150,675
Vancouver	42,834	
TOTAL	134,420	

SOURCE: 1980 Federal Census

Topographically, the Vancouver area is divided into east and west by Interstate 5 (I-5), which is the primary traffic artery in the area. A second artery, Interstate 205 (I-205), also runs north-south and serves as an alternate route for north- and southbound commuters several miles east of I-5. These two freeway arteries provide the only transit across the Columbia River, Vancouver's boundary on the south. Other important area

arteries include Highway 99, also running north-south, and east-west-running major boulevards that include Mill Plain Boulevard, Fourth Plain Boulevard, 78th Street, and Andresen Road. The majority of the 65 service station included in the research study group are located on or near these thoroughfares.

SUPPLIER ATTRIBUTES AND THE MARKET MODEL

The present study analyzed a series of retailing attributes under the categories accessibility, convenience, service, and competition as recovered from 65 gasoline service station in the study area. These 65 constitute 100 percent of service stations located in the Vancouver metropolitan area. For this data, the hedonic model below was specified for recovering implicit prices of the retailing attributes under study (see Table II).

$$SP_i = f(\text{TRAF}_i, \text{FREXT}_i, \text{DISCB}_i, \text{CONV}_i, \text{SIZE}_i, \text{HOURS}_i, \text{FULLS}_i, \\ \text{CARW}_i, \text{GARG}_i, \text{CASH}_i, \text{CRIDT}_i, \text{DISTVM}_i, \text{COMP}_i, \text{MAJ}_i)$$

TABLE II
A SUMMARY OF THE MEASUREMENTS FOR SUPPLIER ATTRIBUTES

VARIABLE	SYMBOL	DESCRIPTION	COEF*
Price	SP _i	Price per gallon of regular unleaded self-service gasoline gas station (i).	Dependent Variable
Traffic flow	TRAF _i	Traffic count on street at gas station's location	±
Freeway exit	FREXT _i	Dummy variable for proximity to freeway exit (1 if within 2,000 feet of exit, 0 if not).	±
Central Business District	DISCBD _i	Distance in feet from Vancouver CBD (as plotted on city map obtained from Clark County Planning & Zoning).	±
Convenience	CONV _i	Dummy variable for presence of convenience store (1 if present, 0 if not) (OAG).	±
Service	SIZE _i	Number of pumps at gas station (OAG).	–
Service	HOURS _i	Hours open (OAG).	+
Service	FULLS _i	Dummy variable for full service (1 if present, 0 if not).	+
Service	CARW _i	Dummy variable for car wash (1 if present, 0 if not).	+
Service	CARG _i	Dummy variable for garage service (1 if present, 0 if not).	+
Service	CASH _i	Dummy variable for cash discount (1 if present, 0 if not).	+
Service	CRIDT _i	Dummy variable for credit card (1 if credit cards accepted, 0 if only cash accepted).	+
Service	DISTVM _i	Distance from Vancouver Mall.	+
Brand	MAJ _i	Dummy variable for major brand (1 if major brand, 0 if not).	nil
Competition	COMP _i	Number of competitors within 90,000 square feet.	–

SOURCE: Author

*Expected sign of coefficient.

Product attributes of unleaded gasoline are relatively homogeneous, which provides a control for determining the relative influence of retailing attributes.

THE RETAILING ATTRIBUTES

Accessibility

Accessibility is modeled by using three variables. The first is the station's proximity to a freeway exit (within 2,000 feet of an exit from either I-5 or I-205). This variable is expected to relate to prices either positively or negatively. Proximity to a freeway exist may represent the station's level of accessibility, which may be reflected in higher prices. However, proximity to a freeway exit may also lead to higher volume of sales, which leads to a constant return to scale that may be reflected in lower prices.

The second variable is traffic flow, which will have a similar expected relationship. The higher traffic count can be expected to result in higher prices due to the station's being accessible, while at the same time lower prices may result from the potentially higher sales volume for the same reasons as given above. The third variable, proximity to the central business district (CBD) is again either positive or negative, again for precisely the same reasons.

Convenience

Convenience is modeled on the basis of the presence or lack of a convenience store located on the premises of the service station. The indirect retailing attributes here include ease of parking, merchandise quality and assortment, shopping ease, and store atmosphere. It is expected that the relationship between convenience and the price of unleaded gasoline could be either positive or negative. The price of unleaded gasoline could increase with the existence of a convenience store because the station is providing a one-stop shopping service. Conversely, the relationship could be negative because gas stations with convenience stores may lure consumers with relatively lower gasoline prices, then compensate for lower prices by building in a higher profit margin on merchandise sold in the convenience store.

Service

Submodel for Stations Offering Full Service: Other portions of the price of services (e.g., pumping gas, washing windshield, checking oil, etc.) are explicit and are not included in the main supply model; accordingly, submodels are used to establish these prices. In the case of the full-service option the submodel for full service will differentiate between the cash prices for unleaded self-serve and unleaded full-serve at each station in the study group that offers the option. The equation for the submodel follows:

$PSER - PNSER = \text{Explicit price of full service attributes, where}$

$PSER$ is the cash price per gallon of full-service unleaded; and

$PNSER$ is the cash price per gallon of self-serve unleaded.

In the equation all other attribute influences remain constant and the explicit price is averaged to indicate the average price charged for obtaining these extra services. The relationship between the presence of these services and cash price is expected to be positive.

Submodel for Credit Option: Establishing the explicit price of the credit option is similar to that for full-service, described above. That is, prices are differentiated within each station offering the option. The equation for the submodel follows:

$PCRED - PNCASH = \text{Explicit price of full service attributes, where}$

$PCRED$ is the cash price per gallon of unleaded purchased with credit; and

$PNCASH$ is the cash price per gallon of unleaded purchased with cash.

As with the explicit price for full-serve, the data will be averaged for all gas stations offering the credit option. The portion of the explicit price attributable to the credit option will be added to implicit prices for the main model, in this way establishing the overall price

of these services. The relationship between the presence of the credit option and the price is expected to be positive.

It is generally expected that, regarding service attributes identified in the main supply model, the greater the level of services provided by the service station, the higher will be the prices at the pump. The level of service is ascertained through an array of variables, including the hours which a station is open (expected to have a positive effect on prices), the existence of a full-service island (positive), the presence of car wash facilities (positive), garage service (positive), and credit card payment option (positive). The variable for the distance of the station from the Vancouver Mall is also considered a service variable, since proximity to the Mall may be considered as providing multipurpose trip potential, which is expected to have a positive relationship on prices. The last of the service variables is the size of the station as measured in the number of pumps. This is presumed to reflect volume of sales and is expected to be negatively related to unleaded gasoline prices, since larger sales volume offsets lower margins resulting from lower prices.

Brand

The possible influence on retail price of brand name is accounted for in the supply model. To test the possibility that brand name creates a loyal following, the variable for brand name was included in the analysis. The relationship with retail price was expected to be nil since gasoline is a homogeneous product.

Spatial Competition

The level of spatial competition is measured by determining the number of competitors within 90,000 square feet of a given station. The relationship is expected to be negative proportional to the density of competition, since more stations translate into a greater number of purchase alternatives for consumers.

CONSUMER ATTRIBUTES AND THE DEMAND MODELS

The Sample

The Vancouver area is divided in the present study into three primary sectors. First is Vancouver North, which includes the suburbs of Hazel Dell, Salmon Creek, and St. Johns. Second is Vancouver Orchard, which includes the suburbs of Orchards, Burton, Evergreen, Cascade Park, and East Vancouver. Last is Vancouver Downtown, which includes the central city and the suburbs of Minnehaha and Walnut Grove. The target number of consumers to be surveyed is 300. The survey group consists of a representative cross-section of the geographic sectors.

Vancouver North

Vancouver North, whose population (29,241) represents 21.8 percent of the population of the total study area, is represented with a corresponding 21.8 percent of the surveys. To assure a random sample and adequate number of responses, 660 active telephone numbers were selected by computer among those telephone prefixes serving the Vancouver North area (573- and 574). The area is also served by 22 of the 65 stations under study (33.85%), which are clustered primarily at the intersection of I-5 with Highway 99, 78th Street, and on the north side of Fourth Plain Boulevard.

Vancouver Orchard

Vancouver Orchard (population 45,885) contains 34 percent of the study area's population; accordingly, 34 percent of the survey's target number (or 102) were selected from this area. For these, 1,020 active telephone numbers were randomly selected by computer in the prefix areas serving Vancouver Orchard (253-, 254-, 256-, and 892). The area is served by 19 of the 65 station in the study group (29.23%), which are clustered primarily east of I-205 at its intersection with Mill Plain Boulevard, and eastern Mill Plain.

Vancouver Downtown

Vancouver Downtown's population (57,184) represents 44 percent of the study group total; accordingly, 44 percent (or 132) of the target number were allocated to this area. As with the other areas, 1,320 active telephone numbers were selected at random from among the area's telephone prefixes (690-, 693-, 694-, 695-, 696-, and 699-). The area is served by 24 of the study group's 65 stations (36.92%), which are primarily clustered on the western portion of Mill Plain and Fourth Plain, west of I-205, and in the CBD on "C" Street.

CONSUMER ATTRIBUTES AND THE MODEL

A questionnaire was used to interview 300 households in the study area. Respondents were asked their household income, the gasoline station they most frequently patronize, and other household attributes (see Appendix and Table III, below). Due to the supply model being linear, conventional hedonic analysis cannot be used for estimating consumer willingness to pay for the specified retailing attributes. Had the model been nonlinear, conventional hedonic analysis would have been used. By regressing the implicit prices of the retailing attributes as established in the supply model against the quantity consumed and marginal price paid by each consumer in the sample, the aggregate value of each retailing attribute will be established. This attempt is illustrated below. This illustration represents the estimation for service CV, but the same equation will be used for the estimation of the other retailing attributes as well. (Because gasoline is a homogeneous product, and supply is assumed to be relatively elastic, the following equation was employed.)

$$PCV_i = CV_i(PCV, Y_i, Z_i)$$

TABLE III
A SUMMARY OF THE VARIABLES FOR CONSUMER ATTRIBUTES

SYMBOL	DESCRIPTION	COEF*
P_{CV_i}	Implicit price paid by consumer i	Dependent Variable
P_{CV}	Marginal price of service	+
CV_i	Quantity of service consumed by consumer i	-
Y_i	Household income of consumer i	$\pm$
Z_i	Other household attributes (e.g., age, sex)	$\pm$

SOURCE: Author

*Expected sign of coefficient.

As seen above, the relationship between the implicit price of attributes and the quantities of these attributes consumed is expected to be negative. This is so because as more is consumed, marginal utility declines. On the other hand, the relationship between the implicit price and household income is expected to be positive, since households with higher levels of income will be expected to be more willing to pay for greater levels of service. Other significant household attributes may include age and sex of the consumer, although the relationship between these factors and implicit price is unknown.

Conventional hedonic specification was tried as a means for estimating inverse demand functions for the continuous variables measuring the retailing attributes traffic count, distance from CBD, hours open, size of station, and distance from Vancouver Mall. However, given that the relationship between these continuous variables and the price of unleaded gasoline was estimated to be linear (see Chapter V), and given that the binary variables are nondifferentiable, the results preclude the use of conventional estimates of

willingness to pay, mentioned above.

Alternately, unconventional hedonic specification was used to investigate and estimate consumer demand by regressing the actual price paid by each consumer at the pumps he most frequently patronized against the consumer attributes listed in Table III, above—that is, frequency of utilization, household income, brand, age, sex, length of time living in the area, and the number in the given household. Then the results can be compared with the supply findings to provide overall price/demand analysis.

Following is the equation for consumer attributes, and in Table IV, below, is a description of the variables in the equation:

$$SP_i = f(Y_i, DISH_i, QGAL_i, CONV_i, FULLS_i, CARW_i, CARG_i, CRIDT_i, QSERV_i, TIME_i, PURP_i, CENG_i, AGE_i, SEX_i, PEPL_i, LENGT_i)$$

TABLE IV
DESCRIPTION OF THE VARIABLES FOR CONSUMER ATTRIBUTES

VARIABLE	SYMBOL	DESCRIPTION	COEF*
Price	SPI	Price that household i pays per gallon for unleaded gasoline at station most frequently used.	Dependent Variable
Income	Yi	Household income of i. (Q-15)**	nil
Access	DISH	Distance household i is located from station most frequently used. (M)***	-
Quantity	QGALi	Quantity in gallons per week consumed. (Q-2, 11)**	-
Convenience	CONVi	Utilization of convenience store dummy (1 = 51-100%; 0 = 0-50%). (Q-3)**	-
Service	FULLSi	Use of full service dummy (1 = 51-100%; 0 = 0-50%). (Q-5)**	+
Service	CARWi	Use of car wash dummy (1 = 51-100%; 0 = 0-50%). (Q-7)**	+
Service	CARGi	Utilization of garage service dummy (1 = 51-100%; 0 = 0-51%). (Q-8)**	+
Service	CRIDTi	Credit card dummy (1 = 51-100%; 0 = 0-50%). (Q-4)**	+
Quality	QSERVi	Scaled measurement of cleanliness, friendliness, and speed of service. (Q-6)**	+
Time	TIMEi	Dummy variable for time of use (1 = prime time; 0 = other time). (Q-9)**	+
Purpose	PURPi	Purpose of station visit (1 = to work; 0 = other). (Q-10)**	-
Engine	CENGi	Size (# of cylinders) of car most frequently used.	-
Age	AGEi	Age of consumer in years. (Q-12a)**	±
Sex	SEXi	Sex of consumer. (0 = female; 1 = male) (Q-12b)**	±
People	PEPLi	Number of individuals in household. (Q-13)**	+
Perception	LENGTi	Length of time in neighborhood (in months). (Q-14)**	-
Brand	MAJi	Dummy variable for major brand (1 = major; 0 = none)	nil

SOURCE: Author

*Expected sign of coefficient.

***Measured on area map.

**Refers to questionnaire number.

The relationship between household income and the price a household pays for unleaded gas is expected to be nil, since it is a homogeneous product. Variability in price, then, must be due to the level of retailing attributes, which is expected to be variable. This variability is expected to be captured in the model. The variable for the distance from the household to the gas station is expected to be negatively related to the price paid, since greater distances increase transportation costs and time investments, which should be inversely proportional to a household's willingness to patronize. Quantity consumed will be negatively related to price, since consumers of large quantities will tend to be very price conscious. The convenience variable may be negatively related to price, since it was found that stations in the area having convenience stores tended to have lower prices for unleaded gasoline. The utilization of full-service pumps will be positively related to the price of unleaded gas, since it includes the implicit price of the additional services rendered. For similar reasons, the utilization of a car wash, garage service, and credit card payment option will also be positively related to the price of unleaded gas. Quality of service is expected to be positively related to price, since consumers will tend to be more willing to pay higher prices for exemplary service. Time of purchase will be positively related to price, insofar as "prime time" (morning and afternoon) be expected to present higher prices. The purpose of the trip was negatively related to price, particularly in cases where the consumer is on his way to or from work. Size of the car's engine is expected to correlate positively with price, in that consumers with cars having larger (less energy efficient) engines are more likely to be indifferent to price. The expected signs for age and sex is unknown. The number of people living in the household will correlate negatively with prices, in that as more people share a household income price consciousness will be greater. Perception is expected to correlate with prices negatively, since the longer the person lives in a given area the more knowledgeable he or she will tend to be about alternative sources of lower priced gasoline.

Brand name is also considered in the demand model, but is expected to have no effect on retail prices since gasoline is a homogeneous product.

CHAPTER V

ANALYSIS AND FINDINGS

Chapter V presents the findings derived from the data established through use of hedonic estimation. It will be remembered that hedonic analysis is employed for the purpose of measuring the effects of specific retailing attributes on pricing and consumer behavior. Hedonic analysis is used to establish implicit and marginal prices, which in turn permit the estimation of attribute importance and, hence, a consumer's willingness to pay for a given retailing attribute. Had it been the case that nonlinearity was found in the first model, marginal prices and quantities would have been used to estimate the inverse demand function, in this way determining consumer utility or benefits. However, since the first model was linear, conventional methods of identifying consumer inverse demand function may not be used. The present study applied hedonic analysis to measure the influence of specific retailing attributes on consumer behavior.

Consumer purchase decisions are influenced by a combination of product and retailing attributes. The value of retailing attributes is estimated by comparing homogeneous products so that retailing attributes, which are variable, may be isolated from product attributes, which remain constant. Through the application of hedonic specification to the supply and demand models of the product under study, it is possible to isolate a scale of values for these retailing attributes. These values are represented in the implicit ask and bid prices for the retailing attributes.

The present research isolates, measures, and determines the market value of specified retailing attributes (accessibility, convenience, service, and competition) for a homogeneous product at different retailing outlets. These were related to demand findings,

which were estimated from actual observed consumer behavior. In the process of analysis it is expected that lower income households will purchase gasoline at stations offering lower levels of attributes as a trade-off for generally lower prices at the pump, while higher income consumers will be expected to show the opposite trend. Spatial competition has a measurable value, which tends to be reflected in lower retail prices.

GENERAL CHARACTERISTICS OF THE SUPPLY FINDINGS

The general findings pertain to the supply of retailing attributes (accessibility, convenience, service, and competition) in the retail sales of gasoline and describe the variable and proxy measurements used to estimate the supply function. The study group encompassed 66 gas station in the Vancouver, Washington, metropolitan area, representing 100 percent of the stations exist in Vancouver urban area. One of the 66 stations was dropped from the sample because it offered exclusively full-service. The research recorded the price of unleaded gasoline at each station as well as the level of retailing attributes provided by each. Station locations were plotted on a city zoning map and the distance of each from the core center (0) of the central business district (CBD) was recorded. By using map measurements, the number of competitors located within 90,000 square feet of one another was also determined, as were those within 2,000 feet of a freeway exit. The data were subjected to the Statistical Package of the Social Sciences (SPSSX) for frequency determination and cross-tabulation, multilinear regression, and to the Shazam Econometric program to test for nonlinearity in the models. SPSSX multiregression analysis is used to test for consistency of findings and stability of the model.

The Product for Describing the Findings

The product used for describing the findings is the R^2 , a multiple coefficient of determination, which measures the variability of the dependent variable that is due to the

influence of the independent variables (Lewis-Beck, 1980). The R^2 is an important tool for describing the relationship between the independent and dependent variables.

In this research, the R^2 in the supply model indicates the sum influence of the retailing attributes accessibility, convenience, service, and competition on the cash price of unleaded gasoline. In the demand model, the R^2 indicates the sum influence on pricing of specified consumer characteristics (household income, distance to station, quantity of gasoline purchased, frequency of utilization of convenience store, credit, full-service, car wash, garage service, quality of service, time of purchase, purpose of purchase, size of car's engine, age and sex of consumer, the number of people living in the household, and the consumer's perception of the gasoline retail environment).

It is generally preferred that an R^2 be higher, since this means that the various dependent variables are being explained by the predictors. However, a significant R^2 should not be a goal in itself, for in special cases a low R^2 may be quite important. Its typical value varies from one research effort to another, and its theoretical implications regarding cause and effect should always be considered when interpreting this product. Under some conditions results with a low R^2 is considered highly important, especially when the same variables show a significant f-ratio. Lewis-Beck (1980) concluded that small coefficients in some instances may be considered statistically significant. More specific is the issue of the present study, in which the cash price of unleaded gasoline was regressed against other multi-independent variables. Given that prices represent the cost of one gallon of gas, findings that may initially seem insignificant may in fact be significant in light of the fact that consumers purchase an average of 60-100 gallons per month. Also to be used in describing the relationships is the f-value. According to Heady and Dillon (1961), the f-value tests the overall significance of the equation regression.

Sample size, mean, standard deviation, and standard error of the regression are reported in the description of the outcome. The standard of error correlates inversely with

the R^2 . The final product reported is the regression coefficient, b , which is the measure of the level of association between the dependent variable and each predictor. In hedonic analysis, this product also represents the implicit price (Freeman, 1979a).

Cash Pricing of Unleaded Self-Serve

As seen in Figure 12, the cash price of unleaded self-serve varied from \$.879 to \$1.179. Four stations offered the lowest available price, three of them Arco stations with a convenience store on the premises; the fourth was a Mobil station located on a busy road (peak traffic count of 1,209) and which also had a convenience store on the premises. The highest cash price (\$1.179) was at a Union station located on a road whose peak traffic count was 1,040. This station was located near a freeway exit and offered garage service.

SOURCE: Author

Figure 12. Breakdown of prices for unleaded gasoline among 65 stations in study group.

Traffic Count

The greatest peak traffic count (2,166) was experienced by two stations in the study (3.1% of total) (see Figure 13). One was an Exxon and the other a Union, and both were located at the 78th Street exit from I-5. The lowest traffic count (315) was experienced by an Exxon station located on a one-way street a marginal distance of 2,000 feet from an exit from I-5.

SOURCE: Author

Figure 13. Breakdown of peak traffic count for 65 stations in study group.

Station traffic was evaluated on the basis of peak-hour traffic count and its location relative to a main road. Traffic counts were limited to vehicles traveling on the side of the road on which the station was located. Stations located at intersections received a count reflecting traffic flow on the proximate side of both adjacent streets. When the intersection cross-street was a residential street with insignificant traffic flow, its count was estimated

and added to the total for the main arterial.

Freeway Exit

This is a binary variable distinguishing between stations located within 2,000 feet of a freeway exit, and those which are not. Findings are shown in Table V, below.

TABLE V
STATION PROXIMITY TO FREEWAY EXIT

Proximity	Number of Stations	Percent of Total
Within 2,000 feet of freeway exit	22	33.8
Beyond 2,000 feet of freeway exit	43	66.2
Total	65	100.0

SOURCE: Author

Proximity to Central Business District

Distance from the CBD for the stations in the study group (see Figure 14) ranged from a maximum of 42,500 feet (and Exxon station which also experienced the lowest peak traffic, with a count of 315). That nearest the CBD was a Texaco with a peak traffic count of 1,412.

SOURCE: Author

Figure 14. Distance from central business district (CBD) of 65 stations in study group.

Presence of Convenience Store on Premises

The presence of a convenience store on the premises is another binary variable, and the results here are shown in Table VI. It was found that the majority of independent gas stations had convenience stores (7-Eleven and Plaid Pantry), while the majority of major brand retailers tended to offer garage service, car wash, and/or full-service islands. No stations offered all retailing attributes.

TABLE VI
PRESENCE ON STATION PREMISES OF CONVENIENCE STORE

Presence of Convenience Store	Number of Stations	Percent of Total
Has Convenience Store	31	47.7
Does Not Have Convenience Store	34	52.3
Total	65	100.0

SOURCE: Author

Number of Pumps

Data on the number of pumps available at each station are shown in Table VII. It was found that major brands tend to offer more pumps than do independent retailers.

TABLE VII
NUMBER OF GAS PUMPS SERVING 65 STATIONS
IN STUDY GROUP

Number of Pumps	Number of Stations	Percent of Total
3	3	4.6
4	10	15.4
5	7	10.8
6	13	20.0
7	1	1.5
8	6	9.2
9	1	1.5
10	4	6.2
11	1	1.5
12	12	18.5
14	2	3.1
16	5	7.7
Total	65	100.0

SOURCE: Author

Mean = 8.1385 pumps
Standard deviation = 3.8725
Variance = 14.996

Hours Open

The minimum number of hours of business for which any station was open was 11 (two stations), and the maximum was 24 hours (19 stations) (see Table VIII). Most of the 24-hour stations also had a convenience store.

TABLE VIII
HOURS OPEN FOR BUSINESS OF 65 STATIONS
IN STUDY GROUP

Hours Open	Number of Stations	Percent of Total
11.0	2	3.1
12.0	1	1.5
13.5	1	1.5
14.0	5	7.7
14.5	1	1.5
15.0	6	9.2
16.0	5	7.7
16.5	2	3.1
17.0	7	10.8
17.5	1	1.5
18.0	7	10.8
18.5	2	3.1
19.0	6	9.2
24.0	19	29.2
Total	65	100.0

SOURCE: Author

Mean = 18.531 hours
Standard deviation = 3.9616
Variance = 15.694

Full-Service, Car Wash, Garage, and Credit Card Options

The four variables represented in tables IX through XII are all binary variables. It was noted that the majority of the stations offering these retailing attributes were major-brand stations.

TABLE IX
STATIONS OFFERING FULL-SERVICE OPTION

Full-Service Option	Number of Stations	Percent of Total
With Full-Service Option	14	21.5
Without Full-Service Option	51	78.5
Total	65	100.0

SOURCE: Author

TABLE X
STATIONS OFFERING CAR WASH FACILITIES

Car Wash Facilities	Number of Stations	Percent of Total
With Car Wash Facilities	10	15.4
Without Car Wash Facilities	55	84.6
Total	65	100.0

SOURCE: Author

TABLE XI
STATIONS OFFERING GARAGE SERVICES

Garage Services	Number of Stations	Percent of Total
With Garage Services	19	29.2
Without Garage Services	46	70.8
Total	65	100.0

SOURCE: Author

TABLE XII
STATIONS OFFERING CREDIT OPTION

Credit Option	Number of Stations	Percent of Total
With Credit Option	37	56.9
Without Credit Option	28	43.1
Total	65	100.0

SOURCE: Author

Distance from Vancouver Mall

The station closest to the Vancouver Mall was an Arco station on Fourth Plain Boulevard approximately 5,000 feet from the Mall. That most distant was an Exxon near Exit 9 of I-5 (see Figure 15 and map, Figure 9).

Figure 15. Distance from Vancouver Mall of 65 stations in study group.

Competition

Seven stations (10.8%) had no competitors within 90,000 square feet (see map, Figure 9), while 22 stations (33.8%) had one. fourteen (21.5%) had two competitors within this distance, while thirteen (20.0%) had three. Two stations (3.1%) had four competitors, five (7.7%) had five competitors, and two others (3.1%) had six competitors within 90,000 square feet.

It was found that stations tended to cluster most near freeway exits onto high-traffic thoroughfares, particularly the exits from I-5 onto Highway 99 and that at 78th Street,

which of course tended to have the highest traffic counts.

Major Brand and Cash Discount

Data for these two binary variables are contained in tables XIII and XIV, below. A numerical breakdown of the stations in the study group is presented in Table XV. Major-brand stations constituted the majority of those in the study group (66.2%). Eight of these (13.3% of the total group) were Arco stations; six (9.2%) were Chevron; four (6.2%) were Exxon; seven (10.8%) were Union; six (9.2%) were Shell; and eleven (16.9%) were Texaco. Independent stations numbered 23, as follows: seven (10.8%) were 7-Eleven; four (6.2%) were Plaid Pantry; three (4.6%) were Minute Mart; and there were one each (1.5%) of Super One, K-Store, Pit Stop, Sifton, Lyleless, Lotto, Stop-and-Hop, Deli, and Express.

TABLE XIII
STATIONS OFFERING MAJOR BRANDS

Major Brands	Number of Stations	Percent of Total
With Major Brand	43	66.2
Without Major Brand	23	33.8
Total	65	100.0

SOURCE: Author

The figures for cash discount were the inverse of those for major brand—that is, major-brand stations tended to offer cash discounts, while independent stations (many of which offered no credit option at all) tended not to.

TABLE XIV
STATIONS OFFERING CASH DISCOUNT

Cash Discount	Number of Stations	Percent of Total
With Cash Discount	20	30.8
Without Cash Discount	45	69.2
Total	65	100.0

SOURCE: Author

TABLE XV
BREAKDOWN OF STATION BRANDS

Brand	Number of Stations	Percent of Total
Arco	8	12.3
Chevron	6	9.2
Deli	1	1.5
Express	1	1.5
Exxon	4	6.2
Hop	1	1.5
K-Store	1	1.5
Lotto	1	1.5
Lyles	1	1.5
Minute Mart	3	4.6
Mobii	4	6.2
Pit Stop	1	1.5
Plaid Pantry	4	6.2
Shell	6	9.2
Sifton	1	1.5
Super	1	1.5
Texaco	11	16.9
Union 76	3	4.6
7-Eleven	7	10.8
Total	65	100.0

SOURCE: Author

ESTIMATION OF THE SUPPLY MODEL

The only model which can provide a basis for estimating marginal prices and quantities is one that is nonlinear, since in this case the ratio of prices to quantities is not

constant. It is important to identify whether the hedonic price function is linear or nonlinear before attempting to estimate the inverse demand function. This can only be accomplished in a nonlinear model.

Linearity exists when consumers are able to "arbitrage" attributes by separating and repackaging them (Rosen, 1974:37-38). Accordingly, the linear model function for gasoline retailing reflects consumer tendencies to separate and repackage bundles of retailing attributes. In the present study, great care was given to the estimation of the implicit value of gasoline retailing attributes. Due to the presence of many binary variables, and pursuant to the recommendations of Crooper et al. (1987), it was determined that the Box-Cox function was the appropriate tool for estimating hedonic function. Accordingly, the data were subjected to the econometric computer program Shazam using Box-Cox estimations.

The Box-Cox transformation (Box and Cox, 1964) was used for parameter estimation to test the model function. In doing so, the lambda of each independent continuous variable was derived, as follows:

$$P = \alpha + \sum_{i=1}^n B_i X_i^{\lambda_i}$$

where X_1 = continuous retailing attributes (traffic count, distance to CBD, hours open, size in number of pumps, and distance from Vancouver Mall).

It was determined that the lambda for traffic count was 1.26; that for the distance from the central business district was 2.11; that for size was 1.62; that for hours open was 0.54; and that for distance from Vancouver Mall was 0.17. The k-test for the log of the likelihood of each (at a confidence level of 0.95), a step recommended by White (1972), Judge et. al (1980), and Spitzer (1982, 1984), resulted in the following:

$$L(\hat{\lambda}, \hat{X}_1) - L(\lambda^*, X_1^*) < X_1^2 (.05) = (3.841)$$

where $\hat{\lambda}, \hat{X}_1$ = estimated lambda and estimated independent nonbinary variable 1;

(λ^*, X^*) = lambda value and nonbinary variable that satisfy the inequality;

L = log likelihood.

This figure was compared with an OLS regression analysis, which includes all variables specified in linear form, and it was found to be insignificant. This precludes the possibility of determining the inverse demand function of the above-listed continuous variables. The log likelihood for each variable was insignificant in that there was no difference between the outcome for log and that for the linear model. Consequently, the result obtained in the linear model will be considered an accurate representation of the implicit price of the given retailing attributes.

FINDINGS FOR THE SUPPLY MODEL

Implicit Price of the Attribute Accessibility

There was found for the general supply model an R^2 of .4552, and a Durbin-Watson of 1.7169. In this model, the relationship between the price of unleaded gasoline and the independent variables for the retailing attributes was found to be moderately related on the basis of its R^2 of .4552.

The implicit price of the accessibility attribute was measured by three variables: traffic count, distance from CBD, and distance from a freeway exit. The influence of traffic count on pricing was found to be negative in that as traffic count increases, price decreases. This is due to the economy of scale, whereby stations experiencing high traffic counts realize correspondingly high sales volume, which results in a lower marginal cost.

The price of unleaded self-serve gasoline represented by the constant in the equation, was \$.9573. An increase in traffic count of one unit led to a decrease in the

average price by \$.00345, as shown in Table XVI. The t-ratio for traffic count was -2.4395. This figure is significant at the level 0.01.

TABLE XVI
FINDINGS FOR THE SUPPLY MODEL

Variable	Est. Coef. (in \$)	Std. Error (in \$)	T-ratio	Partial Corr.	Std. Coef.
Traffic count	-0.0000345	0.000014143	-2.4395*	-0.3261	-0.30828
Freeway exit	0.02545	0.019571	1.1520	0.1608	0.21523
Distance from CBD	0.0005368	0.00060227	0.88611	0.1243	0.10294
Convenience store	-0.047972	0.016906	-2.8376*	-0.3724	-0.48339
Size (# of pumps)	-0.0023696	0.0017144	-1.3822	-0.1918	-0.18370
Hours open	0.0012786	0.0018414	0.69433	0.0977	0.10140
Service	0.0032144	0.016991	0.18919	0.0267	0.026659
Car wash	0.012788	0.014656	0.87252	0.1225	0.093084
Garage service	0.0045213	0.016215	0.27883	0.0394	0.041487
Credit	0.025375	0.015008	1.6908**	0.2326	0.25350
Distance/Vanc. Mall	0.0013286	0.0010042	1.3230	0.1839	0.19599
Competition	-0.0067211	0.0043543	-1.5436	-0.2133	-0.20444
Major brand	-0.0060646	0.016329	-0.37141	-0.0525	-0.057895
Cash discount	-0.023261	0.014095	-1.6502**	-0.2273	-0.21659
CONSTANT	0.95729	0.044386	21.568	0.9502	0.0000

SOURCE: Author

R-square = 0.4552

Adjusted R-square = 0.3027

Standard Error of Estimate = 0.0417

F = 2.984 N = 65

* Significant at .010.

** Significant at .10.

The outcome for the influence of proximity to a freeway exit was positive. Stations within 2,000 feet of a freeway exit showed an increase of \$.02545. The t-ratio of -1.1520 was insignificant, as shown in Table XVI. The relation between price and the distance to the central business district was positive. For every increase in distance of one thousand

feet, the resulting price increase averaged \$.005368. The t-ratio was insignificant .

The variable traffic count, it may be seen, was the only one of the three factors found to be significant.

Implicit Price of Convenience Store

The coefficient for the convenience store variable was negative, in that gas stations with convenience stores on the premises tended to offer lower gasoline prices. This is due to compensation by higher margins on merchandise sold in the store, which was supported in a separate analysis (see Appendix D). In addition, it was noted that stations with convenience stores offered few other retailing attributes. None offered the credit option, and none offered full-service islands. Statistically, the presence of a convenience store resulted in a decrease in the average price of self-serve unleaded by \$.04797. The t-ratio was significant at the .01 level.

Price of Service Attributes

The overall price of service attributes consisted of the sum of the explicit and the implicit prices. The explicit price of full service (attendant pumping gas, checking oil, water, tire pressure, washing windshields, etc.) was identified by differentiating each station's cash price of full-serve unleaded against the same station's price for self-serve unleaded (see Table XVII). Findings are based on data from the 14 major-brand stations offering a full-service option. The explicit price for full service was found to average \$.341. The lowest explicit price of full service was \$.05, and the highest was \$.44.

TABLE XVII

**EXPLICIT PRICES OF FULL-SERVICE UNLEADED REGULAR
AT 14 MAJOR BRAND STATIONS IN STUDY GROUP**

Service Station	Cash Price Self-Service	Cash Price Full-Service	Explicit Price Full-Service
Texaco-1	95.9	125.9	.30
Texaco-2	95.9	100.9	.05
Shell-1	97.9	135.9	.38
Union-1	99.9	135.9	.40
Chevron-1	92.9	128.9	.36
Mobil-1	92.9	133.9	.41
Chevron-2	91.9	126.9	.35
Shell-2	96.9	129.9	.33
Union-2	117.9	144.9	.27
Exxon-1	97.9	125.9	.28
Mobil-2	95.9	139.9	.44
Texaco-3	93.9	127.9	.34
Texaco-4	97.9	103.9	.06
Mobil-3	95.9	139.9	.44

SOURCE: Author

Explicit Price of Credit Option: The explicit price of the credit option was determined in the same manner as that for the full-service option, that is, by differentiating at each of the 22 stations offering the option the price variations between the credit and noncredit prices (see Table XVIII). It was found that the explicit price of the credit option averaged \$.05. The hedonic price of service was identified by the main model and the relationship with prices was positive, as expected, showing a price rise of \$.02537 over the average. The t-ratio was significant at the .10 level.

TABLE XVIII

EXPLICIT PRICE OF CREDIT FOR UNLEADED REGULAR
AT 22 SERVICE STATIONS IN STUDY GROUP

Service Station	Cash Price	Credit Price	Explicit Price of Credit
Chevron-1	106.9	111.9	.05
Texaco-1	95.9	100.9	.05
Texaco-2	95.9	100.9	.05
Shell-1	97.9	102.9	.05
Union-1	99.9	104.9	.05
Exxon-1	88.9	93.9	.05
Chevron-2	92.9	97.9	.05
Mobil-1	92.9	97.9	.05
Chevron-3	97.9	102.9	.05
Texaco-3	99.9	104.9	.05
Union-2	93.9	97.9	.04
Texaco-4	91.9	97.9	.06
Chevron-4	89.9	94.9	.05
Exxon-2	89.9	94.9	.05
Chevron-5	91.9	95.9	.05
Mobil-2	99.9	104.9	.05
Texaco-5	92.9	97.9	.05
Texaco-6	92.9	97.9	.05
Texaco-7	93.9	98.9	.05
Texaco-8	95.9	100.9	.05
Chevron-6	89.9	94.9	.05
Deli	92.9	97.9	.05

SOURCE: Author

Implicit Price of Station Size: The size of the station was represented by the number of pumps. As expected, the size of the station negatively affected prices. As with the variable for traffic count, this may be explained by the economies of scale, assuming

that a greater number of pumps implies a higher sales volume. This results in lower margins, hence, lower prices. Statistically, it was found that an increase of one pump led to a decrease of \$.00236 in the price of unleaded self-serve gasoline. The t-ratio of -1.3822 is not significant.

Implicit Price of Hours Open for Business: As expected, the hours open for business, representing an increase in the level of service, related positively with price. It was found that an increase of one hour resulted in a price increase of \$.00127 in the average price of self-serve unleaded gas. The t-ratio was insignificant.

Implicit Price of Full Service: The presence of full-service islands related positively with price, reflected in an increase of \$.003214 over the average price of self-service unleaded gas. The t-ratio was insignificant.

Implicit Price of Car Wash Facilities: The presence of car wash facilities correlates positively with the price of self-serve unleaded, as expected. The price was found to increase by \$.0127. The t-ratio is insignificant.

Implicit Price of Garage Facilities: As expected, the presence of garage facilities related positively with the price of unleaded self-serve gasoline. The increase was found to be \$.00452 . The t-ratio was insignificant.

Implicit Price of Distance from Vancouver Mall: Distance from Vancouver Mall, which represents locational multicapability, was found to correlate positively with prices. Statistically, every increase of 1,000 feet will result in a price rise of \$.00132 over the average. The t-ratio was insignificant.

Implicit Price of Major Brand: The relationship of major brand to price is negative. It was found that non-major brands had prices that were \$.00606 lower than the majors.

The t-ratio was insignificant.

Implicit Price of Cash Discount: The existence of a cash discount results in a decrease in the price of unleaded self-serve gasoline of \$.02326. This relationship was expected, in that a decrease in the level of service results in lower prices. The t-ratio was significant at the .10 level.

Implicit Price of Spatial Competition

The correlation between price and spatial competition was found to be negative, as expected. Statistically, the presence of one competitor within 90,000 square feet resulted in a price decrease of \$.00672. The t-ratio was insignificant.

Following in Table XIX is a summary of the findings for the supply attributes analyzed in the present study. Included are explicit and implicit prices for each of these attributes.

TABLE XIX
SUMMARY OF FINDINGS FOR SUPPLY ATTRIBUTES:
ASK PRICES

Variable	Expected Finding	Offered Price (in S)	T-Ratio	Std. Error (in S)
<u>ACCESSABILITY</u>				
Traffic Count	±	– .0000345	-2.4395*	0.0000141
Freeway Exit	±	+ .023	1.152	0.019571
Distance from CBD	±	+ .00053	0.88611	0.0006227
<u>CONVENIENCE</u>				
Convenience Store	±	– .04797	-2.8376*	0.016906
<u>SERVICE (Explicit Prices)</u>				
Full Service	+	+ .341		
Credit Option	+	+ .05		
<u>SERVICE (Implicit Prices)</u>				
Station Size	–	– .002	-1.382	0.001714
Hours Open	+	+ .00127	0.69433	0.0018414
Full Service-2	+	+ .0032	0.18919	0.016991
Car Wash	+	+ .0127	0.87151	0.014656
Garage Service	+	+ .00452	0.27883	0.016215
Credit Option-2	+	+ .025375	1.691**	0.015008
Distance from Vanc. Mall	+	+ .00132	1.323	0.0010042
Major Brand	nil	– .00606	-0.3714	0.016329
Cash Discount	–	– .023	-1.6502**	0.014095
<u>COMPETITION</u>				
Number of Competitors	–	– .00672	-1.544	0.004354

SOURCE: Author

* Significant at .010 t-two-tailed test.

** Significant at .10 t-two-tailed test.

GENERAL CHARACTERISTICS OF CONSUMER DEMAND

Consumers of unleaded gasoline were analyzed by means of regressing multiple variables against the price at the station the consumer most frequently patronized. The variables used in the regression included household income; distance of the station from the consumer's household (the locations ascertained by questioning, and their positions plotted on a map); the quantity of gasoline used per week for the car most frequently driven (estimated on the basis of miles driven weekly and the car's expected mileage as established by Consumer Reports [1983, 1987, 1988], The Consumer Guide [1987, 1988], and The Car Book [1987]); the frequency of utilization of convenience stores, credit option, full-service, car wash, and garage service; the quality of service; the time of purchase; the purpose of the trip for gasoline purchase; the size of the car's engine; the consumer's age and gender; the number of people in the household; the length of time the consumer has lived in the area; and preference for major brand purchase. The data were subjected to the Statistical Package of the Social Sciences (SPSSX) for frequency determination and cross-tabulation, multilinear regression, and to the Shazam Econometric program to test for nonlinearity in the models. SPSSX multiregression analysis is used to test for consistency of findings and stability of the model.

The findings for the model are presented in two parts. The first provides the general characteristics of the consumer variables listed above, while the second provides the results and the significance of the findings of the regression model.

Price Paid for Unleaded

Consumers paid from \$.879 (for no credit or services) to as much as \$1.449 (for full service with credit). The greatest number of consumers, 21 percent or 63 of the 300 consumer households surveyed, paid the lower amount. Only one of those surveyed (0.3%) paid the highest price (see Figure 16).

SOURCE: Author

Figure 16. Cash price for unleaded paid by 300 consumers surveyed.

Consumer Income

The lowest annual income of \$7,000 was realized by 0.7 percent (2 of the 300 surveyed), and 9.7 percent of the sample (29 of those surveyed) had incomes less than \$10,000 (see Figure 17). The majority of these drove the longest distance for their gasoline and purchased it most frequently at stations with lower levels of retailing attributes. The highest frequency of 11 percent (33 households) had an annual income of \$25,000. The highest bracket, over \$81,000 per year, was achieved by only 2.7 percent, with only 1.3 percent of respondents reporting incomes over \$100,000 per year. A majority of high income consumers purchased unleaded gasoline from full-service islands, used credit and car wash, and drove only short distances from their homes for their purchases, although it was the reverse for use of convenience stores (see Table XX).

SOURCE: Author

Figure 17. Annual household income of 300 cases in study group.

TABLE XX

ANNUAL INCOME FOR 300 HOUSEHOLDS CROSS-TABLULATED
AGAINST FIVE RETAILING VARIABLES

Retailing Variable	Low Income (under \$15,500) (51 cases)		Middle Income (\$15,501-\$35,500) (134 cases)		High Income (over \$35,501) (115 cases)	
	Cases	%	Cases	%	Cases	%
<u>Full Service</u>						
Not Used	49	96.1	130	97.0	83	72.2
Used	2	3.9	4	3.0	32	27.8
<u>Credit</u>						
Not Used	50	98.0	113	84.3	54	46.9
Used	1	2.0	21	15.7	61	53.1
<u>Convenience</u>						
Not Used	28	54.9	95	70.9	98	85.2
Used	23	45.1	39	29.1	17	14.8
<u>Car Wash</u>						
Not Used	50	98.0	124	92.5	97	72.2
Used	1	2.0	10	7.5	18	27.8
<u>Distance*</u>						
Short Dist.	10	19.6	72	53.7	103	89.6
Middle Dist.	18	35.3	33	24.6	10	8.7
Long Dist.	23	45.1	29	21.7	2	1.7

SOURCE: Author

*Short distance = 100-5400 feet; middle distance = 5401-15,800;
long distance = 15,801 and higher.

Distance from Household to Point of Purchase

The actual distance between the point-of-purchase station most frequented and the consumer household ranged from a low of 100 feet to a high of 85,000 feet (see Figure 18). The closest stations were utilized by one percent (3 households), and the longest distance by only one of the households surveyed (0.3%). The highest frequency of usage was at 5,000 feet (about one mile). These stations were utilized by 32 households

(10%). The mean distance was 8,009.7 feet, and the standard deviation was 12,560 feet. Table XX shows that lower income consumers drove longer distances in search of lower prices, evidence of negative income elasticity.

Figure 18. Distance in feet from household to station most frequently patronized.

Gallons Consumed per Week

The lowest quantity of unleaded gasoline consumed by a household was one gallon per week, which was the case for 8.3 percent of the sample (25 households). The highest consumption figure was 99 gallons per week seen in one household (0.3%). The highest frequency, which was 8.3 percent, was seen for both those consuming one gallon and those consuming 10 gallons per week (see Figure 19). The mean number of gallons consumed per week is 13.883, the standard deviation is 14.159, and the variance is 200.46.

SOURCE: Author

Figure 19. Gallons consumed per week by 300 households in study group.

Convenience Store Patronage

Consumers who do not use a convenience store when purchasing gasoline, either by choice or because there was no convenience store available at the station they most frequently use, total 73.7 percent of the sample (221 households). However, 26.3 percent do use a convenience store at the station most frequently patronized (see Table XXI). The majority of those who patronized convenience stores were from lower- and middle-income groups, again evidence of negative income elasticity (see Table XX).

TABLE XXI

CONSUMER USAGE OF CONVENIENCE STORE

Convenience Store Usage	Value	Frequency	Percent of Total
Does not use	0	221	73.7
Does use	1	79	26.3
Total		300	100.0

SOURCE: Author

Credit Option Utilization

Consumers who paid cash for their gasoline purchases, either because the option for credit was not available at the station they most frequented or because they did not wish to make use of the option, totaled 72.3 percent of the sample (217 households).

Consumers using the credit option totaled 27.7 percent of the sample (see Table XXII).

The majority of those using the credit option were from middle- and higher-income groups (see Table XX). Specifically, credit usage was found to be income elastic, paying on average \$.05 per gallon for this service.

TABLE XXII
CONSUMER USAGE OF CREDIT OPTION

Credit Option Usage	Value	Frequency	Percent of Total
Does not use	0	217	72.3
Does use	1	83	27.7
Total		300	100.0

SOURCE: Author

Full Service Option

Full-service islands were patronized by 12.7 percent of the sample (38 households), while 87.3 percent did not use full-service islands either because they were not available or because they did not elect to use the option (see Table XXIII). Those who patronized full-service islands paid more than \$.341 for this service. As with users of the credit option, the majority of full-service users were from middle- and higher-income groups (see Table XX), again showing income elasticity.

TABLE XXIII
CONSUMER USAGE OF FULL SERVICE ISLAND

Full Service Usage	Value	Frequency	Percent of Total
Does not use	0	262	87.3
Does use	1	38	12.7
Total		300	100.0

SOURCE: Author

Quality of Service

Of the consumers surveyed, 22 percent (66 households) had no impression regarding the quality of service at the station they most frequently patronized. Nine percent (27 households) rated service at their usual station as "poor," while 25.3 percent rated their station "fair," 27.3 percent rated it "good," and 16.3 percent rated it "excellent" (see Table XXIV).

TABLE XXIV
CONSUMER RATING OF QUALITY OF SERVICE

Quality of Service	Value	Frequency	Percent of Total
No impression	0-.99	66	22.0
Poor	1.0	27	9.0
Fair	1.5	32	10.7
	2.49	44	14.7
Good	2.5	25	8.3
	2.9	1	0.3
	3.49	56	18.7
Excellent	3.5	14	4.7
	4.0	35	11.7
Total		300	100.0

SOURCE: Author

Mean = 1.9513

Standard Deviation = 1.3350

Variance = 1.7821

Utilization of Car Wash

The majority of those surveyed (90.3%, or 271 households in the sample) do not use a car wash, either because no car wash was available at the station they most frequently used, or because they did not wish to use this service (see Table XXV). Those who do use a car wash totaled 9.7 percent of the sample, or 29 households. The majority of car wash users were from middle- and higher-income groups (see Table XX), again showing income elasticity.

TABLE XXV
CONSUMER USAGE OF CAR WASH

Car Wash Usage	Value	Frequency	Percent of Total
Does not use	0	271	90.3
Does use	1	29	9.7
Total		300	100.0

SOURCE: Author

Utilization of Garage Service

The majority of those surveyed (91.3%, or 274 households in the sample) do not use garage service, either because no garage service is available at the station they most frequently used, or because they did not wish to use this service (see Table XXVI). Those who do use garage service totaled 8.7 percent of the sample, or 26 households.

TABLE XXVI
CONSUMER USAGE OF GARAGE SERVICE

Garage Service Usage	Value	Frequency	Percent of Total
Does not use	0	274	91.3
Does use	1	26	8.7
Total		300	100.0

SOURCE: Author

Time of Purchase

Most consumers surveyed (77% of the sample) usually purchase their unleaded gasoline during the daylight hours (6:00 a.m. to 6:00 p.m.), while the remainder (23%)

make their purchases during the night hours (see Table XXVII).

TABLE XXVII
TIME OF GASOLINE PURCHASE

Time of Purchase	Value	Frequency	Percent of Total
Night	0	69	23.0
Morning & Afternoon	1	231	77.0
Total		300	100.0

SOURCE: Author

Purpose of Trip

Gasoline was purchased by 57.3 percent of the sample while out shopping, on a leisure trip, out specifically to purchase gasoline, or out for other purposes. The remaining members of the sample (42.7%) purchased gasoline on their way to or from work (see Table XXVIII).

TABLE XXVIII
PURPOSE OF TRIP FOR PURCHASE OF GASOLINE

Purpose of Trip	Value	Frequency	Percent of Total
Errand or Leisure	0	172	57.3
To/From Work	1	128	42.7
Total		300	100.0

SOURCE: Author

Size of Car Engine

Four-cylinder cars are those most frequently driven by the largest number of

households in the sample (38.0%). Next frequent were six-cylinder cars (34.0%), while only 28 percent of the sample drove eight-cylinder automobiles (see Table XXIX).

TABLE XXIX
SIZE OF VEHICLE ENGINE

Engine Size	Value	Frequency	Percent of Total
Four Cylinders	4	114	38.0
Six Cylinders	6	102	34.0
Eight Cylinders	8	84	28.0
Total		300	100.0

SOURCE: Author

Age of Consumer

The age of the consumers varied from 16 years old (0.7% of the sample) to 80 years old (also 0.7%). The age most frequent among survey respondents was 30 years old (6%). Over half the sample (161 respondents, or 53.7%) were between the ages of 26 and 45, with the highest number (83, or 27.3%) being in the 36-45 age group. The mean consumer age was 41.833 years and the standard deviation was 15.155 (see Figure 20).

SOURCE: Author

Figure 20. Age of Consumer.

Consumer Gender

Females constituted the majority of those identifying themselves as consumers of unleaded gasoline at 55.7 percent of the sample. Males represented the remaining 44.3 percent (see Table XXX).

TABLE XXX

CONSUMER GENDER

Gender	Value	Frequency	Percent of Total
Female	0	167	55.7
Male	1	133	44.3
Total		300	100.0

SOURCE: Author

Size of Household

The greatest number of households in the sample reported a household size of two (35.7%, or 107 households). Those reporting four and three members were second and third most frequent (21.7% and 17.0%, respectively). One household reported nine members, which was the largest in the sample. Twenty-six households (8.7%) reported one member (see Table XXXI). The mean household size was 3.136, and the standard deviation was 1.5029.

TABLE XXXI
NUMBER OF MEMBERS OF HOUSEHOLD

Number in Household (value)	Frequency	Percent of Total
1	26	8.7
2	107	35.7
3	51	17.0
4	65	21.7
5	30	10.0
6	14	4.7
7	3	1.0
8	3	1.0
9	1	0.3
Total	300	100.0

SOURCE: Author

Mean = 3.1367
Standard Deviation = 1.5029
Variance = 2.2589

Length of Time in Area

Length of time in a geographical area is a measure of perception of the retail

environment. In the study sample respondents reported living in their area for as short a time as one month (four households, or 1.3%) and for as long a time as 630 months, or over 52 years (one household). The mean was 107.8 months (just under nine years), and the standard deviation was 117.83 (see Figure 21).

SOURCE: Author

Figure 21. Length of time in residence in neighborhood.

Utilization of Major Brand

The majority of those surveyed (209 households, or 69.7%) purchase their unleaded gasoline from major-brand stations (Arco, Exxon, Chevron, Texaco, Mobile, Union, or Shell). The remainder (30.3%) purchase their gasoline from independent stations such as 7-Eleven or Minute Mart (see Table XXXII).

TABLE XXXII
USAGE OF MAJOR BRAND GASOLINE

Major Brand Usage	Value	Frequency	Percent of Total
Does not use	0	91	30.3
Does use	1	209	69.7
Total		300	100.0

SOURCE: Author

ESTIMATION OF THE MODEL FOR CONSUMER DEMAND

The demand function, which regressed the prices of unleaded gasoline on consumer income, quantity of gas purchased per week, the frequency of use of specified station attributes and consumer characteristics, was estimated using the Box-Cox transformation (Box and Cox, 1964). The Box-Cox test was used to determine the demand curve to ensure consistency and precision in finding the statistically best fitting functional form. The lambda for each independent continuous variable was then determined for each of these. The lambda for consumer income was .650; for distance of the household from the station most frequently used it was .040; for quantity of unleaded consumed per week it was -4.00; for the age of the consumer it was -4.0; and for the length of time the consumer has lived in the area it was -4.0.

The test recommended by White (1972) and Judge et al. (1980) for ascertaining log likelihood was used to determine that for the income variable the log likelihood function test was insignificant. For the variable distance to station there was significance at a confidence level of .95. The variable was transformed and generated to the lambda power (.040) through ordinary least-square regression (OLS). The result proved to be significant and was used to interpret consumer demand for unleaded gasoline.

The other continuous variables had a lambda value of -4.0. These values are unrealistic. They were estimated with the Box-Cox transformation with this high negative lambda because they were insignificant in the regular linear equation. Therefore, these values were ignored. In the model of consumer demand the variable for distance was transformed to the lambda power of .040 was used to analyze the demand findings and understand consumer behavior in relation to the supply findings.

FINDINGS FOR THE DEMAND MODEL

The R^2 for the demand function was 0.7890, while the adjusted R^2 was 0.7762. The standard error of the estimate was 0.059237 (see Table XXXIV).

Income

Income proved significant in influencing the price of unleaded gasoline. The outcome proved to be contrary to expectations (a nil effect), since the result was positive. An increase in income of \$1,000 per year led to an increase in the bid price of unleaded gasoline of \$.0008312. The t-ratio was 3.1610, and the two-tailed test was significant at 0.01.

Since it would be expected that unleaded gasoline, being a homogeneous product, would have a nil relationship with income, and since the study's findings indicate that a relationship does exist, it is necessary to explain this findings. It is suspected that some unknown retailing attribute (which is income elastic) was not accounted for in the model. This unaccounted for attribute may pertain to some of the more subjective aspects of retailing, for example an image attribute that is more highly valued by higher income consumers than lower. It has been found that the value of retailing attributes is variable relative to household income. Specifically, full-service, credit card, and car wash usage were found to be income elastic, in that higher-income consumers were more prone to use

these services than were lower-income groups (see Table XX). The findings for the convenience attribute was found to be negatively income elastic, perhaps because the luring effect of lower prices and the convenience of small quantity purchases attracts lower-income groups. Distance was also found to be negatively income elastic, which may be explained by higher-income groups placing a higher implicit value on time.

Distance

The relationship between distance from household to service station and the price paid for unleaded was negative, as expected. The maximum savings for the average travel distance of five miles was \$.2758. The t-ratio was -3.4805, and the two-tailed test was significant at .01.

Quantity of Gasoline Consumed per Week

The finding for the relationship between quantity consumed and price was unexpectedly positive. As quantity consumed increased, price paid for unleaded gasoline also increased. However, the t-ratio was 0.2228, and the two-tailed test was insignificant.

Convenience Store

As expected, the relationship between use of a convenience store and the price paid for unleaded gasoline was negative. A purchase from a station with a convenience store led to a decrease in the bid price for a gallon of unleaded gasoline of \$.0024558. The t-ratio was -0.2654, and the two-tailed test was insignificant.

Credit Option

The relationship between utilizing the credit option and the price paid for unleaded gasoline was positive, as expected. Use of credit led to an increase in the bid price for a gallon of unleaded gasoline of \$.05064. The t-ratio was 5.2712, and the two-tailed test was significant at .01.

Full-Service

Full service was also positively related to the price paid for unleaded gasoline. Use of full service led to an increase in the bid price for a gallon of unleaded gasoline of \$.23646. The t-ratio was 17.694, and the two-tailed test was significant at .01.

Quality of Service

The relationship between the quality of service and the price paid for unleaded gasoline was positive, as expected. An increase in the quality of service led to an increase in the bid price for a gallon of unleaded gasoline of \$.003627. The t-ratio was 1.1780, and the two-tailed test was insignificant.

Car Wash

Presence of a car wash on the premises increased the price paid for unleaded gasoline, as expected. In cases of purchases from stations with a car wash, there was an increase in the bid price for a gallon of unleaded gasoline of \$.024032. The t-ratio was 1.9085, and the two-tailed test was significant at .05.

Garage Service

Presence of garage service on the premises increased the price paid for unleaded gasoline, as expected. In cases of purchases from stations offering garage service, there was an increase in the bid price for a gallon of unleaded gasoline of \$.018059. The t-ratio was 1.2790; the two-tailed test was insignificant.

Time of Purchase

The purchase of gas during prime hours (6:00 a.m. to 6:00 p.m.) was positively associated with the price paid for unleaded gasoline, as expected. Prime time purchases resulted in an increase in the bid price for a gallon of unleaded gasoline of \$.008946. The t-ratio was 1.0603; the two-tailed test was insignificant.

Purpose of Trip

Purchases of unleaded gasoline that were made on the way to work reflected positively, contrary to expectations, on the price paid for unleaded gasoline. Purchases under these circumstances resulted in an increase in the bid price for a gallon of unleaded gasoline of \$.000888. The t-ratio was 0.11799; the two-tailed test was insignificant.

Engine Size

The size of the car's engine was found to be positively related to the price paid for unleaded gasoline. Increases in the size of the engine by one cylinder led to an increase in the bid price for a gallon of unleaded gasoline of \$.002054. The t-ratio was 0.83439; the two-tailed test was insignificant.

Age of Consumer

The age of the consumer was found to correlate positively with the price paid for unleaded gasoline. An increase of one year in age resulted in an increase in the bid price for a gallon of unleaded gasoline of \$.00019429. The t-ratio was 0.65815; the two-tailed test was insignificant.

Gender of the Consumer

It was found that men pay higher prices than do women for unleaded gasoline. The difference was \$.0078761. The t-ratio was 1.0521; the two-tailed test was insignificant.

Size of Household

The size of the household was positively related to the price paid for unleaded gasoline, which is the opposite of what was expected. An increase in the size of the household led to an increase in the bid price for a gallon of unleaded gasoline of \$.0024516. The t-ratio was 0.97659; the two-tailed test was insignificant.

Length of Time in Area

The length of time which a consumer has lived in a given area was found to correlate positively with the price paid for unleaded gasoline. This finding was unexpected. Each month living in a given area led to an increase in the bid price for a gallon of unleaded gasoline of \$.0000082865. The t-ratio was 0.23518; the two-tailed test was insignificant.

Use of Major Brand

Purchases from independent gasoline retailers instead of a major brand led to a decrease in the bid price for a gallon of unleaded gasoline of \$.0062861. The t-ratio was 0.67187; the two-tailed test was insignificant.

TABLE XXXIII
A SUMMARY OF BID PRICES AND CONSUMER DEMAND

Variable	Symbol	Expected Findings	Bid Price (in S)	T-Ratio	Std Error (in S)
Income	Yi	nil	0.0000833	3.1610*	0.00002635
Distance from Household	DISH	-	-0.2758 ^a	-3.4805*	0.079243
Gallons per Week	QGALi	-	0.0000607	0.22280	0.00027246
Convenience	CONVi	-	-0.0024558	-0.26554	0.0092518
Full Service	FULLSi	+	0.23646	17.694*	0.013364
Car Wash	CARWi	+	0.024032	1.9085**	0.012592
Garage Service	GARGi	+	0.018059	1.2790	0.014119
Credit	CRIDTi	+	0.050646	5.2712*	0.0096081
Quality of Service	QSERVi	+	0.0036278	1.1786	0.0030781
Time of Purchase	TIMEi	-	0.0089464	1.0603	0.0084373
Purpose	PURPi	+	0.00088854	0.1179	0.0075308
Major Brand	MAJBi	nil	-0.0062861	-0.67187	0.0093563
Engine	CENGi	-	0.0020543	0.83439	0.0024621
Age	AGEi	±	0.00019429	0.65815	0.0002952
Sex	SEXi	±	0.0078761	1.0521	0.0074860
People	PEPLi	+	0.0024516	0.97659	0.0025104
Perception	LENGTi	-	0.00000828	0.23518	0.00003523

SOURCE: Author

*Significant at .01 t-two-tailed test

**Significant at .05 t-two-tailed test

***Significant at .10 t-two-tailed test

^a Distance transformed to the lambda magnitude 0.040.

TABLE XXXIV
FINDINGS FOR THE MODEL FOR CONSUMER DEMAND

Variable	Est. Coef. (in \$)	Std. Error (in \$)	T-ratio	Partial Corr.	Std. Coef.
Income	0.0000833	0.000026357	3.1610*	0.1850	0.12113
Distance	-0.2758	0.079243	-3.4805* ^a	-0.2029	-0.12322
Quantity	0.0000607	0.00027246	0.22280	0.0133	0.006863
Convenience Store	-0.0024558	0.0092518	-0.26554	-0.0158	-0.0086515
Credit	0.050646	0.0096081	5.2712*	0.2995	0.18122
Full Serve	0.23646	0.013364	17.694*	0.7253	0.62907
Quality of Service	0.0036278	0.0030781	1.1786	0.0700	0.038673
Car Wash	0.024032	0.012592	1.9085**	0.1129	0.056803
Garage Service	0.018059	0.014119	1.2790	0.0759	0.040641
Time of Purchase	0.0089464	0.0084373	1.0603	0.0630	0.00114
Purpose of Trip	0.00088854	0.0075308	0.11799	0.0070	0.003515
Engine Size	0.0020543	0.0024621	0.83439	0.0496	0.026496
Age	0.00019429	0.0002952	0.65815	0.0392	0.023450
Sex	0.0078761	0.0074860	1.0521	0.0625	0.031296
Number of People	0.0024516	0.0025104	0.97659	0.0581	0.029423
Length of Time	0.00000828	0.00003523	0.23518	0.0140	0.0077969
Major Brand	-0.0062861	0.0093563	-0.67187	-0.0400	-0.0045391
CONSTANT	1.1372	0.0903	12.510	0.5974	0.0000

SOURCE: Author R-square = 0.7890 * Significant to .01. ^a Distance transformed to
Adjusted R-square = 0.7762 ** Significant to .05. the lambda magnitude 0.040.
F = 62.017 SEE = 0.059237 ***Significant to .10.
N = 300

CHAPTER VI

ANALYSIS OF THE SUPPLY AND DEMAND MODELS

It has been determined in the present study that retailing attributes (accessibility, convenience, service, and competition) have a measurable effect on retail prices and consumer behavior. This study has arrived at estimations of the value of these retailing attributes. These values were found to be measurable, and they are differentiable between varying consumer groups. For example, consumers with higher incomes tend to purchase unleaded gasoline from retailers offering higher levels of attributes, while lower income consumers tend to patronize stations with lower levels of attributes. Furthermore, other attributes such as distance, credit, and full service also proved significant and differentiable among consumer income groups.

This chapter will be presented in two sections. The first provides an analysis of the findings relating to the supplier market for unleaded gasoline. The second analyzes the unconventional hedonic findings for consumer demand.

ANALYSIS OF SUPPLY FINDINGS

Accessibility

Accessibility was estimated in the supplier model using three variables: traffic count, proximity to a freeway exit, and distance from the central business district (CBD). The finding for traffic count was found to be negative. Proximity to a freeway exit was positive, and distance from CBD was also positive.

The negative sign for the traffic count variable may be explained in terms of agglomeration economies in the area, which lead to economies of scale. A high traffic

count results in a greater number of potential customers, resulting in higher sales volume. Hence, the consumer generally enjoys lower prices at these highly accessible locations.

In the demand model, on the other hand, accessibility, which was measured in the distance of the household to the station most frequently patronized, correlated negatively with the price of unleaded gasoline. In effect, consumers paid for distance. Higher income groups drove shorter distances for gasoline, which is evidence of negative income elasticity. This may be due to their placing a higher implicit value on time. They paid either the full average cash price for unleaded at the nearest station (\$1.1372), or else incurred transportation costs for driving to a more distant station offering lower prices. Due to the variable being related to price in a curvilinear way it was necessary to log the relationship. It was found, then, that a one percent increase in distance leads to a price decrease of \$0.2758. The distance variable is so highly significant for three possible reasons. First, the maximum driving range for gasoline is 16 miles. Second, lower gasoline prices may be obtained by driving relatively shorter distances. Third, the narrow focus of the study sample, being stratified geographically, highlighted the variable for distance.

Stations located near freeway exits tended to have higher prices. This might be considered a contradiction of the traffic-count variable, since relatively high traffic counts are generally common at sites near freeway exits. However, in this study's sample stations near freeway exits did not necessarily experience high traffic counts. In fact, some stations near freeway exits experienced lower traffic counts than did some stations located elsewhere in the study area, and there was no significant correlation between traffic count and a station's proximity to a freeway exit. In this sense, each case is unique and must be examined individually. In the present study, the cash price of unleaded gasoline was found to increase by \$0.02 per gallon over the average for station located within 2,000 feet of a freeway exit. This figure is statistically insignificant in the model, and resulted in traffic

count being the sole significant variable for the measurement of accessibility in the supplier model.

Distance from the CBD was expected to correlate either positively or negatively with the cash price of self-service, unleaded gasoline, and was found to correlate positively, although the relationship was statistically insignificant. This variable was included as a measurement of accessibility because it was assumed that the CBD was the most accessible area of Vancouver. Its insignificance in the model may be due to the proximity of Vancouver to the central metropolitan area of Portland, Oregon, and the influence of Portland as the employment center of the SMSA. The major freeways in the area (I-5 and I-205) emphasize Portland's dominance in this regard.

The attribute of accessibility, whether measured through the supplier or the demand model, was found to have a price. In the present study the attribute was found to be both positive and negative. In the supply model it was found to be negative for highly accessible suppliers who enjoyed heavy traffic counts. However, the price was positive in the consumer model, since the more accessible a station to the consumer, the higher the station's prices. Short distance was found to be valued by the consumer.

Convenience

The presence of a convenience store on the premises led to a decrease of approximately \$0.05 per gallon for self-service unleaded gasoline. It should be noted that stations with convenience stores offered minimum service; none of the stations in the sample with a convenience store on the premises offered full-service islands or garage service, and only one of them had a car wash. Most did not offer a credit option. In addition, these stations compensated for lower gasoline prices by obtaining higher profit margins on retail items offered in the store (see Appendix D). In the demand model it was found by cross-tabulating income against convenience that larger percentages of lower- and

middle-income consumers patronized convenience stores, evidence, perhaps, that these groups are more attracted by cost savings and purchase convenience.

Service

The value of service was estimated in two segments. The first was the estimation of the explicit price through the submodel which differentiated the cost of varying levels of service (i.e., cash, credit, full service, self service, and combinations of these) within each station. From this it was possible to estimate the explicit price. It was found that the explicit price of full service (pumping gas, washing windshield, checking the oil, etc.) averaged \$0.341. The price of credit was found to average \$0.05. Therefore, the explicit price of full service and credit totaled an average markup of \$0.391 for unleaded gasoline, more than one-third of the average price.

The second segment of the estimation of the value of service involved estimating the implicit price. This was done through the hedonic model, which differentiated the cash price of self-service unleaded gasoline among the 65 station in the study group (the supplier model). Following this differentiation, the implicit prices of specified services were estimated in the main model.

The sign for the service variable station size (represented by the number pumps) was found to be negative, as expected, in that an increase in the size of the station led to a lower average price for unleaded gasoline, presumably because of the effects of greater sales volume. However, the sign for the variable was statistically insignificant. This statistical insignificance may be due to the smallness of the unit analyzed (one gallon of gasoline), or to the relatively small number of gas stations available in the study area. It is expected that marginal increments are added to the cash price of a gallon of self-service unleaded gasoline since it represents a high return and low margin of service value.

The impact of the other service variable (hours open, car wash, major brand, etc.)

were also found to be insignificant. The sign for hours open was positive, as expected. This may be explained by noting that stations open more hours per day experience higher marginal costs, which result in higher retail prices. It was found that an increase in the hours open of one hour resulted in an increase in the average asking price of a gallon of unleaded of \$0.00128.

The full-service variable was found to correlate positively with price, as expected, increasing the price of a gallon of unleaded gasoline by \$0.00321. This increase results from higher marginal costs incurred in making available service personnel, resulting in higher prices at the pump. The implicit price of a car wash was positive, as expected, amounting to an increase of \$0.01279 in the cash price of unleaded gasoline. Additionally, the car wash itself had an explicit price of between \$2.75 (for a minimum, no-wax wash) to more than \$5.00 for a full-option wash. Both the car wash and full-service variables were found to be income elastic. The implicit price of garage service correlated positively with the cash price of unleaded gasoline, as was expected. The presence of a garage on the premises results in increased marginal costs to the station, which is reflected in an increase of the cash price of unleaded by \$0.00452.

Distance from Vancouver Mall correlated positively with the cash price of unleaded gasoline, although the relationship was statistically insignificant. Distance to the Vancouver Mall was included as a variable for service because the Mall provides a multicapability shopping service. However, it must be noted that there are other retail districts in the study area which fit the designation of Herbert and Thomas (1982) (that is, divisions into specialized areas, ribbons, and retail nucleations). These other retail districts offer similar multicapability shopping services and are in some cases more convenient than is the Vancouver Mall for combining shopping with the purchase of gas. In fact, gas stations were observed to be more highly clustered around these other shopping areas than around the Vancouver Mall, particularly for shopping areas near major crossroads.

The implicit cash price of unleaded gasoline was found to be lower at independent stations than at major brand stations (Exxon, Chevron, Union, Mobil, Shell, and Texaco). The one exception to this was for Arco stations. The cash price of self-serve unleaded at major brand stations was found to be \$0.00606 higher than prices at independent stations. It should be noted that all independent stations offered only self service. Further, the majority of independent stations had a convenience store on the premises.

Discounts for cash purchase had a statistically significant relationship with cash price, as determined in the main model, resulting in a lowering of the cash price for self-serve unleaded by \$0.02326. This may be explained by the lower marginal cost incurred by retailers dealing in cash, since there are expenses associated with offering credit.

The influence of the brand name on retail prices in the supply model was insignificant, as expected, due to the fact that unleaded gasoline is a homogeneous product; brand loyalty would therefore be expected to be at a minimum.

Competition

Competition was measured by noting the number of stations located within a 90,000 square foot area, and it was found that for every competitor to a given station within this area the cash price of self-serve unleaded was reduced by \$0.00672. The number of competitors within this distance for any given station in the study group never exceeded six. As competition in this study was observed at a very local level, the findings support the concept of submarket linkage advanced by Chamberlain (1956), the principal of rate of diffusion offered by Globerman (1978), and the issue of local competition discussed Haining (1986). For example, competitors in the vicinity of Five Corners (five competitors in this area) and at the intersection of Fourth Plain and Andresen Road (four competitors) showed noticeable price linkage. Furthermore, a relatively high rate of diffusion contributed to the relatively high level of competition, and local competition led to price

regularity. This may be seen in the finding that most of the competitors at the two locations cited above had a cash price for unleaded of \$0.879. However, competition in general was only moderately supported in the main model, and was found to be statistically significant at only 0.20.

Competition as observed in the present study tended to be high where traffic counts were relatively low. At the same time, areas with high demand (e.g., the 78th Street exit on Interstate 5), saw competition that was relatively low, regardless of the number of competitors. This supports the notion that in cases of high demand firms tend to enjoy lower levels of competition, since demand exceeds supply.

Summary

It is the case that data for several variable in the supply model were statistically insignificant. For all variables the direction of the relationship (that is, positive or negative) was found to be as expected. It is the opinion of this researcher that the marginal significance may have been due to the relatively small number of samples available in the study area, and that a larger sample would show the relationships to be indeed significant.

The prices established in this study of the value of retailing attributes may appear at first glance to be only marginally significant. However, on closer examination and in light of the country's total retail gasoline consumption, the implications of the findings are extremely significant. The values for the retailing attributes investigated in the present study were obtained through the regression of the prices of only a one-gallon unit of unleaded gasoline, while actual consumption of unleaded gas in the United States amounts to tens of millions of gallons each day. When taking the broader picture into consideration, the significance of the findings becomes readily apparent. The findings become even more significant when generalized for the entire retail industry, which accounts for sales in excess of \$126 billion per month in the United States alone (Investor's Daily, 1987).

ANALYSIS OF DEMAND FINDINGS

Findings for the demand model strongly support the notion that households differentiate among the specified retailing attributes (accessibility, convenience, service, and competition). The majority of high income households tended to patronize stations with higher levels of attributes, and hence higher prices, apparently willing to pay for attributes such as full service, credit, car wash, and garage service. Lower income households more frequently patronized low attributes stations, accepting lower levels of service in exchange for lower cash prices.

Contrary to expectations, household income was found correlate with the price at the pump of unleaded gasoline. Because gasoline is homogeneous, it should not be income sensitive. Results in the present research can only be explained as a problem of specification in the demand model, most likely the omission of a "subjective" attribute.

The cross-tabulation of the independent variables shows that household income is elastic as it relates to the retailing attributes credit card use, car wash use, use of full-service islands. The pattern continued for middle- and low-income consumers, in that the lower the income the lower the frequency of use. The finding, then, is that higher income consumers use higher levels of retailing attributes, as well as consuming greater quantities of gasoline and owning larger cars.

Distance from the household to the station most frequently patronized was also found to correlate with price, although negatively. Cross-tabulating income against the variable distance showed it to be negatively income elastic. The correlation was statistically significant. The implication is that higher-income groups place a higher implicit value on their time. The cost of this distance was either internalized by the consumer (by driving greater distances to a lower priced station), or else enjoyed the advantage of having the average cash price of unleaded (\$1.1372) posted at the nearest station. A change in

distance of one percent leads to a savings of \$0.2758 within an average distance of 1.516 miles, and a minimum price of \$0.879.

Cross-tabulating income against the variable convenience showed it to be negatively income elastic, which is evidence that lower gasoline prices and small-quantity purchases had a luring effect on lower-income consumers. The availability of full service, credit, a car wash, and quality of service led to an increase in the bid price of \$1.1372. Specifically, the availability of full service led to an increase of \$0.23646; the availability of credit led to an increase of \$0.05046; and the presence of a car wash on the premises led to an increase of \$0.02403. These were all statistically significant.

The remaining variables (time of purchase, purpose of trip, size of vehicle engine, the age and gender of the consumer, size of the household, length of time in the area, and the independent/major brand variable, were all found to be statistically insignificant. That the variable for brand name was insignificant, as expected, supports the contention that it has no influence on consumer demand, which is consistent with findings in the supply model indicating that brand name had no influence on retail prices. This consistency may be explained by the fact that unleaded gasoline is a homogeneous product.

CHAPTER VII

INTERPRETATION OF THE FINDINGS FOR SUPPLY AND DEMAND

Part One of the present chapter will integrate and compare data and associated findings on the ask and bid prices of unleaded gasoline at the service stations in the study area. Part Two will summarize the implications of these findings for the research propositions. It will continue by assessing the relevance of the findings to the literature in the field of retailing, hedonic analysis, and consumer behavior in general, as well as assessing the limitations of the study. Part Three will detail the study's conclusions and provide suggestions for future research.

INTEGRATION OF THE SUPPLY AND DEMAND MODELS

Comparing the ask and bid prices of specified variables is essential for drawing a complete picture of the consistency with which hedonic analysis measures the value of retailing attributes. In the present case, this consistency is discussed as it is reflected in the discussion of categories of variables (i.e., accessibility, convenience, service, and competition).

Accessibility

The accessibility of a retail store was seen to clearly differ from the matter of consumer accessibility. The conceptual difference accounted for both in the model and in the findings which highlight that difference. In the supply model, accessibility (measured by the statistically significant variable traffic count) correlated negatively with lower prices

at the pump. More specifically, it was found that an increase in traffic count of one unit led to a decrease in the price of one gallon of unleaded gas by \$.0000345. This decrease may be explained in terms of the effects of the economies of scale resulting from relatively high sales volume resulting from the higher traffic count.

In the demand model, accessibility (as measured in the distance from, or travel time between, the consumer's place of residence and the point of purchase) proved to be highly valued by consumers of unleaded gasoline. Specifically, consumers either paid the full cash price at the nearest station (\$1.1372), or incurred transportation costs and personal inconvenience in order to travel to a more distant station offering lower prices. Moreover, cross-tabulating income against accessibility showed that higher-income consumers placed a higher implicit value on their time.

In the demand model, the Box-Cox Test lambda distance in the demand-function estimation was found to be statistically significant. Specifically, a one percent increase in distance traveled led to a decrease in price of \$.2758. However, the lower end of available savings in the study area was a minimum price of \$.879 per gallon. This significance might be due to the limits of the driving range for a convenience commodity, which was found to be 16 miles. The average driving range was 1.516 miles. Another possible explanation is the probability that the lowest obtainable price was found at the nearest location. Finally, it must be recognized that the narrow focus of the consumer sample, insofar as it was geographically stratified, led to an inordinate emphasis on the distance variable.

Convenience

The presence of a convenience store on the premises led to a decrease in the price of unleaded gasoline by approximately \$.05 per gallon. Specifically, the implicit ask and bid prices for the attribute convenience were as follows:

Implicit Ask Price = $-\$0.04797$

Implicit Bid Price = $-\$0.0024558$

One would expect that the convenience afforded by these stores would positively influence gasoline prices, which is the expectation most consistent with the proposition advanced in this study. However, the effect was clearly measurable and significantly negative. This outcome may be due to the fact that none of the stations in the sample having a convenience store on the premises also had a full-service island or garage service, and only one of them had a car wash. Most did not offer a credit option. In short, services were limited, marginal cost therefore minimized, and hence retail prices kept relatively low. Another possibility, however, is that retailers consider gasoline as a "loss leader"—that is, a product whose retail selling price is artificially reduced for the purpose of drawing consumers into the convenience store. Relatively high margins on commodities sold in the store may easily offset the low margins realized on gas sales. For a cursory control analysis of this retailing strategy as it pertains to convenience stores in the study area, see Appendix D.

But any explanation is complex, insofar as several factors influence retail pricing. For example, gas stations having convenience stores on the premises were not immune to the effects of agglomeration economies that influence traffic count in their areas, which in turn increases sales volume, provides greater economies of scale resulting in lower marginal costs, and finally promotes lower retail prices. Clearly a combination of several factors are at work.

In the demand model, the majority of consumers interviewed did not value the presence of a convenience store on the premises very highly. In fact, 73.7% of the sample either elected not to patronize convenience stores at service stations, or stated that no convenience store was present at the station they most frequently patronized. This finding

was supported by the fact that the implicit bid price for this variable was statistically insignificant, although the direction of the correlation (negative) was consistent with that for the implicit ask price. Probably not incidental to this finding was the expressed perception of a large majority of respondents that items in convenience stores tend to have relatively high prices (again, see Appendix D for a statistical verification of this perception). In addition, higher numbers of lower- and middle-income groups elected to patronize convenience stores located on the premises of service stations. This is evidence of negative income elasticity. This may be explained by the possibility that these income groups are attracted by lower gasoline prices and the convenience of small purchases.

Regarding the issue of gasoline acting as a "loss-leader" or else priced to realize a relatively low margin in order to attract customers to the convenience store, those who elect to patronize the gas pumps while not purchasing items from the store might be considered free riders. In the case of a true free-rider situation, these non-patrons are subsidized by those who do elect to patronize the convenience store.

In retrospect, it is felt that more precision in operationalizing the convenience variable, as well as some others, may have led to better results. Nonetheless, these findings as established through the use of a dummy variable isolated a measurable value for this retailing attribute which appears to be significantly precise and informing.

Service

Findings for the service variables were also found to be income elastic. The determined ask and bid prices for both variables follow (Table XXXV).

TABLE XXXV

ASK AND BID PRICES FOR THE SERVICE ATTRIBUTES
FULL-SERVICE OPTION AND CREDIT CARD OPTION

	Explicit Ask Price (in \$)	Implicit Bid Price (in \$)
Full-Service Option	0.341	0.23646
Credit Card Option	0.05	0.050646

SOURCE: Author

The difference between the ask and the bid price for the full-service options may be due to a misspecification in the demand model. Contrary to expectations, income variability was found to be sensitive to the price of unleaded gasoline. However, unleaded begin homogeneous, this should not be the case. The finding may be explained by the omission of an income-elastic variable, which probably led to the observed differential. Also contributing to the gap between the ask and bid prices may be confidence levels and margins of error.

The ask and bid prices for the credit card option were virtually equal. This may be explained as representing equilibrium between the supply and demand sides for this variable. However, this equilibrium may not be real, since it has already been noticed that misspecification likely exists in the model.

Competition

The data for the supply model supports the clear conclusion that competition leads to lower prices. It shows that an increase of one competitor within a range of 90,000 square feet reduced the price of unleaded gas by \$.00672. This findings was moderately supported in the general model.

Findings for the effect of competition on pricing in the present study were obtained

at very local levels, and therefore support the concepts advanced in the work of Chamberlain (1956), Globberman (1978), Haining (1986), and others. At two locations in particular (Five Corners, with five competitors, and at the intersection of Fourth Plain and Andresen, with four competitors), noticeable price linkages and a high rate of intrafirm diffusion leading to spatial price regularity were observed. The majority of competitors at these two locations offered the lowest cash price for unleaded gasoline in the study group (\$.879). Furthermore, findings in the supply model relative to these two locations support observations of the tendency for retailers to agglomerate in the vicinity of high traffic density, which is advanced in the work of Smith (1971) and Haining (1986), among others. One may conclude, then, that competition among retail gasoline distributors is largely local, given the high degree of overlapping in retail coverage resulting from the tendency toward agglomeration in high traffic zones. Accordingly, pricing latitude at the local (retail) level is important insofar as it permits price adjustments required to maintain sales under prevailing local conditions.

Also relevant to a discussion of the effects of competition, sales volume, and level of service, is that in areas of extremely high demand (that is, areas of extremely high traffic flow), where in fact the level of demand exceeds the threshold of supply of the agglomerated suppliers, the effect on pricing is reversed, insofar as the competitive pressure to reduce prices is minimized. In such cases, supply may be viewed as being extremely elastic, since the product is relatively homogeneous. This trend was observed in the present study, particularly at the site of Exit 78 on Interstate 5, where retail prices at six competing stations were higher than seen at other points of agglomeration (see the two cited above), largely because traffic counts at this location were the highest in the study group. So stations tend to agglomerate at certain points not for the same reasons as retailers of differentiated products (that is, to offer comparison shopping advantages), but instead to take advantage of high traffic volume at specific sites regardless of the number of

competitors, since under the proper conditions (that is, a higher level of demand than of supply), whatever may be lost to competition is compensated for by the shift outward in demand.

Regardless of these variations, it was possible to isolate and measure the value of the retailing attribute in both the supply and demand models with relative consistency. Of course, measurements in the two models were not in total agreement, but this was largely due to the variations discussed above, as well as the possibility of errors in measurement and possible misspecification in the demand model.

Replacing some of the dummy variable might offer more precision, for example using a square-foot unit to measure convenience, and measuring distance in linear feet from a freeway exit to retail site. Another factor is the small size of the sample in the supply model. It is probable that those independent variables whose relationship with the dependent variable was as expected, but yet statistically insignificant, would in fact be shown to be statistically significant in an analysis using a much larger sample. The number of samples in the present study represented 100% of those offering self-service in the geographical area. (Although the geographical limits of the SMSA under study includes Portland, Oregon, as well as Vancouver, this study was limited to the Vancouver area for the simple reason that Oregon state law prohibits self-service gas stations.) The clear recommendation is for a similar study to be conducted in a larger metropolitan area, for example, the Seattle SMSA.

IMPLICATIONS OF THE FINDINGS

Findings from the supply model support the contention that the value of retailing attributes may be realistically measured and their implicit price estimated. It was further determined that competition results in lower prices, a finding that was moderately well supported by the study's findings. The application in the present study of hedonic analysis

to retailing attributes resulted in the estimation of the relative importance of the actual market values of retailing attributes. A gas station with a lower level of retailing attributes generally offered lower prices, and vice versa.

However, the attempt of conventional hedonic analysis to estimate demand function through the regression of implicit prices against quantity consumer and consumer characteristics did not succeed, since the results of the attempt to do so for the supply model function were constant (linear). This linearity in the supply model function may be explained by the fact that consumers may readily "arbitrage" retailing attribute bundles. This was alluded to by Rosen (1974:37-38) in his explanation of the conditions necessary for estimating the inverse demand function in conventional hedonic analysis. Consequently, the linear function of the supplier model was used to interpret and estimate the influence of retailing attributes on the price of unleaded gasoline.

The finding for the consumer demand function strongly indicate that consumers differentiate between the retailing attributes (accessibility, convenience, service, and competition). Lower income households were found to purchase at stations offering lower levels of attributes as a trade-off for generally lower prices at the pump, while higher income consumer exhibited the opposite trend.

The Findings and the Literature of Retailing

Findings in the present research are consistent with notions, opinions, and generalization prevalent in the literature of retailing. In short, the present research supports the opinion that accessibility, convenience, service, and competition are important influences on consumer behavior. In this research, the relative importance of each of these retailing attributes was precisely measured through an analysis of hedonic prices. The application to retailing of hedonic analysis not only provided a realistic econometric method for measuring retailing attributes, but also provided a tool for confirming other retailing-

attribute measurements for the purpose of consistency, precision, reliability, and validity.

The present findings were also consistent with consumer preference research. It was found, for example, that gasoline consumers did not drive more than 16 miles to purchase gasoline, a finding that is consistent with the range established by Timmerman (1979) and Loyd (1977) in their attempts to refine Rushton's revealed preference approach (1969). Their conclusions were that the true area of consumer preference for spatial attributes is delimited by reasonable travel time, and by what Lloyd termed "the personal range of the goods" (p 17). The present findings support this conclusion, in that the maximum travel distance for the purchase of gasoline was found to be 16 miles and the average 1.516 miles. It may be concluded from the present research that indeed the "personal range of the goods" as expressed by travel time (distance) is a major factor in consumer spatial preference.

The findings also support the concept of "sub-linked markets" Chamberlain (1956), Globerman's (1978) principle of "rate of diffusion," and Haining's (1986) notion of "local competition." More specifically still, the findings support the conclusions of Haining and also of Smith (1971), who argued that gas stations tend to agglomerate on high-traffic thoroughfares, intersections, and/or freeway exits.

The Findings and Hedonic Analysis

Including retailing attributes in hedonic analysis provides a more realistic account of the process of shopping. It has been established in the present research that consumers do recognize differences in retailing attributes. Retail stores are not homogeneous and their variable attribute levels constitute significant and measurable transactional costs. Ignoring the influence of these transactional costs (of retailing attributes) on consumer behavior results in a misspecification and oversimplification of the consumer shopping process. Hence, monitoring and incorporating these attributes into consumer analysis provides a

more realistic picture of consumer behavior.

The present study's findings on the implicit value of retailing attributes are consistent with those derived from the hedonic analysis in hundreds of housing studies, as well as for Rosen's general model (1974) and Blackley's (1984) analysis by hedonic methods of industrial attributes.

The inverse demand function was not identified in the present research because the supplier model function was linear. This may be explained either by the fact that the retailing attributes of gasoline sales are easily untied and repackaged, or else by the fact that the retailing attributes constitute such a small increment since the unit of observation in the study was only one gallon.

The Findings and Retailers

The hedonic findings in this study are consistent with generally accepted notions on retailing, as was the importance of retailing attributes in general. Hedonic analysis provided precise results by establishing implicit prices as a measurement of the relative importance of specified retailing attributes. In short, the implicit prices represented the consumer's willingness to pay for specified bundles of retailing attributes. Furthermore, these attribute bundles were found to be differentiable by consumer income.

Information provided through hedonic analysis of retailing attributes may be a valuable tool to the retailer. Among other things, it may be used to ascertain the amount the consumer is willing to pay for a specified attribute bundle. This is useful to the retailer in a number of ways, including determining site locations, measuring market performance, segmenting markets, and adjusting marketing strategies and advertising campaigns. For example, stations located near low income households or which experience low traffic counts could determine that they are best served by offering a lower level of attributes at a lower cost. A variety of possible attribute bundles may be explored and analyzed for

feasibility by utilizing hedonic analysis.

Generalization of the Research Findings

The study group for the present research included the gas stations in the Vancouver area. For the consumer survey it employed a geographically stratified sample of 300 households that use unleaded gasoline. The findings, therefore, may be generalized for the consumption of gasoline in other urban SMSAs in the United States, since Vancouver is typical in its demographics, roads, commercial profile, and gasoline consumption.

The findings may also be generalized to apply for convenience retail products, since accessibility, convenience, and competitive pricing play a major role in the sales of these products. Furthermore, because of the inclusion of the service variables in the development of both the supply and demand models, may be generalized to the retail sales of durable goods, since accessibility, convenience, and competition are relatively less important to providing consistent and reliable service.

The literature of retailing, as explained by Frankfurt (1984), distinguishes between convenience goods and durable or "shopping goods." One distinction is that shopping goods require service. Frankfurt adds:

The distinction is based primarily on frequency of purchase and product price because convenience goods are relatively inexpensive items that people buy regularly, such as food, cigarettes, beverages, drugs, and gasoline. Shopping goods, on the other hand, are more costly and more intermittently purchased—appliances, stereos, autos, furniture, and apparel. (p. 71)

The inclusion in the present study of the service variables as representative of important retailing attributes influencing prices, as well as other findings which contradict those of Frankfurt (see May, 1965; Newman and Staelin, 1972), insofar as they do not significantly distinguish between convenience goods and shopping goods, confirm the fact that the retailing attributes most essential to selling both convenience and shopping goods are in fact quite similar. Consequently, the present findings may be generalized to the

durable goods sector of retailing.

Limitations of the Present Research

Although study samples were scientific and randomly stratified, and although the rules and ethics of marketing research were strictly adhered to during the interview process and responses were cross-referenced against data observed at each station in the study group, some limitation in the study do exist. The study attempted to incorporate into an econometric model a more realistic measurement of human behavior than is commonly derived from mathematical and statistical models, which tend to simplify and sometimes misrepresent reality. However, human behavior and the structure of the retail environment are enormously complex and therefore defy easy measurement. This difficulty manifested itself in the present study in the use of dummy variables in the measurement of retailing attributes. However, this was unavoidable. A continuous measurement would certainly have provided more accurate results.

CONCLUSION AND SUGGESTIONS FOR FUTURE RESEARCH

Retailing attributes (accessibility, convenience, service, and competition) constitute a significant influence on retail prices and consumer behavior. The essential finding of the present research is that this influence may be measured by hedonic analysis. Retailing attributes are differentiable by household income, with higher income households tending to purchase from retail outlets having greater levels of attributes, while lower income households tend to purchase from outlets offering lower levels of attributes.

There is certainly a need to replicate the present study in the interests of validating the findings and for supporting the viability of applying hedonic analysis to studying retail commodities and deriving implicit prices for retailing attributes. The wider the variety of retail commodities to which the present methods are applied, the stronger will be support

for the research methodology. Furthermore, additional attempts are needed for estimating the inverse demand function for retail attributes.

Hedonic analysis as well as other popular methods of analysis (e.g., the gravity concept, the revealed preference concept, the behavioral concept, and the dynamic and learning concept) that are available for examining retailing attributes should be applied separately to analyses of the same retail commodity, and then their findings compared. This, too, will help establish the viability of the present methods.

There also remains the need to clarify the supply and demand elasticity of retail commodities in relation to retailing attributes, as well as for using a continuous measurement for both supplier and consumer models to obtain more accurate results.

The central contribution of the present research is that it recovers the implicit willingness on the part of consumers to pay for specified retailing attributes. This was established in both the supply and the demand models, and the relationship between the two has been clearly established. Hedonic modeling, as an alternative method for measuring retailing attributes, has been shown to be not only effective, but significant insofar as it measures actual observed consumer behavior as a basis for its estimations.

SUMMARY CONCLUSION

It has been determined that retailing attributes have a determinable value, which may be measured by hedonic analysis. Hedonic analysis provides both ask and bid implicit prices of specified retailing attributes. The value of retailing attributes was found to be variable relative to household income. Spatial competition was seen to have a negative effect on retail prices. The relative precision and consistency of hedonic specification applied to the supply and demand models was emphasized by the extent to which the findings in the present study are consistent with the literature in the field.

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APPENDIX A

SUPPLY DATA

SUPPLY DATA

<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>	<u>F</u>	<u>G</u>	<u>H</u>	<u>I</u>	<u>J</u>	<u>K</u>	<u>L</u>	<u>M</u>	<u>N</u>	<u>O</u>	<u>P</u>
00001	095.9	0344	1	30.00	0	12	24.0	0	0	0	0	15.75	2	1	0
00002	106.9	0565	1	29.00	0	12	15.0	0	0	0	1	16.00	2	1	1
00003	095.9	2003	1	31.25	0	16	24.0	1	1	0	1	16.00	2	1	1
00004	095.9	0396	0	42.00	1	05	18.5	0	0	0	0	24.00	0	1	0
00005	095.9	1015	1	28.00	0	06	18.0	0	0	0	1	14.25	0	1	1
00006	091.9	1015	0	26.50	1	03	18.0	0	0	0	1	13.50	2	0	0
00007	099.9	1015	0	26.00	1	06	24.0	0	0	0	0	13.75	1	0	0
00008	092.9	1160	0	22.25	1	06	18.0	0	0	0	0	13.00	1	1	0
00009	097.9	1001	0	21.00	0	10	14.0	1	1	1	1	12.50	1	1	0
00010	099.9	0682	0	13.25	0	08	15.0	0	0	1	1	12.50	1	1	0
00011	088.9	1231	0	13.00	1	12	17.0	0	0	0	1	12.00	1	1	1
00012	092.9	1201	0	14.00	0	05	14.0	1	0	1	1	14.00	0	1	1
00013	092.9	0868	0	08.00	0	10	14.0	0	0	1	1	18.50	2	1	1
00014	097.9	0745	0	06.00	0	10	15.0	0	0	0	1	23.00	1	1	1
00015	099.9	0746	0	01.00	0	07	11.0	0	1	0	1	23.75	1	1	1
00016	099.9	0514	0	03.50	1	06	17.0	0	0	0	0	25.50	1	0	0
00017	097.9	0744	0	03.00	0	04	14.0	0	0	1	0	25.75	1	1	0
00018	090.9	1300	1	12.25	1	06	24.0	1	0	0	0	21.25	1	0	0
00019	089.9	2166	1	13.50	0	05	16.0	0	0	0	1	21.00	4	1	0
00020	093.9	2166	1	13.75	0	16	16.0	0	1	0	1	21.00	3	1	1
00021	091.9	0810	1	13.75	0	11	16.0	0	0	0	1	21.25	3	1	1
00022	089.9	0810	1	14.75	0	12	14.0	1	0	1	1	21.50	5	1	1
00023	096.9	0914	1	16.50	0	14	17.0	1	1	1	1	22.00	5	1	0
00024	089.9	1911	1	16.25	0	10	16.0	1	1	1	1	22.50	6	1	1
00025	091.9	1912	1	16.00	0	14	18.0	1	0	1	1	22.50	6	1	1
00026	090.9	1912	1	16.25	1	12	24.0	1	1	0	1	22.75	5	1	0
00027	087.9	1750	1	16.25	1	12	24.0	0	0	0	0	22.75	5	1	0
00028	096.9	1912	1	16.00	0	12	15.0	1	0	1	1	23.25	5	1	0
00029	099.9	0770	1	17.50	0	06	12.0	0	1	0	1	22.25	4	1	1
00030	087.9	0746	0	20.50	1	09	17.0	0	0	0	0	23.00	1	1	0
00031	088.9	0957	0	22.00	1	04	24.0	0	0	0	0	23.25	1	0	0
00032	092.9	0843	0	23.50	1	06	18.0	0	0	0	1	23.50	1	1	1
00033	092.9	0843	0	24.25	1	04	19.0	0	0	0	0	23.50	1	0	0
00034	089.9	1243	1	30.00	1	06	24.0	0	0	0	0	27.75	3	0	0
00035	095.9	1020	1	30.25	1	03	17.5	0	0	0	0	27.50	2	0	0
00036	117.9	1040	1	30.50	0	08	24.0	1	0	1	1	28.00	3	1	0
00037	095.9	0523	1	30.75	1	04	16.5	0	0	0	0	29.00	3	0	0
00038	092.9	0519	1	32.00	1	03	16.5	0	0	1	1	29.00	1	1	1
00039	097.9	0315	1	42.50	0	08	13.5	1	0	1	1	40.25	0	1	1
00040	092.9	0981	0	17.00	1	04	18.0	0	1	0	0	19.50	0	0	0
00041	093.9	0981	0	19.75	0	16	15.0	0	0	1	1	13.50	2	1	0
00042	088.9	0940	0	19.75	1	06	24.0	0	0	0	0	13.25	2	0	0
00043	087.9	1157	0	20.25	1	16	24.0	0	0	0	0	13.25	2	1	0
00044	088.9	0450	0	29.25	1	04	24.0	0	0	0	0	07.50	3	0	0
00045	093.9	0320	0	29.00	0	04	17.0	0	0	1	0	07.75	3	1	0
00046	093.9	0350	0	29.50	1	05	24.0	0	0	0	0	07.33	3	0	0
00047	093.9	0370	0	29.50	0	16	15.0	1	0	1	1	07.75	3	1	0

SUPPLY DATA, Continued

<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>	<u>F</u>	<u>G</u>	<u>H</u>	<u>I</u>	<u>J</u>	<u>K</u>	<u>L</u>	<u>M</u>	<u>N</u>	<u>O</u>	<u>P</u>
00048	089.9	1310	0	18.75	1	08	24.0	0	0	1	1	06.50	3	1	0
00049	090.9	0990	0	31.90	0	12	17.0	0	0	0	1	07.00	2	1	0
00050	088.9	1310	0	19.75	1	06	19.0	0	0	0	0	05.75	2	0	0
00051	099.9	0800	0	29.00	0	04	18.5	0	0	1	0	05.00	1	1	0
00052	093.9	0800	0	30.25	1	05	24.0	0	0	0	0	06.00	3	0	0
00053	091.9	0980	0	31.00	0	08	16.0	0	0	0	1	07.00	3	1	0
00054	095.9	0880	0	38.25	1	05	18.0	0	0	0	1	14.00	1	1	1
00055	095.9	1020	0	31.50	1	06	19.0	0	0	0	1	07.50	2	0	0
00056	089.9	0984	0	18.00	0	12	24.0	0	1	0	1	07.00	3	1	0
00057	088.9	0980	0	15.00	1	06	24.0	0	0	0	0	10.00	1	0	0
00058	088.9	1380	0	14.00	1	06	19.0	0	0	0	0	10.50	1	0	0
00059	088.9	1209	0	12.00	0	12	14.5	0	0	0	1	13.00	0	1	1
00060	087.9	1209	0	10.00	1	12	24.0	0	0	0	1	15.00	1	1	0
00061	092.9	0809	0	09.50	1	04	17.0	0	0	0	1	15.00	1	0	1
00062	090.9	1035	0	07.75	1	12	24.0	0	0	0	0	16.75	0	0	0
00063	088.9	1335	0	08.25	1	04	19.0	0	0	0	0	18.50	2	0	0
00064	097.9	0454	0	08.38	0	08	11.0	1	0	1	1	18.75	2	1	0
00065	095.9	0600	0	38.00	1	05	19.0	0	0	0	0	14.00	1	0	0

A = Case Number
 B = Price of unleaded cash gasoline
 C = TR = Traffic count
 D = FR = Freeway exit
 E = CB = Distance from CBD
 F = CV = Existence of convenience store
 G = SZ = Number of pumps
 H = HR = Hours open
 I = SV = Type of service
 J = CR = Existence of car wash
 K = GG = Existence of garage
 L = CD = Availability of credit option
 M = VA = Distance from Vancouver Mall
 N = CP = Number of competitors
 O = M = Major brand
 P = C = Cash discount

BOX-COX ESTIMATION FOR TRAFFIC COUNT
TRANSFORMED AND RESTRICTED VARIABLES

```

I_BOX UNLEAD TS FR CB CV SZ HR SV CR GG CD VA CP M C
I_LAMSDA UNLEAD=1
I_LAMSDA VA=1 / RESTRICT ALL
I_LAMSDA CR=1
I_LAMSDA SZ=1
I_LAMSDA HR=1
I_END

```

REQUIRED MEMORY IS PAR= 20 CURRENT PAR= 752

DEPENDENT VARIABLE =UNLEAD

...VARIABLE FR	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CV	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE SV	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CR	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE GG	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CD	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CP	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE M	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE C	NOT POSITIVE...NOT TRANSFORMED

LAMSDA RESTRICTIONS ---	VARIABLE	LAMSDA
	FR	1.0000
	CB	1.0000
	CV	1.0000
	SZ	1.0000
	HR	1.0000
	SV	1.0000
	CR	1.0000
	GG	1.0000
	CD	1.0000
	VA	1.0000
	CP	1.0000
	M	1.0000
	C	1.0000
	UNLEAD	1.0000

BOX-COX REGRESSION 65 OBSERVATIONS

BOX-COX ESTIMATION FOR TRAFFIC COUNT
LAMBDA ITERATION

ITERATION	LAMBDA	LOG-L.F.	GRADIENT	R-SQUARE	SSE	SSE/N
1	0.000	-177.378	0.177556	0.4410	892.75	13.735
2	1.000	-176.539	0.039663	0.4552	869.93	13.304
3	1.618	-176.554	-0.251675E-01	0.4550	870.40	13.301
4	0.618	-176.730	0.175259	0.4520	875.10	13.463
5	1.236	-176.504	0.364740	0.4558	869.06	13.370
6	1.382	-176.510	-0.392309E-01	0.4557	869.21	13.372
7	1.146	-176.511	0.274952E-02	0.4557	869.23	13.373
8	1.292	-176.504	0.439632E-01	0.4558	869.06	13.370
9	1.326	-176.505	-0.400300E-01	0.4558	869.09	13.371
10	1.271	-176.504	-0.305308E-01	0.4558	869.05	13.370
11	1.257	-176.504	0.607804E-03	0.4558	869.05	13.370
12	1.279	-176.504	-0.312826E-02	0.4558	869.05	13.370
13	1.265	-176.504	-0.647066E-02	0.4558	869.05	13.370
14	1.262	-176.504	0.601485E-03	0.4558	869.05	13.370
15	1.267	-176.504	-0.283829E-03	0.4558	869.05	13.370
16	1.264	-176.504	-0.116950E-02	0.4558	869.05	13.370
17	1.260	-176.504	0.224978E-02	0.4558	869.05	13.370

BOX-COX REGRESSION FOR LAMBDA = 1.260000

BOX-COX ESTIMATION FOR TRAFFIC COUNT
 PRODUCT FINDING I: TRAFFIC COUNT TRANSFORMED

R-SQUARE = 0.4552 R-SQUARE ADJUSTED = 0.3035
VARIANCE OF THE ESTIMATE = 17.381
STANDARD ERROR OF THE ESTIMATE = 4.1690
LOG OF THE LIKELIHOOD FUNCTION = -176.504

ANALYSIS OF VARIANCE - FROM MEAN				
	SS	DF	MS	F
REGRESSION	727.94	14.	51.995	2.992
ERROR	869.05	50.	17.381	
TOTAL	1597.0	64.	24.953	

ANALYSIS OF VARIANCE - FROM ZERO				
	SS	DF	MS	F
REGRESSION	0.57122E+06	15.	38081.	2190.986
ERROR	869.05	50.	17.381	
TOTAL	0.57209E+06	65.	8801.4	

BOX-COX ESTIMATION FOR TRAFFIC COUNT
PRODUCT FINDING II: LOG LIKELIHOOD TEST

VARIABLE NAME	CONDITIONAL			BOX-COX		
	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 50 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
TR	-0.55403E-03	0.25767E-03	-2.1532	-0.2913	-0.30974	-0.36143E-01
FR	7.2291	2.2256	1.0016	0.1402	0.21280	0.90532E-02
CA	0.56659E-01	0.67225E-01	0.83413	0.1172	0.10929	0.12664E-01
CV	-4.8240	1.9243	-2.5074	-0.3342	-0.48619	-0.26939E-01
SZ	-0.23623	0.19538	-1.2091	-0.1685	-0.18313	-0.20521E-01
HR	0.12240	0.20242	0.58446	0.0824	0.97070E-01	0.24210E-01
SV	0.35760	1.9382	0.18450	0.0261	0.29658E-01	0.02214E-03
CR	1.2937	1.6703	0.76854	0.1081	0.03442E-01	0.21091E-02
GG	0.43904	1.9485	0.22751	0.0336	0.40286E-01	0.13697E-02
CD	2.4702	1.7070	1.4518	0.2011	0.24758	0.15058E-01
VA	0.13565	0.11415	1.1883	0.1657	0.20011	0.24940E-01
CP	-0.64656	0.49745	-1.2997	-0.1808	-0.19667	-0.14228E-01
M	-0.59063	1.8615	-0.31729	-0.0448	-0.56384E-01	-0.41706E-02
C	-2.3001	1.4058	-1.4323	-0.1985	-0.21417	-0.75543E-02
CONSTANT	94.072	4.0940	19.052	0.9375	0.00000E+00	1.0137

LOG LIKELIHOOD TEST FOR LAMBDA = 1.260
176.539 - 176.504 = 000.35 x 2 = 0.70 (insignificant)

BOX-COX ESTIMATION FOR GAS STATION DISTANCE FROM CBD TRANSFORMED AND RESTRICTED VARIABLES

```

I_BOX UNLEAD TR FR CB CV SZ HR SV CR GG CD VA CP M C
I_LAMBDA UNLEAD=1
I_LAMBDA VA=1 / RESTRICT ALL
I_LAMBDA TR=1
I_LAMBDA SZ=1
I_LAMBDA HR=1
I_END

```

REQUIRED MEMORY IS PAR= 20 CURRENT PAR= 752

DEPENDENT VARIABLE =UNLEAD

...VARIABLE FR	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CV	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE SV	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CR	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE GG	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CD	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CP	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE M	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE C	NOT POSITIVE...NOT TRANSFORMED

LAMBDA RESTRICTIONS	VARIABLE	LAMBDA
	TR	1.0000
	FR	1.0000
	CV	1.0000
	SZ	1.0000
	HR	1.0000
	SV	1.0000
	CR	1.0000
	GG	1.0000
	CD	1.0000
	VA	1.0000
	CP	1.0000
	M	1.0000
	C	1.0000
	UNLEAD	1.0000

BOX-COX REGRESSION 65 OBSERVATIONS

BOX-COX ESTIMATION FOR GAS STATION DISTANCE FROM CBD
LAMBDA ITERATION

ITERATION	LAMBDA	LOG-L.F.	GRADIENT	R-SQUARE	SSE	SSE/N
1	0.000	-176.903	0.177090	0.4491	879.73	13.535
2	1.000	-176.539	0.363962	0.4552	869.98	13.384
3	1.618	-176.285	0.410039	0.4595	863.22	13.280
4	2.000	-176.232	0.138988	0.4603	861.82	13.259
5	2.236	-176.233	-0.233366E-02	0.4603	861.83	13.259
6	2.292	-176.411	-0.168842	0.4574	866.57	13.332
7	1.584	-176.294	-0.685901E-01	0.4593	863.45	13.284
8	2.639	-176.277	0.164763E-01	0.4596	862.97	13.277
9	1.907	-175.233	-0.668387E-01	0.4603	861.83	13.259
10	2.390	-176.244	-0.276799E-01	0.4602	862.13	13.264
11	2.141	-176.230	-0.566790E-01	0.4604	861.75	13.258
12	2.082	-176.230	-0.539437E-03	0.4604	861.75	13.258
13	2.046	-176.231	0.198903E-01	0.4604	861.77	13.258
14	2.105	-176.230	0.142519E-01	0.4604	861.75	13.258
15	2.118	-176.230	-0.591247E-03	0.4604	861.75	13.258
16	2.096	-176.230	0.113350E-02	0.4604	861.75	13.258
17	2.110	-176.230	0.285536E-02	0.4604	861.75	13.258
18	2.113	-176.230	-0.594134E-03	0.4604	861.75	13.258
19	2.108	-176.230	-0.188500E-03	0.4604	861.75	13.258
20	2.111	-176.230	0.216974E-03	0.4604	861.75	13.258
21	2.110	-176.230	-0.225584E-03	0.4604	861.75	13.258

BOX-COX REGRESSION FOR LAMBDA = 2.110000

BOX-COX ESTIMATION FOR GAS STATION DISTANCE FROM CBD
 PRODUCT FINDING I: DISTANCE FROM CBD TRANSFORMED

R-SQUARE = 0.4604 R-SQUARE ADJUSTED = 0.3093
 VARIANCE OF THE ESTIMATE = 17.235
 STANDARD ERROR OF THE ESTIMATE = 4.1515
 LOG OF THE LIKELIHOOD FUNCTION = -176.230

ANALYSIS OF VARIANCE - FROM MEAN				
	SS	DF	MS	F
REGRESSION	735.24	14.	52.517	3.047
ERROR	861.75	50.	17.235	
TOTAL	1597.0	64.	24.953	

ANALYSIS OF VARIANCE - FROM ZERO				
	SS	DF	MS	F
REGRESSION	0.57123E+05	15.	38082.	2209.566
ERROR	861.75	50.	17.235	
TOTAL	0.57209E+06	65.	8801.4	

BOX-COX ESTIMATION FOR GAS STATION DISTANCE FROM CBD
PRODUCT FINDING II: LOG LIKELIHOOD TEST

VARIABLE NAME	ESTIMATED COEFFICIENT	CONDITIONAL STANDARD ERROR	T-RATIO 50 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	BOX-COX ELASTICITY AT MEANS
TR	-0.32263E-02	0.16236E-02	-1.9871	-0.2705	-0.28828	-0.34788E-01
FR	2.2316	2.1400	1.0428	0.1457	0.21303	0.80622E-02
CD	0.22174E-02	0.21264E-02	1.0428	0.1459	0.13510	0.14503E-01
CV	-4.7625	1.9220	-2.5040	-0.3338	-0.47990	-0.26591E-01
SZ	-0.22513	0.17493	-1.1549	-0.1612	-0.17453	-0.19557E-01
HR	0.17083	0.20890	0.57841	0.0815	0.95827E-01	0.23900E-01
SV	0.21582	1.9339	0.11160	0.0158	0.17899E-01	0.49617E-03
CR	1.3364	1.6651	0.80262	0.1128	0.97281E-01	0.21947E-02
GG	0.56730	1.9468	0.30724	0.0434	0.52063E-01	0.17703E-02
CD	2.5251	1.7015	1.4840	0.2054	0.25226	0.15342E-01
VA	0.12575	0.10258	1.1475	0.1602	0.18551	0.23120E-01
CP	-0.64482	0.49536	-1.3017	-0.1811	-0.19614	-0.14189E-01
M	-0.71167	1.8528	-0.38410	-0.0542	-0.67939E-01	-0.50254E-02
C	-2.3286	1.5742	-1.4606	-0.2023	-0.21682	-0.76478E-02
CONSTANT	95.768	4.8080	19.960	0.9426	0.00000E+00	1.0244

LOG LIKELIHOOD TEST FOR LAMBDA = 2.110
176.539 - 176.230 = 0.309 x 2 = 0.618 (insignificant)

BOX-COX ESTIMATION FOR NUMBER OF PUMPS
TRANSFORMED AND RESTRICTED VARIABLES

```

I_BOX UNLEAD TR FR CB CV SZ HR SV CR GG CD VA CP M C
I_LAMBDA UNLEAD=1
I_LAMBDA VA=1 / RESTRICT ALL
I_LAMBDA TR=1
I_LAMBDA CB=1
I_LAMBDA CR=1
I_END

```

REQUIRED MEMORY IS PAR= 20 CURRENT PAR= 752

DEPENDENT VARIABLE =UNLEAD

...VARIABLE FR	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CV	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE SV	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CR	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE GG	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CD	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CP	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE M	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE C	NOT POSITIVE...NOT TRANSFORMED

LAMBDA RESTRICTIONS ---	VARIABLE	LAMBDA
	TR	1.0000
	FR	1.0000
	CB	1.0000
	CV	1.0000
	CR	1.0000
	SV	1.0000
	GG	1.0000
	CD	1.0000
	VA	1.0000
	CP	1.0000
	M	1.0000
	C	1.0000
	UNLEAD	1.0000

BOX-COX REGRESSION 65 OBSERVATIONS

BOX-COX ESTIMATION FOR NUMBER OF PUMPS
LAMBDA ITERATION

ITERATION	LAMBDA	LOG-L.F.	GRADIENT	R-SQUARE	SSE	SSE/N
1	0.000	-176.895	0.177072	0.4492	877.57	13.532
2	1.000	-176.539	0.356333	0.4552	867.98	13.384
3	1.618	-176.480	0.246043E-01	0.4562	868.42	13.360
4	2.000	-176.497	-0.439165E-01	0.4559	868.87	13.367
5	1.382	-176.488	-0.139022E-01	0.4561	868.64	13.364
6	1.764	-176.483	0.149590E-01	0.4562	868.48	13.361
7	1.528	-176.482	-0.516786E-02	0.4562	868.45	13.361
8	1.674	-176.481	0.641813E-02	0.4562	868.43	13.360
9	1.584	-176.481	-0.107630E-02	0.4562	868.42	13.360
10	1.639	-176.480	0.342941E-02	0.4562	868.42	13.360
11	1.605	-176.480	0.596158E-03	0.4562	868.42	13.360
12	1.626	-176.480	0.232874E-02	0.4562	868.42	13.360
13	1.631	-176.480	-0.114351E-02	0.4562	868.42	13.360
14	1.623	-176.480	-0.735533E-03	0.4562	868.42	13.360
15	1.621	-176.480	0.586375E-03	0.4562	868.42	13.360
16	1.624	-176.480	0.430072E-03	0.4562	868.42	13.360
17	1.620	-176.480	0.580346E-03	0.4562	868.42	13.360

BOX-COX REGRESSION FOR LAMBDA = 1.620000

BOX-COX ESTIMATION FOR NUMBER OF PUMPS
 PRODUCT FINDING I: NUMBER OF PUMPS TRANSFORMED

R-SQUARE = 0.4562 R-SQUARE ADJUSTED = 0.3040
 VARIANCE OF THE ESTIMATE = 17.368
 STANDARD ERROR OF THE ESTIMATE = 4.1675
 LOG OF THE LIKELIHOOD FUNCTION = -176.480

ANALYSIS OF VARIANCE - FROM MEAN				
	SS	DF	MS	F
REGRESSION	720.57	14.	52.040	2.996
ERROR	858.42	50.	17.368	
TOTAL	1579.0	64.	24.953	

ANALYSIS OF VARIANCE - FROM ZERO				
	SS	DF	MS	F
REGRESSION	0.571275+06	15.	38081.	2192.572
ERROR	868.42	50.	17.368	
TOTAL	0.572095+06	65.	8801.4	

BOX-COX ESTIMATION FOR NUMBER OF PUMPS
PRODUCT FINDING II: LOG LIKELIHOOD TEST

VARIABLE NAME	ESTIMATED COEFFICIENT	CONDITIONAL		PARTIAL CORR.	BOX-COX	
		STANDARD ERROR	T-RATIO 50 DF		STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
TR	-0.33954E-02	0.16137E-02	-2.1042	-0.2052	-0.30339	-0.36611E-01
FR	2.2631	2.2292	1.0152	0.1421	0.21604	0.81759E-02
CR	0.56973E-01	0.69056E-01	0.83715	0.1176	0.10989	0.12735E-01
CV	-4.7727	1.9210	-2.4845	-0.3315	-0.48093	-0.26648E-01
SZ	-0.59272E-01	0.47422E-01	-1.2499	-0.1741	-0.19121	-0.18091E-01
HR	0.12315	0.20847	0.59072	0.0833	0.27666E-01	0.24359E-01
SV	0.25060	1.9191	0.13058	0.0105	0.20744E-01	0.57614E-03
CR	1.1341	1.6694	0.79914	0.1123	0.27106E-01	0.21907E-02
GG	0.53007	1.0300	0.29403	0.0415	0.49373E-01	0.16788E-02
CD	2.4951	1.7064	1.4628	0.2026	0.24936	0.15166E-01
VA	0.13254	0.11440	1.1586	0.1617	0.19554	0.24370E-01
CP	-0.67513	0.49551	-1.3625	-0.1892	-0.20535	-0.14856E-01
M	-0.67959	1.8300	-0.37082	-0.0524	-0.54780E-01	-0.47917E-02
C	-2.3061	1.6056	-1.4363	-0.1991	-0.21473	-0.75741E-02
CONSTANT	94.976	5.0373	18.855	0.9363	0.00000E+00	1.0133

LOG LIKELIHOOD TEST FOR LAMBDA = 1.620
176.539 - 176.480 = 0.059 x 2 = 0.118 (insignificant)

BOX-COX ESTIMATION FOR HOURS OPEN
TRANSFORMED AND RESTRICTED VARIABLES

```

I_BOX UNLEAD TR FR CB CV SZ HR SV CR GG CD VA CP M C
I_LAMBDA UNLEAD=1 / RESTRICT ALL
I_LAMBDA V3=1
I_LAMBDA TR=1
I_LAMBDA CB=1
I_LAMBDA SZ=1
I_END

```

REQUIRED MEMORY IS PAR= 20 CURRENT PAR= 752

DEPENDENT VARIABLE =UNLEAD

...VARIABLE FR	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CV	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE SV	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CR	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE GG	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CD	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CP	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE M	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE C	NOT POSITIVE...NOT TRANSFORMED

LAMBDA RESTRICTIONS ---	VARIABLE	LAMBDA
	TR	1.0000
	FR	1.0000
	CB	1.0000
	CV	1.0000
	SZ	1.0000
	SV	1.0000
	CR	1.0000
	GG	1.0000
	CD	1.0000
	VA	1.0000
	CP	1.0000
	M	1.0000
	C	1.0000
	UNLEAD	1.0000

BOX-COX REGRESSION 65 OBSERVATIONS

BOX-COX ESTIMATION FOR HOURS OPEN
LAMBDA ITERATION

ITERATION	LAMBDA	LOG-L.F.	GRADIENT	R-SQUARE	SSE	SSE/N
1	0.000	-176.541	0.176718	0.4552	870.04	13.385
2	1.000	-176.539	0.206635E-02	0.4552	869.98	13.384
3	1.618	-176.551	-0.122637E-01	0.4550	870.31	13.389
4	0.618	-176.536	-0.155365E-01	0.4553	869.90	13.383
5	0.302	-176.536	0.131418E-02	0.4553	869.90	13.383
6	0.764	-176.536	-0.108819E-02	0.4553	869.92	13.383
7	0.528	-176.535	-0.353401E-02	0.4553	869.89	13.383
8	0.472	-176.536	0.127154E-02	0.4553	869.90	13.383
9	0.562	-176.535	0.621330E-03	0.4553	869.89	13.383
10	0.507	-176.535	0.887238E-04	0.4553	869.89	13.383
11	0.541	-176.535	0.450188E-03	0.4553	869.89	13.383
12	0.549	-176.535	-0.274578E-03	0.4553	869.89	13.383
13	0.536	-176.535	-0.189516E-03	0.4553	869.89	13.383
14	0.533	-176.535	0.861865E-04	0.4553	869.89	13.383
15	0.538	-176.535	0.535732E-04	0.4553	869.89	13.383
16	0.539	-176.535	-0.512005E-04	0.4553	869.89	13.383
17	0.540	-176.535	-0.872757E-04	0.4553	869.89	13.383

BOX-COX REGRESSION FOR LAMBDA = 0.540000

BOX-COX ESTIMATION FOR HOURS OPEN
 PRODUCT FINDING I: HOURS OPEN TRANSFORMED

R-SQUARE = 0.4553 R-SQUARE ADJUSTED = 0.3020
 VARIANCE OF THE ESTIMATE = 17.398
 STANDARD ERROR OF THE ESTIMATE = 4.1711
 LOG OF THE LIKELIHOOD FUNCTION = -176.535

ANALYSIS OF VARIANCE - FROM MEAN				
	SS	DF	MS	F
REGRESSION	727.09	14.	51.935	2.985
ERROR	869.39	50.	17.398	
TOTAL	1597.0	64.	24.953	

ANALYSIS OF VARIANCE - FROM ZERO				
	SS	DF	MS	F
REGRESSION	0.57122E+06	15.	38081.	2188.848
ERROR	869.89	50.	17.398	
TOTAL	0.57209E+06	65.	8801.4	

BOX-COX ESTIMATION FOR HOURS OPEN
PRODUCT FINDING II: LOG LIKELIHOOD TEST

VARIABLE NAME	CONDITIONAL			BOX-COX		
	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 50 OF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
TR	-0.34781E-02	0.16201E-02	-2.1468	-0.2905	-0.31078	-0.37503E-01
FR	7.2487	2.2328	1.0070	0.1410	0.21465	0.81235E-02
CB	0.52150E-01	0.68755E-01	0.75629	0.1063	0.10059	0.11657E-01
CV	-4.8165	1.9386	-2.4846	-0.3315	-0.40535	-0.26893E-01
SZ	-0.23708	0.19576	-1.2151	-0.1694	-0.18441	-0.20665E-01
HP	0.50471	0.82313	0.61316	0.0864	0.10446	0.26064E-01
SV	0.33890	1.9351	0.17508	0.0248	0.28098E-01	0.77090E-03
CR	1.2895	1.6711	0.77166	0.1085	0.93862E-01	0.21176E-02
GC	0.44166	1.8476	0.23907	0.0338	0.40525E-01	0.13780E-02
CO	2.5431	1.7125	1.4850	0.2055	0.25406	0.15452E-01
VA	0.13345	0.11472	1.1632	0.1623	0.19687	0.24536E-01
CP	-0.67115	0.49653	-1.3517	-0.1878	-0.20415	-0.14769E-01
M	-0.59861	1.8618	-0.32151	-0.0454	-0.57146E-01	-0.42270E-02
C	-2.3261	1.6066	-1.4478	-0.2006	-0.21659	-0.76396E-02
CONSTANT	94.587	6.4594	14.643	0.9005	0.00000E+00	1.0096

LOG LIKELIHOOD TEST FOR LAMBDA = 0.54
176.539 - 176.535 = 000.004 x 2 = .008 (insignificant)

BOX-COX ESTIMATION FOR DISTANCE FROM VANCOUVER MALL
TRANSFORMED AND RESTRICTED VARIABLES

```

I_BOX UNLEAD TR FR CB CV SZ HR SV CR GG CD VA CP M C
I_LAMBDA UNLEAD=1
I_LAMBDA TR=1 / RESTRICT ALL
I_LAMBDA CP=1
I_LAMBDA SZ=1
I_LAMBDA HR=1
I_END

```

REQUIRED MEMORY IS PAR= 20 CURRENT PAR= 752

DEPENDENT VARIABLE =UNLEAD

...VARIABLE FR	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CV	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE SV	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CR	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE GG	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CD	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CP	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE M	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE C	NOT POSITIVE...NOT TRANSFORMED

LAMBDA RESTRICTIONS ---	VARIABLE	LAMBDA
	TR	1.0000
	FR	1.0000
	CB	1.0000
	CV	1.0000
	SZ	1.0000
	HR	1.0000
	SV	1.0000
	CR	1.0000
	GG	1.0000
	CD	1.0000
	CP	1.0000
	M	1.0000
	C	1.0000
	UNLEAD	1.0000

BOX-COX REGRESSION 65 OBSERVATIONS

BOX-COX ESTIMATION FOR DISTANCE FROM VANCOUVER MALL
LAMBDA ITERATION

ITERATION	LAMBDA	LOG-L.F.	GRADIENT	R-SQUARE	SSE	SSE/N
1	0.000	-176.305	0.176481	0.4591	863.74	13.208
2	1.000	-176.539	-0.234043	0.4552	869.98	13.304
3	-0.618	-176.494	-0.279763E-01	0.4560	863.77	13.366
4	0.302	-176.312	0.181147	0.4590	863.94	13.291
5	-0.236	-176.352	0.642476E-01	0.4584	865.00	13.300
6	0.166	-176.295	0.150010	0.4593	863.47	13.284
7	0.235	-176.297	-0.194290E-01	0.4593	863.52	13.285
8	0.090	-176.297	0.144992E-02	0.4593	863.53	13.285
9	0.180	-176.295	0.223714E-01	0.4593	863.47	13.284
10	0.202	-176.295	-0.193982E-01	0.4593	863.48	13.284
11	0.167	-176.295	-0.144436E-01	0.4593	863.47	13.284
12	0.159	-176.295	0.157216E-02	0.4593	863.47	13.284
13	0.172	-176.295	-0.315759E-03	0.4593	863.47	13.284
14	0.164	-176.295	-0.220232E-02	0.4593	863.47	13.284
15	0.162	-176.295	0.157252E-02	0.4593	863.47	13.284
16	0.165	-176.295	0.112715E-02	0.4593	863.47	13.284
17	0.170	-176.295	-0.181770E-02	0.4593	863.47	13.284

BOX-COX REGRESSION FOR LAMBDA = 0.170000

BOX-COX ESTIMATION FOR DISTANCE FROM VANCOUVER MALL
 PRODUCT FINDING I: DISTANCE FROM VANCOUVER MALL TRANSFORMED

R-SQUARE = 0.4593 R-SQUARE ADJUSTED = 0.3079
 VARIANCE OF THE ESTIMATE = 17.269
 STANDARD ERROR OF THE ESTIMATE = 4.1557
 LOG OF THE LIKELIHOOD FUNCTION = -176.295

ANALYSIS OF VARIANCE - FROM MEAN				
	SS	DF	MS	F
REGRESSION	733.51	14.	52.394	3.034
ERROR	863.47	50.	17.269	
TOTAL	1597.0	64.	24.953	

ANALYSIS OF VARIANCE - FROM ZERO				
	SS	DF	MS	F
REGRESSION	0.57123E+06	15.	38002.	2205.153
ERROR	863.47	50.	17.269	
TOTAL	0.57209E+06	65.	8801.4	

BOX-COX ESTIMATION FOR DISTANCE FROM VANCOUVER MALL
 PRODUCT FINDING II: LOG LIKELIHOOD TEST

VARIABLE NAME	CONDITIONAL			BOX-COX		
	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 50 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
TR	-0.34806E-02	0.15952E-02	-2.1819	-0.2949	-0.31100	-0.37530E-01
FR	2.0390	2.2136	0.92148	0.1292	0.19472	0.73692E-02
CV	0.65402E-01	0.70874E-01	0.92321	0.1296	0.12631	0.14636E-01
CV	-4.9706	1.9379	-2.5650	-0.3410	-0.50086	-0.27753E-01
SZ	-0.24627	0.19426	-1.2678	-0.1765	-0.19092	-0.21394E-01
HD	0.14310	0.21047	0.68027	0.0750	0.11355	0.20321E-01
SV	0.22547	1.9363	0.11642	0.0165	0.18696E-01	0.51827E-03
CR	1.2702	1.5641	0.76811	0.1080	0.93043E-01	0.20991E-02
GG	0.57501	1.0378	0.31280	0.0442	0.52763E-01	0.17941E-02
CD	2.5452	1.7030	1.5056	0.2082	0.25627	0.15586E-01
VA	1.4750	1.1203	1.3166	0.1831	0.22424	0.25543E-01
CP	-0.62064	0.49257	-1.2584	-0.1752	-0.19121	-0.13033E-01
Y	-0.68834	1.8592	-0.37024	-0.0523	-0.65712E-01	-0.48606E-02
C	-2.3487	1.6012	-1.4669	-0.2031	-0.21870	-0.77140E-02
CONSTANT	92.424	6.5937	14.028	0.8930	0.00000E+00	0.98729

LOG LIKELIHOOD TEST FOR LAMBDA = 0.1700
 176.539 - 176.295 = 0.244 x 2 = 0.4880 (insignificant)

PRODUCT FINDINGS OF THE SUPPLY LINEAR FUNCTION
ASYMPTOTIC SAMPLE

EQUATION 1 OF 1 EQUATIONS
DEPENDENT VARIABLE = UNLEAD

65 OBSERVATIONS

R-SQUARE = 0.4552
VARIANCE OF THE ESTIMATE = 13.384
STANDARD ERROR OF THE ESTIMATE = 3.6585

VARIABLE NAME	ESTIMATED COEFFICIENT	ASYMPTOTIC STANDARD ERROR	T-RATIO -----	PARTIAL STANDARDIZED ELASTICITY		
				CORR. COEFFICIENT	AT MEANS	
IR	-0.34502E-02	0.14143E-02	-2.4395	-0.3261	-0.30820	-0.37202E-01
FR	2.2545	1.9571	1.1520	0.1608	0.21523	0.81452E-02
CD	0.53368E-01	0.60227E-01	0.98611	0.1243	0.10294	0.11929E-01
CV	-4.7072	1.6706	-2.9376	-0.3724	-0.49339	-0.26704E-01
SZ	-0.23696	0.17144	-1.3822	-0.1918	-0.18370	-0.20505E-01
HR	0.12706	0.18414	0.69433	0.0977	0.10140	0.25290E-01
SV	0.32144	1.6991	0.18919	0.0267	0.26659E-01	0.73901E-03
CR	1.2708	1.4656	0.87252	0.1225	0.93004E-01	0.21000E-02
GG	0.45213	1.6215	0.27883	0.0394	0.41497E-01	0.14107E-02
CD	2.5375	1.5009	1.6908	0.2326	0.25350	0.15410E-01
VA	0.13286	0.10042	1.3230	0.1039	0.19599	0.24427E-01
CP	-0.67211	0.43543	-1.5436	-0.2133	-0.20444	-0.14790E-01
M	-0.60446	1.6329	-0.37141	-0.0525	-0.57095E-01	-0.42824E-02
C	-2.3261	1.4095	-1.6502	-0.2773	-0.21659	-0.76395E-02
CONSTANT	05.720	4.4136	21.568	0.7502	0.00000E+00	1.0218

PRODUCT FINDING: I FOR THE SUPPLY LINEAR FUNCTION
FIFTY DEGREES OF FREEDOM

I_OLS UNLEAD TR FR CD CV SZ HR SV CR GS CD VA CP M C / PCOR

REQUIRED MEMORY IS PAR= 19 CURRENT PAR= 752

OLS ESTIMATION

65 OBSERVATIONS DEPENDENT VARIABLE = UNLEAD

...NOTE...SAMPLE RANGE SET TO: 1, 65

R-SQUARE = 0.4552 R-SQUARE ADJUSTED = 0.3027

VARIANCE OF THE ESTIMATE = 17.400

STANDARD ERROR OF THE ESTIMATE = 4.1713

LOG OF THE LIKELIHOOD FUNCTION = -174.539

ANALYSIS OF VARIANCE - FROM MEAN				
	SS	DF	MS	F
REGRESSION	727.00	14.	51.929	2.984
ERROR	869.98	50.	17.400	
TOTAL	1597.0	64.	24.953	

ANALYSIS OF VARIANCE - FROM ZERO				
	SS	DF	MS	F
REGRESSION	0.57122E+06	15.	38081.	2188.625
ERROR	869.98	50.	17.400	
TOTAL	0.57209E+06	65.	8801.4	

PRODUCT FINDING II FOR THE SUPPLY LINEAR FUNCTION
FIFTY-DEGREES OF FREEDOM

CORRELATION MATRIX OF COEFFICIENTS

TR	1.0000								
IFM	-0.10017	1.0000							
CR	0.42627	-0.42102	1.0000						
CV	-0.15661	0.40760	-0.17148	1.0000					
SZ	-0.49122E-01	0.76041E-01	0.19191	0.17315	1.0000				
HM	-0.15101	-0.23424	-0.13690	-0.41979	-0.25491	1.0000			
SV	-0.12483	-0.11119	-0.11068	0.27672E-01	-0.24927	-0.77730E-01	1.0000		
CM	-0.99555E-01	0.70840E-01	0.76826E-01	0.16262	0.18034E-01	-0.18193E-02	-0.23279	1.0000	
GG	0.14559	0.18357	0.56452E-01	0.24586	0.23205	0.80729E-01	-0.56397	0.27629	
CD	1.0000								
VA	-0.11258	0.41255E-01	-0.76810E-01	0.36401E-01	-0.96150E-01	0.22556	-0.18894	-0.59915E-01	
CP	0.39577E-02	1.0000							
M	0.20436	-0.68977	0.33392	-0.40259	0.77177E-01	0.31573	-0.15785	-0.62074E-01	
C	-0.66962E-01	0.15026	1.0000						
CONSTANT	-0.96955E-01	-0.53123	0.14518	-0.14267	-0.12546	0.65278E-01	0.28896E-01	-0.13333	
	-0.21217	-0.97510E-01	0.30960	1.0000					
	-0.17405	0.86218E-01	-0.21773	0.31979	-0.39742	0.12880E-01	0.26545	-0.33159E-01	
	-0.28524	-0.25073	-0.17573	0.25712E-01	1.0000				
	0.38016E-01	-0.27314	0.11983	-0.61317E-01	0.12554E-01	0.20662	0.54333E-01	-0.72296E-02	
	0.12385	-0.43064	0.17251E-02	0.26147	-0.89324E-01	1.0000			
	-0.21816	0.51497	-0.38167	0.17642	-0.91547E-01	-0.68459	0.23246	-0.26673E-01	
	-0.21701	-0.20777	-0.65718	-0.21987	0.26621E-01	-0.22012	1.0000		
	TR	ER	CR	CV	SZ	HM	SV	CR	
	GG	CD	VA	CP	M	C	CONSTANT		

PRODUCT FINDING III FOR THE SUPPLY LINEAR FUNCTION
FIFTY DEGREES OF FREEDOM

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 50 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
TR	-0.34502E-02	0.16126E-02	-2.1395	-0.2876	-0.30828	-0.37202E-01
FR	2.2545	2.2315	1.0103	0.1414	0.21523	0.81452E-02
CB	0.53369E-01	0.68669E-01	0.77717	0.1073	0.10294	0.11929E-01
CV	-4.7972	1.9276	-2.4887	-0.3320	-0.48339	-0.26784E-01
SZ	-0.23696	0.19547	-1.2122	-0.1690	-0.18370	-0.20585E-01
HR	0.12786	0.20996	0.60877	0.0858	0.10140	0.25290E-01
SV	0.32144	1.9373	0.16593	0.0235	0.26659E-01	0.73901E-03
CR	1.2788	1.6711	0.76525	0.1076	0.93084E-01	0.21000E-02
GG	0.45213	1.8488	0.24455	0.0346	0.41487E-01	0.14107E-02
CO	2.5375	1.7111	1.4829	0.2053	0.25350	0.15418E-01
VA	0.13286	0.11450	1.1603	0.1619	0.12599	0.24427E-01
CP	-0.57211	0.49646	-1.3538	-0.1880	-0.20444	-0.14790E-01
M	-0.60645	1.8617	-0.32575	-0.0460	-0.57895E-01	-0.42024E-02
C	-2.3261	1.6071	-1.4473	-0.2005	-0.21659	-0.76395E-02
CONSTANT	95.729	5.0607	18.916	0.9367	0.00000E+00	1.0218

PRODUCT FINDING IV FOR THE SUPPLY LINEAR FUNCTION
FIFTY DEGREES OF FREEDOM

CORRELATION MATRIX OF VARIABLES - 65 OBSERVATIONS

FR	1.0000								
CR	0.37411	1.0000							
CH	-0.29269	0.12343	1.0000						
CV	-0.41472E-01	-0.29244	0.13217	1.0000					
SZ	0.36329	0.24494	-0.18110	-0.44655	1.0000				
HR	0.20073	-0.22140E-01	0.20903	0.55597	-0.15559E-01	1.0000			
SV	0.21766	0.51613	-0.11557E-01	-0.39885	0.38095	-0.15186	1.0000		
CA	0.10676	0.21568	-0.18743	-0.27581	0.28425	-0.10096	0.29522	1.0000	
GG	-0.49241E-01	0.11219	-0.52155E-01	-0.51762	0.17050	-0.49087	0.56818	0.77116E-02	1.0000
CD	0.19503	0.22829	-0.10859	-0.58184	0.43561	-0.47530	0.38021	0.28482	0.15416
VA	0.36171E-01	0.57156	-0.88954E-01	-0.43272E-01	-0.52380E-01	-0.24077	0.26536	0.99127E-01	1.0000
CP	0.11205	0.48530E-01	1.0000						
CV	0.51579	0.51143	-0.59819E-01	-0.24705	0.15706	-0.22894E-01	0.31577	0.26551	0.24294
H	0.24294	0.27097	0.64163E-01	1.0000					
M	0.13241	0.23679	-0.48662E-01	-0.60300	0.54191	-0.41621	0.29567	0.21488	0.45970
C	0.45970	0.62527	0.92249E-01	0.20171	1.0000				
C	0.84540E-01	0.29403	-0.11787	-0.36449	0.19285	-0.45040	0.13722	0.17767	0.84540E-01
	0.84540E-01	0.57995	0.26781	-0.27211E-01	0.40641	1.0000			
	FR	CR	CH	CV	SZ	HR	SV	CA	
	GG	CD	VA	CP	H	C			

PRODUCT FINDING V FOR THE SUPPLY LINEAR FUNCTION
FIFTY DEGREES OF FREEDOM

15 VARIABLES AND			65 OBSERVATIONS STARTING AT OBS				1
NAME	N	MEAN	ST. DEV	VARIANCE	MINIMUM	MAXIMUM	
TR	65	1010.2	446.35	0.19923E+06	315.00	2166.0	
FR	65	0.33946	0.47687	0.22740	0.00000E+00	1.0000	
CR	65	20.940	9.6353	92.839	1.0000	42.500	
CV	65	0.52309	0.50335	0.25337	0.00000E+00	1.0000	
SZ	65	0.1385	3.0725	14.996	3.0000	16.000	
HR	65	18.531	3.9616	15.694	11.000	24.000	
SV	65	0.1530	0.41429	0.17163	0.00000E+00	1.0000	
CR	65	0.15305	0.36361	0.13221	0.00000E+00	1.0000	
GG	65	0.29231	0.45836	0.21010	0.00000E+00	1.0000	
CD	65	0.56923	0.42904	0.24904	0.00000E+00	1.0000	
VA	65	17.225	7.3692	54.306	5.0000	40.250	
CP	65	2.0615	1.5194	2.3087	0.00000E+00	6.0000	
M	65	0.46154	0.47687	0.22740	0.00000E+00	1.0000	
C	65	0.30769	0.46513	0.21635	0.00000E+00	1.0000	

APPENDIX B

DEMAND DATA

DEMAND RAW DATA

<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>	<u>F</u>	<u>G</u>	<u>H</u>	<u>I</u>	<u>J</u>	<u>K</u>	<u>L</u>	<u>M</u>	<u>N</u>	<u>O</u>	<u>P</u>	<u>Q</u>	<u>R</u>	<u>S</u>
00001	099.9	350	05.00	05	0	0	0	2.0	0	0	0	0	4	45	0	3	048	1
00002	102.9	350	05.10	20	0	1	0	3.5	0	0	1	1	6	29	1	5	018	1
00003	089.9	450	01.25	18	0	0	0	1.5	0	0	0	0	6	33	1	6	012	1
00004	093.9	450	02.00	08	0	0	0	1.5	0	0	1	0	8	38	1	2	036	1
00005	099.9	300	00.95	01	0	0	0	2.0	0	0	1	0	4	71	1	2	060	1
00006	102.9	550	00.80	40	0	1	0	2.0	0	0	1	1	6	34	1	1	048	1
00007	088.9	125	15.00	10	0	0	0	3.0	0	0	1	0	6	40	1	2	018	1
00008	088.9	300	05.00	08	0	0	0	3.0	0	0	1	0	4	36	1	4	018	0
00009	129.9	600	00.50	30	0	1	1	3.0	0	0	1	0	8	25	1	3	300	1
00010	089.9	125	05.00	03	1	0	0	3.0	0	0	0	1	4	23	0	2	024	0
00011	094.9	200	00.80	15	0	0	0	2.5	0	0	1	1	6	27	0	4	108	0
00012	087.9	450	01.00	30	1	0	0	2.0	0	0	1	1	6	25	0	3	012	1
00013	088.9	200	11.25	08	0	0	0	2.5	0	0	1	0	4	18	0	2	012	0
00014	088.9	150	08.65	10	1	0	0	2.5	0	0	1	1	6	43	0	3	002	0
00015	087.9	150	62.50	10	1	0	0	1.5	0	0	1	0	6	30	0	4	084	0
00016	093.9	250	02.00	15	0	0	0	3.0	0	0	1	0	4	44	0	4	096	1
00017	089.9	150	05.00	02	0	0	0	1.5	0	0	1	1	4	23	0	3	192	0
00018	087.9	400	42.00	02	1	0	0	3.0	0	0	1	0	6	32	0	3	036	1
00019	093.9	250	03.50	50	0	0	0	0.0	0	0	1	1	8	42	1	2	096	1
00020	097.9	500	02.00	40	0	1	0	1.5	0	0	1	1	8	27	1	2	012	1
00021	089.9	200	15.00	36	0	0	0	3.0	0	0	1	1	8	30	1	5	028	1
00022	096.9	200	00.50	10	0	0	0	1.5	0	1	1	1	6	40	1	8	004	1
00023	089.9	200	03.75	05	0	0	0	2.0	0	0	1	0	6	54	0	8	120	1
00024	090.9	190	05.00	10	0	0	0	1.5	0	0	1	1	8	63	1	2	406	1
00025	095.9	500	01.25	10	0	0	0	3.0	1	0	0	1	4	28	0	2	024	1
00026	099.9	500	02.50	15	0	0	1	4.0	0	1	1	1	8	44	0	3	060	1
00027	089.9	140	05.00	01	0	0	0	4.0	0	0	1	0	6	68	0	2	300	1
00028	089.9	150	16.00	25	0	0	0	3.0	0	0	0	0	6	37	0	4	060	1
00029	097.9	200	02.00	08	0	0	0	3.0	0	0	1	0	8	16	1	4	018	1
00030	099.9	900	00.50	30	0	1	0	3.0	0	1	0	0	8	66	1	3	420	1
00031	094.9	250	05.00	50	0	1	0	1.0	0	0	1	1	6	46	1	4	144	1
00032	087.9	090	60.00	08	1	0	0	3.0	0	0	0	0	4	28	0	2	012	0
00033	090.9	500	02.50	07	1	0	0	2.0	0	0	1	1	8	17	1	4	096	0
00034	093.9	300	05.00	07	0	0	0	3.0	0	0	1	0	4	30	0	3	008	1
00035	088.9	250	10.00	25	1	0	0	2.0	0	0	1	1	6	30	0	2	015	0
00036	088.9	200	08.80	03	0	0	0	4.0	0	0	0	0	6	42	0	4	006	1
00037	090.9	350	03.60	01	0	0	0	1.5	0	0	1	1	6	43	0	3	132	1
00038	129.9	500	04.00	14	1	1	1	2.5	0	0	1	0	8	70	1	2	192	1

DEMAND RAW DATA, Continued

<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>	<u>F</u>	<u>G</u>	<u>H</u>	<u>I</u>	<u>J</u>	<u>K</u>	<u>L</u>	<u>M</u>	<u>N</u>	<u>O</u>	<u>P</u>	<u>Q</u>	<u>R</u>	<u>S</u>
00039	089.9	250	08.50	08	0	0	0	2.5	0	0	1	0	8	50	0	3	132	1
00040	097.9	500	02.50	25	0	0	0	1.5	0	0	1	0	4	24	1	3	280	1
00041	090.9	300	06.00	25	1	0	0	1.5	0	0	1	1	4	35	1	4	060	0
00042	089.9	180	00.80	01	0	0	0	1.0	0	0	1	0	8	65	0	2	338	0
00043	096.9	450	04.00	04	0	1	0	4.0	0	0	1	0	8	79	0	1	158	1
00044	087.9	100	00.80	14	1	0	0	1.5	0	0	1	0	4	70	1	1	048	0
00045	133.9	990	00.40	05	0	1	1	2.0	0	0	1	0	4	54	0	5	168	1
00046	088.9	280	20.00	01	0	0	0	2.0	0	0	1	0	4	58	1	2	114	0
00047	108.9	600	02.50	04	0	1	1	4.0	0	1	0	1	4	30	0	2	024	1
00048	134.9	600	02.50	25	0	1	1	3.0	0	0	1	1	8	42	0	5	002	1
00049	088.9	100	10.00	30	0	0	0	3.0	0	0	1	0	6	70	1	2	420	0
00050	089.9	250	05.00	14	0	0	0	3.0	0	0	1	1	6	44	0	3	036	1
00051	097.9	250	03.00	03	0	0	0	2.0	0	0	1	1	6	28	0	3	048	1
00052	095.9	600	00.60	35	0	0	0	2.0	0	0	1	1	8	29	1	2	024	0
00053	138.9	600	00.50	30	0	1	1	3.0	0	0	1	1	8	55	1	2	204	1
00054	095.9	170	00.30	08	1	0	0	1.0	0	0	1	0	4	18	1	3	024	0
00055	102.9	500	02.40	02	0	1	0	4.0	0	0	1	0	6	80	0	1	454	1
00056	095.9	250	01.20	27	0	0	0	1.5	0	0	1	1	6	30	1	2	028	1
00057	128.9	400	01.00	04	0	0	1	4.0	0	0	1	0	6	42	0	4	144	1
00058	138.9	700	02.00	30	0	1	1	4.0	0	1	1	1	8	69	1	2	144	1
00059	132.9	400	03.00	18	0	1	1	3.5	1	0	1	0	8	36	0	5	001	1
00060	087.9	350	15.00	07	1	0	0	1.5	0	0	0	0	4	37	0	2	048	1
00061	088.9	350	07.25	60	1	0	0	1.5	0	0	1	1	8	38	1	2	036	0
00062	088.9	200	03.50	20	1	0	0	1.5	0	0	1	0	6	30	0	8	030	0
00063	127.9	500	01.25	07	0	0	1	3.0	0	0	1	0	8	69	0	2	432	1
00064	088.9	100	10.00	18	1	0	0	2.0	0	0	1	1	6	25	1	5	024	0
00065	088.9	150	07.00	02	1	0	0	3.0	0	0	0	1	4	35	1	2	036	0
00066	093.9	400	02.50	18	0	0	0	3.0	0	0	1	0	6	53	1	2	192	1
00067	095.9	400	02.50	14	0	0	0	2.0	0	0	1	1	8	67	1	2	210	1
00068	089.9	150	11.25	32	0	0	0	4.0	0	0	1	0	6	72	1	1	038	1
00069	097.9	350	02.50	50	0	0	0	4.0	0	0	1	0	4	28	1	1	034	1
00070	087.9	300	10.00	07	1	0	0	2.0	0	0	1	1	6	30	0	4	024	1
00071	090.9	300	05.00	07	0	0	0	2.0	0	0	1	1	6	22	0	2	036	1
00072	133.9	500	02.50	18	0	1	1	4.0	0	1	1	1	4	40	1	2	012	1
00073	090.9	250	05.00	05	1	0	0	2.0	0	0	1	1	6	36	1	2	018	0
00074	087.9	100	10.00	06	1	0	0	2.5	0	0	1	1	6	21	1	1	006	0
00075	093.9	400	02.50	40	0	0	0	3.5	1	0	1	0	8	25	1	3	166	1
00076	087.9	180	17.50	20	1	0	0	3.0	0	0	1	0	6	33	0	9	007	1

DEMAND RAW DATA, Continued

<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>	<u>F</u>	<u>G</u>	<u>H</u>	<u>I</u>	<u>J</u>	<u>K</u>	<u>L</u>	<u>M</u>	<u>N</u>	<u>O</u>	<u>P</u>	<u>Q</u>	<u>R</u>	<u>S</u>
00077	088.9	200	07.50	05	1	0	0	2.0	0	0	1	0	4	26	0	2	048	0
00078	099.9	600	04.00	15	0	1	0	3.0	0	1	1	1	6	56	0	3	300	1
00079	090.9	100	05.00	01	0	0	0	4.0	0	0	1	0	8	62	0	1	240	1
00080	097.9	200	02.80	07	0	0	0	4.0	0	0	1	1	4	34	0	2	048	1
00081	095.9	300	01.25	20	1	0	0	2.0	0	0	1	0	6	44	1	5	180	0
00082	091.9	400	05.00	40	0	0	0	1.5	0	0	1	0	8	64	1	2	168	0
00083	097.9	250	03.00	05	0	1	0	2.0	0	0	1	0	4	30	0	5	120	1
00084	088.9	150	50.00	20	1	0	0	2.5	0	0	1	1	8	33	1	1	042	0
00085	097.9	100	04.00	01	0	1	1	4.0	1	1	1	0	4	79	0	1	240	1
00086	097.9	250	02.00	40	0	1	0	2.0	0	0	1	1	6	27	1	4	005	1
00087	090.9	150	02.50	12	0	0	0	2.0	0	0	1	0	6	42	1	4	024	1
00088	090.9	100	05.00	04	0	0	0	1.0	0	0	1	0	6	50	0	2	244	0
00089	093.9	090	00.50	09	1	0	0	1.5	0	0	1	0	6	42	0	6	003	0
00090	087.9	100	02.80	03	1	0	0	1.5	0	0	1	0	8	66	0	2	540	0
00091	094.9	800	02.00	09	0	1	0	1.5	0	0	1	0	8	62	0	2	456	0
00092	089.9	400	03.20	12	1	0	0	2.0	0	0	1	1	6	47	1	2	006	0
00093	088.9	250	08.80	10	0	0	0	2.0	0	0	1	1	4	21	0	2	006	0
00094	095.9	400	04.00	01	1	0	0	1.5	0	0	1	0	4	33	1	2	036	0
00095	093.9	220	05.00	15	0	1	0	2.0	0	0	0	1	4	48	0	1	012	1
00096	092.9	400	01.60	08	1	0	0	1.5	0	0	1	1	4	41	0	5	196	1
00097	087.9	120	15.20	01	1	0	0	1.5	0	0	1	1	4	41	0	2	024	1
00098	089.9	400	05.60	07	0	0	0	2.0	0	0	1	0	4	39	1	4	072	1
00099	088.9	100	07.60	02	1	0	0	3.0	0	0	1	0	4	28	0	3	012	0
00100	088.9	240	17.50	12	0	0	0	3.0	0	0	0	0	6	30	1	2	012	0
00101	087.9	150	16.00	04	0	0	0	3.0	0	0	1	0	4	60	0	2	336	0
00102	096.9	240	00.20	10	0	1	0	2.0	0	0	1	1	4	44	1	6	178	1
00103	092.9	300	02.00	20	0	0	0	1.5	0	0	1	1	4	56	1	2	360	1
00104	089.9	450	03.00	01	0	0	0	2.5	0	0	1	0	8	30	0	5	036	1
00105	096.9	300	03.50	02	0	1	0	4.0	0	0	1	0	4	62	1	2	420	1
00106	129.9	250	01.00	04	0	1	1	3.5	0	0	1	0	6	38	0	4	072	1
00107	130.9	900	00.20	05	0	1	1	4.0	0	0	1	0	8	62	1	2	084	1
00108	093.9	300	02.50	01	0	0	0	2.0	0	0	1	0	6	30	0	2	180	1
00109	087.9	090	27.00	04	0	0	0	3.0	0	0	1	1	6	28	1	2	006	1
00110	097.9	180	05.00	03	0	1	0	3.0	0	0	1	0	8	80	1	1	490	1
00111	099.9	450	04.00	15	0	0	0	4.0	0	0	1	0	8	64	1	2	240	1
00112	092.9	350	02.50	15	0	0	0	3.5	0	0	1	0	8	32	1	4	096	1
00113	095.9	400	01.25	03	0	0	0	2.5	0	0	1	0	4	38	0	6	012	0
00114	087.9	090	17.00	07	0	0	0	2.0	0	0	1	0	4	44	0	1	012	1

DEMAND RAW DATA, Continued

<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>	<u>F</u>	<u>G</u>	<u>H</u>	<u>I</u>	<u>J</u>	<u>K</u>	<u>L</u>	<u>M</u>	<u>N</u>	<u>O</u>	<u>P</u>	<u>Q</u>	<u>R</u>	<u>S</u>
00115	088.9	150	10.50	09	1	0	0	1.0	0	0	1	0	6	38	0	4	108	0
00116	095.9	100	00.25	05	0	0	0	4.0	0	0	1	0	6	73	0	1	240	1
00117	139.9	400	01.25	09	0	1	1	4.0	1	1	1	0	8	70	0	2	216	1
00118	093.9	600	01.00	45	0	1	0	2.5	0	0	1	1	6	41	1	2	488	1
00119	087.9	100	18.00	30	1	0	0	2.0	0	0	1	1	4	20	1	4	001	0
00120	111.9	500	02.50	25	0	1	0	2.0	0	0	1	0	4	36	0	5	012	1
00121	097.9	200	07.00	06	0	1	1	4.0	0	0	1	0	6	50	0	3	196	1
00122	087.9	350	01.25	03	0	0	0	3.0	0	0	1	0	4	63	1	2	002	1
00123	125.9	450	01.50	20	0	0	1	4.0	0	0	1	0	8	40	0	6	120	1
00124	087.9	550	00.20	35	1	0	0	2.5	0	0	1	1	4	38	1	3	146	1
00125	087.9	100	17.50	06	0	0	0	2.0	0	0	1	0	6	78	0	2	132	1
00126	087.9	180	20.00	02	1	0	0	1.5	0	0	1	0	4	21	0	4	028	0
00127	099.9	400	01.20	18	0	0	0	1.5	0	0	1	1	6	30	1	2	018	1
00128	099.9	600	00.30	08	0	0	0	1.0	0	0	0	1	6	42	0	4	315	1
00129	097.9	250	02.50	08	0	1	0	3.0	0	1	1	0	4	31	0	2	036	1
00130	095.9	220	05.00	09	1	0	0	2.5	1	0	1	1	6	33	0	3	018	1
00131	089.9	350	10.90	13	0	0	0	1.5	0	0	1	0	8	47	0	4	048	0
00132	125.9	500	01.50	06	0	0	1	2.5	1	0	1	1	8	41	1	4	096	1
00133	089.9	200	02.50	18	0	0	0	2.0	0	0	1	1	6	27	1	1	024	1
00134	097.9	400	03.50	08	0	0	0	3.5	0	0	1	1	6	44	1	4	132	1
00135	092.9	350	05.00	28	1	0	0	3.0	0	0	0	1	6	28	0	3	108	1
00136	090.9	999	00.10	14	0	1	0	1.5	0	0	1	0	8	46	1	5	108	1
00137	135.9	400	01.25	07	0	0	1	4.0	1	1	1	0	8	72	1	3	288	1
00138	106.9	430	01.00	08	0	0	1	3.5	0	0	0	0	6	42	0	1	180	1
00139	093.9	250	01.50	07	0	0	0	3.0	0	0	1	0	4	30	0	2	028	1
00140	087.9	150	85.00	15	1	0	0	2.0	0	0	1	1	4	21	1	3	018	0
00141	088.9	100	15.00	05	0	0	0	2.5	0	0	1	0	6	61	0	2	384	0
00142	100.9	500	01.25	16	0	1	0	1.0	0	0	1	0	6	46	0	4	012	1
00143	094.9	300	05.00	08	0	1	0	4.0	1	0	0	1	6	38	0	1	072	1
00144	093.9	099	05.50	01	0	0	1	4.0	0	1	1	0	6	54	1	1	018	1
00145	094.9	350	04.00	18	0	1	0	2.5	1	0	1	1	4	40	1	3	120	1
00146	087.9	350	35.00	25	1	0	0	1.5	0	0	1	0	6	75	1	1	060	1
00147	088.9	250	22.00	14	1	0	0	2.5	0	0	1	1	8	16	1	7	120	1
00148	096.9	450	03.70	01	0	1	0	2.5	0	0	1	4	35	0	3	003	1	
00149	092.9	500	02.50	10	0	0	0	1.5	0	0	1	0	6	20	1	4	180	0
00150	125.9	500	00.50	10	0	0	1	2.0	1	0	1	1	6	43	1	4	060	1
00151	092.9	500	01.25	15	0	0	0	2.5	0	0	1	1	4	43	1	4	120	1
00152	095.9	600	00.10	17	1	0	0	3.0	0	0	0	1	6	43	0	3	036	0

DEMAND RAW DATA, Continued

<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>	<u>F</u>	<u>G</u>	<u>H</u>	<u>I</u>	<u>J</u>	<u>K</u>	<u>L</u>	<u>M</u>	<u>N</u>	<u>O</u>	<u>P</u>	<u>Q</u>	<u>R</u>	<u>S</u>
00153	088.9	300	17.50	28	0	0	0	1.5	0	0	1	1	8	49	1	5	110	0
00154	087.9	090	70.00	06	1	0	0	1.5	0	0	1	0	4	32	1	3	264	0
00155	095.9	250	02.50	13	1	0	0	2.0	0	0	1	1	6	45	1	4	144	1
00156	133.9	600	02.00	09	0	1	1	4.0	1	1	0	1	6	51	0	2	036	1
00157	097.9	350	05.00	10	0	1	0	4.0	0	0	1	0	4	49	1	3	036	1
00158	088.9	130	17.00	10	1	0	0	3.0	0	0	1	0	4	77	0	1	180	0
00159	089.9	100	25.00	22	0	0	0	2.5	0	0	0	1	4	20	1	3	012	1
00160	093.3	400	01.25	14	0	0	1	3.5	0	0	1	0	8	43	0	2	054	1
00161	127.9	450	01.50	20	0	0	1	3.0	0	0	0	0	8	43	1	5	228	1
00162	095.9	400	01.50	10	0	0	0	3.0	0	0	1	1	4	43	0	3	024	1
00163	089.9	260	05.00	05	0	0	0	0.0	0	0	0	0	4	39	0	2	120	0
00164	095.9	999	00.50	40	0	0	0	3.0	0	0	0	1	8	45	0	3	024	1
00165	093.9	750	01.00	16	0	0	0	3.5	0	0	1	0	6	44	0	2	072	1
00166	088.9	460	02.00	05	0	0	0	1.0	0	0	0	0	8	49	1	2	060	1
00167	088.9	350	02.50	13	0	0	0	1.0	0	0	1	0	8	22	0	3	180	1
00168	088.9	250	07.50	06	1	0	0	0.0	0	0	1	1	6	48	0	2	194	0
00169	090.9	350	04.00	32	0	1	0	2.5	0	0	1	0	8	64	1	2	096	1
00170	089.9	400	07.00	08	0	0	0	1.0	0	0	1	0	6	48	1	5	144	0
00171	100.9	300	00.60	01	0	1	0	3.0	1	0	0	1	4	24	0	3	012	1
00172	102.9	270	05.00	06	1	1	0	2.5	0	0	1	0	8	54	0	2	456	1
00173	106.9	400	02.50	28	0	0	0	1.0	0	0	1	1	8	35	1	4	024	1
00174	087.9	170	50.00	20	0	0	0	0.0	0	0	1	0	6	74	0	2	240	0
00175	094.9	350	05.00	14	0	1	0	3.0	1	0	0	0	4	19	1	4	132	1
00176	087.9	330	07.00	07	1	0	0	0.0	0	0	1	0	4	38	0	5	120	0
00177	088.9	120	55.00	01	1	0	0	2.5	0	0	1	0	6	64	1	2	300	1
00178	095.9	220	00.60	03	1	0	0	2.5	0	0	1	1	8	43	1	2	036	0
00179	089.9	240	09.00	40	1	0	0	0.0	0	0	0	0	4	31	0	6	024	1
00180	094.9	500	01.25	08	1	1	0	1.0	1	0	1	0	4	34	0	4	048	1
00181	094.9	400	05.00	16	0	1	0	1.0	1	0	1	0	4	34	0	2	108	1
00182	090.9	400	05.00	01	0	0	0	0.0	0	0	1	0	6	36	0	4	048	0
00183	094.9	700	00.50	28	0	1	0	0.0	0	1	1	0	6	67	0	2	024	1
00184	087.9	360	06.50	20	0	0	0	0.0	0	0	0	1	4	54	1	6	007	0
00185	094.9	200	05.00	08	0	1	0	1.5	1	1	1	0	6	27	0	5	084	1
00186	087.9	170	56.00	18	1	0	0	0.0	0	0	0	0	4	39	0	4	024	0
00187	130.9	600	00.80	10	0	1	1	3.5	0	1	1	0	8	60	0	2	300	1
00188	089.9	250	10.00	09	0	0	0	1.0	0	0	0	1	8	27	0	2	004	1
00189	087.9	330	10.00	03	1	0	0	0.0	0	0	0	0	4	18	1	4	120	0
00190	094.9	250	04.00	03	0	1	0	0.0	1	0	1	0	6	54	0	2	360	1

DEMAND RAW DATA, Continued

<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>	<u>F</u>	<u>G</u>	<u>H</u>	<u>I</u>	<u>J</u>	<u>K</u>	<u>L</u>	<u>M</u>	<u>N</u>	<u>O</u>	<u>P</u>	<u>Q</u>	<u>R</u>	<u>S</u>
00191	087.9	090	55.00	01	1	0	0	0.0	0	0	1	1	4	27	1	2	010	0
00192	089.9	300	10.00	02	0	0	0	1.0	0	0	0	0	6	35	1	2	024	1
00193	091.9	350	05.00	10	0	0	0	2.5	0	0	0	1	4	42	0	3	012	1
00194	087.9	100	55.00	10	0	0	0	0.0	0	0	1	0	6	78	0	2	120	0
00195	087.9	150	22.00	99	1	0	0	0.0	0	0	1	0	8	22	0	5	240	0
00196	087.9	380	06.00	20	1	0	0	0.0	0	0	1	1	8	40	0	2	108	0
00197	095.9	550	00.90	10	1	0	0	0.0	0	1	1	1	4	36	0	4	036	0
00198	087.9	100	35.00	01	0	0	0	3.0	0	0	1	0	6	29	1	5	012	1
00199	087.9	260	10.00	04	1	0	0	3.0	0	0	1	0	6	32	0	5	018	1
00200	088.9	090	13.00	02	1	0	0	0.0	0	0	0	0	6	73	0	2	012	0
00201	088.9	300	05.00	04	0	0	0	0.0	0	0	1	1	6	43	0	2	048	1
00202	091.9	300	05.00	10	0	0	0	0.0	0	0	0	1	4	32	0	5	060	1
00203	087.9	250	14.50	18	1	0	0	0.0	0	0	1	0	4	33	0	4	114	0
00204	087.9	200	20.00	14	0	0	0	0.0	0	0	1	0	8	60	0	2	275	1
00205	133.9	420	00.50	12	0	1	1	3.0	0	1	0	0	6	52	0	3	108	1
00206	125.9	550	00.80	13	0	0	1	4.0	1	1	1	1	8	47	1	6	096	1
00207	099.9	420	02.00	15	0	0	0	0.0	0	1	0	0	4	47	0	2	084	0
00208	087.9	370	11.25	07	0	0	0	0.0	0	0	0	0	4	39	1	5	084	0
00209	087.9	250	07.50	30	0	0	0	0.0	0	0	0	0	4	54	0	2	196	0
00210	093.9	400	01.25	10	0	0	1	2.5	0	0	1	1	6	40	0	4	096	1
00211	093.9	320	01.00	02	0	0	0	0.0	0	0	1	1	6	53	0	2	204	0
00212	092.9	330	02.50	14	0	0	0	0.0	0	0	1	1	4	58	0	4	300	1
00213	097.9	360	00.60	24	0	0	0	2.0	0	1	1	1	4	34	1	4	024	1
00214	094.9	250	02.50	01	0	1	0	1.0	0	0	1	0	4	27	0	2	036	1
00215	093.9	330	02.50	07	0	1	0	2.0	0	0	0	0	4	42	1	4	024	1
00216	094.9	250	01.00	15	0	1	0	1.0	1	0	0	0	4	39	0	4	120	1
00217	087.9	250	13.50	15	1	0	0	2.0	0	0	1	1	8	24	1	1	006	1
00218	087.9	200	15.00	10	1	0	0	0.0	0	0	0	1	4	24	0	3	006	0
00219	091.9	250	01.00	10	0	0	0	1.0	0	0	0	1	4	51	1	2	240	1
00220	144.9	999	00.60	30	0	1	1	4.0	0	1	1	0	8	50	1	2	012	1
00221	087.9	150	40.00	02	0	0	0	0.0	0	0	0	0	8	69	1	2	096	0
00222	087.9	150	15.00	06	1	0	0	0.0	0	0	0	0	6	17	0	4	144	0
00223	091.9	230	01.25	06	0	0	1	3.5	0	0	0	0	6	36	0	4	012	1
00224	087.9	100	55.00	01	0	0	0	0.0	0	0	0	0	4	30	0	4	060	0
00225	088.9	110	15.00	17	0	0	0	0.0	0	0	1	1	6	29	1	4	120	1
00226	087.9	080	15.00	06	0	0	0	0.0	0	0	0	0	6	60	0	1	060	0
00227	089.9	500	01.50	05	0	0	0	0.0	0	0	0	1	4	32	1	5	048	1
00228	088.9	070	10.00	07	0	0	0	0.0	0	0	1	1	4	31	0	3	006	0

DEMAND RAW DATA, Continued

<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>	<u>F</u>	<u>G</u>	<u>H</u>	<u>I</u>	<u>J</u>	<u>K</u>	<u>L</u>	<u>M</u>	<u>N</u>	<u>O</u>	<u>P</u>	<u>Q</u>	<u>R</u>	<u>S</u>
00229	130.9	999	00.50	02	0	1	1	3.0	0	1	1	0	6	29	0	6	012	1
00230	130.9	700	01.00	02	0	1	1	3.0	1	0	1	0	8	36	0	7	076	1
00231	095.9	260	01.00	09	0	0	1	4.0	1	0	1	0	6	50	0	1	009	1
00232	138.9	600	01.50	07	0	1	1	3.0	0	1	1	0	8	38	0	5	132	1
00233	095.9	500	01.85	85	0	0	0	2.0	0	0	1	0	8	65	1	3	096	1
00234	087.9	280	10.00	04	0	0	0	0.0	0	0	1	1	6	36	0	5	009	0
00235	089.9	160	10.00	18	0	0	0	0.0	0	0	0	0	6	35	0	3	060	1
00236	095.9	400	01.50	20	1	0	0	2.0	0	0	1	0	8	46	1	2	180	0
00237	088.9	180	17.50	07	0	0	0	0.0	0	0	1	0	4	60	0	4	300	0
00238	095.9	240	01.00	13	0	0	0	0.0	1	0	1	0	8	40	0	1	144	1
00239	090.9	350	05.00	03	0	1	0	0.0	0	0	1	1	4	50	0	3	204	1
00240	094.9	500	01.00	07	0	1	0	0.0	0	0	1	1	4	20	1	3	072	1
00241	091.9	200	03.50	25	0	0	0	0.0	0	0	1	1	8	21	0	4	010	1
00242	088.9	250	10.00	10	1	0	0	0.0	0	0	1	0	8	22	1	2	096	1
00243	095.9	480	01.60	09	0	1	0	0.0	1	0	1	1	4	62	1	2	048	1
00244	131.9	500	00.50	22	0	1	1	3.0	1	0	1	1	8	31	0	3	028	1
00245	099.9	350	01.50	14	1	0	0	2.0	0	0	0	0	8	48	1	2	180	1
00246	087.9	200	55.00	13	1	0	0	0.0	0	0	1	1	6	41	1	6	036	0
00247	088.9	300	02.50	05	1	0	0	0.0	0	0	1	1	4	37	0	4	144	0
00248	087.9	250	13.50	29	1	0	0	0.0	0	0	0	0	8	34	1	6	036	0
00249	092.9	230	00.50	23	0	0	0	4.0	0	0	0	1	4	22	1	3	024	1
00250	087.9	320	15.00	01	0	0	0	0.0	0	0	1	0	4	31	0	4	012	1
00251	104.9	550	01.25	07	0	1	0	3.0	0	0	1	0	4	40	0	2	152	1
00252	096.9	500	02.00	07	0	1	0	3.0	0	0	1	0	4	46	0	4	024	1
00253	125.9	500	01.50	02	0	1	0	3.0	1	0	1	0	4	67	0	2	001	1
00254	087.9	300	05.25	02	1	0	0	0.0	0	0	1	1	4	20	0	5	036	0
00255	094.9	450	10.00	07	0	1	0	3.0	0	0	0	0	4	50	1	4	300	1
00256	096.9	500	02.50	25	0	1	0	0.0	0	0	1	1	8	45	0	2	240	1
00257	096.9	900	00.40	01	0	1	0	3.0	0	0	1	0	8	65	1	3	196	1
00258	087.9	300	04.00	02	0	0	0	0.0	0	0	0	0	6	46	0	2	150	1
00259	087.9	200	04.50	01	0	0	0	0.0	0	0	0	1	4	20	0	3	024	1
00260	099.9	400	01.50	05	0	1	0	4.0	1	0	0	1	6	34	0	4	006	1
00261	087.9	250	15.00	10	0	0	0	1.0	0	0	0	0	8	33	1	5	048	1
00262	087.9	220	15.00	01	0	0	0	0.0	0	0	0	0	4	54	0	2	001	1
00263	089.9	400	11.90	30	0	0	0	0.0	0	0	1	1	6	47	1	5	002	1
00264	087.9	400	21.00	06	0	0	0	0.0	0	0	1	0	4	29	0	2	060	1
00265	096.9	400	03.00	17	0	1	0	3.5	0	0	0	1	6	55	1	4	192	1
00266	087.9	070	10.00	10	0	0	0	0.0	0	0	0	0	8	68	0	2	456	0

DEMAND RAW DATA, Continued

<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>	<u>F</u>	<u>G</u>	<u>H</u>	<u>I</u>	<u>J</u>	<u>K</u>	<u>L</u>	<u>M</u>	<u>N</u>	<u>O</u>	<u>P</u>	<u>Q</u>	<u>R</u>	<u>S</u>
00267	087.9	400	10.20	16	1	0	0	0.0	0	0	1	0	8	50	1	2	300	1
00268	126.9	450	00.50	70	0	0	1	4.0	0	1	1	1	8	57	1	2	264	1
00269	087.9	250	07.50	06	0	0	0	0.0	0	0	1	0	8	35	0	6	096	1
00270	092.9	250	01.00	08	0	0	0	3.5	0	0	1	1	8	37	1	3	006	1
00271	095.9	280	01.20	30	0	1	0	1.0	0	0	0	1	8	30	1	3	012	1
00272	087.9	300	00.50	02	0	0	0	0.0	0	0	1	0	4	35	0	4	060	1
00273	093.9	550	00.30	03	0	0	0	4.0	0	0	1	0	6	39	0	4	120	1
00274	089.9	300	10.00	03	0	0	0	1.0	0	0	1	1	4	30	0	4	036	1
00275	096.9	380	01.25	01	0	1	0	3.0	0	0	1	0	4	30	0	4	007	1
00276	095.9	650	00.40	13	0	1	0	4.0	0	0	1	0	4	60	1	2	196	1
00277	087.9	200	05.00	09	1	0	0	0.0	0	0	0	1	4	39	0	2	024	1
00278	091.9	200	03.00	09	0	0	0	3.0	0	0	1	1	4	20	0	7	024	1
00279	094.9	350	02.50	08	0	1	0	2.9	0	0	1	1	4	61	0	1	300	1
00280	089.9	200	10.00	05	0	0	0	2.0	0	0	1	1	4	21	0	3	024	0
00281	094.9	250	02.00	18	0	1	0	2.0	0	0	0	0	4	33	0	1	024	1
00282	098.9	400	01.00	48	0	1	0	1.0	0	0	1	1	4	31	1	4	072	1
00283	095.9	420	00.10	03	1	0	0	1.0	0	0	1	0	4	38	1	4	096	0
00284	095.9	360	06.50	11	0	1	0	1.0	0	0	1	1	4	34	1	5	018	1
00285	092.9	200	00.50	04	0	0	0	0.0	0	0	0	1	6	48	0	2	018	0
00286	094.9	380	01.00	55	0	1	0	0.0	0	0	0	0	8	43	1	3	084	1
00287	097.9	550	00.80	95	0	1	0	4.0	1	0	1	1	8	42	1	5	036	1
00288	087.9	380	17.00	15	1	0	0	0.0	0	0	0	1	4	39	1	4	020	1
00289	087.9	300	15.00	10	1	0	0	0.0	0	0	1	1	8	29	1	2	048	0
00290	096.9	500	02.50	17	0	1	0	3.0	0	1	1	1	6	64	0	4	012	1
00291	096.9	250	01.00	20	0	1	0	3.0	0	0	0	0	8	24	0	3	036	1
00292	104.9	420	00.80	25	0	1	0	3.0	1	0	1	0	4	39	0	4	012	1
00293	092.9	300	02.40	13	0	0	0	3.0	0	0	1	0	8	40	0	2	222	1
00294	095.9	550	05.00	40	1	1	0	1.0	0	0	1	1	6	42	1	4	012	1
00295	087.9	090	07.50	04	0	0	0	0.0	0	0	1	1	4	53	1	2	630	1
00296	092.9	200	00.40	09	1	0	0	2.0	0	0	1	0	4	29	0	6	002	0
00297	087.9	150	30.40	11	0	0	0	0.0	0	0	1	0	8	64	1	2	240	1
00298	087.9	200	15.00	18	1	0	0	1.0	0	0	1	1	4	18	1	4	024	0
00299	087.9	240	20.00	35	1	0	0	1.0	0	0	1	0	8	47	1	2	240	0
00300	094.9	500	01.50	02	0	1	0	3.5	0	0	1	0	8	31	0	6	036	1

DEMAND RAW DATA, Continued

A = Case Number
B = Price of unleaded gasoline
C = YM = Consumer income
D = DT = Distance from consumer residence
E = QG = Quantity of gasoline consumed per week (in gallons)
F = CV = Frequent utilization of convenience store
G = CD = Frequent utilization of credit card
H = SF = Frequent utilization of full service
I = QS = Quality of service
J = CR = Frequent utilization of car wash
K = GG = Frequent utilization of garage
L = TM = Time of purchase
M = PP = Purpose of trip
N = CG = Car engine size
O = AG = Consumer age
P = SX = Consumer gender
Q = P = Number of people in consumer household
R = L = Length of time consumer lived in area (in months)
S = M = Brand of gas station

PRODUCT FINDING I FOR THE DEMAND LINEAR FUNCTION

I_OLS UNLEAD YM DT QG CV CN SV QS CR GG TM PP CG AG SX P L M / PCOR

REQUIRED MEMORY IS PAR= 92 CURRENT PAR= 752

OLS ESTIMATION

300 OBSERVATIONS DEPENDENT VARIABLE = UNLEAD

...NOTE...SAMPLE RANGE SET TO: 1. 300

R-SQUARE = 0.7024 R-SQUARE ADJUSTED = 0.7693

VARIANCE OF THE ESTIMATE = 35.183

STANDARD ERROR OF THE ESTIMATE = 6.0152

LOG OF THE LIKELIHOOD FUNCTION = -954.687

ANALYSIS OF VARIANCE - FROM MEAN				
	SS	DF	MS	F
REGRESSION	36687.	17.	2150.1	59.643
ERROR	10204.	282.	36.183	
TOTAL	46890.	299.	156.02	

ANALYSIS OF VARIANCE - FROM ZERO				
	SS	DF	MS	F
REGRESSION	0.28227E+07	17.	0.15713E+06	4344.134
ERROR	10204.	282.	36.183	
TOTAL	0.28395E+07	300.	9464.9	

PRODUCT FINDING II FOR THE DEMAND LINEAR FUNCTION

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 202 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YM	0.11290E-01	0.24782E-02	4.5556	0.2618	0.16415	0.39003E-01
DT	-0.58220E-01	0.32383E-01	-1.7979	-0.1065	-0.58392E-01	-0.48333E-02
QG	0.65531E-02	0.27688E-01	0.23685	0.0141	0.74090E-02	0.94297E-03
CV	-0.37196	0.94549	-0.39341	-0.0234	-0.13104E-01	-0.10152E-02
CD	5.0261	0.97557	5.1519	0.2933	0.17984	0.14413E-01
SV	23.879	1.3571	17.596	0.7234	0.63526	0.31349E-01
QS	0.46311	0.31073	1.4904	0.0984	0.49368E-01	0.93664E-02
CR	2.6552	1.2758	2.0811	0.1230	0.62758E-01	0.26603E-02
GG	1.7921	1.4337	1.2500	0.0742	0.40330E-01	0.16098E-02
TM	0.95573	0.85653	1.1158	0.0663	0.32171E-01	0.76275E-02
PP	0.16494	0.76653	0.21515	0.0128	0.65253E-02	0.72942E-03
CG	0.15359	0.24954	0.61547	0.0366	0.19809E-01	0.92329E-02
AG	0.19764E-01	0.30000E-01	0.65881	0.0392	0.23854E-01	0.85695E-02
SX	0.85340	0.76433	1.1166	0.0663	0.33913E-01	0.39217E-02
P	0.26611	0.25481	1.0443	0.0621	0.31938E-01	0.36515E-02
L	0.10702E-02	0.35807E-02	0.29894	0.0178	0.10070E-01	0.11900E-02
M	-0.66939	0.25505	-0.70089	-0.0417	-0.24613E-01	-0.48335E-02
CONSTANT	84.075	2.3022	36.520	0.9086	0.00000E+00	0.07141

PRODUCT FINDING III FOR THE DEMAND LINEAR FUNCTION

CORRELATION MATRIX OF COEFFICIENTS

YM	1.0000							
DT	0.29037	1.0000						
Q2	-0.78217E-01	0.16580E-01	1.0000					
CV	-0.37887E-02	-0.17103	-0.29315E-01	1.0000				
CO	-0.73318	-0.34314E-02	-0.93088E-01	0.71484E-01	1.0000			
SV	-0.18047	-0.33297E-01	0.10131	0.28912E-01	0.18363E-01	1.0000		
QS	0.29213E-01	0.91424E-01	0.12440E-01	0.19093E-02	-0.75979E-01	-0.28918	1.0000	
CR	0.10122	0.51752E-01	-0.36904E-02	0.30111E-02	-0.22843	-0.15578	-0.25089E-01	1.0000
GG	-0.95417E-01	-0.57757E-03	-0.34733E-01	0.23275E-01	-0.91502E-01	-0.33746	-0.36987E-01	0.46522E-02
IM	1.0000							
IM	0.75166E-02	0.27165E-01	-0.39993E-03	-0.68722E-01	-0.24746E-02	0.10120E-01	-0.14364	0.12119E-01
PP	0.67336E-02	1.0000						
PP	-0.17505E-03	0.11320	-0.11919	-0.56225E-01	0.35371E-01	0.12000E-01	0.99384E-01	-0.28373E-01
CG	-0.94348E-01	-0.47050E-01	1.0000					
CG	-0.11891	-0.13544E-02	-0.27692	-0.15116E-01	0.15902	-0.22454	-0.48408E-02	-0.76743E-02
AG	0.63098E-01	-0.89132E-01	0.65752E-01	1.0000				
AG	-0.49642E-01	-0.44536E-01	0.37312E-01	0.12557	-0.33001E-01	-0.19509E-01	-0.45570E-02	0.79305E-02
MX	-0.14092	-0.50509E-01	0.19938	-0.79726E-01	1.0000			
MX	-0.94107E-01	-0.10905	-0.24531	-0.25394E-01	0.50115E-01	0.81364E-01	-0.85802E-01	0.63425E-01
P	0.35605E-01	-0.48216E-01	-0.15759	-0.87505E-01	-0.75546E-01	1.0000		
P	-0.10979	0.16085E-01	-0.30046E-01	-0.14176E-01	0.16977E-01	-0.54991E-01	0.12178	-0.40298E-04
L	-0.20291E-01	-0.98977E-01	0.10573	0.38510E-02	0.29245	0.15720E-01	1.0000	
L	0.56071E-01	0.61360E-01	0.27095E-01	0.21147E-01	-0.89871E-01	-0.30511E-02	0.85827E-01	0.60272E-01
M	0.61136E-01	-0.10544	0.81771E-01	-0.13299	-0.41583	-0.19839E-01	0.87226E-01	1.0000
M	-0.62495E-01	0.11194	0.17355E-02	0.35504	-0.18097	-0.87771E-02	-0.23377	-0.66760E-01
CONSTANT	0.45471E-01	0.35811E-01	-0.62187E-01	-0.71788E-01	0.13174E-01	-0.39102E-01	-0.22317E-01	0.36411E-01
CONSTANT	1.0000							
CONSTANT	-0.17624	-0.25528	0.71580E-01	-0.22378	0.13892E-01	0.23212	-0.20801	-0.50623E-01
	-0.54542E-01	-0.11226	-0.30142	-0.42407	-0.52681	0.49543E-01	-0.49379	0.74959E-01
	-0.17727	1.0000						
YM	DT	QS	CV	CO	SV	QS	CR	
GG	IM	PP	CG	AG	MX	P	L	
4	CONSTANT							

BOX-COX ESTIMATION FOR CONSUMER INCOME
 TRANSFORMED AND RESTRICTED-VARIABLES

I_BOX UNLEAD YM DT QG CV CD SV QS CR GG TM PP CS AG SX P L M
 I_LAMBDA UNLEAD=1
 I_LAMBDA L=1 / RESTRICT ALL
 I_LAMBDA DT=1
 I_LAMBDA QG=1
 I_LAMBDA AG=1
 I_END

REQUIRED MEMORY IS PAR= 94 CURRENT PAR= 752

DEPENDENT VARIABLE =UNLEAD

...VARIABLE CV	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CD	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE SV	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE QS	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CR	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE GG	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE TM	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE PP	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE SX	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE M	NOT POSITIVE...NOT TRANSFORMED

LAMBDA RESTRICTIONS --- VARIABLE	LAMBDA
DT	1.0000
QG	1.0000
CV	1.0000
CD	1.0000
SV	1.0000
QS	1.0000
CR	1.0000
GG	1.0000
TM	1.0000
PP	1.0000
AG	1.0000
SX	1.0000
L	1.0000
M	1.0000
UNLEAD	1.0000

BOX-COX REGRESSION 300 OBSERVATIONS

BOX-COX ESTIMATION FOR CONSUMER INCOME
 PRODUCT FINDING I: CONSUMER INCOME TRANSFORMED

R-SQUARE = 0.7828 R-SQUARE ADJUSTED = 0.7697
 VARIANCE OF THE ESTIMATE = 36.113
 STANDARD ERROR OF THE ESTIMATE = 6.0094
 LOG OF THE LIKELIHOOD FUNCTION = -954.397

ANALYSIS OF VARIANCE - FROM MEAN				
	SS	DF	MS	F
REGRESSION	36707.	17.	2159.2	59.791
ERROR	10184.	282.	36.113	
TOTAL	46890.	299.	156.92	

ANALYSIS OF VARIANCE - FROM ZERO				
	SS	DF	MS	F
REGRESSION	0.28293E+07	19.	0.15718E+06	4352.584
ERROR	10184.	282.	36.113	
TOTAL	0.28395E+07	300.	9464.9	

BOX-COX ESTIMATION FOR CONSUMER INCOME
LAMBDA ITERATION

ITERATION	LAMBDA	LOG-L.F.	GRADIENT	R-SQUARE	SSE	SSE/N
1	0.000	-955.280	0.956237	0.7815	10244.	34.146
2	1.000	-954.687	0.593168	0.7824	10204.	34.012
3	1.618	-954.322	-2.64528	0.7800	10315.	34.384
4	0.618	-954.399	-1.92302	0.7828	10184.	33.946
5	0.332	-954.562	0.689717	0.7826	10195.	33.983
6	0.764	-954.420	0.349582	0.7828	10186.	33.953
7	0.528	-954.431	0.130819E-01	0.7828	10186.	33.954
8	0.674	-954.398	0.227528	0.7828	10184.	33.946
9	0.708	-954.405	-0.200664	0.7828	10184.	33.948
10	0.652	-954.397	-0.149777	0.7828	10184.	33.946
11	0.639	-954.397	0.147339E-01	0.7828	10184.	33.946
12	0.661	-954.397	-0.465425E-02	0.7828	10184.	33.946
13	0.647	-954.397	-0.240379E-01	0.7828	10184.	33.946
14	0.644	-954.397	0.147388E-01	0.7828	10184.	33.946
15	0.649	-954.397	0.101641E-01	0.7828	10184.	33.946
16	0.651	-954.397	-0.464191E-02	0.7828	10184.	33.946
17	0.650	-954.397	-0.614343E-02	0.7828	10184.	33.946

BOX-COX REGRESSION FOR LAMBDA = 0.650000

BOX-COX ESTIMATION FOR CONSUMER INCOME
PRODUCT FINDING II: LOG LIKELIHOOD TEST

VARIABLE NAME	CONDITIONAL			BOX-COX		
	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 202 OF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YM	0.89971E-01	0.19765E-01	4.5520	0.2616	0.16590	0.40692E-01
DT	-0.52394E-01	0.32734E-01	-1.6006	-0.0949	-0.52548E-01	-0.43496E-02
QG	0.58516E-02	0.27638E-01	0.21172	0.0126	0.66158E-02	0.84202E-03
CV	-0.38099	0.94452	-0.40337	-0.0240	-0.13422E-01	-0.10399E-02
CD	5.0506	0.97162	5.2064	0.2961	0.18101	0.14506E-01
SV	23.914	1.3537	17.666	0.7248	0.63620	0.31396E-01
QS	0.49223	0.31098	1.5828	0.0938	0.52472E-01	0.99554E-02
CR	2.5501	1.2723	2.0043	0.1185	0.60275E-01	0.25550E-02
GG	1.8797	1.4303	1.3142	0.0780	0.42300E-01	0.16885E-02
TM	0.95008	0.95531	1.1108	0.0660	0.31981E-01	0.75824E-02
PP	0.14280	0.76511	0.18664	0.0111	0.56494E-02	0.63151E-03
CG	0.27612	0.45906	0.60148	0.0350	0.19267E-01	0.89717E-02
AG	0.23266E-01	0.30178E-01	0.77094	0.0459	0.28091E-01	0.10088E-01
SX	0.83611	0.76369	1.0948	0.0651	0.33223E-01	0.38419E-02
P	0.44976	0.39146	1.1489	0.0683	0.35470E-01	0.98004E-02
L	0.11903E-02	0.35716E-02	0.33327	0.0198	0.11200E-01	0.13236E-02
M	-0.77313	0.95590	-0.80884	-0.0481	-0.28430E-01	-0.55827E-02
CONSTANT	82.067	2.3736	34.576	0.8995	0.00000E+00	0.95060

LOG LIKELIHOOD TEST FOR LAMBDA = 0.650
954.687 - 954.397 = 0.290 x 2 = 0.580 (insignificant)

BOX-COX ESTIMATION FOR GAS STATION DISTANCE

~~TRANSFORMED AND RESTRICTED VARIABLES~~

1_BOX UNLEAD YM DT QG CV CD SV QS CR GG TM PP CG AG SX P L M
 1_LAMBDA UNLEAD=1 / RESTRICT ALL
 1_LAMBDA L=1
 1_LAMBDA YM=1
 1_LAMBDA QG=1
 1_LAMBDA AG=1
 1_END

REQUIRED MEMORY IS PAR= 94 CURRENT PAR= 748

DEPENDENT VARIABLE =UNLEAD

...VARIABLE CV	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CD	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE SV	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE QS	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CR	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE GG	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE TM	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE PP	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE SX	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE M	NOT POSITIVE...NOT TRANSFORMED

LAMBDA RESTRICTIONS --- VARIABLE	LAMBDA
YM	1.0000
QG	1.0000
CV	1.0000
CD	1.0000
SV	1.0000
QS	1.0000
CR	1.0000
GG	1.0000
TM	1.0000
PP	1.0000
AG	1.0000
SX	1.0000
L	1.0000
M	1.0000
UNLEAD	1.0000

BOX-COX REGRESSION 300 OBSERVATIONS

BOX-COX ESTIMATION FOR GAS STATION DISTANCE
LAMBDA ITERATION

ITERATION	LAMBDA	LOG-L.F.	GRADIENT	R-SQUARE	SSE	SSE/N
1	0.000	-949.682	0.950632	0.7395	9863.6	32.895
2	1.000	-954.687	-5.00570	0.7824	10204.	34.012
3	-0.618	-953.380	-0.802081	0.7843	10116.	33.718
4	0.382	-951.006	2.38243	0.7877	9956.1	33.187
5	-0.236	-950.644	-0.535126	0.7882	9932.2	33.107
6	0.146	-949.904	2.19983	0.7894	9876.7	32.922
7	-0.090	-949.896	0.389669	0.7892	9882.7	32.942
8	0.056	-949.660	1.61760	0.7896	9867.2	32.891
9	0.090	-949.639	-0.854908	0.7895	9869.1	32.897
10	0.034	-949.658	-0.562003	0.7896	9867.1	32.890
11	0.021	-949.563	0.389869	0.7896	9867.4	32.891
12	0.043	-949.657	0.276957	0.7896	9857.0	32.890
13	0.048	-949.658	-0.832112E-01	0.7896	9857.0	32.890
14	0.039	-949.657	-0.451508E-01	0.7896	9857.0	32.890
15	0.044	-949.657	-0.209745E-02	0.7896	9867.0	32.890
16	0.041	-949.657	-0.287197E-01	0.7896	9867.0	32.890
17	0.040	-949.657	0.335809E-01	0.7896	9867.0	32.890

BOX-COX REGRESSION FOR LAMBDA = 0.040000

BOX-COX ESTIMATION FOR GAS STATION DISTANCE
 PRODUCT FINDING I: GAS STATION DISTANCE TRANSFORMED

R-SQUARE = 0.7996 R-SQUARE ADJUSTED = 0.7769
 VARIANCE OF THE ESTIMATE = 34.989
 STANDARD ERROR OF THE ESTIMATE = 5.9152
 LOG OF THE LIKELIHOOD FUNCTION = -949.657

ANALYSIS OF VARIANCE - FROM MEAN				
	SS	DF	MS	F
REGRESSION	37023.	17.	2177.8	62.243
ERROR	9867.0	282.	34.989	
TOTAL	46890.	299.	156.82	

ANALYSIS OF VARIANCE - FROM ZERO				
	SS	DF	MS	F
REGRESSION	0.29296E+07	18.	0.15720E+06	4492.813
ERROR	9867.0	282.	34.989	
TOTAL	0.28395E+07	300.	9464.9	

BOX-COX ESTIMATION FOR GAS STATION DISTANCE
PRODUCT FINDING II: LOG LIKELIHOOD TEST

VARIABLE NAME	ESTIMATED COEFFICIENT	CONDITIONAL		PARTIAL CORR.	BOX-COX	
		STANDARD ERROR	T-RATIO 292 DF		STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YM	0.80830E-02	0.26466E-02	3.0541	0.1789	0.11752	0.27925E-01
DT	-1.1019	0.31636	-3.4831	-0.2031	-0.12307	-0.12412E-01
QG	0.73764E-02	0.27140E-01	0.27179	0.0162	0.83398E-02	0.10614E-02
CV	-0.21415	0.92391	-0.23182	-0.0138	-0.75445E-02	-0.58450E-03
CD	5.0616	0.95044	5.2701	0.2994	0.18111	0.14514E-01
SV	23.678	1.3322	17.773	0.7269	0.52991	0.31095E-01
QS	0.39019	0.30854	1.2647	0.0751	0.41595E-01	0.78916E-02
CR	2.4110	1.2574	1.9175	0.1134	0.56987E-01	0.24156E-02
GG	1.7850	1.4095	1.2664	0.0752	0.40170E-01	0.16034E-02
TM	0.87730	0.84140	1.0670	0.0634	0.30221E-01	0.71652E-02
PP	0.85044E-01	0.74980	0.11342	0.0068	0.33644E-02	0.37609E-03
CG	0.88580	1.2959	0.68352	0.0407	0.21496E-01	0.78498E-02
AG	0.25755E-01	0.30023E-01	0.85783	0.0510	0.31085E-01	0.11167E-01
SX	0.80681	0.74562	1.0806	0.0642	0.32059E-01	0.37073E-02
P	1.0645	0.74782	1.4234	0.0845	0.43836E-01	0.11549E-01
L	0.96107E-03	0.35025E-02	0.24584	0.0146	0.11018E-02	0.95747E-03
M	-0.50026	0.93421	-0.64253	-0.0382	-0.22071E-01	-0.43343E-02
CONSTANT	85.107	2.9552	29.808	0.3713	0.00000E+00	0.88211

LOG LIKELIHOOD TEST FOR LAMBDA = 0.0400
954.687 - 949.657 = 5.030 (significant)

BOX-COX ESTIMATION FOR QUANTITY CONSUMED
 TRANSFORMED AND RESTRICTED VARIABLES

I_BOX UNLEAD YM DT QG CV CD SV QS CR GG TM PP CG AG SX P L M
 I_LAMBDA UNLEAD=1 / RESTRICT ALL
 I_LAMBDA L=1
 I_LAMBDA YM=1
 I_LAMBDA DT=1
 I_LAMBDA AG=1
 I_END

REQUIRED MEMORY IS PAR= 94 CURRENT PAR= 748

DEPENDENT VARIABLE =UNLEAD

...VARIABLE CV	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CD	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE SV	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE QS	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CR	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE GG	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE TM	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE PP	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE SX	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE M	NOT POSITIVE...NOT TRANSFORMED

LAMBDA RESTRICTIONS	VARIABLE	LAMBDA
	YM	1.0000
	DT	1.0000
	CV	1.0000
	CD	1.0000
	SV	1.0000
	QS	1.0000
	CR	1.0000
	GG	1.0000
	TM	1.0000
	PP	1.0000
	AG	1.0000
	SX	1.0000
	L	1.0000
	M	1.0000
	UNLEAD	1.0000
BOX-COX REGRESSION	300 OBSERVATIONS	

BOX-COX ESTIMATION FOR QUANTITY CONSUMED
LAMBDA ITERATION

ITERATION	LAMBDA	LOG-L.F.	GRADIENT	R-SQUARE	SSE	SSE/N
1	0.000	-953.998	0.954863	0.7835	10151.	33.836
2	1.000	-954.697	-0.778969	0.7824	10204.	34.012
3	-0.618	-953.320	-0.845166	0.7844	10111.	33.703
4	-1.000	-952.946	-0.978972	0.7849	10086.	33.619
5	-1.236	-952.721	-0.952548	0.7852	10071.	33.569
6	-2.292	-951.931	-0.748229	0.7864	10018.	33.392
7	-2.944	-951.645	-0.437677	0.7868	9998.7	33.329
8	-3.348	-951.526	-0.295681	0.7869	9990.7	33.302
9	-3.597	-951.468	-0.231731	0.7870	9986.9	33.290
10	-3.751	-951.438	-0.199736	0.7871	9984.8	33.283
11	-3.846	-951.420	-0.182412	0.7871	9983.7	33.279
12	-3.905	-951.410	-0.172545	0.7871	9983.0	33.277
13	-3.941	-951.404	-0.166747	0.7871	9982.6	33.275
14	-3.964	-951.400	-0.163273	0.7871	9982.4	33.275
15	-3.978	-951.398	-0.161166	0.7871	9982.2	33.274
16	-3.986	-951.397	-0.159880	0.7871	9982.1	33.274
17	-3.991	-951.395	-0.159091	0.7871	9982.1	33.274
18	-3.995	-951.395	-0.158605	0.7871	9982.0	33.273
19	-3.997	-951.395	-0.158306	0.7871	9982.0	33.273
20	-3.998	-951.395	-0.158121	0.7871	9982.0	33.273
21	-4.000	-951.395	-0.157937	0.7871	9982.0	33.273

BOX-COX REGRESSION FOR LAMBDA = -4.000000

BOX-COX ESTIMATION FOR QUANTITY CONSUMED
 PRODUCT FINDING I: QUANTITY CONSUMED TRANSFORMED

R-SQUARE = 0.7871 R-SQUARE ADJUSTED = 0.7743
 VARIANCE OF THE ESTIMATE = 35.397
 STANDARD ERROR OF THE ESTIMATE = 5.9495
 LOG OF THE LIKELIHOOD FUNCTION = -951.395

ANALYSIS OF VARIANCE - FROM MEAN				
	SS	DF	MS	F
REGRESSION	36908.	17.	2171.1	61.335
ERROR	9782.0	282.	35.397	
TOTAL	46890.	299.	156.82	

ANALYSIS OF VARIANCE - FROM ZERO				
	SS	DF	MS	F
REGRESSION	0.29295E+07	18.	0.15719E+06	4440.894
ERROR	9782.0	282.	35.397	
TOTAL	0.23395E+07	300.	9464.9	

BOX-COX ESTIMATION FOR QUANTITY CONSUMED
PRODUCT FINDING II: LOG LIKELIHOOD TEST

VARIABLE NAME	ESTIMATED COEFFICIENT	CONDITIONAL		PARTIAL CORR.	STANDARDIZED COEFFICIENT	BOX-COX ELASTICITY AT MEANS
		STANDARD ERROR	T-RATIO 292 DF			
YM	0.10112E-01	0.24930E-02	4.0564	0.2348	0.14703	0.34936E-01
DT	-0.53048E-01	0.32215E-01	-1.8019	-0.1067	-0.58219E-01	-0.48190E-02
QG	6.3101	5.1785	1.2185	0.0724	0.34747E-01	0.17604E-05
CV	-0.27781	0.93878	-0.29592	-0.0176	-0.97870E-02	-0.75824E-03
CD	5.1063	0.96541	5.2892	0.3004	0.18271	0.14643E-01
SV	24.033	1.3249	18.140	0.7338	0.63936	0.31552E-01
QS	0.55673	0.30989	1.7966	0.1064	0.59348E-01	0.11260E-01
CR	2.6955	1.2623	2.1354	0.1261	0.63712E-01	0.27007E-02
GG	1.6653	1.4174	1.1749	0.0698	0.37475E-01	0.14959E-02
TM	1.1324	0.84583	1.3387	0.0795	0.38116E-01	0.90371E-02
PP	0.13925E-02	0.75171	0.18525E-02	0.0001	0.55089E-04	0.61581E-05
CG	-36.521	907.56	-0.40241E-01	-0.0024	-0.12051E-02	-0.33449E-03
AG	0.34666E-01	0.29691E-01	1.1675	0.0694	0.41840E-01	0.15031E-01
SX	0.93311	0.72688	1.2837	0.0762	0.37078E-01	0.42877E-02
P	14.010	5.5063	2.5443	0.1498	0.76987E-01	0.15001E-02
L	-0.88531E-04	0.35291E-02	-0.25086E-01	-0.0015	-0.83299E-03	-0.98442E-04
M	-0.39469	0.94876	-0.41600	-0.0248	-0.14513E-01	-0.28499E-02
CONSTANT	89.814	225.98	0.39745	0.0237	0.00000E+00	0.93089

LOG LIKELIHOOD TEST FOR LAMBDA = -4.000

954.687 - 951.395 = 3.292 x 2 = 6.584 (significant, but ignored due to the insignificance of the variable 'in the regular OLS run)

BOX-COX ESTIMATION FOR CONSUMER AGE
 TRANSFORMED AND RESTRICTED VARIABLES

I_BOX UNLEAD YM DT QG CV CD SV QS CR GG TH PP CG AS SX P L M
 I_LAMBDA UNLEAD=1 / RESTRICT ALL
 I_LAMBDA L=1
 I_LAMBDA YM=1
 I_LAMBDA DT=1
 I_LAMBDA QG=1
 I_END

REQUIRED MEMORY IS PAR= 94 CURRENT PAR= 752

DEPENDENT VARIABLE =UNLEAD

...VARIABLE CV	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CD	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE SV	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE QS	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CR	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE GG	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE TH	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE PP	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE SX	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE M	NOT POSITIVE...NOT TRANSFORMED

LAMBDA RESTRICTIONS --- VARIABLE	LAMBDA
YM	1.0000
DT	1.0000
QG	1.0000
CV	1.0000
CD	1.0000
SV	1.0000
QS	1.0000
CR	1.0000
GG	1.0000
TH	1.0000
PP	1.0000
SX	1.0000
L	1.0000
M	1.0000
UNLEAD	1.0000

BOX-COX REGRESSION 300 OBSERVATIONS

BOX-COX ESTIMATION FOR CONSUMER AGE
LAMBDA ITERATION

ITERATION	LAMBDA	LOG-L.F.	GRADIENT	R-SQUARE	SSE	SSF/N
1	0.000	-954.369	0.955324	0.7829	10192.	33.939
2	1.000	-954.687	-0.318856	0.7324	10204.	34.012
3	-0.618	-954.007	-0.420449	0.7834	10157.	33.858
4	-1.000	-953.755	-0.559506	0.7837	10140.	33.801
5	-1.236	-953.602	-0.647757	0.7840	10130.	33.767
6	-2.292	-953.056	-0.517665	0.7848	10093.	33.644
7	-2.944	-952.850	-0.315564	0.7850	10079.	33.598
8	-3.348	-952.762	-0.218094	0.7852	10073.	33.578
9	-3.597	-952.719	-0.172167	0.7852	10070.	33.568
10	-3.751	-952.696	-0.148532	0.7853	10069.	33.563
11	-3.846	-952.683	-0.135422	0.7853	10068.	33.560
12	-3.905	-952.676	-0.127591	0.7853	10068.	33.559
13	-3.941	-952.671	-0.123058	0.7853	10067.	33.558
14	-3.964	-952.668	-0.122013	0.7853	10067.	33.557
15	-3.978	-952.667	-0.118738	0.7853	10067.	33.557
16	-3.986	-952.666	-0.119869	0.7853	10067.	33.556
17	-3.991	-952.665	-0.121411	0.7853	10067.	33.556
18	-3.995	-952.665	-0.102137	0.7853	10067.	33.556
19	-3.997	-952.664	-0.121194	0.7853	10067.	33.556
20	-3.998	-952.664	-0.122680	0.7853	10067.	33.556
21	-4.000	-952.664	-0.113516	0.7853	10067.	33.556

BOX-COX REGRESSION FOR LAMBDA = -4.000000

BOX-COX ESTIMATION FOR CONSUMER AGE
 PRODUCT FINDING I: CONSUMER AGE TRANSFORMED

R-SQUARE = 0.7853 R-SQUARE ADJUSTED = 0.7724
 VARIANCE OF THE ESTIMATE = 35.698
 STANDARD ERROR OF THE ESTIMATE = 5.9748
 LOG OF THE LIKELIHOOD FUNCTION = -952.664

ANALYSIS OF VARIANCE - FROM MEAN				
	SS	DF	MS	F
REGRESSION	36824.	17.	2166.1	60.678
ERROR	10067.	282.	35.698	
TOTAL	46890.	299.	156.02	

ANALYSIS OF VARIANCE - FROM ZERO				
	SS	DF	MS	F
REGRESSION	0.28294E+07	18.	0.15719E+06	4403.337
ERROR	10067.	282.	35.698	
TOTAL	0.29395E+07	300.	9464.9	

BOX-COX ESTIMATION FOR CONSUMER AGE
PRODUCT FINDING II: LOG LIKELIHOOD TEST

VARIABLE NAME	ESTIMATED COEFFICIENT	CONDITIONAL STANDARD ERROR	T-RATIO 282 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	BOX-COX ELASTICITY AT MEANS
Y4	0.10326E-01	0.25169E-02	4.1027	0.2373	0.15013	0.35673E-01
DT	-0.60020E-01	0.32151E-01	-1.8660	-0.1105	-0.60197E-01	-0.49827E-02
QG	0.11976E-01	0.27104E-01	0.44184	0.0263	0.13540E-01	0.17233E-02
CV	-0.33107	0.93625	-0.35361	-0.0211	-0.11663E-01	-0.90361E-03
CO	5.1123	0.97256	5.2560	0.2987	0.19293	0.14660E-01
SV	24.108	1.3352	18.056	0.7323	0.64137	0.31651E-01
QS	0.56498	0.31185	1.8117	0.1073	0.60228E-01	0.11427E-01
CR	2.7050	1.2674	2.1342	0.1261	0.63936E-01	0.27102E-02
GG	1.8301	1.4093	1.2986	0.0771	0.41186E-01	0.16440E-02
TH	1.0886	0.84769	1.2842	0.0763	0.36644E-01	0.86880E-02
PP	-0.86538E-01	0.74580	-0.11603	-0.0069	-0.34235E-02	-0.38270E-03
CG	91.546	924.93	0.98977E-01	0.0059	0.30208E-02	0.83846E-03
AG	0.20217E+06	0.66094E+06	0.30589	0.0182	0.90115E-02	0.68421E-03
SX	0.93080	0.75947	1.2361	0.0734	0.37304E-01	0.43138E-02
P	12.508	5.3380	2.3432	0.1382	0.68735E-01	0.13393E-02
L	0.19155E-02	0.31543E-02	0.60729	0.0361	0.18023E-01	0.21300E-02
M	-0.54118	0.95119	-0.56895	-0.0339	-0.19899E-01	-0.39077E-02
CONSTANT	-50483.	0.16522E+05	-0.30554	-0.0182	0.00000E+00	-523.24

LOG LIKELIHOOD TEST FOR LAMBDA = -4.000

954.687 - 952.664 = 2.023 x 2 = 4.046 (significant, but ignored due to the insignificance of the variable in the regular OLS run)

BOX-COX ESTIMATION FOR LENGTH OF TIME IN AREA

TRANSFORMED AND RESTRICTED VARIABLES

I_BOX UNLEAD YM DT QG CV CD SV QS CR GG TM PP CG AG SX P L M
 I_LAMBDA UNLEAD=1
 I_LAMBDA AG=1 / RESTRICT ALL
 I_LAMBDA YM=1
 I_LAMBDA DT=1
 I_LAMBDA QG=1
 I_END

REQUIRED MEMORY IS PAR= 94 CURRENT PAR= 743

DEPENDENT VARIABLE =UNLEAD

...VARIABLE CV	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CD	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE SV	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE QS	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE CR	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE GG	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE TM	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE PP	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE SX	NOT POSITIVE...NOT TRANSFORMED
...VARIABLE M	NOT POSITIVE...NOT TRANSFORMED

LAMBDA RESTRICTIONS --- VARIABLE	LAMBDA
YM	1.0000
DT	1.0000
QG	1.0000
CV	1.0000
CD	1.0000
SV	1.0000
QS	1.0000
CR	1.0000
GG	1.0000
TM	1.0000
PP	1.0000
AG	1.0000
SX	1.0000
M	1.0000
UNLEAD	1.0000

BOX-COX REGRESSION 300 OBSERVATIONS

BOX-COX ESTIMATION FOR LENGTH OF TIME IN AREA
LAMBDA ITERATION

ITERATION	LAMBDA	LOG-L.F.	GRADIENT	R-SQUARE	SSE	SSE/N
1	0.000	-954.001	0.954956	0.7834	10157.	33.856
2	1.000	-954.687	-0.686193	0.7824	10204.	34.012
3	-0.618	-951.988	-1.66807	0.7863	10022.	33.405
4	-1.000	-950.733	-3.28560	0.7801	9938.1	33.127
5	-1.236	-950.172	-2.37799	0.7898	9900.9	33.003
6	-2.292	-948.790	-1.11926	0.7905	9823.2	32.744
7	-2.944	-948.758	-0.355796	0.7908	9808.1	32.694
8	-3.348	-948.685	-0.180522	0.7909	9803.3	32.678
9	-3.597	-948.655	-0.121088	0.7910	9801.3	32.671
10	-3.751	-948.640	-0.955155E-01	0.7910	9800.4	32.668
11	-3.946	-948.632	-0.928106E-01	0.7910	9799.8	32.666
12	-3.905	-948.628	-0.759497E-01	0.7910	9799.6	32.665
13	-3.941	-948.625	-0.720363E-01	0.7910	9799.4	32.665
14	-3.964	-948.624	-0.697355E-01	0.7910	9799.3	32.664
15	-3.978	-948.623	-0.583566E-01	0.7910	9799.2	32.664
16	-3.996	-948.622	-0.675204E-01	0.7910	9799.2	32.664
17	-3.991	-948.622	-0.570096E-01	0.7910	9799.2	32.664
18	-3.995	-948.622	-0.666962E-01	0.7910	9799.1	32.664
19	-3.997	-948.622	-0.665033E-01	0.7910	9799.1	32.664
20	-3.998	-948.622	-0.663845E-01	0.7910	9799.1	32.664
21	-4.000	-948.621	-0.662656E-01	0.7910	9799.1	32.664

BOX-COX REGRESSION FOR LAMBDA = -4.000000

BOX-COX ESTIMATION FOR LENGTH OF TIME IN AREA
 PRODUCT FINDING I: LENGTH OF TIME IN AREA TRANSFORMED

R-SQUARE = 0.7910 R-SQUARE ADJUSTED = 0.7784
 VARIANCE OF THE ESTIMATE = 34.749
 STANDARD ERROR OF THE ESTIMATE = 5.8948
 LOG OF THE LIKELIHOOD FUNCTION = -948.621

ANALYSIS OF VARIANCE - FROM MEAN				
	SS	DF	MS	F
REGRESSION	37091.	17.	2181.8	62.789
ERROR	9799.1	282.	34.749	
TOTAL	46890.	299.	156.82	

ANALYSIS OF VARIANCE - FROM ZERO				
	SS	DF	MS	F
REGRESSION	0.28297E+07	18.	0.15720E+06	4524.053
ERROR	9799.1	292.	34.749	
TOTAL	0.28395E+07	300.	9464.9	

BOX-COX ESTIMATION FOR LENGTH OF TIME IN AREA
PRODUCT FINDING II: LOG LIKELIHOOD TEST

VARIABLE NAME	ESTIMATED COEFFICIENT	CONDITIONAL STANDARD ERROR	T-RATIO 202 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	BOX-COX ELASTICITY AT MEANS
Y4	0.10413E-01	0.24745E-02	4.2081	0.2431	0.15140	0.35974E-01
DT	-0.63030E-01	0.31689E-01	-1.9891	-0.1175	-0.63216E-01	-0.52327E-02
QG	0.11640E-01	0.26788E-01	0.43452	0.0259	0.13161E-01	0.16750E-02
CV	-0.26017	0.92814	-0.28032	-0.0167	-0.91657E-02	-0.71010E-03
CD	5.0236	0.95635	5.2529	0.2985	0.17976	0.14406E-01
SV	23.921	1.3190	18.136	0.7338	0.63638	0.31405E-01
QS	0.55982	0.30685	1.8212	0.1078	0.59571E-01	0.11302E-01
CR	1.2612	1.2611	1.7931	0.1062	0.53447E-01	0.22656E-02
GG	1.8838	1.4053	1.3404	0.0796	0.42392E-01	0.16921E-02
TM	1.0512	0.83220	1.2631	0.0750	0.35384E-01	0.83892E-02
PP	0.90738E-01	0.74331	0.12207	0.0073	0.35897E-02	0.40127E-03
CG	210.27	918.79	0.22885	0.0136	0.69383E-02	0.19258E-02
AG	0.30695E-01	0.25987E-01	1.1812	0.0702	0.37049E-01	0.13309E-01
SX	0.92932	0.74621	1.2440	0.0739	0.36887E-01	0.42656E-02
P	13.181	5.4444	2.4210	0.1427	0.72432E-01	0.14113E-02
L	-30.971	12.146	-2.5499	-0.1501	-0.71124E-01	-0.24232E-08
H	-0.48971	0.93683	-0.52274	-0.0311	-0.18007E-01	-0.35361E-02
CONSTANT	37.561	228.57	0.16433	0.0098	0.00000E+00	0.38930

LOG LIKELIHOOD TEST FOR LAMBDA = -4.000

954.687 - 948.621 = 6.066 x 2 = 12.132 (significant, but ignored due to the insignificance of the variable in the regular OLS run)

PRODUCT FINDING I FOR THE DEMAND: GAS STATION DISTANCE GENERATED

I_OLS UNLEAD YM DT JG CV CD SV JS CP GG TH PP CG AG SX P L M / PCOR

REQUIRED MEMORY IS PAR= 92 CURRENT PAR= 740

OLS ESTIMATION

300 OBSERVATIONS DEPENDENT VARIABLE = UNLEAD

...NOTE...SAMPLE RANGE SET TO: 1. 300

R-SQUARE = 0.7890 R-SQUARE ADJUSTED = 0.7762

VARIANCE OF THE ESTIMATE = 35.090

STANDARD ERROR OF THE ESTIMATE = 5.9237

LOG OF THE LIKELIHOOD FUNCTION = -950.089

ANALYSIS OF VARIANCE - FROM MEAN				
	SS	DF	MS	F
REGRESSION	36995.	17.	2176.2	62.017
ERROR	9895.4	282.	35.090	
TOTAL	46890.	299.	156.82	

ANALYSIS OF VARIANCE - FROM ZERO				
	SS	DF	MS	F
REGRESSION	0.28296E+07	18.	0.15720E+06	4479.895
ERROR	9895.4	282.	35.090	
TOTAL	0.28395E+07	300.	9464.9	

PRODUCT FINDING II FOR THE DEMAND: GAS STATION DISTANCE GENERATED

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERR303	T-RATIO 282 DF	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
YM	0.83312E-02	0.26357E-02	3.1610	0.1850	0.12113	0.28792E-01
DT	-27.580	7.9243	-3.4805	-0.2029	-0.12322	-0.30091
QG	0.60703E-02	0.27246E-01	0.22280	0.0133	0.69631E-02	0.87347E-03
CV	-0.24558	0.92518	-0.25544	-0.0159	-0.85515E-02	-0.67027E-03
CD	5.0646	0.95081	5.2712	0.2995	0.19122	0.14523E-01
SV	23.646	1.3364	17.694	0.7253	0.62907	0.31044E-01
QS	0.36278	0.30781	1.1786	0.0700	0.38673E-01	0.73372E-02
CR	2.4032	1.2592	1.9085	0.1129	0.56803E-01	0.24078E-02
GG	1.3059	1.4119	1.2790	0.0759	0.40641E-01	0.16222E-02
TM	0.89464	0.34373	1.0603	0.0630	0.30114E-01	0.71399E-02
PP	0.98854E-01	0.75308	0.11799	0.0070	0.35151E-02	0.39294E-03
CG	0.20543	0.24621	0.83439	0.0496	0.26496E-01	0.12350E-01
AG	0.19429E-01	0.29520E-01	0.65815	0.0392	0.23450E-01	0.84240E-02
SX	0.78761	0.74960	1.0521	0.0625	0.31296E-01	0.36191E-02
P	0.24516	0.25104	0.97659	0.0581	0.29423E-01	0.79703E-02
L	0.82865E-03	0.35234E-02	0.23518	0.0140	0.77969E-02	0.92143E-03
M	-0.62861	0.93563	-0.67187	-0.0400	-0.23114E-01	-0.45391E-02
CONSTANT	113.72	9.0903	12.510	0.5974	0.00000E+00	1.1787

MA 1.0000

[illegible]

APPENDIX C

QUESTIONNAIRE

QUESTIONNAIRE

Subject # _____

Subject exact address _____

1. Where do you most frequently buy unleaded gasoline?

Station _____

Location _____

Distance gas station is from your house _____

2. About how many miles do you drive per week?

3. If there is a convenience store at the gas station you listed above, about how often do you purchase something at the store when you buy gasoline there?

_____ Always

_____ 25% of the time

_____ 75% of the time

_____ Never

_____ 50% of the time

4. About how often do you use a credit card for your gasoline purchases at the gas station you mentioned?

_____ Always

_____ 25% of the time

_____ 75% of the time

_____ Never

_____ 50% of the time

_____ Not Applicable
(does not accept my credit card)

5. About how often do you purchase gasoline at a full-service aisle?

_____ Always

_____ 25% of the time

_____ 75% of the time

_____ Never

_____ 50% of the time

_____ None Available

6. Regarding the station you mentioned, please indicate your impression of:

	Excellent	Good	Fair	Poor	No Impression
Cleanliness					
Friendliness of Personnel					
Speed of Service (i.e., no waiting in line for pump)					

7. If there is a car wash at the gas station listed, about how often do you use it when you buy gasoline there?

_____ Always _____ 25% of the time
 _____ 75% of the time _____ Never
 _____ 50% of the time

8. If there is garage service at the station you listed, which garage services do you use?

_____ Change oil _____ Other-Specify: _____
 _____ Tires Equipment _____
 _____ Mechanical Tuneups _____ None

9. Indicate the general breakdown of times when your gasoline purchases are made (percentages in the four categories should add up to 100%):

a. Morning _____ %
 b. Afternoon _____ %
 c. Evening _____ %
 d. After Midnight _____ %

10. Indicate the general breakdown of the primary purpose of your trip when gasoline is purchased (percentages should add up to 100%):

_____ % On the way to and from work

_____ % While out shopping

_____ % Make special trip for gas

_____ % Out for leisure

_____ % Other

11. What types of cars do you most frequently drive?

Year _____ Model _____

Year _____ Model _____

Year _____ Model _____

Year _____ Model _____

12(a). Age _____

12(b). Sex _____

13. How many people are in your household? _____

14. How long have you lived at your current residence? _____

15. About how much is your annual household income?

_____ \$9,999 or less

_____ 30,001-40,000

_____ 10,000-15,000

_____ 40,001-50,000

_____ 15,001-20,000

_____ 50,001-60,000

_____ 20,001-25,000

_____ 60,001 or over

_____ 25,001-30,000

APPENDIX D

CONTROL ANALYSIS OF PRODUCT ATTRIBUTES

CONTROL ANALYSIS OF PRODUCT ATTRIBUTES

The following analysis is intended to illustrate in a cursory fashion the evidence of higher markups generally found at convenience stores on the premises of some gas stations. To accomplish this, nine consumer products were randomly selected, and their average price at 20 convenience stores in the study group were compared with the average price of identical products at three large grocery stores in the same geographical area (Safeway, Thriftway, and Fred Meyers).

It is clear in the data provided in Table XXVI (below) that convenience stores price their items significantly higher than do large grocery stores. Where some gas stations with a convenience store on the premises realize very low margins on gasoline sales, this margin is offset by higher markups on most items in the store itself. Some items, however (for example milk and bread), may be priced competitively with larger grocery stores.

TABLE XXXVI
CONTROL ANALYSIS OF SELECTED
PRODUCT ATTRIBUTES

	Average Price at 20 Convenience Stores (in \$)	Average Price at 3 Grocery Stores (in \$)*	Average Price Diff. (in \$)	Differential (as % of Groc. Store Price)
Foamy Shaving Cream (regular, 11 oz.)	3.5955	1.77	1.8255	+103.14%
Tylenol Regular Strength (24 tablets)	3.9545	2.636	1.3185	+ 50.19%
Aqua-Fresh Toothpaste (2.5 oz.)	1.7875	1.1766	.6109	+ 51.92%
Taster's Choice Instant Coffee (40 oz.)	5.053	3.943	1.10	+ 27.90%
Franz Wheat Bread (22.5 oz. loaf)	1.290	1.1466	.15	+ 13.08%
Whole Milk (half gallon)	1.28	1.10	.18	+ 16.36%
Campbell's Tomato Soup (10.75 oz. can)	.5635	.2966	.27	+ 91.03%
Minute Maid Orange Juice (2 liters)	1.775	.953	.82	+ 86.04%
Grade A Medium Eggs (one dozen)	1.115	.73	.39	+ 53.42%

SOURCE: Author

* Fred Meyer, Safeway, and Thriftway