A Characteristics Model Approach to Demand

Analysis for Wood Composites

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Summary

This report presents a conceptual framework for analyzing the demand for composite wood products based upon the Lancaster model of consumer demand. The Lancaster approach is opposed to traditional demand theory in that the characteristics or attributes of goods are demanded by the consumers, not the goods per se. This approach has the advantage of explicitly considering technology and quality attributes of products. Thus, intertemporal changes in quality and technology can be explicitly considered. The Lancaster approach may provide a way to analyze the demand for alternative wood-nonwood combinations, the raw material options for producing new composites, and the range of properties that can be obtained with alternative blends of materials.

Keywords: Demand, economic analysis, wood market, wood composites

Introduction

The demand for consumer goods satisfies relatively few simple needs such as food, shelter, and entertainment. These demands are met through the production of various goods and services. Thus, basic human needs can be satisfied through many combinations of materials and technologies. Many goods produced in an advanced economy meet similar needs; consumers apparently select only a few goods on the basis of their price and different qualities or attributes.

The traditional analysis of consumer demand deals with consumer choice under budget constraints in which preference ordering is used to maximize utility when price changes. This kind of analysis provides no way for using information about the properties of goods. Lancaster (1971) proposed an alternative theoretical approach based on the principle that all goods possess characteristics or attributes that are demanded by the consumers, not the goods themselves. For example, consumers do not demand food in itself, but rather the nutrients and flavors in the food.

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Lancaster stated that traditional analysis cannot predict how demand will be affected by a specified change in one or more properties of a good or how a new good fits into preference patterns over existing goods. Moreover, changes in the charactetistics of a good imply a new preference pattern. Consequently, "we must throw away any information derived from observing behavior in the previous situation and begin again from scratch" (Lancaster 1971).

In the Lancaster model of consumer demand, the concept of product attributes enters into the demand functions. The theoretical model of demand is based upon estimates of these attributes rather than simply the products themselves. Mckillop and Wibe (1987) stressed the potential value of the Lancaster approach as a fruitful method for studying the demand for wood products because the qualities and performance of wood determine demand Thus, quality measures of products as related to the technology for their utilization provides the foundation for the analysis of demand. Product quality and variety are incorporated in the model

Batten and Johansson (1987) extended the Lancaster model to preference groups of consumers and producers in a spatial context and combined it with logistics substitution models and export flow analysis. The authors used this approach to analyze product substitution and technological change and applied it to various markets in which forest products compete with other commodities. A space of characteristics was introduced in the model to obtain an invariant structure in which the dynamic competition between products takes place.

Trajtenberg (1990) used the Lancaster approach to lay down the theoretical and econometric framework for the measures of social gains from product innovation. The dynamics of the model form adjustments to changing conditions such as relative prices, production costs, product attributes, and preferences. The Lancaster approach offers promise to the analysis of new composite wood-nonwood combinations that may substitute for traditional wood products or may be used in new markets to replace plastics and other materials.

Traditional Demand Model

The traditional model begins with preference ordering (mapping) of all possible collection of goods. After the goods are ordered, all information about them is incorporated into the analysis. A budget constraint is then superimposed on the preference mapping and utility is maximized. More formally, the solution to utility maximization for an individual good can be stated as a set of demand functions f for each product j:

$$q_j = f(Y, p_1, \ldots, p_m) \qquad j = 1, \ldots, m$$

where q_j is the demand for j, Y is income level, and $p_1, \ldots, p_m$ are prices of $q_1, \ldots q_m$.

Charactesistics Demand Model

Theoretical Basis

The Lancaster characteristics demand model is theoretically based upon estimates of product characteristics rather than simply the products themselves. If z_{ij} is the measure of attribute *i* in good *j*, then the demand for good *q* can be written as a function of its amibute *z* and price *p* as follows:

$$q_j = f(Y,p_1,...,p_m,z_{11}...,z_{im})$$

where, in a general sense, the model of utility maximization is

$$U = U(z)$$

subject to

$$z = g(x)$$

Futhermore, the model can expressed as a transformed utility function

$$U = U(g) = V(x)$$

subject to

$$px = Y$$

This model is then equivalent to the standard utility model, assuming $V(x)$ functions possess the same curvature properties as utility functions, i.e., continuous, quasi-concave with positive first order derivatives. To simplify the model to make it observable and to structure the alternative technologies, Lancaster assumed $g(x)$ is linear where $z = B(x)$ and B is some matrix of fixed or Leontief coefficients. Furthermore, consumers are assumed to behave the same when *x* values are converted into *z* values, or at least consumers can be grouped into similar behavioral groups.

Operational Use

The characteristics model of demand behavior offers great potential for analysis of new products. The inclusion of quality attributes into the theory of demand using the Lancaster approach makes it possible to derive "Shadow prices" for different attributes. This broadens the theoretical approach to demand analysis and increases our understanding of the determinants of demand.

Operational use of the model requires identification of relevant technology and dam on consumption technology. Meeting these requirements in turn presents some interesting and difficult problems. First, the conceptual problem of defining the relevant characteristics must be addressed. Second, the appropriate data may not be readily available. The characteristics must possess a unique universal property; for example, the calorie or nutrient content of food or the strength of a beam. The definition of an acceptable attribute is based upon the physical characteristics of the product or good under consideration. These include basic physical, chemical, biological, and engineering properties. This modeling approach has been most successful when applied to goods whose attributes are additive and nonconflicting, such as the case of nutrient value for foods (Silberberg 1990). Under the simplifying assumptions of linearity and fixed coefficients, solving this type of problem-that is, of attribute utility maximization subject to a budget constraint–is similar to that of the linear programming problem.

The products (or goods) under consideration may be grouped according to the relevant attributes for their intended market. Customers using specific products can include households, firms, and other organizations. The products arc used as either inputs into the production process or for consumption. The customers may also be grouped according to their distinct characteristics (Lancaster 1979). Product groups can consist of products that (1) have similar relevant characteristics or (2) are used to meet similar needs or purposes. Then, for each defined product group, there is a related set of relevant characteristics and price. Preferences for each of these product groups may vary in characteristics for different customer groups. For a full theoretical exposition of this approach, see Batten and Johansson (1989).

Demand Analysis For Wood Composites

The Lancaster approach is particularly useful for assessing the demand for new composite products, where attributes can be "designed" into the products. Composite products are an important and growing segment of the forest industry. Material science has provided new technological capabilities that can provide increased benefits from composites. As a combination of two or, more materials, composites have performance characteristics that can combine the beneficial aspects of each constituent More than 70 percent of all wood materials in use today are composites in that they use some type of adhesive; that figure is expected to grow as new products and processes are developed. Wood composite products include laminated beams, plywood, laminated veneer products, fiberboards, wafer or oriented strandboard panels, particleboards, overlays, composite lumber substitutes, and composite matrix materials. The characteristics of new composite products need to be recognized to assess their potential impact on markets (Youngquist 1990).

New Applications for Wood-Based Composites

Wood-based composites offer optimized performance, minimized weight and volume, cost effectiveness, fatigue and chemical resistance, and controlled biodegradability. A variety of materials such as plastics, glass, metal, synthetic fibers, or other biomass materials can be combined with wood to produce a wide variety of products (Youngquist and Rowell 1988). For example, matrix-methacrylate composites can be used for flooring materials, musical instruments, sporting goods, decorative objects, and windmill blades (Stroebel and others 1984). Another promising application for composites is the combination of wood fibers with an inorganic matrix such as gypsum or portland cement

A host of new natural fiber-synthetic fiber products can be made as a result of the increased processing flexibility inherent in extrusion and nonwoven technologies. Extrusion or injection molding technology can be used for wood-plastic composites. In this process, thermoplastic resins are thoroughly mixed with finely ground wood particles or flour. This mixture is then forced out through a die to form a sheet, which can be processed in a secondary manufacturing operation into a number of molded or corrugated shaped sections. Nonwoven technology can be used to make composites with a high percentage of natural fibers blended with synthetic thermoplastic or thermosetting fibers to form a nonwoven mat. The mat can be handled in roll form and facilitates automated handling and processing in subsequent operations.

Combining wood with nonwood materials permits a manufacturer to consider the development of a wide range of new products, whose performance characteristics have the beneficial aspects of both materials. Wood and other natural fibers are strong, lightweight, abundant, and nonhazardous. Wood composites can also be made from recycled materials. Potential markets **for** these products include building materials, industrial goods, and packaging materials. In the future, wood composites may provide a wide spectrum of materials to complement traditional wood products and to provide new high-performance materials in new markets.

Characteristics Approach to Demand Analysis

The characteristics approach to demand analysis provides a convenient way to look at the market for wood composite products. Demand for most wood composite products is for intermediate goods in the manufacturing or building process. As such, the specific bundle of characteristics is related to its final use. New products can be analyzed directly in terms of their relevant characteristics and associated customer groups. This is particularly useful when considering the vast variety of materials that can be combined with wood. For example, Youngquist and Rowell (1988) identified 15 relevant wood properties and related them to five types of treatments for modifying wood structure or for combining wood fibers with other materials. These properties and related attributes could form the basis for economic analysis using the characteristics model approach. Specific cost information would be required to complete the analysis. The analysis could be further refined by differentiating the specific customer groups and markets associated with the product under consideration.

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