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by

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Health Insurance and Life Style Choices: Identifying the Ex Ante Moral Hazard

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Abstract

There is extensive debate in the literature about the practical significance of the concept of ex-ante moral hazard. This paper uses data from the 1999-2003 PSID waves to estimate a structural model of individual choice of insurance coverage and four life style related decisions: heavy smoking, heavy drinking, sedentarism and obesity. The results show that health insurance has significant incentive effects on life style choices, increasing the propensity to heavy smoking, sedentarism and obesity. Somewhat surprisingly, however, health insurance decreases the propensity to heavy drinking. There is also significant correlation among the errors of each equation. The results might also have implications for the design of health financing policies.

Keywords: Ex ante moral hazard; Insurance; Life Style; Maximum Simulated Likelihood

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1 Introduction

Ex ante moral hazard is an important theoretical concept in Health Economics. Ehrlich and Becker (1972) were among the first to propose a model describing the complex relationship between health insurance and preventive activities. While some kinds of preventive actions are complementary to market insurance, others can be shown to be substitutes. That is, ex ante moral hazard exists in some circumstances, implying that individuals become more reckless about their future health when they are covered by health insurance. This might affect the demand for preventive health services and also individual lifestyle choices which influence future health.

Until recently, there has been a widespread view in the literature that, although a theoretical possibility, ex ante moral hazard has possibly limited practical consequences. Some authors (eg. Kenkel 2000, Zweifel and Manning 2000) have suggested that the welfare loss from ex ante moral hazard is probably small, because health insurance offers incomplete coverage. Although the monetary component is covered, there are still significant utility losses in terms of pain and suffering, which reduce individual incentives to engage in harmful activities[1]. In other words, risk aversion contributes to make indeterminate the effect of insurance coverage on preventive activities (see Zweifel and Manning 2000).

[1] A similar argument should also apply to workers' compensation. The possibility of serious health consequences should make it unlikely that more generous benefits induce workers to become more reckless. However, several studies have documented this effect.

In the empirical literature, several studies have tended to corroborate this view that ex ante moral hazard is of limited importance. Kenkel (1994) has studied the influence of private insurance on the demand for preventive health care (breast exams and pap tests), finding important lifecycle and schooling effects. Kenkel (1994) finds that the use of preventive services decreases with age, which suggests an adaptation to shortening payoff period to invesment in prevention. Increasing coverage for curative services also increases the demand for preventive care, because the out-of-pocket cost is reduced (see also Courbage and de Coulon 2004, Pagán, Puig and Soldo 2007). This suggests that the two types of care are complements, and may serve as substitutes for patient own preventive effort.

Courbage and de Coulon (2004) investigate how private health insurance affects the demand for preventive care (insured) and individual behaviours (non-insured) in the UK. As discussed above, health insurance might increase the demand for insured preventive services simply because the cost for the patient is reduced, but it is unlikely to increase non-insured activities. Therefore, this distinction might help to disentangle the ex ante and ex post moral hazard effects. Their results, based on univariate probit regressions controlling for individual observed characteristics, show that private health insurance increases the probability of exercising and undergoing breast screening, and reduces the probability of smoking. The authors hypothesise that this might be due to the fact that insurance makes individuals more concerned about the risks they are facing. We argue below, however, that this argument ignores the fact that health insurance demand and life style choices might be influenced by common unobservable characteristics of the individual.

In recent years, new studies have started to provide additional evidence on the existence of ex ante moral hazard. Dave and Kaestner (2006) have explored the effect of health insurance on health behaviours, arguing that there is a direct (ex ante moral hazard) and indirect effect. The indirect effect works through increased contact with health professionals, which might improve health information and reduce the probability of illness.

Focusing on the effect of health knowledge on health behaviour, Kenkel (1991) also tests the hypothesis that increased contact with health professionals granted by health insurance might improve health knowledge and decrease the propensity to engage in harmful health-related behaviours. The results show that health knowledge decreases smoking and heavy drinking, and increases exercise, but there is still a significant influence of schooling. This suggests the existence of unobservable factors which affect both schooling and health-related behaviour. Similarly, Zweifel and Manning (2000) comment on the likely endogeneity between insurance coverage and wage income.

A major point in Dave and Kaestner's (2006) study is to consider the exogenous change in insurance status that takes place as people above 65 years old become automatically elegible for Medicare. This allows to identify the ex ante moral hazard, since insurance coverage is independent from health related behaviour. Likewise, Bhattacharya and Sood (2006) research the relation between insurance and obesity. They show that, when premiums are not risk rated for obesity, there is a significant negative externality on non-obese enrolees, which appears because obese enrolees have higher expected medical expenditures.

Another important question relates to the relationship between health risk and insurance demand. Some studies (eg Bundorf, Herring and Pauly 2005, Cardon and Hendel 2001) find evidence of positive relationship between health risk and insurance demand, which is consistent with the existence of adverse selection in the insurance market. Likewise, Courbage and Rey (2006) argue that the fear of sickness exerts a positive influence on the level of effort to prevent the occurrence of sickness. However, other empirical evidence suggests the opposite, that health risk is negatively associated with insurance coverage. For example, Finkelstein and McGarry (2003) find that individuals who invest more on prevention, and therefore have lower risk, also spend more on insurance. They suggest this might be explained by "other unobserved characteristics that are positively related to coverage and negatively related to risk occurence". This also provides some support for the idea of propitious selection, which has been suggested in the literature (see Chiappori and Salanié 2000, de Donder and Hindriks 2006, Hemenway 1990, Hemenway 1992, Jullien, Salanié and Salanié 1999, de Meza and Webb 2001, Pauly and Held 1990).

Recent studies (eg. Contoyannis and Jones 2004, Balia and Jones 2005) show that lifestyle choices are an important determinant of individual health.

Habits like smoking or excess drinking have harmful effects on health status and increase the probability of disease and premature death. As a result, health care expenses are also adversely affected, imposing external costs on the society.

Manning, Keeler, Newhouse, Sloss and Wasserman (1991) have shown that, apart from the internal costs imposed on the individual and the family, over the lifetime each smoker creates an external cost of 15 cents per pack of cigarettes[2] in terms of increased medical expenses and fire damage, and of lower income taxation. Some studies suggest that, due to lower life expectancy, smokers in average can expect to make make positive net contributions to Social Security. Even after controlling for this, Sloan, Ostermann, Picone, Conover and Taylor (2004) estimate the lifetime total social cost of smoking at $106,000 for a woman and $220,000 for a man. The study by Bhattacharya and Sood (2006) cited above estimates that uniform insurance premiums impose an externality of $150 per capita per year on non-obese enrolees resulting from increased health expenditures incurred by obese enrolees.

To date most empirical papers have tended to focus on the demand for preventive services or diagnostic tests (eg. Kenkel 1994). By focusing on the effect of health insurance on lifestyle choices this study would fill an important gap, which has implications for the design of both private plans

[2]In 1986 US dollars. For comparison, the price of a pack of cigarrettes was about US$ 1.

and public systems of social security (see Courbage and de Coulon 2004).

This paper is organized as follows. The next section presents a theoretical model for insurance demand and lifestyle choices, which emphasises the possibility of ex ante moral hazard when premiums are not risk rated. Section 3 describes the dataset used for this study, the waves of 1999, 2001 and 2003 of the Panel Study of Income Dynamics. The econometric strategy and the estimated models are presented in Section 4. Section 5 then gives the results and Section 6 concludes.

2 Theoretical framework

The theoretical framework used here is an extension of the models proposed by Ehrlich and Becker (1972) and Zweifel and Breyer (1997). The consumer makes two related choices. First, the individual decides whether to buy insurance coverage to protect from the cost of medical expenditures in the case of illness, which occurs with probability π. Second, the consumer makes a binary decision $s = (0, 1)$ about whether to engage in a risky behaviour, which corresponds to the lifestyle choices of smoking, drinking, exercising and obesity that we are interested in. The risky behaviour provides a level of utility $v(s)$ and increases the probability of illness at a decreasing rate $(\pi' > 0, \pi'' < 0)$.

The individual is initially endowed with exogenous wealth y. In the sick state, the individual suffers a monetary loss L corresponding to medical care.

The insurance contract charges premium $P(s, I)$, and, in turn, provides an indemnity payment I, which covers all or part of the medical expenses ($0 \leq I \leq L$). Both the utility from wealth and the utility from the risky behaviour are assumed to be increasing and concave ($u' > 0, u'' < 0$ and $v' > 0, v'' < 0$). We normalise to one the price of engaging in the risky behaviour.

2.1 Optimal choice of life style without insurance

We first consider the optimal choice of the risky behaviour when health insurance coverage is not available. The individual choice consists of only one stage and can be represented by:

$$\max_{s} EU = (1 - \pi(s))u(y - s) + \pi(s)u(y - s - L) + v(s). \tag{1}$$

The First Order Condition (FOC) is:

$$s^* : v'(s) = \pi'(s)\left(u_h - u_s\right) + (1 - \pi(s))u'_h + \pi(s)u'_s. \tag{2}$$

Proof. The result is obtained by differentiating (1) with respect to the risky behaviour choice. The Second Order Condition is $\Gamma = -\pi''(s)\left(u_h - u_s\right) + 2\pi'(s)(u'_h - u'_s) + (1 - \pi(s))u''_h + \pi(s)u''_s + v''(s) < 0$. Considering that the marginal benefit of the risky behaviour is decreasing ($v''(s) < 0$), if $\pi''(s) > 0$ the SOC is always satisfied, and it may or may not be satisfied if $\pi''(s) < 0$. ■

Let u_h and u_s denote the utility in the healthy and sick state, and u'_h and u'_s denote the corresponding marginal utilities. The FOC (2) describes the optimal choice s^* of risky behaviour with uniform premiums. The left-hand sides is the marginal benefit that the individual receives from engaging in the risk behaviour. The first term on the right represents the marginal cost in terms of the increased probability of experiencing the utility loss associated with the sick state, while the other two terms give the reduction in utility in both states associated with the cost of the risky behaviour.

2.2 Simultaneous choice of health insurance and life style

Following Ehrlich and Becker (1972), we now consider the incentives for risky behaviour when the individual has the option to contract health insurance. Other empirical studies have tended to assume that the two decisions are not correlated. However, it is reasonable to expect that there are common elements which affect both decisions[3]. For example, factors such as expectations about future health and attitudes towards risk might influence both the propensity to self-select into insurance and the decision to adopt a particular life style (see for example Cardon and Hendel 2001). Ignoring these influences might result in biased estimates of the relation between insurance

[3]When considering the incentives for self-protection, Ehrlich and Becker (1972) argue that "optimal decisions about market insurance depend on the availability of these other activities and should be viewed within the context of a more comprehensive "insurance" decision" (p. 624).

and life style.

2.2.1 Risk rated premiums

First let us consider the case of risk rated premiums, when the insurer adjusts the premium according to individual choices with respect to the risky behaviour. We assume the insurer can observe the individual risky behaviour. The insurance premium $P(s, I)$ depends on the level of coverage and varies with the individual choice with respect to the risky behaviour. Specifically, we assume insurance premiums are actuarially fair, and equal the expected loss for the insurer:

$$P(s, I) = E[I] = \pi(s)I. \tag{3}$$

The individual choice can be represented by:

$$\max_{s,I} EU = (1-\pi(s))u(y-s-P(s,I))+\pi(s)u(y-s-P(s,I)-L+I)+v(s). \tag{4}$$

The First Order Conditions (FOC) are:

$$s^{**} \ : \ v'(s) = (1 + \pi'(s)L)\, u', \tag{5}$$

$$I^{**} \ : \ I = L. \tag{6}$$

Proof. First, differentiate (4) with respect to the indemnity level: $-(1 - \pi(s))\frac{\partial P(s,I)}{\partial I}u'_h + \pi(s)\left(1 - \frac{\partial P(s,I)}{\partial I}\right)u'_s = 0$, and rearrange to obtain $\frac{u'_h}{u'_s} = \frac{\pi(s)}{1-\pi(s)}\frac{1-\frac{\partial P(s,I)}{\partial I}}{\frac{\partial P(s,I)}{\partial I}}$. From (3), we obtain $\frac{\partial P(s,I)}{\partial I} = \pi(s)$, which we substitute into the FOC: $u'_h = u'_s$, which implies $y - s - P(s,I) = y - s - P(s,I) - L + I$ and therefore $I = L$. Next differentiate (4) with respect to the life style choice: $-\pi'(s)u_h - (1-\pi(s))\left(1 + \frac{\partial P(s,I)}{\partial s}\right)u'_h + \pi'(s)u_s - \pi(s)\left(1 + \frac{\partial P(s,I)}{\partial s}\right)u'_s + v'(s) = 0$ and rearrange to obtain $v'(s) = \pi'(s)\left(u_h - u_s\right) + \left(1 + \frac{\partial P(s,I)}{\partial s}\right)\left((1-\pi(s))u'_h + \pi(s)u'_s\right)$. The FOC wrt indemnity (6) implies the first term on the right vanishes, and allows us to rewrite $u'_h = u'_s = u'$ and $I = L$. Thus from (3) we obtain: $\frac{\partial P(s,I)}{\partial s} = \pi'(s)I \Rightarrow v'(s) = \left(1 + \pi'(s)I\right)u'$. The Second Order Condition are $EU_{ss} =$, $EU_{II} =$ and $\Sigma = EU_{ss}EU_{II} - \left(EU_{sI}\right)^2 > 0$. ■

According to the FOC with respect to the indemnity level (6), the individual will choose full coverage when premiums are actuarially fair, which is a standard result in Insurance Economics.

Now focus on the FOC with respect to the life style choice. According to (5), the individual trades-off the marginal benefit from engaging in the risk behaviour (LHS) with the marginal cost, which is given by the marginal cost of the life style choice plus the expected premium increase, both evaluated in terms of marginal utility. This result implies that the optimal choice in this case is equivalent to the solution corresponding to income maximisation in the absence of insurance. Therefore, as suggested by Ehrlich and Becker (1972) and Zweifel and Breyer (1997), risk rated premiums mitigate ex ante moral hazard since the individual choice of life style is the same that maximises income in the absence of insurance[4].

2.2.2 Uniform premiums

Now let us focus on the case when health insurance premiums do not depend on life style choices. This is equivalent to assume that the life style choices are not observable or not contractable. Now the premium is a function only of the insurer loss:

$$P = P(I). \tag{7}$$

The sequential decision process comprises two stages, first the decision to insure and then the decision on whether to engage in the risky life style. By backward induction, we consider first the life style choice, taking the level of insurance as given:

$$\max_{s} EU(s) = (1-\pi(s))u(y-s-P) + \pi(s)u(y-s-P-L+I) + v(s). \tag{8}$$

The FOC is:

$$s^{+}(I) : v'(s) = \pi'(s)\left(u_h - u_s\right) + (1-\pi(s))u'_h + \pi(s)u'_s. \tag{9}$$

Proof. Differentiate (8) wrt to s: $\frac{dEU}{ds} = -\pi'(s)u_h - (1-\pi(s))u'_h + \pi'(s)u_s - \pi(s)u'_s + v'(s) = 0$, and rearrange the FOC (8). ■

[4] This result is slightly different from Ehrlich and Becker's (1972) analysis of optimal prevention because here one also needs to take into account the marginal utility of the life style choice. Specifically, one can show that: $-\pi'(s)L \geq 1$ if $v'(s) \geq u'$ and $-\pi'(s)L < 1$ otherwise.

Following Zweifel and Breyer (1997), this FOC can be interpreted as a reaction curve, which describes the optimal life style choice for each given level of insurance coverage. This reaction curve has two important attributes (see 10, p.181):

1. $s^{+}[0]$ is equivalent to s* given by (2), that is, it corresponds to the same optimal choice in the absence of market insurance and

2. $s^{+}[L]$ is equal to zero, since $I = L$ yields $y_h = y_s = y$. Replacing this into (9) implies $\frac{dEU}{ds} = -u'(s) + v'(s) \gtrless 0$. This means that .....

Now return to the first stage of the decision process, when the individual decides how much insurance coverage to contract by taking into account that this will influence the optimal choice of life style. This is achieved by maximising:

$$\max_{I} EU(I) = (1-\pi(s(I)))u(y-s(I)-P(I))+\pi(s(I))u(y-s(I)-P(I)-L+I)+v(s(I)). \tag{10}$$

The FOC is:

$$I^{+} : P'(I)\left[(1-\pi(s(I)))u'_h + \pi(s(I))u'_s\right] = \pi(s(I))u'_s. \tag{11}$$

Proof. Differentiating (10) wrt indemnity choice, we obtain $v'(s(I))\frac{\partial s}{\partial I} = \frac{\partial s}{\partial I}\left[\pi'(s(I))\left(u_h - u_s\right) + (1-\pi(s(I)))u'_h + \pi(s(I))u'_s\right] + P'(I)\left[(1-\pi(s(I)))u'_h + \pi(s(I))u'_s\right] - \pi(s(I))u'_s$. The FOC for life style choice implies that the first term among square brackets in the RHS is equal to $v'(s(I))$. Therefore, the FOC simplifies to $P'(I)\left[(1-\pi(s(I)))u'_h + \pi(s(I))u'_s\right] = \pi(s(I))u'_s$. ■

According to (11), the individual chooses the level of insurance coverage taking into account the marginal utility cost of increasing coverage associated with the increase in premium payments in both states (LHS), and the marginal benefit, which is given by the increase in marginal utility in the sick state (RHS).

3 Data

The data used in this paper comes from the Panel Study of Income Dynamics (PSID). As described in the website, the PSID is a nationally representative longitudinal study of nearly 8,000 US families, which has been following the same families and individuals since 1968. We analyse the waves of 1999, 2001 and 2003, which contain the information relative to lifestyle choices, health insurance status and other indicators of health status which are relevant for this analysis. We use a balanced sample of 5,126 individuals. The sample includes only the heads of each household, which are all adult individuals (17 years and above).

In average 93% of individuals in the sample are covered by health insurance. Table 1 shows some descriptive statistics separating the sample into insured and uninsured individuals. We notice several differences between the two sub-samples. The uninsured sample can be considered more socioeconomically deprived in many aspects. For instance, the average family income is less than half of the insured sample (US$25,858 versus US$62,609), and the average schooling is also lower. While in the insured sample 20% of the individuals have only primary education and 48% have college education, in the uninsured the proportions are practically inversed (44% and 21%, respectively). The unemployment rate is markedly higher in the uninsured sample (14% versus 5% in the insured sample), but the proportion of retired people is lower (10% versus 18%). Finally, the combined proportion of black and Hispanic individuals is almost double among the uninsured compared to the insured (57% versus 32%).

Let us focus on the observed prevalence of the life style choices. In almost all cases, the uninsured tend to lead a less healthy-conscious life style. They tend to smoke more (5% of heavy smokers compared to 3% in the uninsured sample), drink more alcohol (8% versus 4% of heavy drinkers) and to be more sedentary (16% versus 11%). With respect to the prevalence of obesity, however, the two groups fare very similarly (25% versus 26%).

For almost all health condition indicators the insured group reports higher prevalence rates, both for life style-related (stroke, high blood pressure, diabetes, cancer, heart attack and coronary heart disease) and unrelated conditions (emotional problems, arthritis and loss of mental ability). Perhaps surprisingly, however, the proportion of individuals with fair or poor self-assessed health is higher among the uninsured. As the measure of health status is self-assessed, this might be related to differences among the two groups on individual perception about what constitutes bad health. However, as the health conditions depend on medical diagnosis, this might also be explained by lower access to medical care among the uninsured.

4 Econometric model

Our primary interest is to determine the effect of health insurance coverage on the individual propensity to particular life style choices. A natural way to obtain this is to estimate reduced form equations for the life style choices including health insurance as an explanatory variable. This is essentially the approach implemented, *inter alia*, by Kenkel (1994) and Courbage and de Coulon (2004).

As shown by the theoretical model above, however, the decision to obtain health insurance is intrinsically correlated with life style decisions. In general we might expect the existence of observable and unobservable individual attributes that influence both health insurance coverage and the choice of life style. Reduced form estimation such as in Kenkel (1994) and Courbage and de Coulon (2004), although controlling for observable characteristics, ignores the unobserved individual heterogeneity. Consequently, the estimated effect of insurance is biased.

A candidate method to control for unobserved heterogeneity is to consider an exogenous change in insurance status, and to evaluate how this change might affect the moral hazard variable. Dave and Kaestner (2006) explore the "exogenous variation in health insurance as a result of obtaining Medicare coverage at age 65". They find "limited evidence that obtaining health insurance reduces prevention and increases unhealthy behaviours among elderly people".

Our approach to identify the effect of health insurance on life style choices is to estimate a system of equations based on the multivariate probit model (see Wilde 2000, Cappelari and Jenkins 2003, Train 2003). The multivariate probit is a 5-equation recursive model, with a structural equation for health insurance coverage and reduced form equations for each of our four life style choices: heavy smoking, heavy drinking, sedentarism and obesity. Health insurance is included as explanatory variable in the reduced form equations for life style. Moreover, the model allows the residuals in each equation to be freely correlated, and in this way controls for the unobserved heterogeneity.

Let y_{iI} denote a dummy variable for health insurance status. Also let $Y_{il}^{L} = \{y_{i1}, y_{i2}, y_{i3}, y_{i4}\}$ denote a vector of four dummies representing the life style choices of heavy smoking, heavy drinking, sedentarism and obesity. The multivariate probit model can be formalised as:

$$\begin{aligned} y_{iI}^{*} &= \beta_{I}' x_{iI} + \varepsilon_{iI}, \\ y_{il}^{*} &= \gamma_l y_{iI} + \beta_l' x_{il} + \varepsilon_{il}, l = 1, ..., 4, \end{aligned} \tag{12}$$

$$y_{1I,l} = \begin{cases} 1 \text{ if } y_{1I,l}^{*} > 0 \\ 0 \text{ otherwise.} \end{cases}$$

$$D\begin{pmatrix} \varepsilon_{iI} \\ \varepsilon_{i1} \\ \varepsilon_{i2} \\ \varepsilon_{i3} \\ \varepsilon_{i4} \end{pmatrix} = \mathcal{N}\left(\left(\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & & & & \\ \rho_{1I} & 1 & & & \\ \rho_{2I} & \rho_{21} & 1 & & \\ \rho_{3I} & \rho_{31} & \rho_{32} & 1 & \\ \rho_{4I} & \rho_{41} & \rho_{42} & \rho_{43} & 1 \end{pmatrix} \right) \right). \tag{13}$$

Estimating univariate probit regressions for the life style choices implicitly ignores the unobserved heterogeneity and assumes that the error terms are uncorrelated ($\rho_{jk} = 0 \vee j \neq k$). Therefore, the estimates for the effect of insurance on life style choices are biased.

There are, however, some practical difficulties associated with the estimation of multivariate probit. In particular, the log-likelihood function is of the form:

$$L = \sum_{i=1}^{N} \log \Phi_5(y_{iI}, y_{i1}, ...y_{i4}, x_{iI}, x_{i1}, ..., x_{i4}), \tag{14}$$

where Φ_5 is the 5-dimensional multivariate standard normal distribution. Therefore, the estimation of the multivariate probit requires the evaluation of a 5-dimensional integral over the distribution of the correlated errors. This integral does not have a closed form solution. Moreover, the elevated number of dimensions implies that traditional methods such as the Gauss-Hermite quadrature cannot be applied.

Our approach to circumvent this problem consists on approximating the log-likelihood function using Maximum Simulated Likelihood. This approach is based on the fact that "a multivariate normal distribution function can be expressed as the product of sequentially conditioned univariate normal distribution functions, which can be easily and accurately evaluated" (Cappelari and Jenkins 2003, p. 280). In practical terms, the joint distribution of errors is decomposed into independent univariate normal distributions using the Cholesky decomposition. This is achieved by drawing repeated random samples from the error distribution.

There has been considerable argument in the literature about the identification of this model. In this aspect, we follow Wilde (2000), which shows that the only condition for identification of the multivariate probit is that there is sufficient variation in the data, while exclusion restrictions are not necessary. Moreover, similarly to Adda and Lechene (2004), we construct an indicator of the individual underlying health. This indicator (variable *score*) is based on the indicators for arthritis, emotional problems and loss of mental ability. These conditions are supposedly unrelated to the life style choices, but give an indication of the individual underlying health. Therefore, they are expected to influence the demand for health insurance, but not the life style choices, acting as an additional exclusion restriction.

5 Results

In addition to the multivariate probit, we have also estimated univariate and bivariate probit regressions. The univariate probit results are interesting to compare with previous studies which have used the same method.

The bivariate probit has a similar structure to the multivariate probit, but takes only two equations at a time. That is we estimate four specifications for the bivariate probit, focusing on health insurance and one of the life style choices at each time. The bivariate probit evaluates a bidimensional integral with closed form solution over the distribution of residuals. Therefore, the regressions are estimating without resorting to simulation, and can serve as a good benchmark to compare the estimates from the multivariate probit.

5.1 Effect of control variables

Results including estimated coefficients for the univariate, bivariate and multivariate probit models are presented in Tables 2, 3 and 4, respectively. Let us first consider the effect of control variables. Some patterns of effects of control variables are consistently estimated in all three groups of models.

The constructed indicator of underlying health stock exerts positive effect on the propensity to insure, which might be interpreted as a sign of adverse selection. With respect to other health indicators, bad health has no effect on health insurance, perhaps because any correlation is already being captured by the variable $score$, but is positively associated with heavy smoking, sedentarism and obesity. In some cases diagnosed health conditions affect the propensity to life style choices. However, this might be due to reverse causality, implying that the effects should be interpreted as simple correlations without any causal conotation. Generally we find that diabetes is negatively associated with the propensity to heavy drinking, but positively associated with the propensity to obesity. Similarly, high blood pressure has positive association with obesity. There is also positive association of lung disease with heavy smoking and with sedentarism.

With respect to demographic indicators, males are more likely than females to be heavy drinkers and heavy smokers, but less likely to be insured and obese. The effect of age is a bit contradictory. Compared to adults below 30 years old, those between 41 and 64 years can be considered to engage relatively more in unhealthy life styles. Those above 65 years, however, are more likely to be sedentary, but less likely to be heavy smoker and obese. This might be explained by survival effects, suggesting that individuals with unhealthy life style are less likely to reach old age. The group above 65 years has a higher propensity to be covered by health insurance, reflecting the fact that all individuals in this group are automatically elegible for Medicare. There are few differences among geographical regions, but in general it is possible to say that individual from North Central and West lead healthier life style, and those from rural areas have lower probability to insurance. We also notice a tendency for reduction in heavy smoking and increase in obesity over the time.

Socioeconomic status is important to explain many life style choices. Higher income and education decrease the likelihood to be heavy smoker, heavy drinker[5] and sedentary, but increases the propensity to health insurance. White people are more heavy smokers and heavy drinkers, but less sedentary than other ethnicities. The propensity to obesity is clearly higher

[5]Kenkel (1991) finds that schooling has a positive effect on the total number of drinks. This might be explained either because the stigma of alcohol consumption varies across socioeconomic groups or because better educated individuals are more aware of the beneficial effects of moderate alcohol consumption.

among blacks. Students are less propense to obesity, perhaps due to an association with age, and unemployed are more likely to be heavy drinkers. Again, retired are more likely to be insured due to automatic Medicare coverage above 65 years.

5.2 The effect of insurance on life style choices

Let us now focus on the effect of insurance coverage on the life style choices. Table 2 shows the estimated coefficients from the univariate probit regressions. The univariate probit are estimated separate and independently, and each column corresponds to a different regression. According to this model, insurance coverage has no effect on the propensity to be a heavy smoker, decreases the probability of being a heavy drinker or sedentary, and is associated with an increase in the probability of obesity. Only the latter can interpreted as evidence of ex ante moral hazard.

Based on similar results, previous published studies have argued that health insurance does not have an incentive effect in terms of inducing ex ante moral hazard. For example, Courbage and de Coulon (2004) use a similar model, and find that health insurance significantly decreases the probability of smoking, and increases the probability of practicing a sport (that is, of being non-sedentary) and of undergoing breast screening. This approach, however, ignores that the choice of insurance coverage is not independent of the choice of life style. In fact, our theoretical model suggests that the two choices are jointly or sequentially determined. Ignoring this biases the estimated effect of insurance on life style choices.

The bivariate and multivariate probit models recognise this problem, and explicitly take into account the effect of unobservable attributes which influence both stages of decision. Table 3 presents the bivariate probit estimates, where life style choices are modelled as joint decisions with insurance coverage, allowing for unspecified correlation among the residuals. In the table, life style equations (columns 2 to 5) are, one at a time, jointly estimated with the insurance coverage[6].

In effect, the bivariate probit coefficients for insurance coverage are very different than those for the univariate probit. If we assume the bivariate estimates, the effect of insurance on the propensity to heavy drinking remains negative and significant. However, now insurance coverage exerts positive and significant effects on the probability of being a heavy smoker, sedentary and/or obese. This is very distinct from the results of the univariate analysis. This also suggests the existence the existence of ex ante moral hazard in the sense that insured individuals are more likely to be heavy smokers, sedentary and obese.

It is instructive to analyse more closely the correlations among the residuals in the insurance and life style equations (ρ). This gives an estimate of the correlation among unobservable factors which influence both decisions. For instance, we notice a negative correlation between residuals in the heavy

[6] Table 3 reports the insurance equation estimated together with heavy smoking. The results of the insurance equation with the other life style choices are very similar and are available on request.

smoking and insurance equations. This suggests the existence of unobservable elements which, if they increase the propensity to insure, they decrease the propensity to heavy smoking, and vice-versa. For example, it might be the case that more risk averse people (unobservable characteristic) are more likely to purchase health insurance and less likely to be heavy smokers, for fear of the adverse consequences of smoking (see Kenkel (1994), p. 320, footnote). The univariate probit model ignores this channel of correlation, and consequently yields a negative (and incidentally not significant) estimate of the effect of insurance on heavy smoking. The univariate estimate is, nonetheless, biased.

Similarly, the residuals of the insurance equation are also negatively correlated with the residuals of the sedentarism equation and the obesity equation. Consequently the univariate probit coefficient of the effect of insurance is negative for sedentarism and downward biased or obesity.

With respect to heavy drinking, the correlation between residuals is positive, suggesting that unobservables increase the probability of both insurance and heavy drinking. Therefore, both the univariate and the bivariate probit models estimate negative effects of insurance on heavy drinking, suggesting the absence of ex ante moral hazard in this dimension.

The multivariate probit extends the notion of controlling for unobservable heterogeneity by estimating the correlation of the residuals among all the equations in the recursive system. The five equations are estimated simultaneously and the residuals are allowed to be freely correlated. Estimation is based on the simulation of the multivariate normal distribution of the residuals. We set the number of draws of the simulation to 130, which is approximatelly equal to the square root of our pooled sample size of 14,000 individuals (see Cappelari and Jenkins 2003).

The results of the multivariate probit can be considered qualitatively similar to the bivariate probit estimates. This is a good robustness indicator, since the bivariate probit does not rely on simulation to be estimated. According to the multivariate probit, health insurance increases the propensity to heavy smoking, sedentarism and obesity, and decreases the propensity to heavy drinking. This suggests the existence of ex ante moral hazard, at least for the three first life style choices.

Table 5 shows the correlation among residuals in all five equations. The first column gives the correlation of residuals in the insurance equation with those in the other four equation, suggesting a similar pattern as the bivariate probit regressions. Unobservable attributes of the insurance decision are negatively correlated to those that influence heavy smoking, sedentarism and obesity.

Moreover, we notice significant correlation among residuals in the life style equations. We find, specifically, that unobservable determinants of heavy smoking, heavy drinking and sedentarism are all positively correlated. Similarly, there is positive association between unobservable determinants of obesity and sedentarism. This suggests some degree of complementarity among these life style choices. On the other hand, there is significant negative association between unobservable determinants of heavy drinking and obesity, suggesting these choices are substitutes.

6 Conclusion

In this paper we have used data from the 1999, 2001 and 2003 waves of the Panel Study of Income Dynamics to explore the effect of health insurance coverage on life style choices. We estimated a structural model of the individual choice of insurance and of four life style related decisions: heavy smoking, heavy drinking, sedentarism and obesity.

The underlying correlation between insurance and life style choices is modelled using a Multivariate Probit. This structural approach assumes that insurance coverage and the four life style choices are sequential and interdependent decisions. Most previous studies ignore this feature and consequently find that health insurance is not an important determinant of life style choices.

The results show that health insurance has significant incentive effects on life style choices, increasing the propensity to heavy smoking, sedentarism and obesity. Somewhat surprisingly, however, health insurance decreases the propensity to heavy drinking. There is also significant correlation among the residuals of each equation. The pattern of correlation suggests that heavy smoking and heavy drinking, and obesity and sedentarism may be considered complementary life style choices, whilst heavy drinking and obesity may be considered substitutes.

The results suggest that unobserved heterogeneity plays an important role in the sequential determination of insurance and life style. There is evidence to suggest the existence of ex ante moral hazard in the choice of heavy smoking, sedentarism and obesity. The results might also have implications for the design of health financing policies, particularly with respect to the use of risk rated premiums.

Incomplete data limit the interpretation of some of the results. For instance, it was not possible to control for some characteristics of the insurance plan, such as premium payments, level of coverage and co-payments, and to distinguish the type of health insurance coverage, whether public (Medicare/Medicaid), employer-sponsored or individual. However, sensitivity analysis, which restricts the sample to individuals below 65 years old (ineligible to Medicare), suggests that the results are very robust (full results available on request). Our measure of heavy drinking also deserves additional attention, since it is not clear how to compare different individuals in this aspect.

Among the possible extensions, we would like to explore the economic costs associated with this ex ante moral hazard effect. In particular, we would be interested in estimating the additional costs in terms of extra medical care use and health expenditures. Also if it were possible to control for health plan characteristics, we would like to simulate the potential to use risk rated premiums and co-payments in order to induce the adoption of healthier life styles.

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7 Appendix

Table 1: Variable definitions and descriptive statistics

Variable	Definition	Sample Full	Sample Insured	Sample Uninsured
insured	1 if covered by health insurance, 0 otherwise	0.93		
heavysmoker	1 if smokes 20+ cigarettes per day, 0 otherwise	0.03	0.03	0.05
heavydrinker	1 if has 3 or more drinks per day, 0 otherwise	0.04	0.04	0.08
sedentary	1 if never engages light physical activity, 0 otherwise	0.12	0.11	0.16
obese	1 if BMI equal or above 30, 0 otherwise	0.26	0.26	0.25
bad	1 if SAH is fair/poor, 0 if good/very good/excelent	0.16	0.15	0.19
stroke	1 if ever diagnosed stroke, 0 otherwise	0.03	0.03	0.02
highbp	1 if ever diag high blood pressure, 0 otherwise	0.26	0.26	0.21
diabetes	1 if ever diag diabetes, 0 otherwise	0.08	0.08	0.06
cancer	1 if ever diag cancer, 0 otherwise	0.04	0.04	0.02
lungdisease	1 if ever diag lung disease, 0 otherwise	0.04	0.04	0.04
heartattack	1 if ever diag heart attack, 0 otherwise	0.04	0.05	0.02
heartdisease	1 if ever diag. coronary heart disease, 0 otherwise	0.07	0.07	0.03
emotional	1 if ever diag emotional problems, 0 otherwise	0.05	0.05	0.05
arthritis	1 if ever diag arthritis or rheumatism, 0 otherwise	0.19	0.19	0.12
mentalloss	1 if ever diag loss of mental ability, 0 otherwise	0.02	0.02	0.01
score	Sum of emotional, arthritis and mental loss	0.25	0.26	0.18
income	Total annual family income	59,976	62,609	25,858
male	1 if male, 0 otherwise	0.74	0.74	0.70
age	Age in years	46.77	47.14	41.82
married	1 if married, 0 otherwise	0.57	0.59	0.31
kids	No. of children in the household	0.91	0.93	0.70
primary	1 if primary education, 0 otherwise	0.21	0.20	0.44
hschool	1 if high school education, 0 otherwise	0.33	0.33	0.35
college	1 if college education, 0 otherwise	0.46	0.48	0.21
white	1 if white ethnicity, 0 otherwise	0.63	0.64	0.40
black	1 if black ethnicity, 0 otherwise	0.29	0.28	0.42
hispanic	1 if hispanic ethnicity, 0 otherwise	0.05	0.04	0.14
otherrace	1 if other ethnicity, 0 otherwise	0.03	0.04	0.03
employed	1 if currently working, 0 otherwise	0.74	0.74	0.72
housekeeper	1 if currently keeping house, 0 otherwise	0.03	0.03	0.03
student	1 if student, 0 otherwise	0.01	0.01	0.01
unemployed	1 if unemployed of looking for work, 0 otherwise	0.05	0.05	0.14
retired	1 if retired or disabled, 0 otherwise	0.17	0.18	0.10
neast	1 if lives in Northeast region, 0 otherwise	0.15	0.15	0.09
ncentral	1 if lives in North Central region, 0 otherwise	0.25	0.26	0.21
south	1 if lives in South region, 0 otherwise	0.41	0.40	0.48
west	1 if lives in West region, 0 otherwise	0.19	0.18	0.21
alaska	1 if lives in Alaska or Hawaii, 0 otherwise	0.00	0.00	0.00
metrop	1 if lives in metropolitan are, 0 otherwise	0.72	0.72	0.69
urban	1 if lives in urban area, 0 otherwise	0.25	0.25	0.27
rural	1 if lives in rural area, 0 otherwise	0.03	0.03	0.04
wave1	1 if year 1999, 0 otherwise	0.33	0.33	0.36
wave2	1 if year 2001, 0 otherwise	0.33	0.33	0.33
wave3	1 if year 2003, 0 otherwise	0.33	0.33	0.31
N		15,378	14,307	1,071

Table 2
Univariate Probit Regressions

	Dependent variable				
Explanatory variables	insured	heavysmoker	heavydrinker	sedentary	obese
insured		-0.08	-.19*	-.12*	.13*
score	.22***				
bad	-0.09	.37***	0.03	.48***	.23***
lnincome	.44***	-0.05	-0.01	-.086***	-.053**
male	-.41***	.58***	.82***	-.13*	-.14**
age3140	-0.06	.25*	0.08	.16**	.11*
age4150	-0.06	.37***	.18*	.26***	-0.02
age5164	0.03	.34**	0.12	.23***	-.15*
age65above	.75***	-.58***	-0.10	.32***	-.51***
married	.4***	-.27***	-.31***	0.08	0.09
kids	.17***	-0.01	-0.01	.035*	0.00
stroke	0.15	-0.09	-0.01	.28***	-.27**
highbp	0.04	0.01	0.10	0.02	.53***
diabetes	0.09	-0.19	-.23*	0.05	.54***
cancer	-0.16	-0.06	-0.06	0.10	0.01
lungdisease	-0.03	.45***	0.21	.21**	0.01
heartattack	-0.08	0.04	-0.22	0.06	0.06
heartdisease	0.15	-0.07	0.02	0.04	0.09
hschool	.29***	-.26***	-.13*	-.11*	0.02
college	.61***	-.72***	-.28***	-.3***	-0.04
white	.44***	1.3***	.24*	-.29***	0.04
black	.36***	0.40	.26*	-0.12	.29***
housekeeper	.26*	-.6*	0.23	0.14	-0.05
student	0.10	-0.11	0.05	-0.11	-.48**
unemployed	-0.09	0.08	.21*	-0.04	-0.05
retired	.3**	-0.01	0.02	.14*	0.01
ncentral	-0.09	0.07	-0.03	-.15**	-0.08
south	-.19*	0.05	-0.08	0.06	-0.07
west	-.2*	-.29*	-0.11	-.13*	-0.08
alaska	0.13	-0.11	0.00	-0.02	-0.43
urban	0.03	0.07	0.02	0.05	0.04
rural	-.37**	0.07	0.02	-0.07	0.17
wave2	-0.03	-.13***	0.05	0.01	.039*
wave3	0.00	-.18***	0.06	-0.04	.1***
_cons	-3.7***	-2.4***	-2.1***	-0.15	-0.40
Pseudo R^2	0.22	0.16	0.056	0.11	0.073
N	14,557	14,517	14,540	14,515	14,344
N clusters	5,481	5,478	5,480	5,481	5,456

Legend: * p<.1; ** p<.05; *** p<.01

Table 3
Bivariate Probit Regressions

	Dependent variable				
Explanatory variables	insured†	heavysmoker	heavydrinker	sedentary	obese
insured		1.1***	-.66*	.72***	.65**
score	.24***				
bad	-0.10	.33***	0.03	.47***	.22***
lnincome	.43***	-.18***	0.02	-.15***	-.089***
male	-.4***	.66***	.77***	-0.04	-0.10
age3140	-0.04	.23*	0.07	.16**	.12*
age4150	-0.05	.34***	.17*	.26***	-0.01
age5164	0.03	.28**	0.12	.21**	-.15*
age65above	.75***	-.71***	-0.08	.22**	-.54***
married	.41***	-.35***	-.28***	0.01	0.06
kids	.17***	-0.05	0.00	0.01	-0.01
stroke	0.15	-0.12	0.00	.26**	-.28**
highbp	0.03	-0.01	0.10	0.01	.52***
diabetes	0.10	-0.18	-.22*	0.03	.53***
cancer	-0.15	0.00	-0.07	0.12	0.02
lungdisease	-0.06	.39***	0.22	.21**	0.01
heartattack	-0.10	0.05	-0.22	0.06	0.06
heartdisease	0.16	-0.10	0.02	0.03	0.08
hschool	.28***	-.32***	-0.11	-.15***	-0.01
college	.6***	-.79***	-.26***	-.36***	-0.07
white	.46***	.87***	.27**	-.35***	0.00
black	.37***	0.19	.28*	-.18*	.26***
housekeeper	.25*	-.59*	0.24	0.09	-0.07
student	0.11	-0.11	0.06	-0.13	-.48**
unemployed	-0.10	0.11	.19*	0.00	-0.03
retired	.29**	-0.12	0.04	0.08	-0.02
ncentral	-0.07	0.09	-0.03	-.14*	-0.08
south	-.18*	0.09	-0.08	0.07	-0.06
west	-.18*	-0.19	-0.11	-0.11	-0.08
alaska	0.05	-0.15	0.01	-0.04	-0.45
urban	0.03	0.05	0.03	0.04	0.04
rural	-.36**	0.17	0.00	-0.01	.19*
wave2	-0.04	-.1**	0.05	0.01	.041*
wave3	0.00	-.16***	0.06	-0.04	.1***
_cons	-3.6***	-1.6**	-2***	-0.07	-.44*
ρ		-0.73***	0.25**	-0.48***	-0.29**
N	14,517	14,517	14,540	14,515	14,344
N cluster	5,478	5,478	5,480	5,481	5,456

Legend:† estimates from insured and heavysmoker regression; * p<.1; ** p<.05; *** p<.01

Table 4
Multivariate Probit Regression

	Dependent variable				
Explanatory variables	insured	heavysmoker	heavydrinker	sedentary	obese
insured		.64**	-.38*	.54**	.49***
score	.27***				
bad	-.12*	.37***	0.03	.47***	.23***
lnincome	.44***	-.11**	0.00	-.14***	-.077***
male	-.39***	.63***	.8***	-0.06	-.11**
age3140	-0.04	.24**	0.08	.16**	.11**
age4150	-0.06	.36***	.17**	.27***	-0.02
age5164	0.03	.31***	0.14	.22***	-.15**
age65above	.78***	-.65***	-0.08	.24**	-.53***
married	.41***	-.31***	-.3***	0.02	0.07
kids	.17***	-0.03	-0.01	0.02	0.00
stroke	0.09	-0.09	0.01	.28***	-.29***
highbp	0.02	0.01	.1*	0.02	.53***
diabetes	0.10	-.19*	-.27**	0.03	.52***
cancer	-0.16	-0.03	-0.06	0.13	0.02
lungdisease	-0.07	.41***	.22*	.22***	0.00
heartattack	-0.07	0.04	-0.22	0.06	0.06
heartdisease	0.15	-0.10	0.03	0.04	0.08
hschool	.28***	-.29***	-.12*	-.14***	0.00
college	.6***	-.76***	-.26***	-.35***	-0.06
white	.42***	1.1***	.28**	-.32***	0.01
black	.35***	0.28	.29**	-.14*	.27***
housekeeper	0.22	-.59*	0.21	0.13	-0.08
student	0.11	-0.07	0.04	-0.10	-.48**
unemployed	-0.09	0.10	.2*	-0.01	-0.04
retired	.3***	-0.04	0.04	0.09	-0.01
ncentral	-0.04	0.09	-0.05	-.15**	-.082*
south	-.15*	0.07	-0.10	0.06	-0.07
west	-.16*	-.24**	-0.12	-.12*	-0.08
alaska	0.12	-0.12	0.02	-0.06	-0.45
urban	0.05	0.08	0.04	0.05	0.04
rural	-.35***	0.15	0.01	-0.03	.19**
wave2	-0.03	-.12*	0.05	0.02	0.04
wave3	0.00	-.18**	0.04	-0.04	.1***
_cons	-3.8***	-2.2***	-2***	-0.13	-.43*
N	14,260	14,260	14,260	14,260	14,260
draws	130	130	130	130	130

Legend: * p<.1; ** p<.05; *** p<.01

Table 5
Correlation of Residuals from the Multivariate Probit

	insured	heavysmoker	heavydrinker	sedentary	obese
insured	1.00				
heavysmoker	-0.41***	1.00			
heavydrinker	0.09	0.33***	1.00		
sedentary	-0.37***	0.19***	0.07**	1.00	
obese	-0.2**	-0.04	-0.06**	0.09***	1.00

Legend: * p<.1; ** p<.05; *** p<.01

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The major resource offered to visitors is access to a series of internationally comparable longitudinal surveys on living conditions at the household and individual level. The anonymised micro-data provide information on wages and income, health, education, employment and professional activities, accommodation, social relations,... Comparable micro-data are available for EU countries, Central European countries, as well as the USA. These data offer opportunities to carry out research in fields such as *survey and panel data methodology*, *income distribution and welfare*, *income and poverty dynamics*, *multi-dimensional indicators of poverty and deprivation*, *gender, ethnic and social inequality*, *unemployment and labour supply behaviour*, *education and training*, *social protection and redistributive policies*, *fertility and family structures*, *new information technologies in households and firms*, ...

Who may apply?

All individuals (doctoral students as well as experienced academics) conducting research in an institution within the EU-25 or an FP6 Associated State. IRISS-C/I can be meeting place for groups of researchers working on a joint project. We therefore encourage joint proposals by two or more researchers.

For more detailed information and application form, please consult our website: http://www.ceps.lu/iriss or contact us at

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