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Adverse selection in the health insurance market: some empirical evidence

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Abstract This paper tests for the existence of adverse selection in the Brazilian individual health insurance market in 2003. The testing approach adapts that conceived by Chiappori and Salanié (Eur Econ Rev 41, 943–950, 1997; J Polit Econ 108, 56–78, 2000). After controlling for sex, age, income, number of dependents, occupational groups and schooling levels, the evidence favors adverse selection as indicated by a positive correlation between the coverage of the contract and occurrence of illnesses (as approximated by hospitalization) was not strong. The consideration of complex sampling in the probit estimations led to empirical evidence that does not indicate the presence of adverse selection, but which highlighted some interesting features of the relationship between the selected variables.

Keywords Adverse selection · Health insurance market

JEL Classification D82 · I11

Introduction

The theoretical relevance of adverse selection has already been established for health insurance markets [see, e.g., 13–15]. In fact, the existence of asymmetric information with respect to exogenous and intrinsic characteristics of one of the involved agents would be relevant to the better design of regulatory policies. In particular, the term adverse selection was coined in the context of insurance where the insurer has to offer contracts based on the average of a pool of candidates comprising agents with good and bad intrinsic characteristics, and therefore will select clients with adverse characteristics (types). In the context of health insurance, the inability to properly discriminate clients with distinct probabilities of becoming ill could lead to the prevalence of that form of asymmetric information. It is important to stress that even though health insurance firms use various preliminary screening mechanisms to detect previous unfavorable medical records, informational asymmetries can still prevail. A distinct manifestation of asymmetric information is given by moral hazard when there is uncertainty with respect to some endogenous variable as, for example, when considering the contract coverage, one could be less health conscious or even engage in unnecessary medical visits.

At a conceptual level, the prevalence of different forms of asymmetric information appears to be potentially appealing in the context of the health insurance segment. Nevertheless, the empirical strand of the literature, on the other hand, has experienced a much slower progress that is bound by the availability of suitable data. Empirical studies on other types of insurance include Chiappori and Salanié [5, 6], Finkelstein and Poterba [9], and Saito [16], among others.

Empirical papers in the more specific context of health insurance can be divided in two categories: studies that concentrate on specific parts of the general health market [7, 8, 20], and those in which the market is national and general in nature [1, 3, 4, 17].[1] Results for adverse

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[1] The first group of studies considers specific segments of the market. Ettner [8] focused on Medicare supplementary (Medigap) insurance, Wolfe and Goddeeiris [20] focused only on the elderly segment, and Cutler [7] considered health plan choices by employees of Harvard University.

selection are scant and found only in some of the papers that analyze specific segments of the markets. Within the second group, the evidence on adverse selection was mixed.

The present paper intends to search for adverse selection by adapting the empirical procedure advanced by Chiappori and Salanié [5, 6]. The market selected is the Brazilian health insurance market, where data from 2003 is suitable for the test of a positive correlation between plan coverage and occurrence of illnesses (as indicated by hospitalization).

The contribution of the paper is then twofold: first, to consider an econometric model that incorporates features of the sampling design in the testing procedure for adverse selection in the health insurance market. Second, to use the results to try to preliminarily explain features of the Brazilian health insurance market—the Brazilian case can be especially illuminating as the bulk of the literature is concentrated in developed countries. A similar study by Wanick and Resende [19] emphasized health insurance utilization instead of hospitalization and therefore was not tailored to capture adverse selection.

Should adverse selection be a relevant feature of the Brazilian health insurance market, higher equilibrium prices of health insurance contracts would prevent access by a large part of the population to that market, while the alternative in terms of low quality services in public hospitals is unsatisfactory.

The paper is organized as follows. The following section describes the empirical strategy for testing adverse selection. The third section briefly describes the institutional and regulatory features of the Brazilian health insurance market and presents the data construction. The fourth section presents the empirical results. The fifth section brings some final comments.

Empirical testing of adverse selection

Chiappori and Salanié [5, 6] advanced a test strategy for adverse selection based on the assessment of the correlation between contract coverage and occurrence of accidents in the context of car insurance. The idea is that such a manifestation of asymmetric information would prevail if, after controlling for different variables that might explain sample heterogeneity, one detects a positive correlation between the aforementioned variables.

In the context of the health insurance market, the binary choice variables referring to the contract coverage and occurrence of illnesses (as given by hospitalization) are specified in terms of a limited dependent variable econometric framework. More specifically, two different probit models are considered, where one precludes or allows for correlation between the errors of the different choice equations. The probit model is well established and assumes that the probability of a given binary variable conditional on observable explanatory variables evolves in accordance to a cumulative distribution function of the standard normal distribution.[2] In generic terms, the empirical model is defined in terms of a pair of equations for contract coverage and hospitalization (as indicating an actual occurrence of an illness) that can be described as follows:

$$\text{CCOV} = f(X, \beta, \varepsilon_1) \qquad \text{HOSP} = f(X, \gamma, \varepsilon_2) \tag{1}$$

where CCOV assumes a value of 1 if the contract coverage is comprehensive and 0 otherwise. HOSP assumes a value of 1 if (in the present context) the plan is used for hospitalization and 0 otherwise. X denotes a vector of individual characteristics, and ε_1 and ε_2 represent stochastic disturbances.

The testing strategy involves the estimation of two independent probit models and the construction of a statistic to test the independence of the errors from the two equations based on the residuals for each individual ($i = 1{:}n$). In this sense, one can rely on the following statistic suggested by Gouriéroux et al. [10]:

$$W = \frac{\left(\sum_{i=1}^{n} e_{1i} e_{2i}\right)^2}{\sum_{i=1}^{n} e_{1i}^2 e_{2i}^2} \tag{2}$$

Under the null hypothesis of conditional independence $\text{Cov}(e_{1i}, e_{2i}) = 0$, W is distributed asymptotically as a $\chi^2(1)$. The test is potentially limited because it assumes no dependence between the errors of the two equations.

A complementary analysis could be provided by the estimation of a bivariate probit model that explicitly allows for correlation between the errors of the two equations in terms of a bivariate normal distribution for the referred errors with a correlation coefficient ρ. The focus of the analysis would then be on the magnitude and sign of the correlation coefficient. However, in the case where one considers the same set of explanatory variables in the two equations, one is led to the well known result that the estimates of the bivariate model (and therefore the residuals) are identical to those from two independent probit models, and thus that additional analysis would become redundant irrespective of the correlation pattern between the errors of the two equations.

Empirical analysis

The Brazilian market

The Brazilian health market was essentially unregulated until 1998, when laws 9656/98 and 9961/00 defined,

[2] See, e.g., [11] for a useful introduction.

among other things, the minimum level of coverage and premium restrictions to elderly enrolees so as to as to avoid, for example, abusive sliding scales. Moreover, as broader minimum plan coverage was discussed, rules for migrating between old and new plans were important. The reform also created a regulatory agency [Agência Nacional de Saúde Suplementar].[3] Two types of contracts are offered in the market: individual and group contracts. We restrict our analysis to individual contracts or collective contracts where the individual can choose from a large menu in terms of coverage (types of illnesses and medical procedures that are covered). Applying this restriction allows a better search for adverse selection, because asymmetric information can be identified when the individual has the ability to adopt more comprehensive plans than he/she would otherwise due to private information.

In 2007 there were 1,246 health insurance firms, 22,127 health insurance plans and 44.4 millions enrolees in the Brazilian market (but proportion was heavily skewed towards rich regions; in the Southeast—richest region—averaging 39.4% of the population covered by private health insurance, with the North and Northeast regions—the poorest parts of the country—averaging 9.2 and 12.0%, respectively).

The private health insurance market gradually started to fill the gap left by a deficient network of public hospitals. In fact, public provision of health services exists at the three levels of government (federal, state and municipal) where poor coordinating policies typically prevail. Some public hospitals operate in particular specialities, and, in some, specific units are still considered reference centers—this occurs especially in high complexity procedures (like transplants) that are not covered by private health insurance. However, as a rule, public hospitals are subject to non-negligible congestion, which is manifested in terms of significant queues for obtaining consultations with specialists, hospitalization and surgical treatments.[4] Patients may be asked whether they have private health plans for the purpose of reimbursements to the public sector [Sistema Único de Saúde–SUS]. However, anecdotal evidence appears to show that this information is often not reported, and therefore hospitalization information by policyholders could involve underreporting and thus we are considering a conservative test for adverse selection.

Although the regulatory environment is still evolving and far from consolidated, it is worth mentioning that abusive practices by health insurance firms are still common, as indicated by the substantial number of complaints to consumer defense organisations. It is clear that a substantial part of the Brazilian population does not have access to private health insurance, and therefore has to rely solely on public hospitals with their associated congestion, and most people consider the public health network to be under par.

Data description

The data source was a specific survey of various aspects of health that was conducted by the Brazilian Statistical Bureau [Pesquisa Nacional por Amostra de Domicílios—PNAD] in 2003.[5] The survey was national in scope, with 384,834 households. The sampling procedure was stratified in three stages. First, the probability of selection of a municipality conditional on the stratum was defined. The basic criterion is based on the fact that larger municipalities (called self-representative) are selected with probability 1. Secondly, the probability of selecting a sector conditional on the municipality was highlighted. Finally, the probability of selection of a household conditional on sector was defined. In the first two stages there are unequal probabilities of selection, whereas in the third stage there is a simple random sampling procedure. The probability of a given household i (for $i = 1,\ldots, N$), and individuals within that household, being selected is given by:

$$\pi_i = \pi_{\langle \text{municipality}|\text{stratum}\rangle} \cdot \pi_{\langle \text{sector}|\text{municipality}\rangle} \cdot \pi_{\langle \text{household}|\text{sector}\rangle} \tag{3}$$

The reciprocal is relevant for setting weights in the pseudo maximum likelihood estimation.[6] The final sample with 31,418 observations was obtained after a filter that required disregarding observations for which no sampling weights were provided. Moreover, since the main policyholder of the health insurance is not necessarily the head of the household, we did not consider individuals below 18 years of age so as to guarantee a better reliability for the variable referring to the number of dependents (NDEP).

Sampling weights are often ignored by economists but unequal probabilities of individuals being selected by a survey can be potentially important in the context of heterogeneous economies. In fact, the continental nature of Brazil and the fact that the survey comprises individuals from very distinct regions and characterized by various

[3] Institutional details on that market are discussed in [18].

[4] Evidence provided by Bahia et al. [2] indicate that high-cost procedures are somewhat shared between the private and public. The former segment has a higher importance for cardiac bypass, cardiac angioplasty, hip arthroplasty, and morbid obesity surgery, whereas the latter has a more decisive role in terms of hepatic transplants and substitutive renal therapies.

[5] The special supplement referred to had been previously available for 1998.

[6] In general, applied economists ignore complex sampling in econometric estimation based on survey data, but the importance of sampling design has been outlined at least since 1965 [12].

heterogeneous attributes renders the effort of acknowledging complex sampling as potentially relevant to the econometric estimation.

Endogenous variables

CCOV Dummy variable concerning contract coverage. Assumes value 1 if the contract is comprehensive (comprising access to primary and auxiliary exams, ambulatory care, private room in case of inpatient care, and national coverage), and 0 otherwise;

HOSP Dummy variable for contract utilization in terms of hospitalization that assumes value 1 if any medical procedure covered involving hospitalization has been used, and 0 otherwise.

Exogenous variables

AGE in years;
SEX 1 if the individual is male, and 0 if female;
INCOME monthly individual income (insurance premiums are paid monthly);
NDEP number of dependents specified in the contract;
SCHOOL number of years in school.

Occupational variables

The underlying notion is that different occupational groups can exert different impacts on the probability of using a particular medical procedure. The available classes of occupations are aggregate and therefore comprise occupations with distinct income levels and also potentially distinct chances of favoring illnesses. In any case, occupational factors are complex as one might have occupations with high incomes that nevertheless are associated with high stress levels for example. Dummy variables were constructed for:[7]

OCCUP1 agriculture;
OCCUP2 manufacturing;
OCCUP3 other services;
OCCUP4 retail;
OCCUP5 transport and communication;
OCCUP6 financial services;
OCCUP7 education and health.

[7] In order to avoid the so-called dummy trap that would relate to perfect collinearity, the variable referring to individuals with no occupation is dropped in the econometric analysis.

Table 1 Summary statistics (number of observations: 31,418)

Variable	Minimum	Maximum	Mean	Standard deviation
CCOV	0	1	0.106	0.307
HOSP	0	1	0.090	0.286
AGE	18	101	43.387	15.044
SEX	0	1	0.550	0.497
INCOME	100	56,600	2,867.299	3,190.211
NDEP	0	11	1.193	1.341
SCHOOL	1	17	11.331	4.110
OCCUP1	0	1	0.030	0.172
OCCUP2	0	1	0.125	0.331
OCCUP3	0	1	0.191	0.393
OCCUP4	0	1	0.142	0.349
OCCUP5	0	1	0.051	0.220
OCCUP6	0	1	0.102	0.302
OCCUP7	0	1	0.156	0.362

The summary statistics for the variables considered in the estimations are presented in Table 1 and indicate strong heterogeneities in the sample.

Taking as reference the endogenous variable CCOV and HOSP, independent univariate probit models were estimated. The assessment of the adverse selection hypothesis is related directly to the association between the residuals of the two equations. The analysis is based on the W statistic obtained from the estimation of two independent probit models. This class of models embodies the normality assumption for the conditional probability of the binary dependent variable given observables. Aoki [1] followed a similar testing strategy but considered non-parametric estimation procedures. The study was based on the Medical Expenditure Panel Survey data in 1996 and found some evidence for asymmetric information. However, the data referred to non-emergency medical visits that comprised different categories of procedures and did not necessarily highlight adverse selection aspects as it did not necessarily deal with an actual occurrence of an illness. In that sense, we understand that it is relevant to consider hospitalization data, and this is done in the present paper. Moreover, we are not aware of nonparametric procedures incorporating complex sampling and therefore decided to explore this neglected aspect in terms of parametric probit models. Finally, we consider occupational control variables that could in principle be relevant in a large and heterogeneous developing economy like Brazil.

Empirical results

Prior to discussing the evidence on the proposed test statistic it is worth briefly discussing the results from the

estimation of the probit models that give rise to the relevant residuals used in the test. The results appear in Table 2 and the estimations were implemented using Stata S.E. 10.0 (http://www.stata.com/).

Some salient aspects can be summarized as follows:

(1) There are some differences in particular coefficients in the two equations when one considers complex sampling in the estimation, though part of the coefficients are somewhat similar in magnitude;
(2) Age exerts a positive and significant effect on both contract coverage (CCOV) and hospitalization (HOSP). This result was expected not only because of the greater probability of actually becoming ill but also due to a broader awareness in this respect as evidenced by the positive effect on CCOV;
(3) Regarding SEX, the salient result is the stronger likelihood of hospitalization in the case of women, which could reflect, in part, childbirth procedures;
(4) INCOME exerts a significant and positive effect only in the case of CCOV;
(5) SCHOOL exerts a positive effect on health awareness as indicated by CCOV but not on actual occurrence of illnesses;
(6) The number of dependents (NDEP) typically does not exert a significant effect on either CCOV or HOSP for the policyholder;
(7) The occupational variables are somewhat aggregated and the interpretation is not completely clear cut. Nevertheless, distinct patterns for different occupations appear to prevail, especially if one focuses on the complex sampling estimates;

Altogether, the statistical results are satisfactory in terms of the significance of the individual coefficients. Moreover, the expected signs largely prevail for the coefficients used, and therefore one can place more confidence in the implemented test, which is based on the residual of the equations.

The evidence provided by the test statistic W, as presented in Table 3, indicates that, after controlling for relevant exogenous factors, the null hypothesis of zero covariance (and therefore correlation) between the error terms of the two equations was rejected in the case of traditional probit models, whereas it could not be rejected when one accounts for complex sampling. The latter case would indicate a positive correlation between contract coverage and hospitalization, which would favor the prevalence of adverse selection. The former evidence, however, does not indicate this form of asymmetric information, which indicates that, despite the many shortcomings of the Brazilian health insurance market, the incidence of asymmetric information appears not to be an important issue to be acknowledged in terms of regulation design.

Final comments

The present paper addressed the test of adverse selection in the context of the Brazilian health insurance market. The phenomenon referred to can be related with the positive association between contract comprehensiveness and hospitalization.

Table 2 Regression results—two independent probit models (no. of observations: 31,418)

Explanatory variable	Traditional model		Model with complex sampling	
	Dependent variable			
	CCOV	HOSP	CCOV	HOSP
Constant	−2.494 (0.000)	−1.163 (0.000)	−2.580 (0.000)	−1.344 (0.000)
AGE	0.007 (0.000)	0.004 (0.000)	0.008 (0.000)	0.006 (0.006)
SEX	0.096 (0.000)	−0.214 (0.000)	0.059 (0.263)	−0.166 (0.013)
INCOME	5.97E-05 (0.000)	−2.54E-06 (0.485)	6.18E-05 (0.000)	−3.59E-07 (0.965)
NDEP	0.002 (0.803)	4.26E-04 (0.957)	0.017 (0.377)	0.041 (0.077)
SCHOOL	0.067 (0.000)	−0.009 (0.001)	0.080 (0.000)	−0.010 (0.207)
OCCUP1	−0.128 (0.058)	−0.039 (0.507)	−0.101 (0.585)	0.105 (0.578)
OCCUP2	−0.157 (0.000)	−0.301 (0.000)	−0.156 (0.123)	−0.281 (0.024)
OCCUP3	−0.148 (0.000)	−0.188 (0.000)	−0.153 (0.077)	−0.327 (0.001)
OCCUP4	−0.167 (0.000)	−0.214 (0.000)	−0.164 (0.082)	−0.169 (0.149)
OCCUP5	−0.184 (0.001)	−0.339 (0.000)	−0.221 (0.067)	−0.507 (0.001)
OCCUP6	0.036 (0.354)	−0.287 (0.000)	0.017 (0.846)	−0.318 (0.004)
OCCUP7	−0.326 (0.000)	−0.150 (0.000)	−0.397 (0.000)	0.045 (0.678)

P values are displayed in parentheses

Table 3 Testing for adverse selection: empirical results

Two independent probit models	
Traditional models	Models incorporating complex sampling
$W = 5.796$	$W = 2.179$
P-value $= 0.016$	P-value $= 0.140$

Using methods that acknowledge complex sampling, the evidence indicated that, after controlling for relevant exogenous factors, there is no support for the existence of adverse selection.

The evidence indicated that the heterogeneity of the sample as reflected in the sampling weights can make a difference to the test results. The sample thus considered led to a conservative test as previously mentioned so additional research is warranted. Future research should focus on similar data for coming years as they become available so as to consider a more consolidated regulatory environment, and also on other manifestations of asymmetric information such as moral hazard.

Finally, it is important to emphasize that if the prevalence of adverse selection was deemed to be important it would tend to lead to higher equilibrium prices of health insurance contracts with the related perverse consequences in terms of blocked access to the poorer parts of the population. In the present case, despite the negative evidence with respect to adverse selection, one cannot discard high prices associated with the exercise of market power. Regulatory actions to foster competition have been scant but one should mention the portability of plans that has been recently implemented in 2009, by which policyholders can migrate between similar health plans provided by different health insurance firms without waiting times. The present analysis in the context of a developing country is particularly interesting because it highlights the finding that, despite the many flaws in the Brazilian system, the non-incidence of asymmetric information shows that the regulatory framework may be having a positive impact in the selection of insurance plans by the population. The fact that the market is behaving properly is interesting in itself in the instance of regulation design in the private insurance markets of developing countries. But in the present context the main results are even more interesting because, alongside the non-incidence of asymmetric information, they also reveal many interesting relationships among the selected variables in the estimation, especially regarding the impact of variables like income and schooling on health awareness.

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