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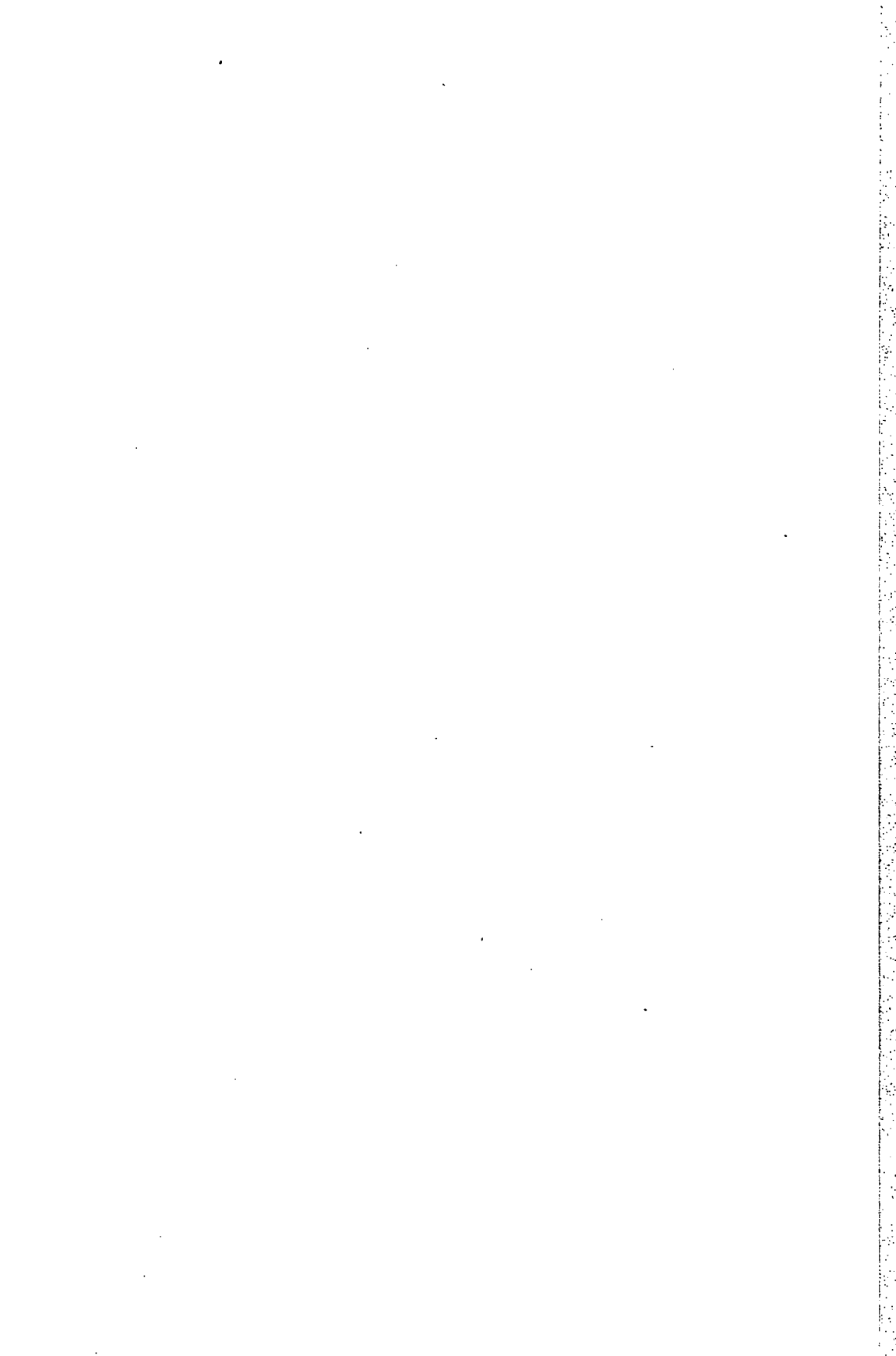
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Part III
Level of Aggregation
in Consumer Analysis

Consumer Demand and Characteristics of Consumption Goods *

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RECENT extensions of the theory of consumer behavior have led us to consider, on the one hand, production processes that occur in what has traditionally been regarded as the location of consumption activity (the household production literature), and on the other, to analyze consumption activity in the production place (consumption on the job). In the present session, we remain in territory with a longer history of habitation: we are considering consumption in the consumption place.

The three papers of this session have in common their concern with consumer behavior toward the kinds of market-purchased goods (food, housing, and automobiles) that have traditionally been thought of under the rubric "consumption." In this respect, they are in contrast to the papers of the previous two sessions, which have dwelt on extensions of the concepts of consumption and household behavior to encompass relatively new subject matter. But though the ground may seem familiar, the three papers of this session lead us down some paths hitherto unexplored, and expose new vistas along some old ones.

One paper (Christensen and Manser) is a demand analysis on goods, as goods have traditionally been defined. It shows us that despite an already extensive body of empirical estimates of systems of demand relations,[1] there is a great deal yet to be said about the traditional

[1] A recent survey of this literature is Brown and Deaton (1972).

economic world of consumer behavior – that is, a world in which consumers purchase market-provided goods and services, and these goods and services are entered directly into utility functions (without first feeding the goods into some intermediate transformation function, and without taking explicit account of nonmarket inputs to the consumption process).

With all the emphasis in the past several years on new approaches to consumption theory, and the attention captured by novel applications of the theory of consumer behavior, it is easy to overlook the fact that the implications of traditional theory have never really been thoroughly tested. In the past, empirical implementation has been hindered by the fact that devising sets of demand equations which could be estimated required severe restrictions on the utility functions from which they were derived. The price of producing estimable relations has been the a priori exclusion of a good part of the economic behavior that traditional theory admits. The translog function employed by Christensen and Manser promises – as do some other functional forms for demand analysis that have recently appeared – to permit more adventuresome exploration of the standard theory of consumer behavior, so that we may, with some confidence, determine responses to price and income changes, allowing for the full range of interaction effects between related goods.

Another paper (Ohta and Griliches) may be interpreted as an exercise in specifying and measuring *characteristics* of goods, in the sense that the term "characteristics" has been used in the "New Theory of Demand" associated with Lancaster (1966, 1971). The Ohta-Griliches mechanism for doing this is a hedonic quality function.

Finally, we have the paper by King, which investigates consumer behavior toward sets of characteristics – characteristics which have been measured, and their respective prices estimated, by means of a hedonic function.

I shall have little to say directly about the Christensen-Manser paper, largely because I think it is an excellent piece of work that stands on its own within the context of previous literature on estimating sets of consumer demand functions, and partly because both authors were colleagues during the period when most of the research for the paper was carried out. Any slight input I am capable of making to that paper has long since been imparted to the authors.

The papers of Ohta and Griliches and of King, however, raise once again the specter of the relation between hedonic quality functions and consumer demand functions or consumer preference systems. On

this matter, there has already been a not inconsiderable volume of speculation or criticism (much of which has remained in an oral tradition, rather than appearing in print). Certain comments on the conceptual framework of hedonic studies, and on the relation between hedonic estimates and consumer preferences or consumer demand functions, seem to me an appropriate accompaniment to the Ohta-Griliches and King papers—a judgment which is reinforced by the lively discussion which took place during the session. I am, however, making no attempt to summarize any of the discussion. Rather, the present paper represents my own views, distilled from the experience of having perpetrated one or two of the hedonic recipes on the profession, and having from time to time wrestled with trying to improve the flavor of the dish. Moreover, it is not intended that this introduction should be taken as implying disagreement with any of the papers in the session, or with the remarks of any of the discussants, except where explicitly indicated. Finally, the reader should not infer that Ohta, Griliches, or King necessarily agree that my view of the conceptual setting within which they are working corresponds to their own.[2]

By "hedonic function," or "hedonic quality function" or "hedonic price function" (all three designations are used interchangeably in the literature), I mean a regression of the form

$$P = f(\chi) \tag{1}$$

The dependent variable P is a vector of prices of different varieties of some product (for Ohta-Griliches, prices refer to different makes and models of automobiles of equivalent vintage; in King's study, product varieties are particular houses offered for sale within a specified geographical area); χ is a matrix, the columns of which designate a set of specifications, attributes, or "characteristics," and there is, of course, one row of values on the characteristics for each variety of the product. The statistical analysis is designed to determine which of the specifications are relevant to explaining the value of the transaction, and to estimate values—or implicit prices—for the specifications variables which are revealed as important ones. These implicit prices are

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[2] Though in the following I discuss only aspects of hedonic measures that have a bearing on consumer demand studies, this does not imply that I think the hedonic results are without relationships on the supply side. For some purposes, one might wish to treat disaggregation through hedonic methods as supplying a set of joint outputs, which could, for example, replace a single output measure in a production function study. However, because the topic of this session is aggregation in *consumption*, supply or production relationships are more appropriately discussed elsewhere.

estimated in the form of the regression coefficients (i.e., $\partial P/\partial \chi$), or else are derived from them.

A partially developed relationship between consumer theory and empirical hedonic functions may, it is well known, be provided through the medium of Lancaster's (1966, 1971) "New Theory of Demand." I would emphasize the partially developed state of the relationship. Hedonic studies and the "New Theory" both embrace the concept of disaggregation of the units ("goods") in which transactions are conducted into some less aggregative (and presumably more basic) quantities that New Demand theorists and hedonicists alike call "characteristics." But after agreeing that it is desirable, or even imperative, to shift the analysis away from goods in the direction of characteristics (after their opening pages, that is) the hedonicists and the New Demand theorists more or less go their separate ways.[3]

Theoretical and conceptual clarification of the nature of hedonic estimates, and of the implications of their employment in various contexts, deserves high priority. If we do not know, to use the words of Ohta and Griliches, "what meaning, if any, is to be given to the [hedonic] constructions," and if we do not have at least some idea "what [hedonic] indexes measure and under what conditions . . . they measure it unambiguously,"[4] we have little basis for asserting that employment of hedonic estimates would really lead to improvement in existing price or quantity measures. Because of the nature of the measurement provided by hedonic estimates, we are very much in need of establishing a firm understanding of the conceptual underpinnings of the hedonic technique, from which to develop a theoretical rationale for the appropriate employment of hedonic results. Thus, the set of questions raised by Ohta and Griliches at the beginning of their paper is an exceedingly important (though by no means exhaustive) agenda for research. Finding at least provisional answers to such questions is crucial for using hedonic results to improve economic measurement of various sorts, and even more crucial if one hopes to employ hedonic results in studies of behavior toward characteristics, on the lines of the "New Theory of Demand."

Having said this, and I trust making clear my support for additional theoretical analysis in this area, I must at the same time strongly demur

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[3] That separate roads are taken seems to me as much the fault of the degree of operational content — or lack of same — provided by the theorists as the excessively empiricist orientation of some of the contributors to the hedonic literature. I have elaborated on this view elsewhere (Triplett, 1973).

[4] The quotations are from Ohta and Griliches, pages 325–326.

from the general tenor of some of the proposals that have been made for theoretical work on the hedonic technique. My reservations stem from the formulation of the problem or problems on which it has some-times been alleged that theoretical work is required.[5] In short, I think that some of the proposals for a "theory" of hedonic functions suffer from misconception of the setting in which hedonic estimates are made, and from consequent mis-specification of the theoretical prob-lem to be attacked.

It was perhaps inevitable that work on the theoretical structure of the hedonic technique should become enmeshed in a discussion on de-fining what the problem is or is not. A large part of the literature on the "Quality Problem" (the problem of producing economic measurements of quality differences) is similarly introspective and concerned with the attempt to formulate, define, or understand the nature of the quality phenomenon.[6] At worst, such discussions descend to metaphysical speculation, and one cannot claim that the quality literature is entirely free from a taint of this. Nevertheless, it should be recognized that the quality problem has been formidably elusive, and that formulating approaches to elusive problems often requires a largely verbal setting.

One way to formulate the theoretical problems that need attention is to make use of analogs to other problems in economic analysis whose parameters are more familiar to us. Not surprisingly, the analytical framework we seek is thus likely to contain elements borrowed from other applications. The trick is to select the most useful analogies, and to identify aspects of the problem wherein the analogy is not exact.

The most useful analogies for this problem, it seems to me, are a set which involve the concept of characteristics (the same concept that is central to the ideas of the "New Theory of Demand"). The notion of characteristics, however, is abstract and unfamiliar. In order to free ourselves from the task of trying to reason exclusively in terms of characteristics of products, I offer the following parable or simile. In it, product characteristics, and the results of hedonic investigations, may be discussed in language which is usually employed in conventional consumer theory, so that correspondences may readily be arrayed between analyses in characteristics space and in commodity space.

[5] As already noted, part of the reference here is to a strand of reasoning that emerges frequently whenever hedonic research is discussed within the profession, and which can-not be associated with the work of any particular economist or group of economists. A flavor of this thought is contained in some of the items cited at the beginning of the Ohta-Griliches article. Some of the points in the following pages are particularly relevant to the last half of the Muellbauer (1974) article.

[6] See the bibliography in Griliches, ed. (1971).

Suppose that grocers, rather than placing their wares on shelves with unit prices marked on them, instead loaded various assortments of items into grocery carts or baskets, attaching prices to each of the pre-loaded baskets. Buyers in this marketing system would select a pre-loaded basket, and pay the specified price for the collection of groceries that it contains.

It is instructive to examine the hedonic methodology in the context of this simile, and to consider the nature of Lancastrian characteristics and the questions of economic behavior that arise in this same context. First, applying the hedonic technique to the simile would yield the usual hedonic regression, $P = f(\chi)$. The dependent variable (which in hedonic regressions is normally the price of some product, such as a group of automobiles) in this regression consists of the prices charged for the various preloaded baskets of groceries. The independent variables (the matrix χ), which are, in the usual hedonic study, measures of attributes or specifications, are here the quantities of various groceries in the available preloaded baskets. Thus, in the context of the simile, groceries found in the carts may be regarded as characteristics of the grocery bundle. The estimated regression coefficients are usually interpreted as implicit prices for characteristics — which are, in this case, groceries. We can therefore think of the hedonic investigation as an attempt to find out what prices of individual grocery items would have been, had the groceries been stocked on the shelves in the customary way.

Notice that what is written as a price in the hedonic regression (the dependent variable, P) is readily interpretable as expenditure on groceries when a cartload is purchased.[7] Similarly, when in normal hedonic studies we move from the level of the good to that of characteristics, the quantity we normally think of as *the* price (the price of the good) has no further interpretation as a price. It becomes, instead, the expenditure on characteristics implied by the act of purchasing the variety in which the characteristics are embedded.

Two questions — both of which seem to me unproductive lines of inquiry — have repeatedly emerged in discussion of the hedonic technique. Within the context of the simile, the first can be put thus: Are implicit prices derived from the hedonic function estimates of consumer valuations or of the grocer's costs?

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[7] This quantity does not necessarily correspond to the usual concept of total expenditure for an individual consumer over any time period, because he may well purchase more than one cartload. It is simply total expenditure on the groceries included in one transaction.

Posing this question of hedonic prices has exactly the same import as posing the same query regarding the prices we do, in fact, observe on grocery store shelves—no more and no less.[8] The standard welfare implications of those prices which are observed in the usual way tell us that if consumers are competitive, then relative prices can be taken as measures of marginal rates of substitution; and if producers are competitive, they also measure transformation rates. Furthermore, if competition does not prevail on, say, the seller side of the market, then prices do not necessarily reflect marginal costs, though the interpretation of them as measures of marginal consumer evaluations remains valid.[9] All this is well known. That so much argument has been carried on over a question of so little real difficulty probably indicates that the framework within which hedonic estimates are obtained has not been adequately comprehended.

The second question commonly posed of the hedonic results concerns the *form* of the hedonic estimating function. Specifically, the question is usually framed as: Which possible estimating forms are derivable from behavioral relations (preference functions, or production or cost functions), and which functional forms are theoretically inappropriate? Although the functional form question can encompass some interesting problems, trying to derive information about functional form from behavioral postulates is not likely to yield dividends. Basically, the problem here is that the hedonic function has often been confused with some sort of demand or cost function, when in fact it corresponds to an opportunity locus, or a portion of one.

Recall that in the grocery cart simile, the price or ticket on the preloaded cart was interpretable as the expenditure on the groceries contained in it. The form of the hedonic function establishes the nature of characteristics prices (Are they straight dollar values, as is customary for true shelf prices, or are they determined as percentages of the total, or by some other procedure?); and the function also tells us how expenditures on each of the groceries are to be combined to reach the total (the ticket on the cart).

Because the ticket on the preloaded grocery cart is interpreted as an expenditure, it is tempting to infer that the hedonic function is akin to a consumer demand function, perhaps one expressed in expenditure

[8] That is, provided that the implicit prices derived from the hedonic function can be used as if they were estimates of shelf prices (an important question, which is considered below).

[9] One still hears repeated the canard that imperfect competition among sellers destroys the consumer-valuation interpretation of hedonic prices, when just the opposite is plainly the case.

form. That is, the hedonic function $P = f(\chi)$ is to be interpreted as an equation that says

$$\text{Expenditure} = f(\chi) \tag{2}$$

We then proceed to estimate regression coefficients which are interpreted as implicit prices, so that equation 2 looks deceptively like the consumer demand function

$$\text{Expenditure} = g(\Pi, y) \tag{3}$$

where Π is the vector of prices of all related goods, and y is a measure of income.

This is, however, not the correct correspondence. We can indeed find an analog to the demand or expenditure function of equation 3 in the grocery cart simile. The direct characteristics analog to equation 3 would be a relation that explained how the consumer determined *what quantitites of the various groceries he wanted to consume.* This relation would, as is true of familiar consumer demand functions, be derived from the utility function via the usual constrained maximization process; but in the context of the simile, it would explain *which cart,* given a set of grocery prices and the consumer's income, the consumer selects.

The distinction between equations 2 and 3 is that equation 3 is a behavioral relation that pertains to an individual consumer, who is assumed to carry out a specified maximization process under prescribed constraints. Equation 3 tells us his response to values of variables over which the maximization process is defined. The analog to equation 3, in a characteristics world, is a demand function for characteristics.

The hedonic function tells us something entirely different. With respect to the theory of consumer behavior, a hedonic function on consumer goods assumes the role of an empirical estimate of the constraint (or, in the general case, part of it) to which the consumer is subject.

Consider equation 2 in the context of the grocery cart simile. Hold total expenditure on groceries (the ticket on the cart) constant, but vary the quantities in χ (that is, let one or more χ_i increase, but decrease one or more χ_j just sufficiently so that the total outlay for groceries in the basket remains unchanged). The resulting locus is an iso-expenditure line for groceries. This iso-expenditure line resembles the familiar budget constraint from conventional consumer theory. And this is precisely where the analogy lies. The hedonic function corres-

ponds, not to a demand or expenditure function, but rather to a function from which we can derive the budget constraint.

To conduct analysis on consumer behavior toward characteristics, we replace the quantity of a good with a vector of quantities of characteristics derived from it. The hedonic function can be used to determine what those characteristics are, and to establish prices for them; moreover, from the hedonic function, a budget constraint may be derived which can be employed in a study of the demand for characteristics.

Therefore, any theoretical questions we can ask of the form of the hedonic function have nothing to do with deriving it from the consumer's preference function — that is impossible, for the same reason that one cannot derive the budget constraint in the conventional consumption problem from the consumer's preference function. Neither will the form of the hedonic function be determined directly by the form of any "household production function" which may combine characteristics, time, and other elements. Rather, we may ask whether the functional form chosen for the hedonic study gives rise to budget constraints with appropriate properties for conducting demand analyses. I return to this matter later in the paper.

One point with respect to supply deserves to be made. It has sometimes been said that hedonic studies have been technically deficient because investigators have failed to consider supply conditions when estimating hedonic functions, or because they have overlooked identification problems of the type that have become familiar in the usual demand or supply studies. The argument, of course, is simple transference to hedonic studies of problems associated with demand studies. The reply is largely a reiteration of points made earlier: the hedonic function is not a demand function, and conditions which must be satisfied in order to identify empirical demand estimates are not necessarily requirements for carrying out hedonic studies. If one is interested in carrying out a *demand* study on characteristics, of course, then it is essential to consider these matters: King's study of the demand for housing characteristics, for example, requires the assumption that buyers are adjusting their requirements for space and other characteristics to characteristics prices, but sellers are not varying the amount of the characteristic space they sell in response to these same prices. However, the validity of estimated implicit prices for housing characteristics does not depend on equivalent assumptions.

Yoram Barzel, during the discussion, noted that there must be some

reason why grocers stock shelves instead of behaving as in the simile. Quite so. Some characteristics are sold prepackaged, rather than separately, for economic or technical reasons, and one can think of many of them.[10]

The implication of this observation, however, is that even though we want to employ hedonic prices for purposes similar to the ways in which we use directly observed prices, implicit prices derived from a hedonic function are nevertheless not the same thing as prices directly observed. There are quite a number of differences, which should be considered carefully when using the hedonic prices for purposes such as demand analysis, or for constructing price or cost-of-living indexes. Moreover, if one believes (as many economists apparently do) that a better understanding of the hedonic estimates is required in order to justify their employment in various applications, then the analytical work that will give us the understanding we need must focus on the differences between hedonic prices and directly observed ones.

In the remaining portion of this paper, I intend to discuss a few of these differences (and also some similarities). The list I present is not an exhaustive one nor is it meant to be. Rather, it should be viewed as providing a few illustrative examples.

I. TRANSLATING HEDONIC ISO-EXPENDITURE LINES INTO BUDGET CONSTRAINTS ON CHARACTERISTICS

The usual hedonic function is estimated using an array of prices — that is, the data for a hedonic investigation almost always include a number of different levels of expenditure on characteristics of the product under investigation. This means that the data, in combination with hedonic estimates of characteristics prices, generate a family of iso-

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[10] There is nothing very obscure or arcane about these reasons. In a few cases, it may be technically impossible to break up characteristics. In most cases, however, the usual bundle of characteristics incorporated into a good are by no means technically immutable; rather, they are tied together mainly for convenience or cost advantages. For example, it is clearly technically feasible to sell cars without engines (so performance characteristics could be sold as a package separate from the rest of the car). At one time, cars could be purchased without bodies, and sent to a firm which specialized in construction of the body and finishing the completed car (and this practice was by no means uncommon, among expensive cars especially). The reason cars are now sold complete with engines and bodies is mainly that it is much cheaper to put the whole package of characteristics together at the factory than to buy the packages separately and have them assembled. On the other hand, there seems to be no production-economy reason why refrigerators and other appliances have come to be included in the package of characteristics we call "housing," rather than purchased separately. Here, the reason seems to be related primarily to inefficiencies in the distribution system for appliances, and partly to institutional mortgage practices.

expenditure lines, not just one. All the commonly used functional forms for hedonic studies yield families of iso-expenditure lines that are radial displacements of each other.

Moreover, data on characteristics for automobiles, or housing, or groceries must be combined with information on other goods consumed — or on characteristics of those goods — in order to define the full budget constraint. This means that, in the general case, one may derive from a hedonic function for *one* product a family of segments of budget constraints. If there are many different products, and each product has many characteristics, the number of budget segments, or characteristics, that must be considered in a demand study may easily become unmanageable.

The data size problem is not, however, unknown in conventional demand studies on goods. Specifying all possible cross-effects quickly results in a very large matrix of parameter estimates. The solution has been to find recourse to the notions of separability and "branches" of utility functions,[11] which impose restrictions on some of the cross-price terms. Obviously, a similar approach will be appealing for use in demand studies on characteristics. If it can be assumed that the utility function is separable with respect to the characteristics derived from the product for which the hedonic study was carried out, then the hedonic estimates can be taken as defining a "branch" budget constraint, or a family of them (this is precisely the use King has made of the housing hedonic function in his paper).

Thus, this question is not really so different in characteristics and in goods worlds. Very probably, however, appropriate separable branches will be more difficult to find in a characteristics world, and the characteristics in the branch frequently will not coincide with the characteristics that happen to come prepackaged in the product being investigated. King notes that some of his housing characteristics are undoubtedly made up using goods not included in the home-purchase transaction; and a demand study for automotive characteristics could hardly neglect the price of gasoline.

Another problem is the treatment of services of durable goods. Most hedonic studies are concerned with durables, but there have been few attempts to define characteristics as service flows. Moreover, although this precedent is well established for single-equation demand studies, it has not so far been extended to the estimation of sets of simultaneous demand equations.

[11] The reference is to the "utility tree" concept proposed by Strotz (1957).

II. "MARGINAL" CHARACTERISTICS PRICES

One of the most striking differences between hedonic and directly observed prices is the fact that in the hedonic world, the summation of price times quantity seldom yields total expenditure. For one thing, a significant, positive intercept term has been reported in almost all existing hedonic studies. A nonzero intercept means that multiplying estimated prices of characteristics by the quantities of characteristics included in the package falls short of total expenditure on the package. This is true even with a linear hedonic function (such as the one used by King), which yields estimated prices for characteristics in terms of dollars, unless some economic interpretation is forthcoming for the expenditures accounted for by the intercept.[12] More crucially, with other forms (such as the semilog and double-log functions) the price of incremental units does not remain constant as larger packages are purchased.

In other words, all three functional forms yield a "marginal price" (the price paid for incremental units of characteristics when purchased as part of the same bundle) which differs from the average price; moreover, in the semilog and double-log cases, this marginal price is an increasing function of the quantities of characteristics purchased in the bundle. Our conventional theory of consumer behavior does not encounter such phenomena, and so, not surprisingly, existing empirical consumer demand systems cannot deal with them.[13] Nor does any of our conventional upward-sloping supply price notions seem adequate to characterize these situations.[14]

There is, however, more than one marginal price concept that may plague attempts to explore behavior toward characteristics using hedonic prices. The preceding marginal price concept corresponds to an increment in expenditures on characteristics. Call this, for convenience, the "marginal Engel price of characteristics."

Demand studies are typically concerned with consumption effects of relative price changes. In demand studies carried out on goods, one assumes that the relative prices consumers face are not affected by

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[12] A good example of such an interpretation is provided by Stone (1956), who interpreted the positive intercept in a hedonic regression of transportation fares and distances as the charge for loading and unloading. In other instances, the intercept may measure the value of characteristics which were omitted from the investigation.

[13] King evades the problem by throwing the intercept into the "price" of two of his characteristics.

[14] There is, however, a crude analog to the Phelps-Winter (1970) result that pushing more purchases into a fixed time dimension will only be possible by increasing the price paid. In the present case, increasing unit price (of characteristics) is paid when more units of characteristics are forced into a single physical package.

individual decisions on proportions in the consumption basket—that is, budget constraints are straight lines, with constant slopes.

In the hedonic, or characteristics, world relative prices may have altogether different properties. Lancaster (1971) explicitly introduces the possibility that in a world of characteristics, budget opportunity sets may be convex, such as Figure 1 (the segmented linearity of Lancaster's locus stems from assuming that only a limited number of characteristics proportions are available).

With hedonic estimates of a characteristics world, whether branch budget constraints have constant slopes depends on the form of the hedonic function. Two of the three most commonly employed functional forms for hedonic studies (the linear and the semilog forms) yield budget constraints with constant slopes.[15] The double-log form, however, yields the awkward budget constraint of Figure 2, which would pose analytical problems for studies of consumer behavior unless indifference curves on characteristics χ_1 and χ_2 were sharply bent.

Thus, functional forms that have been used for hedonic studies admit price phenomena that are not present under the assumptions employed in working out the conventional theory of consumer behavior toward goods. What can economic theory say about the admissibility of these various functional forms?

Basically, theory can say very little. The characteristics world, or the hedonic world, contains a consumer optimization problem that is in many ways analogous to the standard textbook problem. However, they are not identical problems. The nature of the budget constraint facing the consumer in the standard problem stems from the assumption that he can buy all he wants at the prevailing price, without influencing that price.[16] In the Lancastrian, or hedonic, world, charac-

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[15] Contrary to assertions that have been made, the semilog form, though producing nonconstant marginal Engel prices, exhibits *constancy* of relative prices with respect to changes in *proportions* of characteristics. Recall that the price of product variety *i* (call it P_i) is interpreted as total expenditures on characteristics when variety *i* is purchased. Then, with the semilog hedonic function

$$\ln P = a_0 + a_1 \chi_1 + a_2 \chi_2$$

the budget constraint is the slope $d\chi_1/d\chi_2$ (ln P_i constant), which is: $-a_2/a_1$—clearly a constant. I presume that the notion that the semilog function yields nonlinear budget constraints has arisen because of confusion over the concept of expenditures in a world of characteristics.

[16] Actually, there are such things as one cent sales, special prices for limited quantities, tied sales, and so forth, even when we are considering markets for goods; if the standard theory were modified to take account of these details, budget constraints on goods would become more complex than the usual textbook case (see also the closing sentence in Barzel's comment).

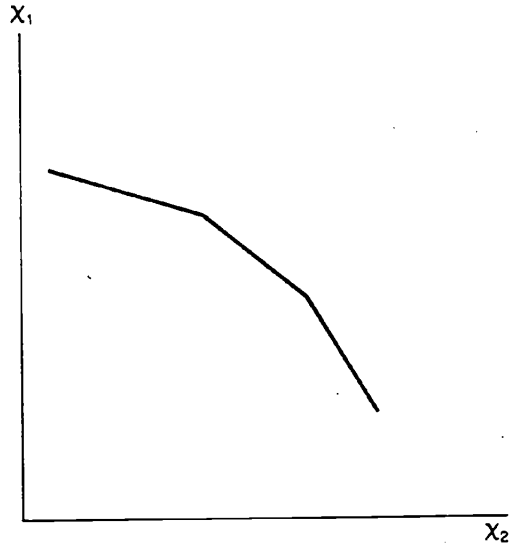## FIGURE 1

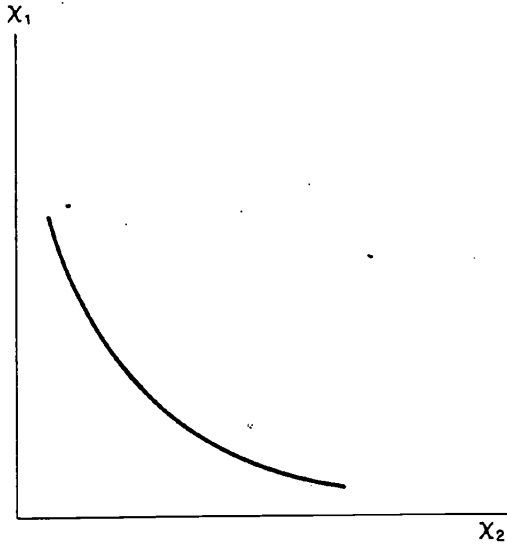### A Lancastrian Budget Constraint

FIGURE 2

A Budget Constraint Implied by a Double-Log Hedonic Function

teristics must be packaged into goods before they are sold. The consumer may indeed buy as many *goods* as he wishes without affecting the prices of goods; but he may not be able to insist that larger quantities of characteristics be built into a particular variety of good without changing the terms on which he acquires characteristics, and he may find that proportions of characteristics contained in a single characteristics bundle are not infinitely variable at constant characteristics prices. Just because the standard theory of consumer behavior defined on goods is set in a world where relative prices are insensitive to individual budget allocations does not mean that we can assume (or insist!) that the world of characteristics must exhibit like properties. Therefore, if the double-log form (or any other form that yields concave iso-expenditure segments) does indeed describe the situations encountered empirically, then this is simply a fact that must be dealt with.

### III. VARIANCE IN THE COMPOSITION OF CONSUMER'S BUDGET ALLOCATIONS

In performing demand analyses on goods, it is conventional to treat aggregative data as appropriate for estimating behavior of a "representative consumer." Whether time series or cross-section data are employed, the investigator typically attempts to determine how the average budget allocation changes in response to price or income variations.

Normally, variance among budget allocations of different individuals is treated as an annoying aggregation problem. Suppose we observe two individuals (I and II) whose preferences for apples and oranges are depicted in Figure 3. It is a formidable step to propose aggregating these two observations into a point midway between, and to use the resulting mean quantities of apples and oranges as observations applicable to studies of economic behavior. This is a well-known point (see Brown and Deaton, 1972, pp. 1167–1170, for a discussion of some proposals for dealing with it).

In the characteristics world, we encounter similar budget variance, though we usually give it a different name. If we substitute, for the apples and oranges of Figure 3, characteristics r and s, we may find that individuals I and II choose them in different proportions; if this occurs in characteristics space, then when the event is transferred back into goods space, we say that individual I chose variety A (a variety which combines characteristics r and s in the proportions indicated by point A in Figure 3), and individual II chose variety B.

FIGURE 3

Budget Allocation in a Goods World and in a Characteristics World

Apples (*r*)

Oranges (*s*)
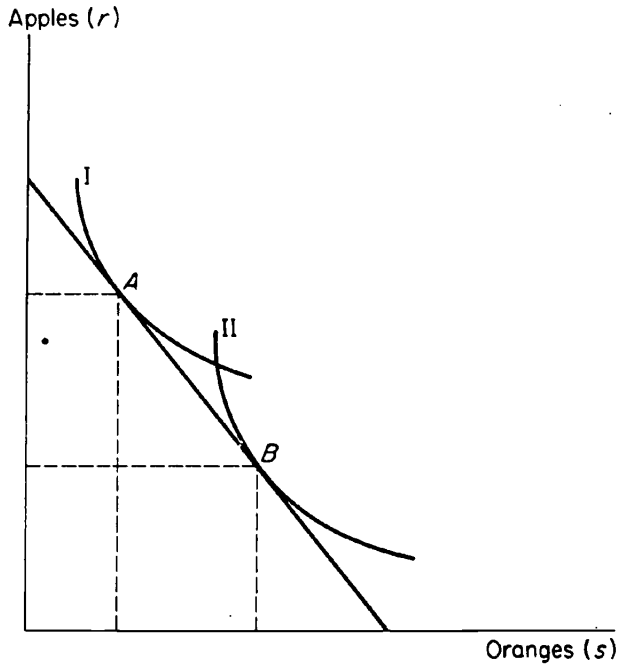
Therefore, the "taste difference" problem (or at least this aspect of it) has much the same force in empirical work on goods or on characteristics. Interpreting Figure 3 as applying to the characteristics world signals the death of the "representative consumer" to exactly the same degree that that embattled individual's existence is threatened by Figure 3 as it depicts budget allocations in the goods world.

But there is a difference. In the goods world, budget variance is merely a hindrance to performing demand analysis on aggregative data. If there were no variance (for given prices and income), we should be pleased. In the characteristics world, budget variance is still an annoyance, if the objective is to perform demand studies. But to obtain characteristics prices from hedonic studies, we need the variance. If everyone had identical tastes, then the number of varieties of a good on the market could not exceed the number of characteristics it contains, and it would not be possible to estimate the hedonic function.

Conventional demand studies usually assume that budget variance does not exist (through the assumption of the representative consumer). Though empirically incorrect, this assumption does no violence to the logic of the investigation. With respect to studies on demands for characteristics, assuming no budget variance is equally inaccurate empirically; but in addition, this necessary assumption for the demand study contradicts the framework required to develop prices for characteristics.

IV. PACKAGING

Characteristics come as a tied sale, in packages. This fact results in a number of problems which are not usually considered in consumer demand studies on goods. Lumpiness, corner solutions, and discontinuities are the most obvious points, but packaging may also account for nonconstant marginal characteristics prices (discussed in point II above). As Rosen (1974) has pointed out, if characteristics were not packaged into a limited number of varieties of goods, arbitrage could enforce linearity on the hedonic function.

Unfortunately, it is a fact that the number of packages is usually limited. Since this fact is so fundamental a part of the quality phenomenon, and of the analysis of the implications of characteristics of consumption goods, one cannot really expect to get very far without taking it into explicit consideration. In particular, assuming packaging discontinuities away in order to be able to employ traditional calculus methods (as does Rosen, 1974) seems a dubious methodology, particularly in view of Lancaster's (1971) demonstration of alternative programming models which can encompass these problems.[17]

V. ECONOMIC REALITY OR STATISTICAL ARTIFACT?

One may interpret hedonic results as measures of characteristics and characteristics prices. That does not make them so. Can we be sure that estimated hedonic prices represent something real, and that they are valid measurements for use in studies on consumer behavior?

The problem of determining whether a pricing concept or measure is an appropriate one is not a problem unknown in economic research in the realm of goods. One can cite, for example, the distinction between a true cost-of-living index (or constant-utility price index) and a fixed-weight index, or the choice between the price of a durable good

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[17] As noted in the preceding footnote (and also in Barzel's comment), traditional consumer theory defined on goods assumes away discontinuities and corner solutions, but greater empirical applicability requires that they be taken into account in the goods domain, as well as in that of characteristics.

and the price of its service flow; in both cases, the statistic readily available may not be the one appropriate for the problem at hand.

But if in this respect the difference between goods and characteristics worlds is one of degree, rather than of kind, nevertheless the degree is sufficient to be troubling. We are relatively inexperienced in research on characteristics, and only recently have hedonic studies emerged from the state where the investigator is both pleased and content if he can find some set of variables which seem to be associated with the price of the product. Now that we have evidence that such variables are around, the more difficult question of the validity of hedonic measures requires serious attention.

If hedonic results prove successful in dealing with other research problems, this would provide perhaps the most convincing evidence that hedonic estimates represent economic reality and not just some statistical accident. King's study is one persuasive test. Studies by Cowling and Cubbin (1971, 1972) apply an entirely different test, one first suggested by Griliches (in his now classic 1961 article, reprinted in his 1971 book). Cowling and Cubbin find that residuals from hedonic functions (which may be measures of over- or underpricing for packages of characteristics) are associated with changes in market shares among different sellers.[18] And although Barzel raises supply and demand factors for characteristics as an estimating problem, if hedonic prices are valid then one should expect that changes in them would be explainable by supply and demand factors — which suggests another form of test (partly applied in the Cowling and Cubbin papers).

One step that investigators can take to assure that hedonic measures are valid for research on consumer behavior is to require that, wherever possible, variables chosen for explanatory variables in hedonic functions should be in fact characteristics, and not some other variables which stand in proxy relations of some sort to what consumers want. For this reason, I would prefer measures of automotive characteristics somewhat along the lines of Ohta-Griliches' set of *Consumer Reports* data, in place of specifications such as weight and length, which stand as the roughest sort of proxies for attributes that are useful.[19] If, as Ohta-Griliches show, one gets about the same "fit" and results with one set as with the other, the possible use of hedonic

[18] However, a similar test applied to data on the U.S. automobile market (Triplett and Cowling, 1971) found no association between hedonic residuals and changes in market shares.

[19] Though there may well be a "two-state" relation between engineering variables and the performance characteristics buyers want, I am not convinced that Ohta-Griliches' specification variables can be regarded as engineering variables either.

measures in other economic studies swings the balance toward working with measures that can be regarded as characteristics.

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