Dental Care Demand: Age-Specific Estimates for the Population 65 Years of Age and Over

by Douglas A. Conrad

This paper derives estimates of the demand for dental care among the U.S. population 65 years of age and over. The analysis is unique in that it focuses on a segment of the population with particular relevance to future policy regarding dental insurance coverage and distinguishes determinants of dental care demand by type of service. The empirical estimates suggest that the use of dental service by elderly persons does respond to price changes and that price-elasticity of demand varies significantly among different dental procedures.

Policy discussions regarding dental insurance mechanisms for the elderly population inevitably founder on the shoals of inadequate information. For example, evidence based on a small national sample of people over age 65 (American Dental Association, 1978) indicates that approximately 40 percent of the elderly with private dental insurance sought dental care during 1970, as compared to 25 percent of the elderly without dental coverage. However, the small sample size (40) does not permit one to generalize to the over-65 population. The provision of dental care benefits, under Part B of Medicare, has been proposed on a number of occasions in Congress and was considered in a U.S. House of Representatives Report (Select Committee on Aging, 1976), but the information required to rigorously estimate the cost and utilization impacts of dental insurance for the elderly has not been analyzed. Limited data from Medicaid programs are available but are applicable mostly to low-income persons.

Clearly, the lack of quantitative estimates of the independent effects of price, income, insurance, and other variables on the use of dental services by the over-65 population has hindered the development of public and private policy in this area. The major objective of this study is to reduce that substantial gap in knowledge by presenting measures of the partial effects mentioned above which are specific to those over age 65.

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Reprint requests: Douglas Conrad, B509 Health Services Center, University of Washington, SM 35, Seattle, Washington, 98195.

It is well-established that persons over age 65 are less likely to visit the dentist in any given year and have a lower overall rate of dental visits *per capita* as compared to other age groups (1.2 for those over 65 versus 1.6 for the all ages category). However, the underlying factors explaining these age-related differences are less clear. The data in Table 1 (NCHS, 1975) indicate the substantially greater delay in visiting the dentist for those over age 65 in comparison to those ages 45 to 64 and the all-age category.

TABLE 1

Time Interval Since Last Dental Visit by Age, 1975

Last Dental Visit	Age 65 and over (%)	Age 45 to 64 (%)	All Ages (%)
Less than 1 year ago	30.3	48.2	50.3
1 to 2 years ago	6.4	9.6	10.9
2 to 4 years ago	15.0	17.2	13.9
5 or more years ago	46.6	23.1	13.8

The most recent analyses to provide age-specific estimates of the effect of insurance (and/or price) on the use of dental services were performed by Avnet and Nikias (1962), Faine and Brisseau (1971), O'Shea and Bissell (1969), and Manning and Phelps (1978). The study by Avnet and Nikias presented cross-tabulations of utilization rates for specific dental services by age, sex, and occupational status of persons insured by Group Health Dental Insurance, Inc., of New York (GHDI). Comparison of these demographic-adjusted utilization rates with those of the nationwide population over age 65 reveals interesting differences, but these rates by their nature do not capture the partial effects of net out-of-pocket price, insurance, and other individual-specific factors (such as the presence of a usual source of dental care or household income) on the demand for dental care. In addition, the data were drawn from a single geographic area and from a predominantly employed population, so their results are difficult to generalize nationally and necessarily under-represent persons over age 65. The studies by Faine and Brisseau (1971) and O'Shea and Bissell (1969) relate only to Medicaid claimants in Chemung County and Erie County (both in New York), respectively. Apart from the limited geographic area considered, the number of people over age 65 in those two selected populations is relatively small, so generalizing from their findings is doubly problematic.

In contrast, the empirical investigation of Manning and Phelps (1978) is based on a 1970 nationwide household sample survey of utilization and expenditures for health services, including dental care. The survey, jointly conducted by the Center for Health Administration Studies (CHAS) and the National Opinion Research Center (NORC) of the University of Chicago, was combined with 1971 price data from the Bureau of Labor Statistics (1973) to determine the relationship between individuals' use of (demand for) particular dental services and sex, age, income, price, relative dentist supply, family size, and other factors. The demand functions estimated by Manning and Phelps are similar in form to (and in some sense have motivated) the equations presented in this paper. Since the concern of this analysis is the demand characteristics of a specific age group—those over 65—my demand estimates are for that group only, whereas Manning and Phelps did not estimate separate equations for those over age 65. Their estimates point to differences in the *level* of dental demand between those over 65 and the other age groups, but they do not address differences in the coefficients of effect on demand of various independent variables (especially price and income) among those over 65 versus other age groups. This study extends their work by focusing on one particular population group, thus permitting estimates of the coefficients of key independent variables within a group where individual responses to specific factors are more likely to be similar.

Study Sample

The analysis in this paper differentiates two components of demand by the elderly for dental care: 1) the decision to contact the dentist, and 2) the level of dental services used, given contact. As in Manning and Phelps (1978), the data base for this study is drawn from the CHAS/NORC 1970 stratified nationwide sample survey of individuals' (and households') health services utilization and expenditures. That survey sample included 1,506 individuals age 65 years and older,[1] of whom 1,253 persons are included in this study. Two hundred forty eight individuals were excluded from this analysis because they received dental care through public programs (for example, the Veterans Administration, Medicaid in selected States), on a charity basis, or through private dental insurance.

The rationale for these exclusions is as follows:

1) The impact of money price on the demand for dental services is neutralized to a significant extent by non-price rationing in the care of patients receiving charity care or prepaid care through a public program.
2) Since the CHAS/NORC data file did not specify the coinsurance rate, deductible, or other features of the private dental insurance policy, it was not feasible to construct a net out-of-pocket price for the elderly with private coverage.
3) Only 40 individuals with private dental insurance were included in the CHAS/NORC sample, and (particularly in the absence of details on the nature of their coverage) generalizing from such limited experience probably would be misleading. Thus, it seems preferable for this demand analysis to focus on the over-65 population facing the full money price of dental services, and that is the procedure which is used here.[2]

The 1970 sample provides a propitious data base for analyzing the demand for dental care among the elderly. By focusing on a population facing the full market price for dental services, one is able to estimate the price-sensitivity of dental services utilization—unencumbered by the non-price rationing which typically occurs in heavily insured markets.

Empirical Model and Measures

This study employs two analytic approaches. Discriminant analysis explores those factors which influence the initial decision to contact the dentist, and ordinary least-square (OLS) regression estimates the effects of that same set of factors on the level of dental services usage by elderly individuals. The OLS regressions are performed both on the entire sample of 1,253 elderly persons included in the data file for this study and on the sub-sample of elderly who visited the dentist at least once during 1970. The discriminant analysis yields estimates of the net impact of the independent variables on utilization through their influence on the dentist at least once during 1970. The first regression analysis yields estimates of the total impact of the independent variables on utiliza-

[1]As described in Andersen *et al.* (1973), the sampling design purposively overpresented the inner city poor, the aged, and rural residents.

[2]Manning and Phelps (1978) adopted analogous exclusion criteria in their empirical work, citing a similar justification.

tion through their influence on the probability of contacting a dentist at least once and at least one contact.[3] The second regression analysis produces estimates of the independent variables' effects on the "conditional" level of utilization—that is, the level of use during the year, given at least one visit. Table 2 explains empirical analysis measures.

The following section describes the specific dependent variables and independent variables incorporated in the analyses of this paper and closes by discussing the statistical models used. The dependent variables include for each sample respondent whether a dentist was visited during the year 1970, whether specific dental services were received during the year, the number of dental visits during the year, and total expenditure for all dental services during the year.

Independent Variables

The determinants of demand (independent variables) included in the analysis were those suggested by economic theory, subject to the limitations of the CHAS/NORC data base: price, family income, family size (to reflect the number of persons who might draw on family income), level of education, sex, race, regular source of medical care, the respondent's general perceived health status,[4] whether the individual reports a toothache, bleeding gums, nature of residence location (possible proxy for travel time costs of going to the dentist), and the relative supply of dentists in the market area where the elderly person lives. Economic theory also suggests that the prices of substitutes and complements for dental care be included in the demand function, but it is not clear what these related commodities are in the case of dentistry (for example, self-care as a substitute), or how one would measure their prices empirically. Thus, I made no explicit attempt to incorporate these related elements in the empirical work, nor have other analysts done so.[5]

[3]The results should be interpreted as suggestive only. Since only 20.8 percent of the full elderly sample visited a dentist at least once during 1970, these OLS regression estimates are subject to the "limited dependent variable" problem discussed by Tobin (1958). The essence of this problem is that the normal assumptions of OLS regression are not realized when there is a concentration of the dependent variable, for example, level of use, at some limiting value (in this case, zero). Tobin points out that the OLS approximation to the Tobin maximum likelihood estimates is fairly close for the central range of sample values, but one should be cautious about OLS point estimates of the dependent variable at sample extremes. In this paper, the limited dependent variable problem is addressed by estimating a "2-part" model: discriminant analysis to predict the probability of any use coupled with OLS regression on the subsample of positive users, for whom the limited dependent variable problem is minimized.

[4]Oral health status measures were not available for the elderly on the CHAS/NORC data file, and they would have been preferable to include as positive determinants of the derived demand for dental care.

[5]See Manning and Phelps (1978), Feldstein (1973), and Holtmann and Olsen (1976).

TABLE 2

Definitions of Measures in the Empirical Analysis[1]

Variable Name	Concept	Coding
1) FAMINC	Real family income	Continuous measure
2) FAMSIZE	Family size	Continuous measure
3) EDUCAT	Years of schooling completed by respondent	7 categories in ascending order of years of schooling
4) RESIDN	Residence in urban area, but outside inner city	Dummy variable (=1 if in urban area outside inner city)
5) REGCARE	Presence of regular source of medical care (proxy for regular dental source	Dummy variable (=1 if had regular source)
6) SEX	Sex of respondent	Dummy variable (=1 if male)
7) WHITE	Ethnicity	Dummy variable (=1 if white)
8) DENDENS	Dentists/populations	Continuous measure/ dentists per 1,000 persons in county of respondent's residence
9) PERHEAL	Individual's perception of his/her general health status	Dummy variable (=1 if reported) "fair" or "poor"
10) TETHACH	Toothache experienced during year	Dummy variable (=1 if symptom reported)
11) GUMSBLD	Bleeding gums experienced during year	Dummy variable (=1 if symptom reported)
12) REALPRICE	Real price of dental services (nominal price deflated by index of area specific cost of living	Continuous measure (as described in text)

[1]Means, standard deviations, and numerical coding are available from the author upon request.

I measured real price in the following way. The Bureau of Labor Statistics (BLS) surveyed a sample of dentists in 39 standard metropolitan statistical areas (SMSAs) in the fall of 1971 to determine average prices for dental fillings, extractions, and teeth cleaning (BLS, 1973). Using a cost-of-living index developed from BLS urban area family budgets by Manning and Phelps (1978), I have deflated all nominal data on dental prices, expenditures, and family income in this study. Reasoning that geographic proximity is a reasonable basis for assigning SMSA-specific price values to CHAS/NORC sample areas with missing BLS price data, I established SMSA-CHAS/NORC sampling area matches. Thus, every sample individual was assigned a set of dental prices, divided by the area value for the cost-of-living index. Accordingly, in the discriminant analyses the price for a filling, cleaning, and extraction was used in its respective equation. An index using the BLS budget weights of .370, .111, and .519, respectively, for fillings, extractions, and cleanings represented the real price measure in the denture care and oral exam equations, services for which an own-price measure was not available.

It is expected that price will be negatively related to the demand for dental services. Family income should affect demand positively, and family size is expected to reduce demand (holding constant family income). The individual's level of education is likely to increase the probability of contacting a dentist within the year, but to the extent that increased education raises the individual's efficiency in the "production" of oral health (Grossman, 1973), the level of dental services demanded (given contact) may decline. In this argument, education alters the production function for health to lower the derived demand for one of the productive inputs, professional dental care. No particular signs are posited for the sex and race variables, which are included as personal characteristics which may influence preferences for dental care.

The CHAS/NORC data file did not indicate whether the individual had a regular source of dental care, so the presence of a regular source of medical care is used here and a positive sign is expected in the discriminant analyses. If the use of a regular source of medical care is a useful proxy for the presence of a regular dental source, one might further expect this variable to be negatively related to the level of use, given contact with the dentist. This pattern is likely if individuals with a regular source of dental care substitute regular oral exams and preventive care for more extensive but less frequent restorative and reconstructive dental services. Similarly, higher levels of perceived general health are expected to increase the likelihood of contacting the dentist but to decrease the level of conditional use. The measure of reported symptoms, toothache and/or bleeding gums, provides a direct measure of perceived dental illness, and is expected to be positively related to the derived demand for dental care.

Other things being equal, persons living within an urban area but outside the inner city are likely to have better access to dental care, so the residence is included to capture such travel time and access effects. Finally, the dentist/population ratio is included on two conceptual grounds:

1) Higher dentist/population ratios are probably related to lower travel time, in-office waiting time, and appointment delay for dental care, these impacts being driven by the greater geographic density of providers and competition among them on non-pecuniary dimensions of service.
2) There may be more demand inducement by dental providers in areas of greater relative supply.[6]

Discriminant Models

This study employed discriminant analysis to estimate the direction and magnitude of the effects of the above independent variables on the probability of visiting the dentist at least once during the year for any service and the probability of receiving a particular kind of service at least once during the year. The latter analyses, which were conducted for teeth cleaning, fillings, extractions, dental care, and oral examinations, provide service-specific estimates of the impact of determinants of dental care demand. Particularly for price effects, it is important to allow for differential responses across services since the potential for substituting alternatives for dental care is likely to vary among specific types of dental services.

A stepwise subroutine of discriminant, the SPSS version (Nie *et al.*, 1975) which minimizes Wilks lambda, is employed for each dependent variable.[7] Equivalent F-statistics are presented for each step to indicate the statistical significance of each discriminating variable. Each of the dependent variables is coded as (0,1), depending on whether the individual used a particular type of dental care. Thus, the sign of the discriminant function coefficient indicates whether the discriminating variable had a positive or negative effect on the probability of receiving a particular kind of dental care; its magnitude reflects the relative importance of that variable in explaining variation in the dependent measure.

Taking advantage of the fact that the discriminant function is an approximation to the logit formulation (Manning and Phelps, 1978), one can use the unstand-

[6]Manning and Phelps (1978) concluded that the positive effect of relative dentist supply on demand was consistent with point (1), which might be termed the "access and non-pecuniary cost effect," but one cannot rule out the demand inducement hypothesis in this data set.

[7]The Wilks lambda criterion uses the overall multivariate F-ratio to test for differences among groups. A variable which maximizes the Wilks lambda, a measure of discrimination among the groups, also maximizes the F-ratio. Thus, the test seeks maximum discrimination among groups and maximum homogeneity within each group.

ardized discriminant function coefficients and the mean values of the independent and dependent variables to calculate the implied price elasticities of the probability of receiving specific dental services.[8] The implied price elasticity of the probability of receiving services (evaluated at the sample mean of p_i and X) is presented in Table 4 for each type of dental care. It should be remembered that this is the price elasticity of the first stage in the demand for a particular dental service—that is, the probability of any contact with a dentist for that service—not of the *total* demand for that type of service (which includes level of use, conditional on any use).

The study also presents classification results (the percent of cases correctly assigned to 0,1 categories), and it should be noted that the prior probabilities of each individual using versus not using particular services have been set equal to 0.5 and 0.5, respectively. This amounts to ignoring our prior knowledge (see, for example, Table 1) that fewer than half of the elderly visit the dentist during any given year. The justification for this choice is that the analysis seeks to explain these probabilities of contact by reference to a set of discriminating variables. One wishes to test the explanatory power of those factors apart from outside redundant information regarding the elderly's prior probabilities of dental care use during a year.[9]

Regression Models

The discriminant analysis just discussed are designed to model the individual's binary choice of whether to visit the dentist or seek any particular service during the year. To address the complementary analytic question of the impact of demand determinants on the *volume* of dental visits and expenditures during the year, I have estimated a set of linear regression models. Since the economic theory of demand does not differentiate between the determinants of any consumption versus the volume of consumption of a given commodity, the independent variables in the regression models are identical to those in the discriminant equations. However, one might expect differences in relative explanatory power of the demand determinants between the probability of any use and volume of use analyses, since providers will influence the volume of care to a greater degree than the patient's initial decision as to whether to visit the dentist.

Results

Discriminant Analyses

The discriminant estimates in the first column of Table 3 generally confirm the expectations of normal economic demand theory presented earlier. Family income, family size, education, regular source of (medical) care, dentist/population ratio, the presence of a toothache during the year, and the real (adjusted for cross-sectional, cost-of-living differences) price of dental services all have the expected signs and are statistically significant at conventional levels. It appears that elderly persons who perceive their overall health status to be relatively poor are less likely to visit the dentist during a year. Neither gender, residence, nor racial status is significantly related to the probability of visiting the dentists, other things being equal. Approximately 17 percent of the variance in the discriminant function is explained by the use/no use grouping.

The discriminant results for specific dental services are qualitatively similar to those above, so only noteworthy findings are highlighted here. First, family income is most significantly related to, and a *relatively* important predictor for, the probabilities of receiving fillings, cleanings, or oral examinations. Its relative importance (as measured by the beta coefficient) and statistical significance are much lower for denture services and extractions. This tentatively suggests a positive income elasticity of demand for preventive/restorative dental care, but much more detailed procedure-specific data is required to validate this preliminary suggestion. The statistical significance and relative importance of education follow a similar pattern although, in contrast to family income, education does carry a positive and strongly significant sign for denture care. Urban, non-inner city residence has a significant and positive influence only in the discriminant functions for fillings and cleanings, but it also has the expected positive sign for oral exams. With the exception of denture care, the presence of a regular source of medical care appears to be a poor surrogate measure for a regular *dental* source in the service-specific analyses. However, coupled with the significance of REGCARE in the discriminant function for any services, these results suggest that the great importance and statistical significance of whatever

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[8]Where p_i = probability of being in group i and X are the independent variable and its logit regression coefficient, respectively:

$$p_i = 1 / [1 + \exp(\chi\beta + \mu)]$$

in the logit equation. The elasticity of p_i with respect to X (that is, the percent change in p_i for a 1 percent change in X)

$$= \frac{p_i}{x} \quad \frac{\chi}{p_i} = \beta\chi(1 - p_i).$$

Using the mean of price and the relevant proportion receiving services, discriminant approximations to these elasticities have been calculated in the text.

[9]Canonical correlations are presented for each discriminant analysis. The canonical correlation measures the association between the discriminant function and the set of g-1 dummy variables which define the g group memberships (in this case, g = 2). It provides another measure of the discriminant function's ability to differentiate the groups. The canonical correlation squared can be interpreted as the proportion of variance in the discriminant function explained by group membership (analogous but reversed in order as compared to the coefficient of determination R^2 in multiple regression).

TABLE 3

Discriminant Estimates

Dependent variable Sample Size (N): Standardized *Discriminant Function* Coefficients (significance)	(1) Visited the *Dentist for* Any Service (N = 1253)		(2) Teeth Filled (N = 1251)		(3) Teeth Cleaned (N = 1251)		(4) Teeth Extracted (N = 1251)		(5) Denture Care Received (N = 1251)		(6) Had Oral Exam (N = 1251)	
FAMINC	.3978	(.000)	.4624	(.000)	.4139	(.000)	.0560	(.000)	.1154	(.000)	.2031	(.000)
FAMSIZE	−.1671	(.002)	−.2648	(.011)	−.1849	(.012)	−.0230	(.735)	.1211	(.388)	−.0328	(.929)
EDUCAT	.3287	(.000)	.4618	(.000)	.4127	(.000)	.0277	(.541)	.1982	(.005)	.2553	(.000)
RESIDN	.0782	(.209)	.2957	(.004)	.2412	(.002)	[1]		−.1240	(.292)	.0794	(.329)
REGCARE	.2138	(.005)	[1]		.0968	(.255)	.0948	(.104)	.3203	(.010)	.1173	(.133)
SEX	−.0667	(.293)	−.1036	(.326)	−.1042	(.197)	.1370	(.022)	−.0598	(.610)	−.1852	(.020)
WHITE	.1024	(.127)	.1666	(.170)	.1380	(.135)	−.0834	(.285)	.2208	(.106)	.1658	(.029)
DENDENS	.1156	(.051)	.0240	(.000)	.3203	(.000)	.1560	(.006)	.1566	(.210)	.4058	(.000)
PERHEAL	−.1842	(.004)	−.0964	(.373)	−.1882	(.043)	−.0260	(.630)	−.2555	(.029)	−.1961	(.028)
TETHACH	.7869	(.000)	.2778	(.004)	.2794	(.000)	1.0870	(.000)	.8612	(.000)	.6429	(.000)
GUMSBLD	.1198	(.068)	.1436	(.196)	.2199	(.016)	−.0415	(.483)	−.1011	(.413)	.1935	(.035)
Real Price:	−.1212	(.020)	−.3307	(.000)	−.2180	(.004)	.0081	(.890)	−.0953	(.415)	−.1802	(.007)
Chi-square (significance):	232.0509	(.000)	86.3226	(.000)	137.6859	(.000)	268.3892	(.000)	72.6203	(.000)	146.2671	(.000)
Canonical correlation:	.4124		.2590		.3238		.4406		.2382		.3332	
% cases correctly classified:	75.6%		71.9%		75.6%		93.2%		75.9%		80.6%	

[1]Did not meet stepwise entry criterion.

phenomenon REGCARE is capturing in the denture care equation is present also in the "any services" equation.[10]

The effects of gender and race are generally small in relative importance and statistical significance, after removing the influence of the other independent variables. A notable exception is found in the extractions equation, where males have significantly higher probabilities of receiving such services. Also, females and whites are more likely to have an oral exam during the year, according to column 6 of Table 3.

Relative supply of dentists has a positive effect on the probability of using each of the five services but is statistically significant only for teeth cleaning, oral exams, and extractions. Individuals perceiving their general health as fair or poor are less likely to use dental services with the exception of teeth extractions, and these effects are statistically significant in the teeth cleaning, oral exams, and extraction equations. One plausible interpretation of this pattern of results is that general health status affects the elderly person's perceived mobility. Thus, the less healthy elderly persons are, the less likely they are to visit the dentist for services perceived as discretionary.

The effect of specific symptoms on use varies across dental services. The presence of a toothache is positively and strongly related to the probability of visiting the dentist for any service (Table 3, column 1) and for each specific service. Interestingly, its relative importance as a discriminating variable is greatest for extractions and denture care, services which presumably are less discretionary for the patient. Among all services the presence of bleedimg gums is much less important than toothache in differentiating users from non-users, but bleeding gums are significant in discriminating those elderly who received two types of preventive care: teeth cleaning and oral exams.

[10]It is unfortunate that the CHAS/NORC survey did not include a question on whether the individual was edentulous (without teeth) in either the upper or lower arch of his or her mouth. This oral health status measure has a strong positive relation to the probability of receiving *denture care* and dental care in general, and it would have been desirable to partial out the effects of edentulousness from the above utilization analyses.

The pattern of the price elasticities summarized in Table 4 is interesting and in accord with economic intuition: services generally viewed as relatively discretionary—that is, for which substitutes are relatively more available—have price elasticities which are greater in absolute magnitude, for example, filling, cleaning, and oral exams. In addition, these point estimates of price elasticities fall well within the range of estimates from other studies (Holtmann and Olsen, 1976; Maurizi, 1975; Manning and Phelps, 1978; and Feldstein, 1973). The insignificant effect of price in the denture care equations may be a statistical artifact of the measurement error in the price variables (to wit, the lack of a denture care-specific price measure). The insignificance of extraction price is puzzling. (Manning and Phelps, 1978, had a similar insignificant finding in their discriminant equation for adult females. In the adult male equations, their extraction price elasticity was significantly negative.)

Regression Analysis of Total Dental Care Demand for Visits

Table 5 presents OLS estimates of the parameters in the demand function for dental visits. Subject to the statistical limitations of OLS estimates with a limited dependent variable, the results are illuminating. The total sample regressions (column 1) capture the joint effect of each independent variable on the probability of any use multiplied by the number of visits given any use. One would expect, and the results do show, differences between the incremental effects of certain factors in these regressions and the discriminant equations. The total sample regression reveals a positive and significant impact of dentist density, Caucasian racial status, family income, reported toothache, reported bleeding gums, the presence of a regular source of medical care, and perceived general health status. The only other variable close to conven-

TABLE 4

Price Elasticities (Point Estimates) of Probability of Receiving Selected Dental Services

Type of Service	Price Measure's Unstandardized Discriminant Coefficient	Sample Mean (of 1 − p)	Sample Mean ($\bar{x}$) of Price Measure	[$\beta\bar{x}$(1-p)] Price Elasticity Estimate
Any Services	−.0685	.8005	9.7717	−0.536
Filling	−.1734	.9361	8.6971	−1.412
Cleaning	−.1246	.9225	10.3208	−1.186
Extraction	.0035[1]	.9384	10.8008	.035[1]
Denture Care[2]	−.0539[1]	.9153	9.7733	−.0482[1]
Oral Exam[2]	−.1018	.9321	9.7733	−.9277

[1]Not statistically significant at the .10 level of Type 1 error on a 2-tailed test of significance.
[2]It should be noted that the price index for fillings, extractions, and cleanings is used for the denture care and oral exam discriminant equations since individual prices are not included for those services in the BLS sample.

TABLE 5

Dental Visit Regression Estimates

Dependent Variable: (N) Independent Variable Unstandardized Regression Coefficients (t-statistic)	(1) Dental Visits, Entire Sample (N = 1253)		(2) Dental Visits, Sample with Visits > 0 (N = 250)	
DENDENS	1.0753[1]	(4.02)	3.3801[1]	(3.14)
WHITE	.4095[2]	(2.34)	1.3653	(1.46)
FAMINC	.0992[2]	(2.22)	−.1042	(0.62)
FAMSIZE	−.05712	(0.97)	−.0738	(0.27)
TETHACH	2.1117[1]	(8.28)	.6308	(1.00)
GUMSBLD	1.1838[1]	(3.14)	1.1732	(1.17)
REGCARE	.4161[2]	(2.14)	.2765	(0.26)
PERHEAL	−.1272[2]	(2.11)	−.1327	(0.52)
RESIDN	−.0899	(0.65)	−.6624	(1.24)
SEX	−.1136	(0.92)	−.1742	(0.35)
REAL PRICE	−.0486	(1.39)	.0158	(0.11)
EDUCAT	.0328	(0.75)	−.3367[3]	(1.86)
CONSTANT	.2235	(0.38)	2.6775	(1.05)
F-VALUE (Significance):	13.2336	(.000)	2.0632	(0.20)
$\bar{R}^2$	.1050		.0487	

[1]Significant at .01 level of Type 1 error for 2-tailed t-test.
[2]Significant at .05 level of Type 1 error for 2-tailed t-test.
[3]Significant at .10 level of Type 1 error for 2-tailed t-test.

tional levels of statistical significance is the dental real price index, for which the t-statistic is significantly different from zero for a 2-tailed test at the .16 level (and significantly negative at the .08 level for a one-tailed test). When one uses these estimates to compute the elasticity of response at the mean values of the sample data to dentist density, family income, and real price, the values are .841, .339, and −.673, respectively. These elasticities measure the partial effect of a 1 percent increase in the independent variable on the dependent variable, number of dental visits. Thus, a 10 percent increase in dentists per 1,000 population (in the range of data close to sample means) is associated with an 8.41 percent increase in annual dental visits, other things being equal.

Comparing these results with those of Manning and Phelps for adult males and adult females, the findings indicate:

1) a somewhat larger proportionate effect of dentist density on the number of dental vistis by elderly persons (Manning and Phelps estimated an elasticity of .626 and .339 for adult males and females, respectively)
2) a smaller income elasticity for elderly persons (the Manning and Phelps estimates were .61 and .55, respectively)
3) a similar price elasticity of demand for dental visits (Manning and Phelps estimates were −.65 and −.78, respectively).

The dentist density effects are illuminating: in comparing its elasticity in the total sample regressions to its implied elasticity (=.219) in the discriminant function for any dental services, DENDENS clearly exerts most of its impact by influencing the number of visits, given some use, rather than the probability of use. In addition, cross-reference to the discriminant results is revealing. For example, both the relative importance (as judged by its beta coefficient) and proportionate effect (elasticity =.701 and beta = .348, respectively) of DENDENS are greatest in the discriminant equations for *cleaning and extractions*. These services involve non-pecuniary costs (service time, inconvenience, and pain) which are relatively high in comparison to their money prices, and one might infer that a significant portion of the DENDENS effect is due to non-pecuniary and amenity factors, in contrast to demand-inducement.

The price coefficient in the dental visits regression for the total sample, while not significant at conventional levels, implies a money price elasticity of total demand (−.67) only moderately larger in absolute value than the money price elasticity of the probability of any use (−.54 from Table 4). Combining these results with the very small (.04) and insignificant (α level = .91) elasticity in the visits equation for the subsample with dental visits greater than zero, one can infer that money price influences patient choice at the initial stage of visiting the dentist, but its impact on subsequent use appears to be negligible in this sample of elderly people. Clearly the analysis of this paper should be replicated on an insured population, to determine if these results are generalizable to the range of experience for elderly persons not facing full market prices for dental care.

Regression Analysis of Conditional Dental Care Demand

The estimates in column 2 of Table 5 are noticeably imprecise, especially in comparison with the results in column (1) for the total elderly sample. Given the reasonably large number of degrees of freedom in the subsample, the relatively small number of independent variables in the model, and the significantly smaller explanatory power of the subsample equation,[11] I conclude that the weak results on individual variables are not due to difficulties in statistical estimation. Instead, the regression suggests that the patient and area-specific factors in the model are relatively poor predictors of use subsequent to initial contact with a dentist, even though the same variables seem to explain differences among elderly individuals in the probability of any use.

[11]Note also that the subsample equation is not subject to the limited dependent variable problems of potential bias and inefficiency in estimation, since the zero visits cases (80 percent of the total sample) are excluded.

Only the dentist/population ratio and education are significant in the subsample regression. The dentist density effect has already been discussed. The negative sign of the education coefficient is consistent with its hypothesized role in increasing the efficiency of health production, thereby reducing the derived demand for dental care. One must be cautious in discussing a series of insignificant coefficients, but when one couples the subsample results with the total sample regressions and earlier discriminant estimates, a plausible interpretation for the pattern of these findings may be offered. Factors such as income and education positively influence the likelihood of visiting a dentist at least once, but this effect is counterbalanced in the total visits equations as multiple visits for dental problems are averted by regular professional care.

Notably, the presence of dental symptoms is not significantly related to total visits among the population of elderly users. Perceived symptoms appear to contribute to the likelihood of initial contact with a dentist, but they contribute little, if at all, to the subsequent use of services.

To explain the level of utilization among users, as opposed to the probability of any use of dental services, a broader model is required. In particular, such analysis should include dentist-specific variables, detailed measures of the organizational structures within which different individuals receive dental services, and more precise indicators of the non-pecuniary terms of dental care transactions. In other words, the influence of travel time, waiting time, appointment delay, and the patient's perceived satisfaction with particular dental care providers should be reflected in such models of conditional use.

The preliminary results in column 2 of Table 5 imply that money price is not an important rationing mechanism once the elderly individual has decided to seek dental care. Clearly, other factors (largely missing from the CHAS/NORC data on dental care) come into play at the second stage of dental services utilization. Understanding such variables is necessary to make accurate predictions of elderly persons' dental services utilization and expenditures under insurance.

Regression Analysis of Total Dental Expenditures

I ran the real dental expenditure regressions in Table 6 as a check on the dental visit analyses, the former being a "value-weighted" (the weights being the fee for each dental service) form of the dental visits measure. The pattern of the results is broadly similar to that of the dental visit equations, so only certain findings will be highlighted. Again, the impact of dentist density operates mostly through the level of conditional use: the coefficients of DENDENS in column 1 and 2 translate to an elasticity at the sample means of .660 and .445, respectively. Since the total sample elasticity should equal approximately the elasticity on conditional use plus the elasticity on probability of any use, the above estimates suggest an elasticity on the probability of any use of about .215 (= .660 − .445). This implied proportionate effect is quite close to the estimate produced from the discriminant equation for any dental services (= .219).

The net effect of family income, controlling for family size, on total real dental expenditures is not significantly different from zero in column 1; its positive effect on probability of use is partially offset by a negative influence on expenditures *per capita* among those who visit the dentist at least once. This may suggest a substitution of regular preventive visits for sporadic, high-cost reconstructive and restorative procedures among those elderly with greater household resources.

Neither price coefficient is statistically significant in the real expenditure regressions, but that result (by itself) is not unexpected. Recall that the earlier estimate of the money price elasticity in the dental visits regression was approximately −.067. Given the relatively large standard error of the coefficient from which that elasticity was calculated (absolute value of t-statistic = 1.39), the 95 percent confidence interval for the price elasticity of total demand would include 1.0. If the price elasticity of demand for dental services were zero, a 10 percent rise in price (denote

TABLE 6

Dental Expenditure Regression Estimates

Dependent Variable: (N) Independent Variable Unstandardized Regression Coefficients (t-statistic)	(1) Total Dental Expenditures in Real Terms, Entire Sample (N = 1253)		(2) Total Real Dental Expenditures, Sample with Dental Expenditures > 0 (N = 247)	
DENDENS	.2150[2]	(2.38)	.6747[3]	(1.68)
WHITE	.1115[3]	(1.89)	.4375	(1.25)
FAMINC	.0096	(0.64)	−.1205[3]	(1.91)
FAMSIZE	.0156	(0.79)	.1960[3]	(1.93)
TETHACH	.4950[1]	(5.75)	−.0369	(0.16)
GUMSBLD	.0737	(0.58)	−.1286	(0.34)
REGCARE	.1163[3]	(1.77)	.2372	(0.59)
PERHEAL	−.0084	(0.41)	.0853	(0.88)
RESIDN	.0173	(0.37)	−.1693	(0.85)
SEX	.0423	(1.02)	.3085	(1.64)
REAL PRICE	.0050	(0.42)	.0902	(1.65)
EDUCAT	.0228	(1.56)	−.0174	(0.26)
CONSTANT	−.3453[3]	(1.74)	1.4397	(1.51)
F-VALUE (Significance):	5.2442	(.000)	1.3513	(.191)
$\bar{R}^2$	.0391		.0169	

[1]Significant at .01 level of Type 1 error for 2-tailed t-test.
[2]Significant at .05 level of Type 1 error for 2-tailed t-test.
[3]Significant at .10 level of Type 1 error for 2-tailed t-test.

price as *P*) would lead to a 10 percent rise in expenditures (= PQ). On the other hand, a price elasticity of − 1.0 would imply that, other things being equal, total real expenditures would remain constant as price changes. Thus, the elasticity of visits with respect to price (E_P^Q) and of expenditures with respect to price (E_P^{PQ}) are related to each other as the following formula suggests:

$$E_P^Q = E_P^{PQ} - 1.$$

Since the E_P^{PQ} computed from column 1 of Table 6 equals .272, the formula implies an underlying price elasticity of demand for dental services equal to − .728. While this elasticity is not statistically significant at conventional levels, it is quite close to the analogous price elasticity of − .673 computed in column 1 of Table 5 (the dental visits equation for the total sample). Considering the total sample of elderly persons, the point estimates of price elasticity of total dental care demand across a set of alternative specifications (visits, probability of any use, and real dental expenditures as dependent measures) fall within a relatively narrow range, that is, − .53 to − .73. However, the confidence intervals which bound these estimates are relatively large, and more detailed service-specific output and price measures are clearly needed.

The weak results of the regression specification in column 2 of Table 5 (the F-value for the equation is not significant, and less than 2 percent of the variation in expenditures is explained when R^2 is adjusted for degrees of freedom) indicate the inability of the empirical measures used in this study to explain individual differences in dental expenditures among users. The difficulties in explaining "conditional" (on use) expenditures are similar to those encountered in the conditional utilization equations (column 2, Table 4). Given the poor performance of the equation as a whole, individual coefficients will not be discussed in detail. The case made earlier for better measures, specifically at the service-specific and transaction-specific level, applies with even greater force to empirical analyses of dental expenditures among the over-65 population.

Summary and Conclusions

The relative prices of dental services do influence the use of certain dental services by those over age 65. If dental insurance were provided to the elderly, the effect of the reduced out-of-pocket price for services would lead to an increased proportion of the elderly receiving restorative, prophylaxis, and oral examination services during the year.

The point estimates in Table 4 imply that a 10 percent decline in the out-of-pocket price of dental services, other things being equal, would lead to approximately a 5.4 percent increase in the proportion of elderly persons visiting the dentist in a year and to 14.1 percent and 11.9 percent increases in the proportion receiving fillings and teeth cleaning, respectively. These estimates, computed at the mean of the sample data in the discriminant analyses, probably understate the full impact of insurance-induced decreases in out-of-pocket price, since they abstract from the effect of price changes on the *volume* of services and the relative quality (expensiveness) of the services chosen. Our estimates in the dental expenditures and total visits regressions suggest that the degree of such understatement is relatively small, but it should be noted that the effects of out-of-pocket price decreases in an insured population may differ in certain qualitative details from the effects observed in the uninsured sample studied here.

As an extension to the work presented here, future analyses of the effect of insurance on dental care demand among the elderly should focus on determining the *actual* price faced by the individual for specific dental services, and such studies should incorporate the non-pecuniary dimensions of the individual's consumption of dental services, in particular, the opportunity costs of time and travel involved in visiting the dentist. This study's estimates, based on a non-insured nationwide sample of elderly people, should be viewed as a first step toward forecasting the "price" effects of the provision of dental insurance on the elderly's demand for dental care.

In addition, economic theory (Phelps, 1973) suggests that the provision of insurance will alter the consumer's sensitivity to money price, as opposed to non-pecuniary dimensions, of dental services. As the share of money price covered by insurance increases, the elasticity of demand with respect to money price is expected to decline proportionately, while that of time price (for example, the opportunity costs of waiting in the dentist's office or of travelling to the dentist's office) is expected to increase proportionately.[12] Thus, the estimates of price elasticity presented in this paper may overstate the implied effects on demand of the provision of dental insurance, since they are based on an uninsured sample in which persons presumably have a higher price elasticity in absolute terms than would an otherwise comparable population of insured elderly. Accordingly, a worthwhile extension of this analysis would be to analyze the dental services utilization of a large sample of elderly people both before and after the provision of dental insurance. This kind of longitudinal panel study—for example, using data from the United Auto Workers and other large benefit plans covering persons over age 65—would provide insights which the current data base did not allow.

[12]This prediction assumes that the elasticity of demand with respect to full price (money plus non-money price opportunity costs) is not changed by the provision of insurance.

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