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WORKSHOP IN HEALTH ADMINISTRATION STUDIES

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"A New Approach to the Demand for Dental Care"

WORKSHOP PAPER

for

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A New Approach to the Demand for Dental Services

by

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Introduction:

On initial consideration, the demand for dental services may seem rather uncomplicated. Dentistry is small industry which provides a relatively limited number of services without need for large-scale technology or complicated organizational structures. However, dental services must be tailored to each individual's needs and, therefore, can neither be inventoried nor mass produced. Moreover, the individual receiving dental services must participate intimately, both with his time and his body, in their production. In addition, institutional characteristics, such as product differentiation and prepayment plans with deductibles and coinsurance, greatly complicate the concept and measurement of price. These features provide economists with fertile ground in which to think about various aspects of the general theory of economic demand, but they also impose considerable challenge to the construction of empirical tests.

Most previous research has approached the study of the demand for dental services from the traditional theory of consumer demand. The theory assumes that goods are the immediate objects of individual preferences. Consumers are constrained in the choices by their income from various sources. For those collections of goods that are attainable, consumers prefer some collections over others. Their actual choices reveal their preferences.

Some economists regard this aspect of traditional demand theory as unduly barren and incapable of explaining critical elements of consumption behavior. It is more likely, they contend, that individuals really choose goods because they possess particular characteristics. Automobiles, for example, possess the many characteristics, including transport (i.e., movement from place to place) and capacity (i.e., the space to accommodate different numbers of travellers). It is the characteristics of goods that are the ultimate objects of individual preference. Goods themselves are simply used as

inputs along (in some cases) with the individual's time in the production of these characteristics.

Recently, a new issue has emerged which greatly complicates demand analysis for dental services. It is the reduction in the prevalence of dental caries (tooth decay) that appears to be occurring throughout the industrialized world. From 1971 to 1980, caries experience has declined by approximately 30 percent for children between 5 and 17 years old. Evidence is beginning to accumulate that these reductions are not transitory and are extending into young adult age groups. Little is currently understood about the relationship between a reduction caries and the demand for dental services. However, since caries has been the economic base of the dental industry throughout the 20th Century, it is not unlikely the large reductions of the disease will have a profound effect on demand.

To address this as well as other limitations of traditional theory, a new approach is used in this study. It is called a characteristics/needs approach to the demand for dental services. On the new model, the characteristics possessed by dental services are the immediate objects of individual preferences. The demand for services is derived from the demand for these characteristics.

The remainder of the presentation will describe the characteristics approach to demand and contrast it with the traditional theory. This will be done through a series of bullets describing each model. Next the data used to estimate the new model will be described followed by an explanation of the statistical estimators used. The empirical results of the estimation of a five different utilization or demand relations will be described. These are for 1) utilization of any dental services, 2) the demand for oral examinations, 3) the demand for preventive services, 4) the demand for restorative services, and 5) the utilization of periodontal services.

TRADITIONAL DEMAND THEORY:

o Traditional demand theory abstracts from the intrinsic characteristics of goods and from the time required from the individual to consume them.

o On this theory, if an individual chooses to receive dental services, it is because he desires those services in and of themselves. Dental services are the ultimate objects of individual preferences.

o Consumers are constrained in the choices by their income from various sources. For those collections of goods that are attainable, consumers prefer some collections over others. Their actual choices reveal their preferences.

o Changes in observable choices are explained by changes in relative prices and real changes in the budget constraint.

o If an individual alters his choice ordering, absent changes in prices or his budget constraint, the different choice set is attributed to a change in the individual's preference structure. Since the concept of preference is primitive to the theory, those types of choice changes are, in fact, unexplained.

o Traditional theory does not offer a well-articulated justification for incorporating individual characteristics such as educational level, the time necessary for consumption, clinically defined need for health care, or measures of health status into the analysis.

o When education, need, or other such variables have been included in a traditional model, they have been justified on an 'ad hoc' basis or as part of a 'tastes' matrix.

o A large proportion of the American public do not visit a dentist regularly. In the sample survey used in this analysis, approximately 35 percent did not utilize dental services over a previous 24 month period.

o Non-utilization does not fit well into the conceptual framework of traditional demand theory.

o On traditional theory, if an individual consumes a large number of dental services during one year, it is because he prefers those services to other choices available.

o If the next year (holding relative prices and income constant), he does not consume any services, it is because his preferences have changed and he now prefers other available goods to dental services.

o No real explanation is provided within the theory as to why some people may attend the dentist regularly while others go only after long intervals, if at all.

CHARACTERISTICS APPROACH TO DEMAND THEORY:

o   A new approach is used in this study. It is called a characteristics/needs approach to the demand for dental services.

o   On the new model, the characteristics possessed by dental services are the immediate objects of individual preferences. Demand for dental services is derived from the demand for the characteristics possessed by dental services.

o   In aggregate, dental service possess several desirable characteristics. Oral disease, trauma, and other conditions can damage tissues to the extent the tissues lose their structural integrity. When structure is damaged sufficiently, oral function is impaired. An individual can no longer chew effectively or speak clearly.

o   Dental services remove disease, restore structure, and restore function. Disease, trauma and maldevelopment also affect an individual's physical appearance. Dental services can change appearance.

o   These characteristics do not depend on subjective judgment; instead, they are objective and measurable. Different dental services possess different combinations of characteristics. Not all characteristics are possessed by each service.

o   The relationship between dental services and the characteristics they possess is embodied in a technology which relates the goods to characteristics. Usually, consumption technology is assumed to exhibit constant returns to scale.

o   The characteristics possessed by dental services are tied to particular services through the concept of need for care.

o   If a person needs a service because of an objective condition, biological or physical, that exists in the oral cavity, then consumption of that service can provide some of the above characteristics.

o   If a person does not have those conditions, then the service will not provide characteristics.

o   Although the above characteristics are objective, individuals' preferences for them are not.

o   Two people can have a missing tooth, creating a very noticeable space, one may be unconcerned and do nothing while the other will get a replacement at the earliest opportunity.

o   A carious tooth may cause intolerable discomfort in one individual while another will consider the pain a minor nuisance requiring no immediate action.

o   In addition, dental services provide two generic characteristics that are not tied to a particular need for treatment. These are information and prevention.

o   Individuals also exhibit different preferences with regards to preventing future dental problems and acquiring up-to-date information about their oral conditions. Individuals with high aversion to risk will visit the dentist regularly for an examination, cleaning, and removal of presymptomatic pathology. Others go years without visiting a dentist.

o   With a characteristics approach non-utilization could occur for a number of reasons that would be consistent with the model.

o   In the absence of a clinical need, the rational individual will not seek services since those services will not provide any of the characteristics that individuals want.

o   Of course, without a recent oral examination by a dentist, individuals will not have up-to-date objective information regarding their need for services. In that case, they must rely on their perception of need which may be inaccurate. Extremely risk averse individuals will not take the chance that their perception of need could be inaccurate. They will seek a dental examination regularly to acquire up-to-date information.

o   Individuals, however, learn from experience. If they do not have history of accumulating need for care rapidly, they may wait longer intervals between dental examinations and take the chance that their perception of their needs is not too different from their actual needs.

o   The characteristics that individuals desire from dental services will also influence whether or not they routinely seek oral examinations and preventive services.

o   Accurate information acquired through periodic examinations is more important for individuals who want to preserve oral function and structure by consuming the characteristics of disease prevention and presymptomatic disease removal.

o   Individuals without a preventive orientation are more likely to wait until they have symptoms and then visit the dentist to get relief from the symptoms through removal of advanced disease. They, of course, must be content with the degree of function, structure, and/or appearance that can be provided under those circumstances.

o   A third reason for non-utilization that is implied by the current model is the assumption that individuals are not indifferent to time spent at the dentist. In fact, on this model individuals prefer to minimize time at the dentist because they view that experience as both uncomfortable and threatening.

o   In any sufficiently large sample of individuals, both utilizers and non-utilizers should be present.

Comparison of Traditional and Characteristics Specifications:

o   The functional relationship is: $Q = f(p, I; Z)$

o   The functional relationship under the new approach is: $Q = f(p, I, N; Z)$

Data:

o   The data were collected by a national probability household survey conducted in 1981 for the U.S.P.H.S. by the Research Triangle Institute.

o   Detailed data on prices and utilization are used to test the new model.

o   Several different instruments were used to collect data from the most reliable source.

o   The personal characteristics of individuals were obtained through a household interview.

o   The extent and type of oral disease and treatment needs were obtained with a personal oral examination by trained dentists.

o   Features of dental prepayment coverage were obtained from insurance booklet obtained from the carriers.

o   Prices and dental services received were collected directly from the individual's dental practice.

o   These data are more accurate than any yet available, and they permitted the valid measurement of theoretical concepts at the level of disaggregation necessary to estimate demand functions for homogenous groups of dental services.

o   THe means and standard deviations of the continuous variables and the definitions of the categorical variables are shown in the following table.

Means and Standard Deviations of Continuous Variables

Variable	Mean	Stand Dev
Expenditures		
Exams	$38.80	$33.32
Preventive	45.71	34.23
Restorative	178.34	214.25
Nominal Prices		
Exams	11.30	7.65
Preventive	20.23	6.41
Restorative	19.62	6.28
Periodontal	49.35	17.55
Crowns	261.15	66.86
Effective Prices		
Exams	6.36	7.04
Preventive	11.16	9.83
Restorative	11.00	9.56
Periodontal	30.10	13.54
Crowns	250.15	137.80
Income (1000's)	24.3	18.9
Age	31.2	13.6
Family Size	3.5	1.5
Yrs Educ Head of Family	13.1	3.2

Definitions of Dummy Variables

|	
Dental Insurance	1 = has dental insurance
Race	1 = non-white
Sex	1 = female
Hispanic	1 = hispanic ethnicity
Marital Status	1 = married
SMSA	1 = family lived in an SMSA
Clinical Gingival Inflam	1 = some clinical gingiva inflam
Clinical Perio Needs	1 = some clinical perio needs
Education of Family Head	
Elementary School	1 = completed elementary school
College	1 = completed college

Estimation of the Models:

o Two different relations are involved in the empirical estimation of the model.

o One relation discriminates between utilizers and non-utilizers on the basis of various personal and economic variables.

o The other relation is a traditional demand function, expressing the relationship between quantity demanded and prices, income, and need for services among utilizers.

o Estimation of the both relationships with one equation using an ordinary least squares (OLS) estimator will not produce consistent estimates of either utilizer/non-utilizer relationship or the demand function.

o The large number of individuals with zero utilization causes inconsistency due to inappropriate functional form.

o Logistic multiple regression (Logit) is used to estimate the utilization/non-utilization equation.

o Logit assumes an underlying logistic probability distribution of a binary dependent variable. Conditional on that assumption, Logit is a maximum likelihood estimator of the relation between the binary dependent variable and both continuous and categorical independent variables.

o Estimation of the demand function involves four major issues:

1) the use single equation or simultaneous estimators, 2) the possibility of self-selection of dental insurance by individuals, 3) intrafamily correlation among the variables, and 4) inefficiency caused by the skewed distribution of expenditures for dental services.

o The first issues two relate to bias and consistency of estimators; the latter two relate to efficiency of the estimators.

o Extended specification analysis indicates that the first two are not expected to be major drawbacks to the use of OLS estimators. Moreover, specification error tests were performed to assess for the bias in the residuals which would indicate the presence of these factors.

o The latter two issues (intrafamily correlation and skewed expenditures) are important.

o All demand equations are estimated using a random effects variance component estimator to control for intrafamily correlation.

o Log transformation of expenditures are used for the dependent variable to reduce the inefficiency due to skewed expenditures. See following table.

BAR CHART OF LOG OF EXPENDITURES
FOR ORAL EXAMINATIONS

5.3+

2.9+

0.5+

BAR CHART OF OF EXPENDITURES
FOR ORAL EXAMINATIONS

185+

95+

5+
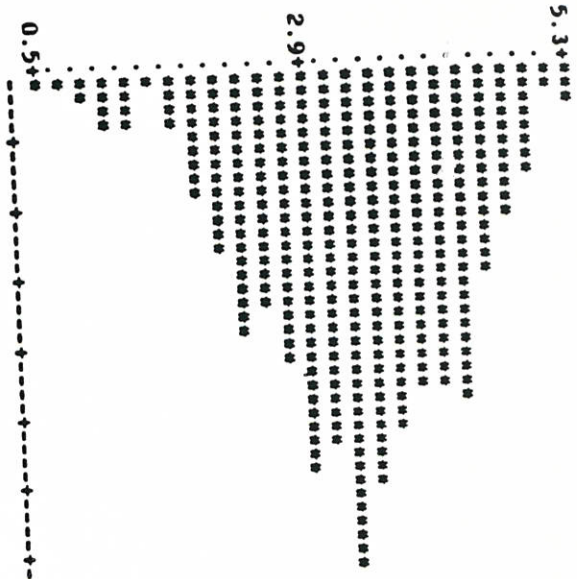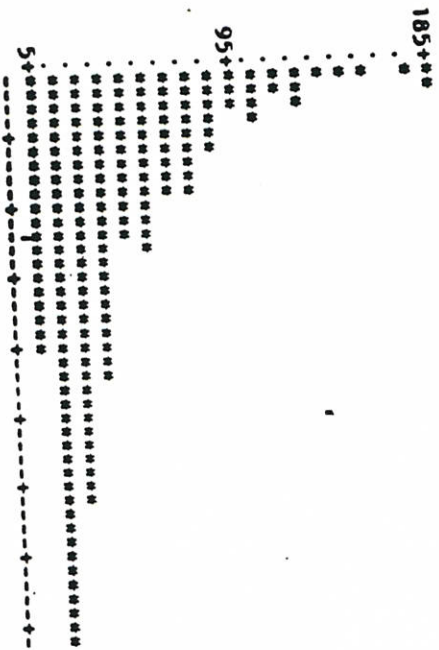
NORMAL PROBABILITY PLOT OF LOG
EXPENDITURES FOR ORAL EXAMINATIONS

5.3+

2.9+

0.5+

-2   -1   +0   +1   +2
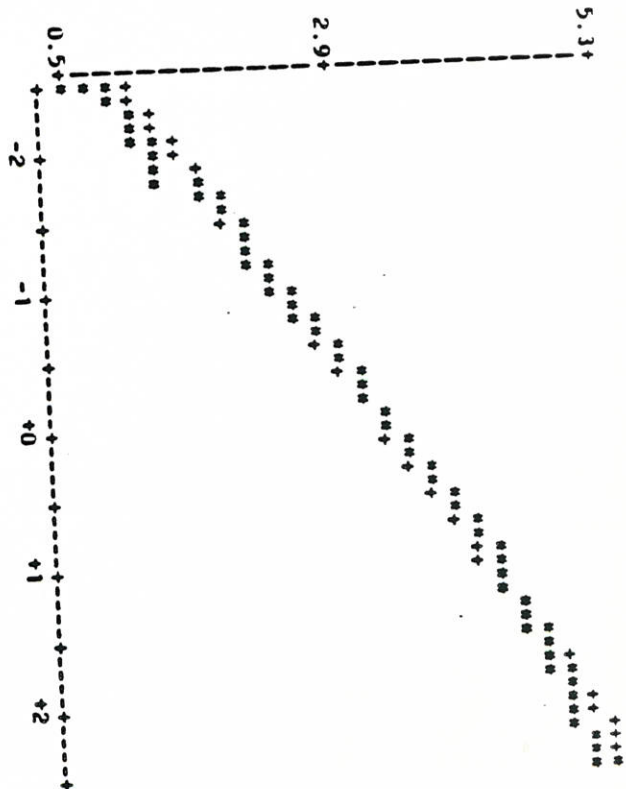
NORMAL PROBABILITY PLOT OF
EXPENDITURES FOR ORAL EXAMINATIONS

185+

95+

5+

-2   -1   +0   +1   +2
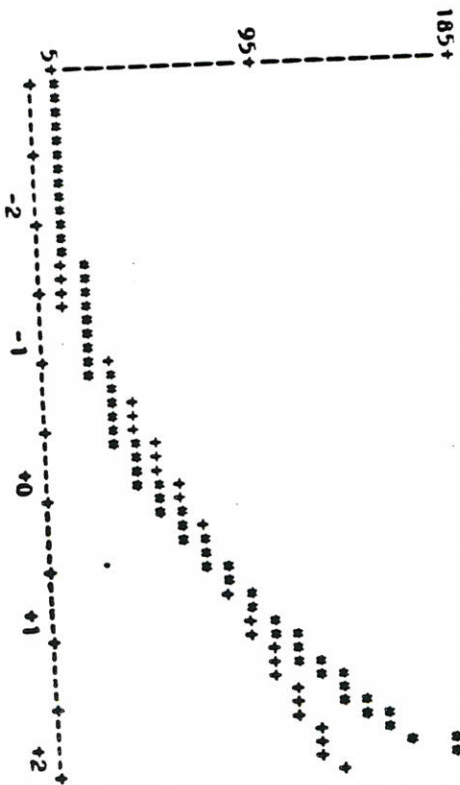
Empirical Results:

I. Logit Estimation of Utilization/Non-utilization:

o   The results of the Logit model to discriminate between utilizers and non-utilizers are shown in Table One.

o   The Chi-Square for the model is 162.8. This is highly significant; the probability of Type I error is close to zero.

o   A good method of assessing the overall predictive ability of the model is the estimated probability of concordance between predicted probabilities and responses.

o   Consider all pairs of observations which are different; one is a utilizer while the other is a non-utilizer.

o   Count the number of pairs in which the utilizer has a higher predicted probability of utilization than the non-utilizer.

o   For these observations, the predicted probability and actual behavior are concordant.

o   The fraction of concordant pairs (the probability of the model's prediction being concordant with behavior) measures the predictive ability of the model.

o   For example, if the utilizer from each pair was chosen randomly, the expected fraction of concordant pairs would be 50 percent.

o   A perfectively predictive model would have a concordance fraction of 100 percent.

o   For this equation, the fraction of concordant pairs is 74 percent. Thus, the Logit equation increased the ability to discriminate utilizers by 24 percent over random choice. This is about one-half the increase expected from a perfectly predictive model. This results in a rank order correlation (loosely analogous to R^2 in regression) for concordant pairs of 0.504.

o   A visual representation of the predictive power of the model is shown in Plot One. The cumulative true proportion of the sample utilizing dental services is plotted against the average predicted probability of utilizing dental services.

o   Completely accurate prediction would be a straight line running diagonally from lower left corner of the plot to upper the right corner. As Plot One illustrates, the model is very accurate throughout most the sample. The incorrect predictions are in the higher average predicted probability range.

o   The results for specific variables included in the model are consistent with the characteristics model.

o   Having a regular dentist is the most powerful predictor of utilization. It is significant with probability of Type I error of less than 0.0001.

o   The Logit coefficient is 1.64. This indicates the log of the odds ratio changes by that amount for the individual who has a regular dentist compared to one who does not. The actual change in the probability of utilizing dental services depends on both the Logit coefficient and the level of probability. Suppose the level of probability of utilizing is chosen to be the sample level (79%). Then, the probability of visiting a dentist during the previous 2 years is increased by 13.9 percent if the individual has a regular dentist.

o   This finding is thoroughly consistent with the characteristics model of demand for dental services. People who have a regular dentist have one because they consume a different bundle of characteristics. They are not content to wait until oral conditions manifest themselves through symptoms. Instead, they attend a dentist regularly, with or without symptoms. They attend because they want current information concerning their oral conditions, because they want to consume preventive services, and because they want presymptomatic disease removed.

o   Self-assessed problems with chewing and untreated conditions are not significant predictors of utilization. This is not unexpected. Seventy-nine percent of the sample utilized dental services during the previous 2 years. The sample was largely composed of regular utilizers who do not wait for symptoms to visit the dentist. With oral disease declining, the number of symptoms in the general population is also likely to be declining. We may be becoming a nation with relatively few oral symptoms.

o   The only statistically significant clinical needs variable is restorative needs--the more teeth that needed restorations at oral examination, the less likely the individual utilized dental services during the previous two years. Again, a very reasonable finding. Utilizers do not allow clinical restorative needs to accumulate; non-utilizers, perforce, do. The two groups prefer a different bundle of dental characteristics. The probability of visiting a dentist decreases by 10 percent with each tooth that needs a restoration.

o   Neither the measure of gingival symptoms nor the measure of periodontal treatment needs is significant. They are both discrete variables (need--no need), but this does not explain their insignificance. Continuous measures of these conditions are also insignificant. These conditions simply do not discriminate between utilizers and non-utilizers. The reason for this is most likely because individuals, even if they are regular utilizers, allow these conditions to accumulate instead of having them treated.

o   The reason may be that periodontal conditions usually do not produce symptoms; they seldom impair function to the point where individuals cannot function as they prefer; and they do not produce readily apparent changes in appearance. Consequently, individuals are more likely to allow these conditions to accumulate rater than demanding periodontal services to restore the above characteristics.

o   Dental insurance coverage increases the probability of utilizing dental services. This is consistent with theoretical predictions since insurance lowers price, other things being equal. Dental insurance increases the probability of utilization by 9.6 percent, given the 79 percent level of utilization by the sample.

o   Two socioeconomic variables are statistically significant at the 5 percent error level--hispanic ethnicity and years of education for the head of the family. Both decrease the probability of utilization once the effects dental insurance, clinical needs, and having a regular dentist are controlled. Race increases the probability of utilization but it carries a higher risk of Type I error.

Empirical Results:

II. The Demand for Oral Examinations:

o   The model explains almost all of the variation in the log of expenditures for oral examinations. The R^2 for the equation is 0.96 (Table Two).

o   The usual stochastic specification of a theoretical model is that the error terms are independently, normally distributed variates with zero mean and constant variance.

o   For a regression equation without misspecification this specification is true. A systematic component is not present in the mean squared error of the residuals of the regression model. Instead the residuals are solely composed of the true errors which are independently, normally distributed variates.

o   Misspecification introduces a systematic component to the residuals. The statistical test used to test for misspecification is called the Reset Test. This test is used to test where the residuals have a zero mean. The test involves re-estimating the equation with the addition of three variables: the predicted value of the dependent variable from the original equation, squared, cubed, and quadrupled. The additional terms are the three lowest order terms of a polynomial in the predicted values of the dependent variable. When included in the test equation, they pick up a systematic component in the residuals. The reasoning behind the test is that a systematic component of the residuals can be viewed as some unknown function which, however complicated, can be approximated by a polynomial of sufficiently high degree. Previous research has found that the 4th order polynomial with the linear and constant terms removed yields good results for a test of a non-zero mean for error terms.

o   Individually, none of the powers of the predicted values of the dependent variable is statistically significant at usual error levels. The Reset F statistic tests the joint significance of the three powers of the predicted values of the dependent variable. The Reset F Statistic for this equation is 5.65 which is significant at one percent error level. Thus, the total absence of misspecification is not accepted.

o   However, the size of the Reset F Statistic can also be used as an index of the amount of misspecification present. F values of 50 or 100 are not uncommon is models with substantial misspecification such as omission of an important variable. The Reset F Statistic for this equation is the smallest of any formulation tried and indicates that the the amount of misspecification is minimal. Moreover, the hypothesis that the residuals are normally distributed is accepted.

o   The only variables in the model that are significant are economic variables of theoretical importance. They all have the expected signs. Family income is significant with less than a 1 percent chance of error. It is positive and has an elasticity of 0.17. The own price variable is negative and statistically significant with almost no chance of error. Thus, the demand curve for oral examinations is downward sloping against own price as expected for a normal good. The elasticity of own price is -0.45 which is somewhat inelastic but consistent with other estimates from cross-sectional data.

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o   There is substantial collinearity among prices for different services in dental practices. Therefore, only a few other prices for dental services could be included in the model. The prices which are most likely to be complements or substitutes and which were not too collinear are included. The price of cleanings is very correlated with the price for examinations. In fact, they seem to function as a single price and only one could be included in any equation.

o   In this model, prices for restorations and periodontal services are included. The price for periodontal services is not significant. However, the price for restorative services is significant and positive, indicating that examinations and restorations are substitutes. The restorative cross-price elasticity is 0.29.

o   Neither travel time to the dental office or office waiting time are significant. This is not surprising in view of the theoretical discussion regarding the role of time. The opportunity cost of annual time spent for dental visits is not large, especially for the unemployed and for those with paid sick leave. Moreover, market forces distribute dental practices geographically to limit extremely long travel times.

o   Clinical needs for restorations and for periodontal services are not significant. This is consistent with a model that specifies that clinical need is not generic but related to specific services. Oral examinations provide information about clinical needs, but they are not functionally related to any particular clinical need. With prices, family income, time, and need included in the equation, it is not surprising that sociodemographic variables are not significant. Only one is close. Individuals with a college-educated head of family spent more for oral examinations, ceteris paribus.

Empirical Results:

III. The Demand for Preventive Services

o The demand for preventive services is also estimated using the random effects variance component estimator to control for intrafamily correlation.

o The results for the <u>log of expenditures</u> are shown is Table Three. The R^2 for the equation is 0.97.

o The normality of the residuals is accepted at the 5 percent error level.

o The Reset F Statistic for non-zero mean is 2.73 which is not significant at the 1 percent error level. Misspecification cannot be detected in the residuals.

o The price of preventive services (own price) is significant and negative with an elasticity of –0.41.

o The price of restorative services is significant and positive with an elasticity of 0.30.

o Travel time and office wait are not significant; neither is family income or any measure of clinical needs.

o Only the result for family income is unexpected. The log transformation may have reduced the variation in the dependent variable so much that the influence of income cannot be detected.

o Age is significant and is positively related to expenditures.

o The dummy variable indicating a elementary education for the head of the family is significant and negatively related to expenditures.

o Sex and hispanic ethnicity are marginally significant. Females and hispanics spend slightly less for preventive services, ceteris paribus.

Empirical Results:

IV. The Demand for Restorative Services

o   The demand for restorative services is also estimated using the random effects variance component estimator to control for int afamily correlation.

o   Expenditures for restorative services are very skewed; the log of expenditures is clearly the superior formulation.

o   The results for the equation for restorative services are shown in Table Four.

o   The R^2 for the equation is 0.96.

o   Normality of the residuals is accepted at the 3 percent error level.

o   The Reset F Statistic for non-zero mean is 6.55 which is significant, but once again, the size of the statistic indicates that the amount of misspecification is minimal.

o   The price of restorative services (own price) is significant and negative with an elasticity evaluated at the mean price of restorations of -0.26.

o   The price of examinations is also significant and positive with a cross price elasticity of 0.27. This indicates that examinations and restorations are substitutes which is the same relationship found in the examination equation.

o   Family income is significant and positive with an elasticity of 0.15.

o   The most powerful variable in the model is the need for restorative services. It is positively related to expenditures as predicted, and provides strong confirmation for the theoretical model.

o   Periodontal need, in contrast, is not significant. This also is consistent with the model and supports the hypothesis that the influence of clinical needs on the demand for dental services is specific. The only other variables that are significant are dental insurance coverage and hispanic ethnicity.

o   Family size is close to being significant. They all are positively related to expenditures for restorative services.

Empirical Results:

V. Logit Estimation of Periodontal Utilization

o   Oral examinations, preventive services, and restorative services comprise over 80 percent of all services received by the study sample. None of the other dental services were received by a sufficient number of individuals to allow the estimation of a demand function.

o   However, in view of the potential importance of periodontal services as the prevalence of caries declines, maximum likelihood logit estimation is used to develop a prediction equation for expenditures for periodontal services conditional on some dental expenditures.

o   Only 14 percent of the study sample actually had expenditures for periodontal services.

o   The results of the logit estimation are shown in Table Five. Overall, the model is very significant.

o   The model Chi-Square is 119.4. The model is very predictive.

o   Ninety-two percent of its predictions are correct.

o   The fraction of concordant pairs is 85.4 percent.

o   Since random choice would correctly classify utilizers of periodontal services 50 percent of the time, the model increases the correct classification by 35 percent over a random choice or by about 70 percent of the increase in concordance expected from a perfect model. Rank order correlation is thus 0.708.

o   The price for periodontal services (own price) is significant and negatively related to the probability of expenditures for periodontal services. A unit change in the price of periodontal services changes the probability of expenditures for those services by 6 percent in the opposite direction of the price change.

o   The prices of an examination, a restoration, and a crown are also included in the Logit equation. Examination price is not significant; the other two are strongly significant and positively related to the probability of expenditures for periodontal services.

o   A unit change in the price either a restoration or a crown changes the probability of periodontal expenditures by 6 percent, this time in the same direction as the change in price.

o   The only other variable that is significant at the 5 percent error level is clinical need for restorative services.

o   Periodontal need, crown and bridge need and the presence of gingival inflammation are not significantly related to the probability of expenditures for periodontal services.

o   The results provided no support for the contention by some that as the prevalence of caries declines (and with it the need for restorative services in the long-run) the utilization of periodontal services will increase to fill the void.

o   For these results to support that hypothesis the need for restorations should be negatively, not positively, related to expenditures for periodontal services. Moreover, periodontal needs, as measured by the presence of deep pockets, should be positively related to probability of periodontal expenditures. Neither relationship is found.

o   Instead, the evidence is consistent with evidence from the other equations. Individuals are willing to have untreated periodontal pathology in their mouth to a much greater extent than they find acceptable for caries. This may be because the early stages of periodontal diseases do not reduce function or change appearance as much as caries. It may be that individuals are unaware of these conditions because dentists are not diagnosing them. It may also be that the treatment of caries is traditional and accepted while the treatment of periodontal conditions is not. Whatever the reason, unless these preferences change, it is likely to prove overly optimistic to expect an increase in the demand for periodontal services to balance a decrease in the demand for caries-related services.

Summary:

o   The characteristics approach to the demand for dental services has several advantages over both traditional and health production function models of demand.

o   Most observers would agree that the clinical need for services which result from pathology and other objective conditions is important to understanding the demand for dental services.

o   Previously, measures of need were included in demand analysis on an 'ad hoc' basis.

o   The current model allows the integration of concept of clinical need directly into the theory of demand.

o   It does this by introducing characteristics of dental services as the immediate objects of individual preferences.

o   Dental services only provide characteristics if an objective need for services exist.

o   The relationship between needs and the characteristics of dental services is specific. Only services that are appropriate to a particular type of need will provide characteristics.

o   The empirical results of the study are strongly supportive of the characteristics/needs model of demand.

o   An equation to discriminate between utilization and non-utilization of dental services is estimated using maximum likelihood Logit estimators. The model increases predictive power by 24 percent over random choice which is 50 percent of the increase in predictive accuracy which would result from a perfect model.

o   Demand functions for oral examinations, preventive services, and restorative services are estimated using a random effects variance components statistical model to remove the effects of intrafamily correlation.

o   Logs of expenditures are used to remove the skew from expenditures and increase the efficiency of the estimates.

o   All of the equations are highly predictive and consistent with the characteristics/needs model of the demand. Own prices are negatively related to quantity demanded. Cross-prices are included and their influence identified. The elasticities are generally smaller than 1 but somewhat larger than most other estimates from cross-sectional data. Family income is positively related to quantity demanded.

o   As predicted by the model, needs for services are important but their influence is specific.

Summary: (cont)

o   Needs are not related to generic services such as oral examinations.

o   The need for restorative services is highly related to expenditures for restorative services.

o   The need for periodontal services are not related to probability of expenditures for periodontal services.

o   These results are consistent with the hypothesis that individuals allow periodontal need to accumulate in their mouths while they have restorative needs treated.

o   In this sample, at least, individuals utilize those dental services that provide the characteristic of presymptomatic disease removal for caries, but they allow presymptomatic periodontal disease to accumulate.

o   Finally, it should be emphasized that although the results of this study are supportive of the characteristics/needs approach to the analysis of the demand for dental services, the model needs to be submitted to further empirical tests using stronger research designs before final judgment can be reached on its predictive power. These tests should be with data from prospective studies using well-calibrated measures of clinical need taken at the beginning of the study.

Table One

Maximum Likelihood Logit
Binary Dependent Variable
Visited a Dentist During Previous Two Years

Variable	Parameter Estimate	x^2 Stat.	Prob. > x^2
Intercept	1.10	4.7	0.0302*
Dental Insurance	0.32	3.8	0.0500*
Regular Dentist	1.64	89.0	0.0001*

Self-Reported Perceptions of Dental Conditions

Problems Chewing	0.58	0.1	0.7919
Untreated Conditions-	0.28	2.5	0.1133

Clinical Needs at Oral Examination (after utilization-postdiction)

Restorative Needs	- 0.45	6.7	0.0098*
Periodontal Needs	- 0.07	0.1	0.8263
Gingival Symptoms	- 0.29	2.3	0.1274

Individual and Social Control Variables

Age	- 0.02	0.7	0.4059
Race Dummy	0.48	2.7	0.0983
Sex Dummy	- 0.06	0.1	0.7262
Hispanic Dummy	- 0.58	3.9	0.0471*
Marital Status	- 0.04	0.0	0.8420
Family Head			0.0447*
Yrs Educ	- 0.05	4.0	

Total Observations = 1091
Visited a DDS = 858
Did Not Visit DDS = 233
Model Chi-Square = 162.8
Percent Correct
    Concordant Pairs = 74
Rank Correlation of
    Concordant Pairs = 0.504

PLOT 1

CUMULATIVE TRUE PROPORTION OF THE SAMPLE WHICH UTILIZED
DENIAL SERVICES DURING THE PREVIOUS 24 MONTHS
VERSUS
THE AVERAGE PREDICTED PROBABILITY OF UTILIZATION FROM LOGIT

1.02 +

0.99 +

0.96 +

C   0.93 +
U
M
U 0.90 +
L
A
T 0.87 +
I
V
E 0.84 +

T 0.81 +
R
U
E 0.78 +

P 0.75 +
R
O
P 0.72 +
O
R
T 0.69 +
I
O
N 0.66 +

    0.77   0.79   0.81   0.83   0.85   0.87   0.89   0.91   0.93   0.95   0.97   0.99

AVERAGE PREDICTED PROBABILITY>=P

Table Two

Dependent Variable--Log of Expenditures for Oral Examinations

Variable	Parameter Estimate	T-Statistic	Prob. > T
Intercept	3.26	8.3	0.0001*
Economic Variables			
Own Price	- 0.04	- 4.8	0.0001*
Restoration Price	0.02	2.0	0.0488*
Periodontal Price	- 0.0007	- 0.3	0.7466
Family Income	0.007	2.6	0.0099*
Travel Time	- 0.004	- 0.8	0.4262
Office Wait Time	0.002	0.3	0.7981
Clinical Needs			
Restoration Needs	- 0.005	- 0.4	0.6622
Periodontal Needs	0.13	0.9	0.3469
Dental Insurance Indicator			
Insurance Dummy	0.27	1.4	0.1603
Individual and Social Control Variables			
Family Size	- 0.22	- 1.5	0.1464
Age	0.02	1.4	0.1547
SMSA Dummy	- 0.11	- 0.9	0.3433
Race Dummy	- 0.04	- 0.3	0.7846
Sex Dummy	- 0.06	- 0.6	0.5732
Hispanic Dummy	- 0.28	1.3	0.1877
Marital Status	0.09	0.7	0.4670
Education of Head of Family			
Elementary	- 0.25	- 1.23	0.2203
College	0.21	1.95	0.0527

N=254
R^2=0.96

Reset Test F=5.65
Normality of Residuals--accepted 15% level

Elasticities:
   Own Price   = - 0.45
   Cross Price =   0.29 (Restorations)
   Income   =   0.17

Table Three

Dependent Variable--Log of Expenditures for Cleaning

Variable	Parameter Estimate	T-Statistic	Prob. > T
Intercept	3.48	1056	0.0001*

Economic Variables

Own Price	- 0.02	- 2.7	0.0057*
Restoration Price	0.014	2.4	0.0179*
Crown Price	- 0.0007	- 1.0	0.3030
Family Income	0.003	1.2	0.2395
Travel Time	- 0.001	- 0.6	0.6136
Office Wait Time	0.006	- 1.3	0.1794

Clinical Needs

Restoration Needs	- 0.004	- 0.5	0.6364
Periodontal Needs	0.04	0.4	0.7091

Dental Insurance Indicator

Insurance Dummy	0.09	0.6	0.5575

Individual and Social Control Variables

Family Size	- 0.13	- 1.0	0.3028
Age	0.026	2.4	0.0181*
SMSA Dummy	- 0.026	- 0.2	0.8092
Race Dummy	- 0.12	- 0.9	0.3691
Sex Dummy	- 0.166	- 1.9	0.0597
Hispanic Dummy	- 0.32	2.0	0.0519
Marital Status	0.16	1.6	0.1201

Education of Head of Family

Elementary	- 0.53	- 3.2	0.0018*
College	0.06	0.7	0.4943

N=238   Reset Test F=2.73

R^2=0.97   Normality of Residuals--accepted 5% level

Elasticities:
    Own Price   = - 0.41
    Cross Price =   0.30 (Restorations)
    Income   =   0.07

Table ~~Five~~ Four

Dependent Variable--Log of Expenditures for Restorations

Variable	Parameter Estimate	T-Statistic	Prob. > T
Intercept	3.11	12.5	0.0001*
Economic Variables			
Own Price	- 0.01	- 2.3	0.0226*
Examination Price	0.02	3.0	0.0028*
Family Income	0.006	2.1	0.0407*
Travel Time	0.005	1.4	0.1468
Office Wait Time	- 0.006	- 1.2	0.2447
Clinical Needs			
Restoration Needs	0.13	13.3	0.0001*
Periodontal Needs	0.18	1.5	0.1284
Dental Insurance Indicator			
Insurance Dummy	0.29	2.6	0.0089*
Individual and Social Control Variables			
Family Size	0.10	1.8	0.0643*
Age	0.01	0.9	0.3731
SMSA Dummy	0.19	1.6	0.1015
Race Dummy	0.05	0.3	0.7288
Sex Dummy	0.006	0.1	0.9478
Hispanic Dummy	0.40	2.0	0.0423*
Marital Status	0.14	1.3	0.1975
Education of Head of Family			
Elementary	- 0.25	- 1.6	0.1127
College	- 0.12	- 1.2	0.2440

N=374
R^2=0.96

Reset Test F=6.55
Normality of Residuals--accepted at 3% level

Elasticities:
    Own Price =- 0.26
    Cross Price = 0.27 (Examinations
    Income = 0.15

Table ~~Six~~ Five

Maximum Likelihood Logit

Binary Dependent Variable
Expenditures for Periodontal Services
Given Some Expenditures for Dental Services

Variable	Paramenter Estimate	x^2 Stat.	Prob. > x^2
Intercept	− 2.9	6.1	0.0135*
Family Income	−0.004	0.1	0.7090
Prices for Dental Services			
Examination Price	− 0.005	0.0	0.8753
Restoration Price	0.061	6.8	0.0091*
Periodontal Price	− 0.064	53.5	0.0001*
Crown Price	0.013	29.1	0.0001*
Clinical Needs			
Restorative Needs	0.097	3.8	0.0500*
Periodontal Needs	0.880	1.0	0.3127
Gingival Symptoms	− 0.600	1.1	0.2935
Crown/Bridge Needs	0.087	0.4	0.5290
Individual and Social Control Variables			
Age	0.054	1.3	0.2530
Race Dummy	− 0.412	0.6	0.4306
Sex Dummy	0.302	0.6	0.4339
Hispanic Dummy	0.463	0.4	0.5275
Marital Status	0.358	0.7	0.4002
Family Head Yrs Educ-	0.002	0.0	0.9755

Total Observations = 391
Perio Services = 55
No Perio Services = 336
Model Chi-Square = 119.4

Percent Correct
   Concordant Pairs = 85.0

Rank Correlation of
   Concordant Pairs = 0.708