

ADVERSE SELECTION AND THE DEMAND FOR SUPPLEMENTARY  
DENTAL INSURANCE\*\*

BY

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*Summary*

In 1995 dental services were excluded from the compulsory health insurance package that covers the families of all Dutch employees in the market sector with incomes below a certain threshold. People had to choose between no insurance and supplementary insurance. The exclusion of dental services was unexpected and was accompanied by a generous acceptance policy and almost uniform premiums. Due to these features the exclusion constitutes a natural experiment to investigate whether customers with poorer teeth conditions are more likely to buy insurance. This is a key condition for adverse selection to matter. The empirical results show that adverse selection indeed occurs; individuals with poor teeth condition are more likely to choose insurance. The same holds for customers with more frequent visits in the past. Differences in prices play some role, whereas differences in income do not.

**Key words:** health insurance, adverse selection, dental insurance

1 INTRODUCTION

Adverse selection is a potentially important phenomenon in many markets. Health insurance markets offer prominent examples. The classic treatment of adverse selection in insurance markets is Rothschild and Stiglitz (1976).<sup>1</sup> An important assumption in this – and other – adverse selection model is that customers who belong to a low risk group are less inclined to buy insurance than customers who belong to a high risk group. While this assumption is plausible, it remains an empirical question whether customers indeed select themselves on the basis of their risks. If that is not the case, the adverse selection model breaks down. Or, as Marquis (1992) formulates it: whether customers' forecasts of their risks affect their purchase of insurance coverage is a key condition for adverse selection to matter.

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1 Salanié (1997, pp. 61-65) summarizes the model and discusses the main criticisms. Recently, Newhouse (1996) modified Rothschild and Stiglitz' model, yielding more realistic conclusions.

Testing the empirical relevance of this assumption is, however, difficult. Problems arise because of the following reasons. Firstly, the basic assumption is that the buyer of insurance has some private information which is unknown to the seller. The question then arises how the researcher got access to this information while the seller did not despite the fact that such information is profitable for the seller. Secondly, the maintained assumption is that this hidden condition is exogenous. Yet, in actual practice it may be hard to distinguish between exogenous and endogenous factors affecting someone's risk. Are insured people less healthy because less healthy people are more likely to buy insurance, or because insured people care less about their health as a result of the insurance? In other words, is the correlation between health condition and insurance status the result of adverse selection or of moral hazard? Disentangling the two has proven very difficult and requires specific data. Finally, to test whether high risks actually drive low risks out of the market, one should have a situation where both risk types are offered the same insurance terms and where sellers do not select buyers. Otherwise it would be difficult to determine whether the selection is due to the customers or to the sellers. In addition one should not only have information about buyers applying (and being accepted) for the insurance, but also about those not purchasing the insurance. Without such information, it is impossible to determine whether those not buying the insurance are indeed low risk customers.

These problems indicate what kind of data are required to actually investigate whether customers indeed select themselves on the basis of their risks, and thus whether an important assumption underlying adverse selection is satisfied. In this paper, we exploit a unique data set, which – as we will argue – satisfies these requirements. In the Netherlands, the families of all employees in the market sector with gross annual incomes below a threshold of around 55,000 guilders (in 1995) – which includes over 60% of the Dutch population – are covered for medical expenses by a compulsory health insurance (Ziekenfonds). The insurance covers the costs of a standard package of services. This standard package includes a broad range of medical services, but not all services available are included. Until 1995 expenditures on dental services were included in the standard package. But late 1994 the Minister of Health announced that starting January 1995 the coverage of most of these services would be excluded. This was primarily for budgetary reasons. Regular check-ups and dental services for children (not older than 18 years) remained in the standard package. People could choose between being uninsured or buying supplementary insurance. Supplementary insurance was offered by the same insurance agencies that offered the regular packages. There was an informal agreement among these agencies that, for some period, they would accept all people applying for supplementary insurance (see Ziekenfondsradaad (1995), p.11).<sup>2</sup> Moreover, premiums for a similar package were not differ-

2 People who did not go to a dentist for regular check-ups twice a year were admitted as well, without costs for the initial check-up.

entiated according to the condition of a person's teeth. Without selective admittance and with undifferentiated prices, insurance agencies were unable to protect themselves against adverse selection by high risk clients.

The exclusion of dental services from the standard package was rather unexpected so that people could not anticipate the introduction of the new system. Because of this we think it is safe to say that the condition of people's teeth in the beginning of 1995 is exogenous with respect to the choice of supplementary dental insurance. If people would have known the introduction of this policy change in advance, this could have affected their behavior with regard to taking care of their teeth. In that case the condition of their teeth at the moment of choosing between buying insurance or not depends on the introduction of the policy and would then be endogenous. This would make it impossible to distinguish adverse selection from moral hazard.

Due to the general acceptance policy, the insurance companies cannot gain from having knowledge about the buyers' teeth condition. Whether they know this or not does not affect their profits because they are unable to exploit such information. Hence, it is not strange that we as researchers have knowledge about the condition of buyers' teeth, whereas the sellers do not. The reason is simply that sellers have no interest in obtaining this knowledge.

The above situation constitutes an almost perfect natural experiment to study the relevance of adverse selection in the market of dental insurance. Three features stand out: the generous acceptance policy of the sellers, undifferentiated premiums, and the unexpected introduction. Given this unique circumstance, it is very fortunate that shortly after the exclusion of dental services from the standard package data were collected about individual insurance choices and the condition of persons' teeth. We use this data set in the empirical analysis of this paper.

A number of other studies have addressed the question whether customers with higher risks are more inclined to buy health insurance. We briefly summarize these studies here. The main aim of this summary is to show that these studies do not produce unambiguous results.

Cameron and Trivedi (1991) use Australian data to estimate a logit model for the choice between a standard package and a more generous level of coverage. They find no significant effect of health condition variables on insurance choice.<sup>3</sup> The authors do not mention, however, whether or not there is any differentiation of insurance conditions based on the risk people bring in. Hence it cannot be precluded that a weak effect of health risk on insurance choice is found because of selection or pricing policies of the insurance companies.

3 The variables measuring health condition are information on current and past illnesses experienced, the length of illness, the degree of concern arising from the illness, the general well-being of the respondent as measured by the score on the general health questionnaire and the existence of limiting and non-limiting chronic conditions.

Wolfe and Goddeeris (1991) use a longitudinal data set from the US to disentangle moral hazard effects of supplementary insurance on health care expenditures from adverse selection effects of poor health. They report some evidence for adverse selection in the form of a significant effect of past expenditures on insurance demand. They find no effect, however, from self-assessed health status and disability indicated chronic health conditions on insurance demand. The authors suggest that this may be explained by possible differentiation of premiums by insurance companies. As premiums are not observed in their data set, this hypothesis cannot be tested.

Marquis and Phelps (1987) and Marquis (1992) examine the effects of adverse selection on insurance choices using data from the RAND Health Insurance Experiment. The authors find that adverse selection may be a serious problem in health insurance markets if insurers charge a single premium. Adverse selection can be reduced if premiums are differentiated across demographic groups, or if supplementary packages are offered. The main shortcoming of these two studies is that they relate to stated rather than to actual choices. Respondents were confronted with hypothetical questions of the 'if-then' format. More specifically: (i) risk is measured by health expenses in the next 12 months as anticipated by individuals, and (ii) insurance choices are not measured by actual choices but by responses to hypothetical offers.

A last study we need to mention in this brief review of the literature is that of Geurts and Rutten (1987). This research is particularly relevant for the current study as it deals with dental insurance in the Netherlands. For this study data were collected before the exclusion of dental expenses from the standard package. In the mid-1980s, 1728 persons insured by the compulsory package were interviewed and asked the following question: 'If you now would have the opportunity to buy health insurance for your family with the possibility to choose which things would be covered, would you then buy insurance for dental expenses?' The answer to this question is related to background characteristics including the respondent's subjective evaluation of his/her teeth condition and the frequency of past visits to a dentist. People with frequent visits in the past more often answer that they would buy dental insurance. Geurts and Rutten find, however, no relation between subjective teeth condition and the response to the insurance question; people with good teeth are equally likely to be willing to buy insurance for dental expenses than people with bad teeth. This suggests that – insofar as subjective teeth condition proxies risk – adverse selection is not an issue for dental insurance. Like Marquis, and Marquis and Phelps, Geurts and Rutten base their analysis on stated choices. Since the study by Geurts and Rutten basically deals with the same issue as ours, it is particularly interesting to compare the findings of both analyses as this may provide some information about the validity of methodologies based on stated rather than revealed choices. We return to this later on.

The remainder of this paper is organized as follows. Section 2 presents the statistical model. Section 3 describes the data set and the choice and construction of variables. Section 4 presents and discusses the empirical results, while section 5 summarizes and concludes.

## 2 STATISTICAL MODEL

For the empirical analysis in this paper we apply the probit model. This model is appropriate when individuals face a dichotomous decision problem. In the present case, after the elimination of dental services from the standard package, individuals could either buy supplementary dental insurance or become uninsured for expenditures on dental services.<sup>4</sup>

Let  $V_{Hi}$  be the indirect utility level person  $i$  extracts from buying dental insurance. This level is assumed to depend on the condition of the person's teeth  $C_i$  (with higher values indicating poorer conditions), the person's income ( $y_i$ ), the price of insurance faced by the individual ( $p_i$ ) (see below), a vector of personal characteristics ( $X_i$ ), and a random term  $\varepsilon_{Hi}$  which reflects unobserved characteristics of the individual, unobserved taste variation, and genuine indeterminacy of individual behavior (cf. Cramer (1991), p. 49). Indirect utility obtained from becoming uninsured for dental services ( $V_{Ni}$ ) also depends on  $C_i$ ,  $y_i$ ,  $X_i$  and a random term  $\varepsilon_{Ni}$ . We propose the following linear functional forms for these indirect utility levels:

$$V_{Hi} = \alpha_0 + \alpha_1 C_i + \alpha_2 y_i + \alpha_3 p_i + X_i \alpha_4 + \varepsilon_{Hi}$$

$$V_{Ni} = \beta_0 + \beta_1 C_i + \beta_2 y_i + X_i \beta_4 + \varepsilon_{Ni},$$

with the  $\alpha$ 's and  $\beta$ 's (vectors of) parameters of the model. Define  $I_i$ , the net value of buying insurance, as the difference between  $V_{Hi}$  and  $V_{Ni}$ :

$$I_i = \gamma_0 + \gamma_1 C_i + \gamma_2 y_i + \gamma_3 p_i + X_i \gamma_4 + \varepsilon_i, \quad (1)$$

4 Actually, customers could choose between no dental insurance, standard dental insurance, and extended dental insurance. While the questionnaire asks respondents which kind of insurance they have chosen, we have lumped the two insurance packages together. The main reason for doing so is that for the extended package admittance was not automatic, but might require some selection. Furthermore there was quite some non-response to this particular question. This approach does not affect our estimation results provided that customers whose first preference is the extended coverage prefer standard coverage to no insurance. In that case the current analysis can be regarded as the first stage in a two stage model. In the first stage customers decide whether to buy supplementary dental insurance or not, in the second stage the joint decisions of the insured customers and the insurance companies determine whether someone has standard coverage or extended coverage.

where  $\gamma_0$ ,  $\gamma_1$ ,  $\gamma_2$  and  $\gamma_3$  are parameters,  $\gamma_4$  is a parameter vector and  $\varepsilon_i$  is the difference between  $\varepsilon_{I_i}$  and  $\varepsilon_{N_i}$ .  $I_i$  is a latent variable, its actual value is never observed. What we do observe, however, is a dummy variable which takes value one if an individual purchases insurance and zero otherwise. For individuals who purchase insurance we infer that the net value is positive ( $I_i > 0$ ). While for individuals who do not purchase insurance it is deduced that the net value is non-positive ( $I_i \leq 0$ ). When we furthermore assume that  $\varepsilon_i$  is drawn from a normal distribution, we have a probit model for which the parameters  $\gamma_0$  to  $\gamma_4$  can be estimated by maximum likelihood. The adverse selection mechanism predicts  $\gamma_1$  to be positive.

Equation (1) expresses the individuals' decisions to apply for insurance. Normally, another equation should describe the insurance companies' admission policy. Together, the application and admission functions determine whether an individual will be insured or not. Given the general admission policy of the insurance firms in the present case, however, the application and insurance equations coincide.

A richer model than the one described above would not only take account of adverse selection effects, but would also relate the insurance choice to individuals' behavior regarding their teeth. People may differ in the way they protect their teeth by brushing and flossing regularly and in their eating habits. Moral hazard occurs when people behave differently depending on whether they are insured or not. Although the data set we employ for our analysis includes information about protective behavior as well as eating habits, this information is not suitable to analyze moral hazard along with adverse selection. To address the issue of moral hazard and disentangle it from adverse selection effects one needs to take account of the endogeneity of behavior. That is, the model should not only consist of an equation describing insurance choice, but should also include an equation explaining behavior towards protecting ones teeth. The disturbance terms of the two equations are likely to be correlated. To implement this empirically one either needs longitudinal data or variables that can legitimately be considered as valid instruments for behavior. As we work with a cross sectional data set, and since we cannot think of such valid instruments (even if their availability in the data set would not be a constraint), the issue of moral hazard cannot be addressed in this paper.

### 3 DATA, CHOICE OF VARIABLES AND PRELIMINARY ANALYSIS

Following the exclusion of dental services from the standard package, the Dutch Council of National Health Insurance (Ziekenfondsraad; currently known as the College voor Zorgverzekeringen) commissioned the collection of information about the impact of the change. In 1995, 1601 persons were interviewed and asked questions about whether they bought supplementary insurance for dental services, the condition of their teeth, how frequently they visited their dentist,

and familiar background characteristics like income, education, gender, and age. After deleting observations with missing values for important variables and cases with dental plates, we were left with 893 valid observations. 740 (83%) of them reported that they had chosen supplementary insurance.<sup>5</sup>

Six questions were asked as to whether the condition of a respondent's teeth caused problems.<sup>6</sup> As different causes for teeth trouble, the questionnaire distinguished: (i) inflamed gums; (ii) retracted gums; (iii) ignition of teeth; (iv) sensitive teeth; (v) bad breath; and (vi) chewing problems. For each of these items four different answers are possible: never, sometimes, often, and always. In its most extended form, this gives us 24 dummy variables. We summarized this information in three different ways. Firstly, we assigned to the answers never, sometimes, often and always, the values 1, 2, 3, and 4 respectively. We then have six variables related to the causes (i) to (vi), where a higher value indicates increasingly worse teeth conditions. The responses to the six items turn out to be highly correlated (none of the fifteen possible pairwise correlation coefficients is below 0.25) which may cause multicollinearity problems in our empirical analysis. To deal with this, we computed two alternative measures of teeth condition which both compress the information of the six items. For the first alternative measure we simply added the scores on the six items. This produces a new variable 'Teeth condition (unweighted)' which ranges from a minimum of 6 to a maximum of 24. For the second alternative measure of teeth condition, we used the six items in a factor analysis and used the loadings of the first factor (which were all positive) to create the variable 'Teeth condition (factor analysis)'.<sup>7</sup>

The measures of teeth condition we just discussed are all based on the respondents' subjective evaluation. While in the end it is the objective rather than the subjective teeth condition which determines a customer's risk, it is from the perspective of this paper's topic preferable to employ a subjective measure for the essence of adverse selection is that there is asymmetric information: customers have some relevant private information that the insurance company does not have. And the information which the customer has about his/her objective teeth condition is of course included in the customer's own evaluation of his/her (subjective) teeth condition. In contrast, if a person is not aware of some aspects of his/her objective teeth condition then these aspects cannot be a source of adverse selection. Another reason why a subjective measure is preferable is that these are fairly common in the health literature. While we did not select the studies cited above on this criterion, these studies all use subjective health measures. Using a

5 This is close to the figure reported by Geurts and Rutten (1987); 85.5% of their respondents indicate that they would buy insurance to cover dental expenses.

6 The items in the questionnaire used to measure teeth condition are based on epidemiological dental studies (cf. Kalsbeek et al. (1998)).

7 The first factor has an eigenvalue of 4.33, while the second factor has an eigenvalue of 0.42. This sudden drop points to the fact that subsequent eigenvalues are just sampling noise. The first factor accounts for 72.2 percent of the variance in the six variables.

subjective health measure keeps our findings comparable to those of other studies.

Another measure likely to indicate the future use of dental services is the frequency of visits to the dentist in the past. Frequent visits do not necessarily indicate poor current teeth condition. But, in order to acquire their current teeth condition, frequent visitors had to go to their dentist more often than others did. And hence, given the current teeth condition, more frequent visitors in the past are likely to be more frequent visitors in the future as well. If they recognize this relation, they will be more inclined to buy supplementary insurance. In normal circumstances, insurance companies counter this by implementing some form of experience rating where premiums are related to past claims. But, as mentioned before, the exclusion of dental expenses from the standard package and the subsequent opportunity for customers to buy supplementary insurance, do not represent 'normal circumstances.' The questionnaire includes the question 'How frequently did you visit the dentist before January 1 1995?' The possible answers are: at least twice a year (824 respondents); once a year (17); less than once a year (6); never for a check-up (29); never (17). Given the frequencies we decided to create a dichotomous indicator distinguishing only between at least twice a year and less than twice a year.

Besides adverse selection, standard economic theory suggests that prices and income may affect a person's demand for insurance. As the general acceptance policy of insurance companies only applies to the clients who were already insured with that company, people are assumed to buy supplementary dental insurance only from their 'own' company.<sup>8</sup> Since different companies levy different premiums for a similar package of supplementary dental insurance, different people are confronted with different prices. For individuals who have chosen to buy insurance as well as for those who have chosen not to buy insurance we know the name of their own insurance company. Hence we could add to our original data set information about the prices of supplementary dental insurance. Since the actual price variation is very small, we should not be too optimistic that this source of information will give much insight into the role of prices on the demand for dental insurance.

Also included in the data set is information about respondents' income levels. Gross annual income is measured on a continuous scale and is included as a regressor. Since only people with incomes below the threshold level of 55,000 guilders per year are insured through the compulsory scheme, the income bracket to which our results apply is limited. Hence, all results and conclusions only relate to this particular population, which – as was noted before – includes around 60% of the Dutch population. In addition to this, the following regressors are used in the analysis: age (measured continuously), a dummy for gender, and education

<sup>8</sup> This is related to the notion of stickiness introduced by Neipp and Zeckhauser (1985) to express that customers remain in a plan once they are in it.

measured as the number of years nominally required for the highest level completed. Table 1 presents descriptive information on the explanatory variables included in the analysis, separately for insured and uninsured respondents. This allows a first inspection of possible differences between the two groups. We briefly discuss the results here.

With the exception of 'bad breath' for all indicators, the group who chose to become insured contains higher percentages in the categories that are associated with bad teeth condition. Differences are most pronounced for the frequencies with regard to 'inflamed gums' and 'sensitive teeth'. This carries over to the summary statistics 'teeth condition (unweighted sum)' and 'teeth condition (factor analysis)'. Insured respondents have on average higher scores for these two measures, indicating weaker teeth condition. The frequency of past visits also shows a substantial difference between both groups. Among the uninsured 82% belongs to the group who used to visit the dentist twice a year, while this is 93% among the insured respondents. Furthermore, uninsured respondents are on average somewhat younger than insured respondents, they are more likely to be male, they earn slightly higher incomes, they are confronted with slightly higher prices, and are higher educated. In the next section we test whether these bivariate correlations carry over to a multivariate model.

#### 4 ESTIMATION RESULTS

Table 2 presents three columns with estimation results. Each of the three columns gives maximum likelihood estimates for equation (1). The columns differ in the way in which the key variable teeth condition is measured. In column (A) 'teeth condition' is measured by the six separate items listed in the previous section. In column (B) teeth condition is measured by the simple (unweighted) sum of the scores on the six items. Finally, in column (C) the measure of teeth condition is the weighted sum of the six items, with the weights resulting from a factor analysis (cf. section 3).

In the first column only one out of six coefficients related to teeth condition differs significantly from zero. People who have sensitive teeth are more likely to buy supplementary dental insurance than people who never have sensitive teeth. As mentioned earlier, the insignificance of the other five indicators of teeth condition in the first column are likely to result from the high correlation between the scores on the six items. The results in columns (B) and (C) – which are based on compressed measures of teeth condition – show that respondents with bad teeth are significantly more likely to buy supplementary dental insurance. An increase of the bad teeth condition measure with one standard deviation (measured at mean values of the other regressors) increases the probability of buying insurance with 2.6 percentage points. High risk customers are more inclined to buy supplementary dental insurance than low risk customers. This is the key finding of our paper.

TABLE 1 – DESCRIPTIVE STATISTICS OF EXPLANATORY VARIABLES BY INSURANCE STATUS

	Uninsured		Insured	
	Mean	S.D.	Mean	S.D.
Inflamed gums				
Never	0.73		0.65	
Sometimes	0.24		0.32	
Often	0.03		0.03	
Always	0.01		0.01	
Retracted gums				
Never	0.73		0.74	
Sometimes	0.22		0.18	
Often	0.04		0.05	
Always	0.01		0.03	
Ignition of teeth				
Never	0.74		0.73	
Sometimes	0.25		0.25	
Often	0.01		0.02	
Always	0.00		0.00	
Sensitive teeth				
Never	0.50		0.42	
Sometimes	0.45		0.47	
Often	0.04		0.08	
Always	0.01		0.03	
Bad breath				
Never	0.67		0.68	
Sometimes	0.30		0.29	
Often	0.03		0.03	
Always	0.00		0.00	
Chewing problems				
Never	0.90		0.87	
Sometimes	0.08		0.11	
Often	0.02		0.02	
Always	0.00		0.00	
Teeth condition (factor analysis)	3.72	0.87	3.87	1.00
Teeth condition (unweighted sum)	7.94	1.81	8.24	2.09
Past use	0.82		0.93	
Age	34.95	10.95	36.00	11.63
Female	0.53		0.58	
Income * 1000	40.76	15.81	38.99	13.98
Premium	8.95	1.31	8.74	1.31
Education	12.09	2.65	11.57	2.54
Number of observations		153		740

Note: For categorical variables the numbers refer to the share of the group of uninsured/insured belonging to this category. For continuous variables the numbers are the mean value and the standard deviation (S.D.) within the group of uninsured/insured.

Our finding contrasts with the finding reported by Geurts and Rutten (1986). Based on persons' responses to the hypothetical question whether they would buy coverage of dental expenses if they had free choice, these authors find that there is no relation between people's subjective teeth condition and their response to this question. At least to the extent that dental insurance is concerned, there appears to be an important difference between results obtained from a study based on actual choices and a study based in stated choices. Such differences question the usefulness of analyses based (solely) on stated choices.

Future use of dental services is not only likely to be related to the condition of a person's teeth, but may also be related to a person's usage of dental services in the past. It seems likely that those who visited their dentist more often under the old system, will also be the more frequent users once they buy supplement-

TABLE 2 – PROBIT ESTIMATION RESULTS FOR EQUATION (1) FOR THREE DIFFERENT MEASURES OF TEETH CONDITION

Explanatory variables	(A)	(B)	(C)
Inflamed gums	0.107(0.108)		
Retracted gums	-0.022(0.086)		
Ignition of teeth	-0.041(0.118)		
Sensitive teeth	0.195(0.084)**		
Bad breath	-0.041(0.100)		
Chewing	0.087(0.140)		
Teeth condition (factor analysis)		0.110(0.055)**	
Teeth condition (unweighted)			0.053(0.027)**
Age	0.008(0.005)*	0.007(0.005)	0.007(0.005)
Female	0.053(0.104)	0.066(0.103)	0.068(0.102)
Income*1000	-0.004(0.004)	-0.003(0.004)	-0.003(0.004)
Premium	-0.065(0.039)*	-0.063(0.038)*	-0.063(0.038)*
Education	-0.044(0.021)**	-0.046(0.020)**	-0.046(0.020)**
Past usage	0.710(0.160)***	0.718(0.158)***	0.718(0.158)***
Constant	0.767(0.532)	0.787(0.516)	0.768(0.519)
Loglikelihood	-389.69	-391.98	-391.96
$\chi^2$ (DF)	38.59	34.02	34.05
Pseudo R <sup>2</sup>	0.047	0.042	0.042
Number of cases	893	893	893

Note: Standard errors are in parentheses; \*/\*\*/\*\* indicates significance at the 10/5/1%-level.

tary insurance. Therefore, frequent users in the past have a higher expected benefit from insurance and are thus more likely to buy insurance. The results in Table 2 give strong support to this additional adverse selection channel. The associated coefficient differs significantly from zero, and the size of the effect is very substantial; other things equal (including current teeth condition), frequent past users have a 23 percentage points higher probability to buy supplementary dental insurance than others. This is in line with findings in other studies which report a substantial positive effect of past usage on the probability of buying (more) health insurance.<sup>9</sup>

Although the variation in premiums for dental insurance is fairly modest we find that persons who have their health insurance from a company that charges a higher premium for the supplementary dental insurance are less likely to buy this insurance. This suggests that the demand for this insurance option is sensitive to changes in prices. Increasing the monthly premium by one guilder (about 10%) leads to a reduction of the probability of being insured of 1.7 percentage points (again evaluated at mean values for the regressors). Usually, premium differences are associated with differences in risk, which makes it difficult to compare this result with other findings. Our results can be compared with the findings of Marquis and Phelps (1987) and Marquis (1992) who vary the loading fee<sup>10</sup> in their hypothetical offers. In both papers it is found that an increase in the loading fee decreases the probability that a family is prepared to accept an offer.

More highly educated persons are (other things equal) less likely to buy supplementary dental insurance than persons with less schooling. This finding is not unexpected given that in the present case insurance is bought against risks which are fairly limited in terms of their financial consequences. The difference in wealth between the worst possible outcome and the best possible outcome is not very substantial. More highly educated people may be more aware of the possible future states. Here again, our findings deviate from the results reported by Geurts and Rutten (1987) who find that respondents with more education are more likely to answer that they will buy supplementary dental insurance. Studies which examine the demand for health insurance (as opposed to dental insurance only) typically find that customers with more education are more likely to opt for (more) insurance.<sup>11</sup>

Independent of how teeth condition is measured, gender and income differences have no impact on the probability of supplementary insurance. The absence of an effect of income suggests that the results of the current analysis can perhaps be extrapolated to individuals with incomes above 55,000 guilders. But this is somewhat speculative as we have no data from this group. Age only has a significant effect (at the 10%-level) in the first specification – with older people

9 See Cameron and Trivedi (1991), Geurts and Rutten (1987) and Wolfe and Goddeeris (1991).

10 Defined as  $(P-B)/B$ , with  $P$  the premium and  $B$  the benefits from the insurance plan.

11 Cf. Cameron and Trivedi (1991) and Wolfe and Goddeeris (1991).

having a higher propensity to buy insurance – but the size of this effect is very modest. With regard to gender and income our findings are similar to the results reported by Geurts and Rutten (1987), but for age they find that older customers are less likely to buy supplementary dental insurance.<sup>12</sup> Studies dealing with the demand for health insurance find that women are more likely to buy (more) insurance, while the results for age and income/wealth are mixed.<sup>13</sup>

## 5 CONCLUSION

In this paper we have exploited the exclusion of dental services from the compulsory medical insurance package that covers 60 percent of the Dutch population to identify the causal effect of a person's teeth condition on his/her insurance choice. Our key finding is that individuals with poor teeth condition have a greater preference to buy supplementary dental insurance than individuals with healthier teeth. Due to the special circumstances surrounding the exclusion we can be fairly certain that this effect is not biased by insurance companies' admittance or pricing policies or by the effects of moral hazard.

Although the circumstances allowing us to examine the working of adverse selection in the dental insurance market are very special, this does not mean that our results only pertain to these special circumstances. The mechanism that high risk customers are more inclined to buy dental insurance will also be at work when insurance companies take measures to counteract adverse selection such as selecting customers, differentiating premiums, and offering menus of insurance contracts. Our results show that without such measures, adverse selection would occur, and hence insurance companies have indeed reason to take such measures. This conclusion differs from the conclusion that would be drawn from the results of the study by Geurts and Rutten (1987). There the conclusion would be that adverse selection in dental insurance is not an issue since customers' insurance choice is unrelated to their teeth condition – and hence it would not be necessary for insurance companies to introduce policies against adverse selection. The key difference between Geurts and Rutten's study and ours is that their results are based on stated preferences whereas our results refer to revealed preferences.

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<sup>12</sup> The tests statistics in Geurts and Rutten (1987) suggest that there are significant differences between different income categories. This is due, however, to the category for which income is unknown.

<sup>13</sup> See Cameron and Trivedi (1991), Marquis and Phelps (1987), Marquis (1992), and Wolfe and Goddeeris (1991).

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