Dental Care Demand: Insurance Effects and Plan Design

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This study concentrates on an important health policy question: the impact of dental insurance on the demand of adults for dental services. Demand equations for individuals are estimated from a systematic random sample of 4,173 families with complete information on their dental claims (insured through Pennsylvania Blue Shield) and survey data. The principal contributions of the research are twofold: (1) to provide rigorous, large-sample estimates of the demand for dental services of insured *individuals—providing a complementary set of "natural" experiment results to the randomized experiment results of the RAND Health Insurance Experiment—and (2) to estimate the incremental effects on dental care demand of certain factors related to adverse selection. The study is a companion to a previously published study of children by the same authors. Generally, the analysis shows relatively small money price elasticities of dental care demand among this* insured *adult population (ranging from −.01 to −.266 across specific types of service). Given a finding that total expenditures for Basic services are 37 percent and 90 percent higher, respectively, for community-rated (versus experience-rated) primary subscribers and insureds, we conclude that differential adverse selection between community- and experience-rated groups accounts for significant differences in dental demand.*

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This study concentrates on an important health policy question: the impact of dental insurance on the demand for dental services. The influence of insurance coverage on the utilization of dental services is of particular interest because of the rapid growth of dental insurance in recent years: in 1967, only 2 percent of the U.S. population had private dental coverage; by 1981, 38 percent were covered by a private dental plan. With the singular exception of the recently published findings of the RAND Health Insurance Experiment (Manning et al., 1985 [1]), available information on the effects of insurance coverage on dental care demand is from the early 1960s [2] and on limited sample sizes of insured individuals [3].

At a time when the U.S. Congress continues to consider further tax reform, including limits on the tax exemption for employer premium contributions to health insurance benefits, the quality of our collective decisions would be advanced by knowledge of the effects of private dental coverage on utilization. In that respect, our study is a significant complement to the RAND Health Insurance Experiment (HIE). The HIE was a randomized trial of health insurance, in which a nationwide sample of individuals was allocated randomly to different health insurance plans (free care, 25 percent coinsurance, 50 percent coinsurance, 95 percent coinsurance, and an individual deductible plan—all subject to an income-related upper limit on maximum out-of-pocket expenditures). In contrast, ours is a detailed analysis of the wide array of different benefit packages offered under the Pennsylvania Blue Shield (PBS) dental program, which covered approximately 1.2 million persons in the state of Pennsylvania in 1980. The nature of the PBS sample did not permit a comparison of dental demand by those with insurance versus those without insurance, but rather focused on the effects on demand of variations in the *level* of insurance. However, because the study of the PBS program is drawn from a natural experiment rather than a controlled trial, our findings offer a useful comparison with those of the HIE. For example, previous work from this same study of PBS [4] produced the first published measurement of the effects of adverse selection in dental insurance.

METHODS

STUDY POPULATION

The study's sampling frame consists of 1.2 million adults and children covered by PBS under its usual, customary, and reasonable (UCR)

dental program in 1980. A systematic random sample of 11,260 households was selected, including 19,592 employees and their dependents, or 2.89 percent of all PBS dental insureds. Our sampling frame excluded the small number of PBS dental insureds who (1) were covered under indemnity (fixed allowance or table of allowances) contracts or (2) had deductibles included in their dental plans. The numbers in these categories were too small to permit separate analysis, so excluding them from the analysis allows us to examine demand response under conditions where (a) the individual knows his or her effective coinsurance rate *prior* to utilization of a particular provider and (b) the marginal and average price faced by the insured are equal. This would not be the case for individuals utilizing services subject to a deductible, which may or may not be exceeded in a particular dental care episode.

Table 1 describes the pattern of PBS coverage among households in our sample. The four riders (A through D) are available in varying combinations to groups. They were not sequenced in any particular order, nor were specific combinations of riders precluded by PBS underwriting regulations.

Using a household mail survey, information on the determinants of dental care demand was collected from a sample of 4,173 families,

Table 1: Pennsylvania Blue Shield Dental Insurance Program

Plan Category		*Services Covered*	*Households with Coverage (%)*	*Average Coinsurance Rate (%) among Households with Coverage*
Required:	Basic	Diagnostic, preventive, restorative, endodontic, simple extractions	100	2
Optional riders:	A	Oral surgery: surgical removal of teeth, intra-bony apicoectomy, crowns*	60	11
	B	Prosthodontics: complete and partial dentures, bridge pontics, and crowns†	56	29
	C	Periodontal services: gingivectomy, osseous surgery, scaling, and root planing	54	24
	D	Orthodontic services	50	29

*American Dental Association codes 2710–2893.
†American Dental Association codes 6710–6793.

with complete information on their dental claims and survey data required for estimating the demand equations. We also merged data on relative dentist supply in each of the 22 economic market areas served by PBS as well as data on each individual insured's dental contract (length of time covered by the PBS plan, whether the employee paid a portion of the dental insurance premium, and whether the plan was community- or experience-rated) with the survey and claims data to create a complete record for each individual insured in the sample.

THEORETICAL FRAMEWORK FOR DEMAND ANALYSIS

The theory of dental care demand in this study proceeds from the premise that the demand for dental *care* is derived from the underlying demand for oral *health*. Thus, the specification of our empirical model reflects the pioneering work of Gary Becker in 1965 [5] on the theory of the allocation of time in household production and Michael Grossman [6] who, in 1972, applied the household production approach to the demand for health care.

Our demand model controls statistically for the effect on the demand for dental services (*net* of the impact of specific features of the plan actually chosen) of unmeasured characteristics of individuals associated with their choice of whether or not to participate in the particular dental plan chosen by their group. We posit that those in experience-rated (versus community-rated) contracts will be those with lower levels of need for dental services, since their premium cost over time will reflect more closely their experience.

In contrast, among employees who pay a portion of their premium, those more likely to participate in the group's dental plan will be those who expect greater use of the dental benefits.

Our model, which treats dental services as a kind of durable good or investment in producing health, suggests the following set of determinants of the demand for health services (with the expected sign of the effect on demand following in parentheses):

- Net money price of the specific service being analyzed (-)
- Net money price facing the consumer for services, which substitutes to or complements for the specific service being analyzed (- for complement, + for substitute)
- Family income, adjusted for family size (+)
- The value of the individual's own time, which measures productivity in market and nonmarket activities (including the production of health) (+)

- Usual travel time and waiting time costs borne by the individual per dental visit, i.e., units of time multiplied by the individual's actual or imputed value of time (-)
- Usual direct transportation costs (two-way) per dental visit (-)
- Education (- or + depending on whether the effect on efficiency in health production or on permanent income dominates)
- Age (+)
- Length of time the individual has had PBS dental coverage (-)
- Attributes of the insurance contract choice situation: experience- versus community-rating (-), the presence of a positive dental premium contribution by the employee (+), and the presence of more than one dental insurance plan for the family (-)
- Relative dentist supply, as a measure of the incentive for demand creation facing individual dental care providers (+).

ESTIMATION METHODS

In estimating this demand model, we have employed a two-part approach (ref. Duan et al. [7]) to dental services utilization: we split the analysis into (a) estimates of the determinants of the probability of use of dental services and (b) estimates of the determinants of the intensity of use (expenditures), given some utilization of dental services. We term the first set (a) probability of use analyses and the second set (b) conditional use analyses. Separate estimates are presented for primary subscribers (employees) and their covered spouses. We estimate the probability of any use equations with discriminant analysis, and we employ ordinary least squares (OLS) regression in the equations with continuous demand. We tested alternative specifications of our regression model, using logarithmic transform and untransformed versions of the dependent variable. Ultimately, we settled on the log transform specification since it displayed the best goodness-of-fit properties ($\bar{R}^2$) and was closest to the variable elasticity form of the demand function.

We also conducted an earlier analysis using grouped data from the largest experience-rated groups covered by PBS (Grembowski and Conrad, 1984 [8]). Where applicable, the results from that study are compared to the micro (individual-specific) analysis results. The 1984 paper presented a detailed literature review, which is not repeated here.

To the best of our knowledge, our demand study is the first to

incorporate an analysis of the *residual* effects of the health insurance contract choice situation (for example, community-rating) on the demand for health services (in this case, dental services). Presumably, any such indirect influence on demand is due to adverse selection of plan on dimensions of choice other than coinsurance rate and scope of coverage benefits (that is, whether to participate in the plan or not), since the former are captured directly in the model's measures of net money price for specific dental services.

PBS places a number of conditions on the terms under which it enrolls insured parties for its dental contracts, and each of these conditions is directed explicitly to controlling incentives for adverse selection:

1. The smallest group PBS will enroll for dental coverage is five primary subscribers (the primary subscriber is the employee seeking the coverage as part of a group for himself or herself and potentially for family members).
2. Where the employer pays all of the dental insurance premium contribution, PBS requires that all employees participate in the dental plan chosen for the group. In contrast, where the employee pays a portion of the premium, PBS limits to 10 percent the number of employees who may opt not to participate in the dental plan.
3. In order for a group to offer coverage of family members in addition to the primary subscriber (family contract) for *any* of the members of the group, at least 75 percent of the primary subscribers within a given group must opt for a family contract.
4. Generally, all members of a given insured group are covered by the same PBS contract provisions (that is, identical coinsurance rates and covered riders across all members of the given group, so the potential for self-selection by individuals seeking an insurance contract tailored to their unique personal and family dental health care needs is attenuated, if not eliminated (at least for large groups).

Thus, any demand differences between community-rated and experience-rated groups observed in this study must reflect unmeasured (and presumably unobservable by the insurer) differences in propensity to use dental services between the two groups. In addition, this study measures the impact of another feature of insurance contract

design on demand—the presence of an employee contribution toward the plan's premium cost.

RESULTS

Since our empirical results for the demand of children for dental care and for the impact of adverse selection on *plan choice* have been published previously, we present here only the microdemand analyses for adults. The variables in the empirical model for demand estimation are defined specifically in Table 2. Table 2 is self-explanatory concerning our measures, but our use of dental *expenditures* as a measure of demand deserves some comment. We interpret this measure as a value-weighted index of Basic dental services consumed by the individual, which improves substantially on the (undifferentiated and equally-weighted) dental visits measure used in most prior studies of dental demand (cf. Feldstein, 1973 [9]; and Manning and Phelps, 1979 [10]). The expenditures measure captures (via the price weights) variation in the nature and quantity of Basic dental services consumed across subscribers.

DEMAND ANALYSIS FOR ADULTS

The authors have analyzed (a) the probability of any use, (b) Basic expenditures (unconditional), and (c) intensity of Basic use (measured as Basic expenditures, conditional on any use), and (d) the volume of visits for and expenditures on a series of specific dental services.[1] In the interest of brevity, tables are displayed only for dependent variables (a) and (c), but references are made occasionally to the specific service results to enhance the interpretability of findings.[2] We estimate the model separately for primary subscribers (the employee in whose name the dental insurance contract is underwritten) and their spouses, to eliminate the effects of intrafamily correlation, which otherwise might bias the standard errors of our regression coefficients. Summary descriptive statistics for variables in our demand are presented in Table 3.

PROBABILITY OF ANY USE

Tables 4 and 5 provide a summary of the key results of the analyses of probability of any use,[3] intensity of Basic use (for users only), and unconditional Basic expenditures. Detailed results of the discriminant

Table 2: Dental Care Demand Model

Dependent Variables

Any use: Probability of use of any dental services (covered by PBS) during 1980

Basic expenditures: Total amount paid by PBS and the subscriber for all Basic services during 1980, analyzed separately for users only and all subscribers

Independent Variables

- Orthodontic services coinsurance rate (PRider D)
- Net (out-of-pocket) price for Basic dental services (PE)
- Net price for denture and other prosthodontic procedures (PRider B)
- Net price for periodontal services, e.g., gingival curettage (RiderC)
- Net price for crowns, inlays, and onlays (PRider A)
- Length of time the primary subscriber has had the insurance coverage with PBS: (COV1 = 1 to 2 years, 0 otherwise; COV2 = 2 to 3 years, 0 otherwise; COV3 = 3 or more years, 0 otherwise)
- Person missing all teeth in one or more arches (EDENT = 1, 0 otherwise)
- Age of insured (Age 1 = 18 to 34 years, 0 otherwise; Age 2 = 35 to 44 years, 0 otherwise; Age 3 = 45 to 64 years, 0 otherwise)
- Education of primary subscriber (ED1 = highest grade completed is high school, 0 otherwise; ED2 = some college, 0 otherwise; ED3 = graduation from college, 0 otherwise; ED4 = at least some graduate school, 0 otherwise)
- Insured's imputed value of time or wage per hour if working (WAGE)
- Dentist-to-population ratio in market area of insured's residence (DENTPOP)
- Female (= 0 if male)
- Family income(FAMINC)
- Family size (FAMSIZE)
- Estimated usual time cost of travel to dentist's office (T-TCOST)
- Estimated usual cost of insured's waiting time in dentist's office (OW-TCOST)
- Usual direct out-of-pocket or imputed costs (if drives own vehicle) of transportation to dentist's office (TRAVEL)

Vector of Contract Attributes

- CONTRIB = 1 if employee paid at least part of PBS dental insurance premium, 0 otherwise (NSCONTRIB = 1 if insured respondent "not sure")
- MULTIPLA = 1 if family (contract unit) has more than 1 dental insurance plan, 0 otherwise
- INDCONT = 1 if PBS plan dental insurance contract covers only the primary subscriber (employee), 0 otherwise
- Experience-rated contract (EXPRATED = 1)
- Community-rated contract (COMRATED = 1)
- ORALH = insured individual's self-perceived dental health status; 1 if rated "fair" or "poor," 0 if "excellent" or "good"
- USOURCE = presence of a usual source dental care; 1 if so, 0 otherwise
- OVERMAX = dummy variable; 1 if the contract unit's insured dental expenditures exceeded the maximum dollar limit of the plan's coverage

Table 3: Descriptive Statistics

Label	*Mean*	*Standard Deviation*
Primary Subscribers		
Basic price index	.359	1.478
Rider A price index	194.292	270.369
Rider B price index	242.780	288.799
Rider C price index	50.220	60.714
Rider D coinsurance rate	.652	.754
1-2 years coverage	.151	.388
2-3 years coverage	.109	.331
Over 3 years coverage	.560	.748
Shadow wage ($/hr)	7.955	8.403
Completed high school	.349	.591
Some college	.182	.427
Completed college	.110	.332
Grad work—degree	.282	.531
18-34 years old	.391	.625
35-44 years old	.253	.503
45-64 years old	.337	.581
Family income	24097.891	26068.086
Family size	3.034	3.359
Dentist-population ratio	.001	.001
Transportation costs	3.225	4.237
Time travel costs	1.767	2.531
Office-waiting time costs	1.425	2.162
Edentulousness	.165	.406
Female sex dummy	.441	.664
Community-rated dummy	.477	.690
Experience-rated dummy	.523	.723
Individual contract dummy	.313	.560
Multiple dental plans	.117	.342
Employer contribution dummy	.100	.316
Dummy for respondent	.079	.280
Natural log of total expenditures	2.632	3.422
Total	83.123	206.541

Continued

analyses and OLS regressions, on which Tables 4 and 5 are based, are presented in the Appendix.

We focus first on the net price variables. Three money price elasticities in Table 4 are significant in the probability of any use equations for primary subscribers. The elasticities are: Basic net price, -.014; Rider A (crowns, inlays, and oral surgery) net price, -.075; and Rider C (periodontal services) net price, -.083. Only Rider A net price, with

Table 3: Continued

Label	*Mean*	*Standard Deviation*
Spouses		
Basic price index	.427	1.602
Rider A price index	186.038	262.288
Rider B price index	240.006	284.353
Rider C price index	48.806	59.645
Rider D coinsurance rate	.647	.752
1-2 years coverage	.142	.376
2-3 years coverage	.108	.328
Over 3 years coverage	.601	.775
Shadow wage ($/hr)	6.943	7.443
Completed high school	.471	.687
Some college	.168	.410
Completed college	.107	.327
Grad work—degree	.149	.386
18-34 years old	.360	.600
35-44 years old	.360	.600
45-64 years old	.259	.509
Family income	26406.568	28047.611
Family size	3.436	3.669
Dentist-population ratio	.001	.001
Transportation costs	3.326	4.366
Time travel costs	1.822	2.399
Office-waiting time costs	1.491	2.049
Edentulousness	.181	.425
Female sex dummy	.670	.818
Community-rated dummy	.443	.666
Experience-rated dummy	.557	.746
Individual contract dummy	0	0
Multiple dental plans	.111	.333
Employer contribution dummy	.099	.314
Dummy for respondent	.067	.259
Natural log of total expenditures	2.216	3.118
Total	71.092	220.458

an elasticity of -.121, is significant for the spouses. Both time elasticities, -.031 for travel time and -.090 for office waiting, are significant for primary subscribers. Only the office waiting time elasticity (-.191) was significant among spouses. The income elasticity of probability of any use for primary subscribers (.09) was significant but relatively small, implying that a 10 percent increase in family income is related to a 0.9 percent increase in probability of any use.

Table 4: Selected Elasticities for Any Use and Basic Expenditures

	Any Use		*Basic Expenditures Users and Nonusers*		*Basic Expenditures Users Only*	
Variables	*Primary Subscriber*	*Spouse*	*Primary Subscriber*	*Spouse*	*Primary Subscriber*	*Spouse*
Basic net price	-.014†	—	-.025†	—	—	—
Rider A net price	-.075†	-.121†	-.14†	-.15†	—	—
Rider B net price	—	—	—	—	—	—
Rider C net price	-.083†	—	-.19†	—	—	—
Travel time cost	-.031†	—	-.062†	-.096*	—	-.063*
Office-waiting time cost	-.090†	-.191†	-.169†	-.174†	—	—
Family income	.09*	—	.06*	—	—	—

*$p < .10$.
†$p < .05$.
Note: this table reports only elasticities significant at $p < .10$ levels on a two-tailed t-test.

Table 5: Proportionate Effects of Sociodemographic Factors, Insurance Contract Attributes, and Relative Dentist Supply on Dental Care Demand Among Adult Insureds

		Proportionate Effects on Demand	
Independent Variable	*Measure of Demand*	*Primary Subscribers (%)*	*Spouse (%)*
Age	Probability of use of any dental service during 1980	-13.4	13.8
18–34 yrs.		-8.0	16.1
35–44 yrs.		-8.2	14.6
45–64 yrs.		(relative to adult insureds over age 65)	
Education	Probability of use of any dental service during 1980		
High school completed		5.6	6.6
Some college		4.7	3.1
College completed		3.5	3.9
Some graduate school		7.6	4.6
		(relative to adult insureds not completing high school)	
Female	Probability of use of any dental service during 1980	N/S	16.5
	Total Basic expenditures, conditional on use	-3.5	N/S
	Total Basic expenditures (unconditional)	N/S	25.9
		(relative to males)	
Duration of PBS dental coverage	Probability of use of any dental service during 1980		
1–2 yrs.		-3.6	-5.3
2–3 yrs.		-1.8	N/S
3 + yrs.		-6.6	N/S
1–2 yrs.	Total expenditures on Basic dental services, conditional on use of some services during 1980	-54.8	-35.5
2–3 yrs.		-57.4	-42.7
3 + yrs.		-59.7	-43.5
Community-rated insureds	Probability of use of any dental service during 1980	9.4	N/S
	Total expenditures on Basic dental services (unconditional on whether some services used or not)	37.0	90.0
		(relative to experience-rated adult insured)	

Continued

Table 5: Continued

Independent Variable	*Measure of Demand*	*Proportionate Effects on Demand*	
		Primary Subscribers (%)	*Spouse (%)*
Family has more than one dental insurance plan	Probability of use of any dental services during 1980	N/S	-4.8
		(relative to subscribers with only the single PBS plan)	
Dentist/Population	Probability of use of any dental services during 1980	N/S	0.44
	Total expenditures on Basic dental services, conditional on some use of services	N/S	N/S
	Total expenditures on Basic dental services (unconditional)	N/S	0.59
		(implied response to 10% increase in dentist/population ratio)	

Table 5 highlights only the statistically significant ($p < .10$, 2-tailed test) relationships between sociodemographic factors (age, education, and sex), insurance contract attributes (duration of coverage, community- versus experience-rating, and multiple dental plans), and relative dentist supply on adult demand for dental services.

Considering first the effect of sociodemographic factors on probability of any use, the age differences are in opposite directions for primary subscribers and spouses. Among primary subscribers, the probability of any use is from 13 to 8 percent lower among the younger age groups, as compared to those 65 years or older (approximately 2 percent of PBS primary subscribers). Conversely, the probability of any use is some 14–16 percent *greater* among the younger age groups in the case of spouses. Education has positive, though not monotonic, effects on the probability of any use. For both primary and spouse subscribers, the use rates are from 4 to 7 percent higher among those who have at least a high school education relative to those not completing high school. Female spouses have a 16.5 percent higher probability

of any use than males, but the difference between males and females is not significant for primary subscribers.

The first insurance contract attribute in Table 5, duration of coverage, shows lower probabilities of any use (use rates) among primary subscribers in the second and later years of dental coverage, as compared to those in the first year of their dental coverage in 1980: use rates of those in the second, third, and fourth or greater year of coverage were 3.6, 1.8, and 6.6 percent less, respectively. Among spouses, only the 5.3 percent lower use rate in the second year of coverage was significant. The second contract feature, community-rating, was related to a 9.4 percent higher use rate for primary subscribers, but the community- versus experience-rated difference was not significant for spouses. The presence of multiple plans showed a significant effect only for spouses, where those with multiple plans were less likely to use any PBS-covered services.

The relative dentist supply variable is significant only in the spouse analyses: the estimated discriminant coefficients imply a 0.44 percent increase in use rates for a 10 percent rise in the dentist/population ratio.

CONDITIONAL BASIC EXPENDITURES (INTENSITY OF BASIC USE)

None of the money price variables is significant in the intensity of Basic use analyses (presented in Table 4 either for primary subscribers or spouses). Only the travel time cost elasticity (-.063) for spouse insureds ($p < .10$, 2-tailed test) is significant among the time price effects in the intensity of Basic use analyses. The family income effect is significant.

Age differences in the intensity of Basic use are insignificant, as displayed in Table 5. While not shown in Table 5, the primary subscribers' intensity of Basic use is approximately 20 percent greater among those with at least a high school education, as compared with those not completing high school. There are no significant differences in intensity of Basic use by level of education among spouse insureds. The intensity of Basic use is 3.5 percent less among female as compared to male primary subscribers, but differences by sex are insignificant for spouse insureds. The relative dentist supply variable is insignificant.

Among the insurance contract attributes, large differences in intensity of use according to duration of PBS dental coverage are observed. Intensity of Basic use varies from 35 percent to almost 60 percent less among adults (primary subscribers and spouses) in the

second or later years of their PBS dental coverage, as compared with those in their first year of coverage. There are no significant differences in intensity of Basic use between community-rated and experience-rated subscribers. Also, the variable for whether or not the employee contributed toward the dental insurance premium is not significantly related to intensity of use, nor is the dummy variable for presence of multiple dental plans.

TOTAL BASIC EXPENDITURES (UNCONDITIONAL)

The money price effects on total Basic dental expenditures, shown in Table 4, mirror the effects found in the probability of any use analyses. The money price elasticities are of the same sign and statistical significance as in the probability of use equations, but of larger magnitude for total Basic expenditures: -.025 for the Basic price elasticity, -.14 (-.15 for spouses) for Rider A, and -.19 for Rider C. The time price elasticities also are qualitatively similar to those in the probability of any use analyses, but are somewhat larger than the latter: the time price elasticities (travel and office waiting time) vary from -.062 to -.174 (among primary subscribers and spouses) in the total Basic expenditure equations.

In Table 5, the elasticity of total Basic expenditures for primary subscribers (only) with respect to family income is .06 ($p < .10$ on 2-tailed test), slightly less than the income elasticity of .09 for the probability of any use. As shown in Table 5, education is positively related to total Basic expenditures. The small difference in expenditures between male and female primary subscribers (2.1 percent greater among females) is not statistically significant. In contrast, among the spouses, female Basic expenditures per year are 25.9 percent greater than males. Only one of the age differences is even marginally significant ($p < .10$, 2-tailed test) although the relative magnitudes between age categories are the same as in the analyses of the probability of any use. As in the probability of any use equations, the dentist/population ratio is significantly positively related to Basic expenditures only among spouse insureds. The estimated coefficients imply, other things equal, that a 10 percent increase in relative dentist supply leads to a 0.59 percent increase in total Basic expenditures per spouse subscriber.

Total Basic expenditures by community-rated primary subscribers are approximately 37 percent greater, other things equal, than those of experience-related subscribers. Among spouses, the difference is roughly 90 percent and in the same direction.

DISCUSSION

GENERAL CONCLUSIONS

The most significant finding of this research is that the net price elasticities of demand for dental services are relatively small (and often statistically insignificant) in a population with dental insurance. The price elasticities reported here, which range from -.010 to -.266, are at the lower end of price elasticities of dental care demand previously estimated in the literature (cf. Manning and Phelps, 1979 [10]). This is not to say that the presence of some insurance does not substantially increase the utilization of dental services; it does. However, our findings do suggest that, *at the margin*, lowering coinsurance rates within an already insured population will have small incremental effects on demand over the range of dental coverage represented in the PBS study sample. Referring back to Table 1, which shows average coverage levels in the study sample, it is clear that PBS dental coverage is quite comprehensive.

Our findings therefore support the theoretical proposition (Phelps and Newhouse, 1974 [11]), which states that the money price elasticity of demand declines proportionately as the share of money price in full price (money plus time prices) declines. As that same theory would predict, time price elasticities of demand tend to be larger than the money price elasticities for the PBS-insured population.

The income elasticities of demand for the PBS sample are also relatively small—in the range of .06 to .09 among adults. Just as the presence of insurance coverage reduces the sensitivity of consumer demand to money prices, it seems to attenuate substantially the effect of income on demand.

In contrast, education plays a significant role as a determinant of dental care demand among adults. The probability of any use by adults is from 4 to 7 percent higher among those with at least a high school education, and the intensity of Basic use is 20 percent greater for that same group.

Duration of PBS dental coverage for the individual also shows several large effects on demand in our sample. While we do not perform a time series analysis of demand per se, our demand models do incorporate measures (as of 1980) of how long each individual has had dental coverage. Therefore, we can ascertain indirectly the differences in demand arising from differences in the "vintage" of the individual's dental coverage. We find that in the second and later years of dental coverage the probability of any use (use rate) is significantly lower (by

roughly 2 to 7 percent) than in the first year of coverage for adult primary subscribers, and we also observe a significantly lower use rate (by 5.3 percent) in the second coverage year for spouse insureds.

The differences for adults in the intensity of Basic use by duration of coverage are much larger than differences in use rates—on the order of 35 to 60 percent lower intensity of Basic use in the second and later years of dental coverage.

Our empirical analysis also has uncovered several statistically significant and economically meaningful differences in dental care demand between community-rated and experience-rated groups. These differences are striking since they are independent of the effects of differences across plans in coinsurance rates and scope of benefits, which are captured directly by the independent variables for the net money price of each type of dental service. Total Basic expenditures are 37 percent and 90 percent higher, respectively, for community-rated primary subscribers and spouse insureds. Given that the *marginal* elements of plan choice (coinsurance rate and covered benefits) cannot account for the self-selection effects in this study, we postulate that the net differences between demand are attributable to differential adverse selection between community- and experience-rated groups on the question of whether to purchase any dental benefit.

COMPARISON TO THE HEALTH INSURANCE EXPERIMENT (HIE)

One obvious comparison is between our results on dental care demand and the recent published results from the HIE. For this comparison only, we include the results from our analysis of children's demand, the details of which are reported elsewhere [12]. The use rates (probability of any use) we observe for adults and children in our PBS sample—55.5 percent (weighted average probability of any use for primary subscribers and spouse insureds) and 55.3 percent, respectively—fall within the range of use rates (52.6 percent for the 25 percent coinsurance plan and 66.8 percent for the free care plan) determined in the HIE in the second year of coverage. The average coinsurance rates for Basic services and the four Riders generally range from 2 to 28 percent (see Table 1), so it appears best to compare these two HIE plan categories with our own.

Expenditures per enrollee (children and adults added together) were $261 and $190 in January 1984 dollars for the free care and 25 percent coinsurance plans, respectively, in the HIE in the second coverage year. In contrast, the mean total expenditures in 1980 dollars

(the year of our study) for our PBS sample were $78.55 for adults and $49.10 for children per year. Even adjusting for inflation in dental prices between mid-1980 and January 1984, our PBS total expenditures per insured, per year, are $103 and $64 in 1984 dollars for adults and children, respectively—still well below the HIE figures.[4]

Based on a detailed comparative analysis of our findings and those of the RAND HIE, differences in the nature of the sample apparently do not explain the large difference in inflation-adjusted dental expenditure. Nor does out-of-plan utilization appear likely to account for more than a small amount of the aggregate difference. By deduction, a reasonable conclusion is that the cumulative impact of a series of design differences between the HIE and PBS study—controlled trial versus natural (quasi-) experiment, HIE compensation for anticipated worst-case financial risk, and the HIE upper limit on out-of-pocket cost to the enrollee—accounts for the lion's share of the difference.

We also compare our findings respecting money price elasticities with the implicit price (actually coinsurance) elasticities in the HIE conducted by the RAND Corporation. The HIE analysis of predicted steady-state annual use of dental services for a standard population by insurance plan (Table 4, p. 898, Manning et al. [1]) finds insignificant differences in expenses per enrollee between all but the free care plan and the 95 percent coinsurance plan. Qualitatively, the HIE results for the intermediate coverage levels are consistent with our general findings for the PBS sample of small price elasticities. The coinsurance structure of the PBS plans does not permit a direct comparison to the RAND HIE findings of the effect on demand of a move from a coinsurance of 25 percent for all services (except orthodontia) to free care. However, one can simulate the effect of such a move on Basic expenditures of the PBS sample, using the Basic estimated elasticities from the total Basic expenditure (demand) equations for primary subscribers in Table 2.

We have converted those net price elasticities into "insurance rate" elasticities[5] and then used the insurance rate elasticities to estimate the effect of a 33⅓ percent increase in the insurance rate on total Basic expenditures. That exercise suggests a 50.6 percent increase in total Basic expenditure per insured when coverage changes from a 25 percent coinsurance plan to a free care plan. By comparison, the RAND-predicted steady-state annual total expenses per enrollee (not distinguished within service category by plan type) are 31.4 percent higher in the free care than in the 25 percent coinsurance plan. We conclude that the PBS and HIE estimates of demand response to net price changes are in the same ballpark.

The final comparison between the PBS and HIE estimates is on the measured differences in expenditures by duration of coverage. Both studies find evidence of a positive one-shot impact of insurance coverage on demand in the first year. The RAND HIE results, which are not presented separately for adults and children, show a 31.3 percent decline in total expenses per enrollee between the first and second year of coverage among participants in the free care plan. The declines are more modest in the other plans—15.2 percent in the 25 percent coinsurance plan and 19.2 percent in the 50 percent plan, for example (with the 95 percent coinsurance plan showing an increase of 21.8 percent)—but generally in the same direction.

Our findings on the effects of duration of coverage are mixed. Among children insureds the probability of any use and the probability of orthodontic use both are unaffected by coverage duration. However, the intensity of Basic use is related substantially to coverage duration: the difference of $39 per user between years 1 and 2 is roughly 57 percent of the mean Basic expenditures per user. Adults' 1980 use rates are lower among those in the second and subsequent years of coverage by about 2-7 percent. More dramatically, the intensity of Basic use is from 35 to 60 percent less among adults in their second and later years of coverage. On balance, we conclude that there appear to be lower utilization rates and expenditures for dental services beyond the first year of coverage, but that the underlying behavior generating these changes is not clear.

IMPLICATIONS FOR HEALTH CARE POLICY AND DENTAL INSURANCE PLAN DESIGN

This detailed study of a major natural experiment in private dental insurance offers several implications for policy and plan design.

- Within the range of variation observed in the PBS sample, the effects on demand of lowering out-of-pocket price at the margin are significant, even though the price sensitivity of insured consumers—over a spectrum of estimated elasticities from -.010 to -.266 in this study—appears considerably smaller than the price sensitivity implied by previous estimates for largely uninsured populations.

- Time price factors are significant determinants of dental services utilization among an insured population. Policymakers, e.g., in considering Medicare Part B coverage for dental services, and private insurance carriers structuring dental benefits should account in their premium calculations for the influence on demand of dentist location

patterns and the role of dentist competition on time prices and amenities in the delivery of dental care.

• Assuming that, *if* individual dentists were able to create demand for their own services, demand creation would take place once the consumer received some dental care, we find no support for the following syllogism: higher relative dentist supply provides each dentist with a greater incentive to shift the demand for his services, not by competing on price or quality, but simply by altering the information to consumers about their need for dental care. Controlling for money price and time price, we find no independent effect of relative dentist supply on demand among those consumers already using the dental care system. Our findings of small positive effects on the probability of any use among spouse insureds are consistent with competitive responses which improve nonprice elements of dental care, thus inducing new consumers to enter the system.

• Dental insurance does seem to attenuate differences in demand by family income, but not education-related differences. Our findings indicate that more educated adults have higher probabilities of any use and (among primary subscribers only) a substantially higher intensity of Basic use.

• The one-shot impact on dental services utilization in the first year of coverage at a minimum should be anticipated by carriers when rating the initial versus steady-state premiums for an insured group. Premium pricing over time should reflect the time pattern of dental care utilization, and insurers should evaluate the extent to which first-year utilization represents a backlog of dental treatment needs versus a positive early response to economic incentives, which results in reduced dental care costs over the long term of the insurance contract.

• The observed differences in demand for dental services and in the comprehensiveness of dental plan chosen between subscribers with and subscribers without multiple plans also suggest certain adjustments in the design of dental benefits. Neither the utilization of services nor the choice of dental plan type among *primary subscribers* is affected by the presence of multiple plans. However, children in family units with multiple dental plans have lower probabilities of any orthodontic use, and a higher intensity of Basic use than those with only the single PBS plan. For children 14 years old and older in family units with multiple dental plans, the comprehensiveness of the PBS dental contract is significantly greater than for those with a single dental plan. The findings suggest that dental insurance claims of children are allocated among multiple plans—perhaps to optimize total dental cover-

age. Families with multiple dental plans appear to choose richer coverage for children 14 years and older, which suggests that carriers would gain efficiencies in claims payout by coordinating their benefits for children dependents with each other.

• Finally, this study provides the first published analysis of the effect of adverse selection factors on demand for dental care and on the type of dental plans chosen by employee groups. Community-rating is related to significantly higher dental services consumption among both children and adult insureds. We attribute this to the effects of adverse selection on the decision to have any insurance plan, since the key attributes of the plan (services covered and coinsurance rate) are incorporated independently in the analysis. Since PBS appears successfully to have counteracted adverse selection on the dimension of comprehensiveness of dental plan, the major effort at reducing adverse selection should concentrate on the terms of the group's initial decision to purchase any dental benefit. The evidence presented in our demand analyses suggests that, to the extent community-rating is necessary for small groups, the premium rates for those groups should be significantly higher—our data for Basic services imply some 37–90 percent higher for adults and approximately 30 percent higher among children. PBS's rating structure appears to have accounted for such differences. Other private carriers should conduct similar studies to support actuarial determinations for community-rated groups. Based on our work, the effects are large in dollar terms and are likely to have important impacts on any given insurer's competitive position.

APPENDIX: DENTAL DEMAND ESTIMATES

Dental Demand Estimates for Primary Subscribers

Variable	*Any Use* Coeff. (f-stat)	*Ln (Total Basic Use Expenditures)* Coeff. (t-stat)	*Ln (Total Basic Expenditures: Users Only)* Coeff. (t-stat)
Basic net price	-.094**	-.069**	.001
	(10.85)	(3.15)	(0.062)
Rider A net price (crowns, inlays, and oral surgery)	-.0009**	-.0007**	.0002
	(5.35)	(2.33)	(1.29)
Rider B net price (fixed and removable prosthodontics)	-.00004	.00009	-.00005
	(0.00)	(0.24)	(0.20)
Rider C net price (periodontal services)	-.0041*	-.0037*	-.0003
	(3.63)	(2.28)	(0.30)
Rider D coinsurance (orthodontic services)	.256	.290**	.111
	(2.23)	(2.21)	(1.53)
Education: high school completed	.384**	.422**	.219**
	(5.58)	(3.39)	(2.59)
Some college	.619**	.596**	.203**
	(11.91)	(4.35)	(2.27)
College completed	.757**	.753**	.215**
	(14.35)	(4.93)	(2.24)
Some graduate school	.644**	.663**	.212**
	(12.50)	(4.77)	(2.36)
Family income	.000009*	.000006*	.014
	(3.07)	(1.63)	(1.04)
Family size	-.0075	.0034	-.000002
	(0.06)	(0.14)	(0.87)
Female	.063	.021	.077
	(0.49)	(0.31)	(1.88)
Age: 18-34 yrs.	-.777**	-.379**	.022
		(6.57)	(1.63)
35-44 yrs.**	-.752	-.341	.054
	(5.95)	(1.44)	(0.408)
45-64 yrs.	-.584	-.240	.057
	(3.78)	(1.04)	(0.441)

Continued

Appendix: Continued

Variable	*Any Use* Coeff. (*f*-stat)	*Ln (Total Basic Use Expenditures)* Coeff. (*t*-stat)	*Ln (Total Basic Expenditures: Users Only)* Coeff. (*t*-stat)
Coverage: 1-2 yrs.	-.564**	-.103	-.548**
	(6.01)	(.97)	(8.32)
2-3 yrs.	-.388	.005	-.574**
	(2.66)	(.04)	(8.05)
3 + yrs.	-.283	.078	-.597**
	(1.75)	(.89)	(10.69)
Transportation cost	.050**	.054**	.013**
	(10.79)	(4.64)	(2.00)
Travel time cost	-.052**	-.044**	-.002
	(3.92)	(2.19)	(.21)
Office-waiting time cost	-.122**	-.096**	.0005
	(19.55)	(4.52)	(.039)
Value of person's own time	-.012	-.008	-.009
	(.38)	(.52)	(.92)
Experience-rated contract	—	2.39**	4.34**
		(8.09)	(24.91)
Community-rated contract	.472**	2.76**	4.36**
	(17.53)	(9.10)	(24.31)
Employee positive premium contribution	-.090	-.022	-.007
	(.45)	(.22)	(.11)
Employee not sure on contribution	-.435**	-.294**	.067
	(8.60)	(2.58)	(.96)
Individual (not family) contract	.006	.029	.087**
	(.017)	(.38)	(2.01)
Family has more than one dental plan	-.069	-.080	-.038
	(.29)	(.82)	(.69)
Dentist/population ratio for the (each of 22) economic market area	4.91	-.473	-12.25
	(.02)	(.02)	(.85)
Constant	—	—	—
R^2	—	.637	.965
Canonical correlation	.396	—	—

Continued

Appendix: Continued

Variable	Any Use Coeff. (f-stat)	Ln (Total Basic Use Expenditures) Coeff. (t-stat)	Ln (Total Basic Expenditures: Users Only) Coeff. (t-stat)
Percent using	58.2%	—	—
Average expense	—	$52.97	$85.64
Number of cases	4,173	4,173	2,117

Dental Demand Estimates for Spouse Insured

Basic net price	-.033	-.019	.0005
	(.92)	(.75)	(.03)
Rider A net price	-.0013**	-.0008**	.0000098
	(6.52)	(2.16)	(.04)
Rider B net price	-.057	-.0004	.0003
	(.29)	(.75)	(.92)
Rider C net price	.0013	.0012	-.0008
	(.22)	(.58)	(.66)
Rider D coinsurance	.292	.114	-.109
	(1.75)	(.70)	(1.10)
Education: high school completed	.280	.305**	.074
	(2.23)	(2.20)	(.74)
Some college	.362	.372**	-.016
	(2.69)	(2.30)	(.14)
College completed	.729**	.716**	.128
	(8.53)	(3.91)	(1.05)
Some graduate school	.613**	.549**	.018
	(6.63)	(3.15)	(.157)
Family income	-.000007	-.000003	-.000003
	(1.15)	(.52)	(.96)
Family size	.063	.059*	-.007
	(2.04)	(1.80)	(.34)
Female	.745**	.587**	-.012
	(37.70)	(6.58)	(.19)
Age: 18-34 yrs.	.765**	.702**	.643**
	(4.13)	(2.53)	(2.53)
35-44 yrs.	.891**	.747**	.617**
	(5.54)	(2.68)	(2.41)
45-64 yrs.	1.12**	.845**	.517**
	(9.03)	(3.06)	(2.02)
Coverage: 1-2 yrs.	-.746**	-.119	-.353**
	(5.45)	(.82)	(3.46)
2-3 yrs.	-.320	.102	-.427**
	(.95)	(.65)	(4.03)
3 + yrs.	-.468	.048	-.435**
	(2.49)	(.42)	(5.12)

Continued

Appendix: Continued

Variable	*Any Use* Coeff. (f-stat)	*Ln (Total Basic Use Expenditures)* Coeff. (t-stat)	*Ln (Total Basic Expenditures: Users Only)* Coeff. (t-stat)
Transportation cost	.048**	.038**	.0004
	(6.04)	(2.64)	(.05)
Travel time cost	-.068	-.053**	-.036*
	(1.28)	(1.85)	(1.85)
Office-waiting time cost	-.256**	-.119**	.031
	(20.14)	(3.93)	(1.40)
Value of person's own time	.045	.015	.004
	(.53)	(.88)	(.312)
Experience-rated contract	—	.713**	3.87**
		(2.01)	(12.80)
Community-rated contract	.111	.803**	3.92**
	(1.07)	(2.25)	(12.79)
Employee positive premium contribution	-.152	-.113	-.062
	(.72)	(.85)	(.70)
Employee not sure on contribution	-.184**	-.517**	-.005
	(12.14)	(3.30)	(.04)
Family has more than one dental plan	-.856**	-.652**	.072
	(24.76)	(5.13)	(.76)
Dentist/Population ratio for the (each of 22) economic market area	86.86**	58.65*	-18.58
	(3.47)	(1.71)	(.92)
Constant	-4.64	—	—
R^2	—	.546	.959
Canonical correlation	.380	—	—
Percent using	49.8%	—	—
Average expense	—	$40.53	$79.24
Number of cases	2,558	2,558	1,151

NOTES

1. The specific services analyzed were oral exams, prophylaxis, fluoride treatment, amalgam restorations (1, 2, or 3+ surface amalgams analyzed separately), composite restorations, porcelain-fused-to-metal crowns, root

canals, gingival curettage, scaling, full dentures, partial dentures, bridge crowns, extractions, and orthodontia.

2. Specific service results on probability of use, intensity of use, and volume of use (unconditional) are available from the authors on request.
3. This transformation uses the formula: proportionate effect of $X = B(1 - p)$, where B = estimated coefficient of X and p = the probability of any use of dental services. When we discuss *percentage* changes, we are referring to the relative change rather than the absolute change in the probability of use. To illustrate a change in the probability of any use, from .50 to .75 is a 50 percent *relative* change: (.75 - .50/50 × 100), while the absolute change is 25 percent: (.75 - .50) (100).
4. A detailed analysis of the likely sources of difference between the RAND HIE results and our own is available from the authors upon request.
5. Insurance rate is the percentage of expenses covered by the insurance carrier, i.e., 1 minus the coinsurance rate ($1 - c$). It can be shown that the insurance rate elasticity = $(-1)(1 - c/c)$ (coinsurance rate elasticity). So, using the coinsurance rate elasticities (equivalent to net price elasticities) from Table 2, we derive the effect as follows:

Rider (Category)	*Coinsurance Elasticity*	×	*(1 - c/c)*	×	*(-1)*	=	*Insurance Rate Elasticity*
Basic	-.014		(.98/.02)	×	(-1)		.686
A	-.075		(.89/.11)	×	(-1)		.607
B	.021		(.72/.28)	×	(-1)		-.054
C	-.083		(.77/.23)	×	(-1)		.278

(Orthodontia Rider excluded)

Thus, increasing the insurance rate by 33⅓ percent yields a predicted increase in total Basic expenditures of 50.6% = (.686) (33⅓%) + (.607) (33⅓%) - (.054) (33⅓%) + (.278) (33⅓%).

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Erratum

In the article by David Grembowski, Douglas A. Conrad, and Peter Milgrom, entitled, "Dental Care Demand Among Children with Dental Insurance" (*HSR* 21(6):755-75, February 1987), an error occurs in the *Results* section. The last paragraph on page 769, which addresses basic expenditures among all children, should read:

> Among the plan variables, length of coverage has a positive effect on basic expenditures. Using the formula for calculating total effects of changes in exogenous variables in Tobit regression [15], children with 12 or more months of dental coverage have $13-$20 greater annual basic expenditures than children covered less than 12 months. Children in community-rated plans spend $11 more for basic services than children in experience-rated plans, suggesting adverse selection effects. Paying part or all of the premium increases basic expenditures by $12 over those with employer-paid premiums. Finally, having multiple dental plans reduces a child's annual basic expenditures by $7 relative to families with dental coverage only through the PBS plan.

In Tobit regression, total effects are calculated by multiplying the Tobit regression coefficient times the predicted probability that Y (basic expenditures, in this case) is greater than zero at mean values of the independent variables. This probability is .51 in the study. Thus, the fundamental change is multiplying the expenditure values in the original paragraph by .51. This change has no impact on the conclusions of the study.