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Health insurance and health care utilization: Theory and evidence from Australia 1989-90

by

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EXECUTIVE SUMMARY

The Australian hospital system is characterised by the co-existence of private hospitals, where individuals pay for services and public hospitals, where services are free to all but delivered after a waiting time. The decision to purchase insurance for private hospital treatment depends on the trade-off between price of treatment, waiting time and the insurance premium. Clearly the potential for adverse selection and moral hazard exists. When the endogeneity of the insurance decision is accounted for, the extent of moral hazard can be substantial increasing the expected length of a hospital stay by a factor of up to three.

1. INTRODUCTION

Different countries have different health insurance and health care systems. The United States of America has a mainly private system with a small public (free) sector that acts as a safety net for the disadvantaged. On the other hand, the United Kingdom has a mainly public (free) system with a small private system for those prepared to pay for their health care. Australia is distinctive in having a mixed system with large private and public (free) sectors. In 1989-90 around 44% of income units had private hospital insurance and 35% of hospital users used a private hospital. In addition private hospital insurance is chosen at the individual or family level unlike in the US where health insurance is commonly a compulsory part of the employment contract.

There is an on going debate in the U.S. concerning whether the public system should be extended and in the U.K. concerning whether the private system should be extended. A similar debate is on going in Australia and as in the U.S. and U.K. is concerned with the appropriate sizes of the private and public sectors. Research that analyses the relationship between health insurance and the use of health care in the private and public sectors is needed to inform this debate.

There are two well-known difficulties associated with providing health insurance to individuals. These arise because the insurer does not know (a) the risk class to which a particular individual belongs and (b) the extent of the loss in well being an individual experiences. In a world with purely private health insurance, ignorance of an individual's risk class leads to adverse selection as only high-risk individuals purchase insurance. Ignorance of the extent of the illness or the actual loss in well being leads to moral hazard as individuals, who have some control over the extent of their treatment and receive insurance payouts on the basis of their health care expenditure, over-utilize health services.

Private hospital insurance takes the form of a schedule of allowances for particular private hospital services that result in individuals with different insurance policies facing a different set of net prices. One reason insurance policies take this form is because expenditure on hospital services is observable by insurance companies while the individual's health state vector is not. As previously mentioned, this introduces the possibility of moral hazard. Moral hazard can occur because the insurance policy alters the individual's behaviour in a way that decreases the expected profit of the insurance company. For example, (i) the existence of insurance might induce the individual to devote less resources to preventive care and so increase the probability of an insurance claim and decrease the expected profit of the insurance company, or (ii) the existence of insurance might induce the individual to purchase more private hospital services than are strictly needed to return the individual to a healthy state. This paper will be concerned with the latter case though both are manifestations of the same phenomena, namely, that private hospital insurance induces individuals to over-utilize private hospital services. In order to determine the appropriate mix of private and public health service and health insurance provision, studies need to be done to ascertain the extent of moral hazard and adverse selection under various insurance and health care regimes.

The aim of the empirical sections of this paper is to ascertain the extent to which the existence of insurance induces individuals to purchase more private hospital services than they would if they faced the true price of those services rather than the net price under insurance. As such, an indication of the extent of welfare losses that result from the price distortion is given.[1] Moral hazard is present if the use of private hospital service k is decreasing in the 'net' price of service k.

A number of empirical papers have examined the determinant of an individual's or families' insurance choice, Ngui, Burrows, and Brown, (1989), Propper (1989), Cameron, Trivedi, Milne, and Piggott (1988), and Hurd and McGarry (1997). The general findings are that individuals or families are more likely to have private health insurance the greater is their income, the older they are, and if they are employed. Health status variables do not seem to impact on health insurance choice. A second group of papers take an individual's or families' insurance status as given and examine the determinants of health service use, Manning, Newhouse, Duan, Keeler, Leibowitz, and Marquis (1987), Manning and Marquis (1996), and Hurd and McGarry (1997). The general findings are that individuals and families consume more health services the more health insurance cover they have, the greater is their income, and to some extent the lower is their health status.

Health insurance choice depends, amongst other things, on expected future consumption of health services and so both the insurance and use decisions are interdependent. Of the papers previously mentioned, only the paper by Cameron *et al* models the interaction between health insurance choice and health services use and so is the only paper that can address issues of adverse selection and moral hazard. In a more recent contribution Lee (1993) also models this interaction. However, neither paper distinguishes between private or public hospital service use and given that much of the current debate concerns this issue, work needs to be done with this emphasis. This is particularly so in the Australian context because private hospital services are provided at different 'net' prices depending on the insurance cover held whereas public hospital services are available free to all. As a result, moral hazard can only be identified amongst the private hospital users as this is the only group that faces different 'net' prices.[2]

This paper is an attempt to model and empirically test the interaction between private hospital insurance choice and private hospital service use. A three-period model of health insurance and

[1] The classic paper on the welfare losses associated with health insurance is Feldstein (1973). More recent papers include Feldman and Dowd (1991) and Manning and Marquis (1996).
[2] Cameron et al (1988) did not distinguish between private and public hospital use.

health care utililization is developed. In the first period, an income unit makes an insurance decision not knowing what its health state will be in the second period. In the second period the income unit's health state is realized. Given their first period insurance decision, the income unit chooses the quantity of private hospital services to consume. In the third period, after a waiting time has elapsed, the income unit can consume free public hospital services. The income unit's insurance decision depends on its probability distribution over health states in period 2, the 'net' prices of private hospital services (given insurance), the waiting time for the various services to be available free in a public hospital, insurance premiums, and other socio-economic variables. The consumption of private hospital services in period two depends on the realization of the health state, the 'net' prices, the waiting time, and other socio-economic variables. The consumption of public hospital services in period three depends on the realized health state in period 2, whether private hospital services were consumed in period two, and other socio-economic variables. The theoretical model produces reduced form equations for insurance choice and private hospital use that provide a rationale for the variables included in the empirical sections of the paper.

The empirical implementation of the model uses data from the 1989-90 National Health Survey in Australia, but is hampered by a lack of data on insurance premiums, 'net prices', and waiting times. Chronic conditions and reason for hospital use are used as proxies for these variables. Insurance choice is estimated with a probit model. In general, it is found that an income unit is more likely to have private hospital insurance the greater is income, age of head of the income unit, health status as measured by chronic conditions, and other socio-economic variables. The significance of some of the health status variables contrasts with previous studies and suggests that adverse selection may be present.

The only quantity variable related to hospital use that appears in the data is the length of the hospital stay. This is the dependant variable in the duration model that is estimated. As insurance choice is endogenous in the model, the estimated probability of insurance is used as a regressor in these duration equations to provide consistent estimates of the moral hazard effect. In addition, reason for hospital service use and other socio-economic variables are also included as regressors. Separate equations are estimated for income units with different structure and at different stages of the life cycle and tests are performed to ascertain whether insurance choice is endogenous, that is, whether there is adverse selection.

In the private hospital duration equations, evidence of moral hazard was found to be significant for some, but not all income unit types. Where moral hazard was present, the effect of it on duration was quite large, increasing expected durations by a factor of up to three. In contrast to previous studies, income was generally found to have a negative effect on duration, perhaps reflecting the opportunity cost of time. Finally, insurance choice was found to be endogenous for all but one income unit type suggesting the presence of adverse selection.

2. THE MODEL

2.1 Single Person Income Units:

To keep the analysis as simple as possible the theory will be developed for the case where an income unit consists of one individual. The individual consumes a consumption good, c, and a vector of hospital services, h. The utility function of the individual is given by

$$u(c,h;s), \qquad (1)$$

where s is the individual's health state vector. The m^{th} element of s is denoted $s^m \in [0,1]$ and takes on higher values the worse is the outcome for this particular element of the health state vector.[3] The worse are the outcomes in the health state vector, the lower is utility for a given c and h. If the health state vector is indexed so that worse health state vectors get bigger numbers, then for those vectors $s > \bar{s}$, $\frac{\partial u}{\partial h} > 0$ while for $s \leq \bar{s}$, $\frac{\partial u}{\partial h} = 0$, where $\bar{s}$ is defined by the two inequalities and can be interpreted as the health state vector above which hospital services add to utility. It is assumed that $\frac{\partial u}{\partial c} > 0$, and that conditional on s, $u(.)$ is a strictly concave function of c and h.[4] In addition it is assumed that

$$\frac{\partial(\partial u/\partial c)}{\partial s} > 0 \qquad (2)$$

so that the marginal utility of the consumption good increases with worse health outcomes. The income unit can borrow and lend at interest rate r. It is assumed that the individual's income is the same in each period and given by y.[5]

There are three periods. In period 1, the individual knows its current health state vector, s_1, but not its health state vector for period 2, s_2. However, the individual does know the probability of attaining health state vector s_2 in period 2. This is given by $f(s_2)$. It is assumed that the elements of the health state vector in period 1 cannot be reduced by consuming hospital services even if they take on values other than zero. In period 1, the individual chooses an insurance policy against private hospital use in period 2 that specifies a premium and an amount of coverage. Coverage takes the form of a schedule of allowances for particular private hospital services. If the price charged for

[3] For example, let blood pressure be the m^{th} element of s. The further is the individual's blood pressure from normal, the higher is s^m. Normal blood pressure has $s^m = 0$.

[4] This utility function can be found in Arrow (1976). For $s \leq \bar{s}$, $u(\cdot)$ is just a function of c.

[5] This assumption simplifies notation. Nothing is significantly changed by having different income in different periods.

a service by a private hospital exceeds the allowance, then the user of the service is liable for the difference. This difference will be denoted the 'net' price. Let π_i be the premium attached to insurance policy i and let p_i^k be the net price of hospital service k under policy i.

In period 2, s_2 is realized and private hospital services can be purchased. Consumption of the appropriate hospital services reduces the elements in the individuals health state vector towards their initial level. It is assumed that public hospital services can not be purchased in period 2. However, after a waiting period t^k for hospital service k, it is assumed that the service is available in a public hospital at a price of zero. Period 3 is the period after this waiting time.

The individual faces a dynamic programming problem. In period 1 it chooses how much income to allocate to the consumption good, lending / borrowing, and private hospital insurance, given its health state in period 2 is unknown. Given these choices, in period 2, after the realization of the individual's health state vector, the individual chooses whether to obtain treatment in a private or public hospital and allocates income between the consumption good, lending / borrowing, and private hospital services (if treatment in a private hospital was chosen). The net price of these private hospital services is determined by the insurance policy purchased in period 1. Given these choices in period 2, in period 3, the income unit allocates income to the consumption good and the individuals health state vector is returned to its initial level through the consumption of public hospital services. Note that the consumption of private hospital services in period 2 might already have achieved this end. Period 3 is the last period in the model

Periods 1 and 3 have fixed length, normalized to 1, while the length of period 2 depends on health state vector, s_2. Assume that the realization of this vector is s_2^k and requires hospital service k in order for the elements of s_2^k to be reduced. In this case, the length of period 2 is t^k. As is usual, the individual's problem is solved backwards.

Period 3

In period 3, all health state vector elements are returned to their initial level (if need be) through the consumption of free public hospital services. Therefore, all period 3 wealth is allocated to the consumption good. That is

$$c_{3i} = (y + a_{2i}(1+r)^{t(s_2^k)}) / p_c, \qquad (3)$$

where p_c is the price of the consumption good, c_{3i}^k is the quantity of the consumption good consumed in period 3 under policy i, t is the waiting period required for the appropriate hospital service given s_2^k, and a_{2i}^k is lending / borrowing in period 2 (borrowing is represented by a negative value of a_2) under insurance policy i. Substituting the solution for c_{3i}^k into the utility function gives period 3 maximized utility under insurance policy i,

$$V_{3i}^k(y, a_{2i}^k, r, t(s_2^k), p_c) = u(c_{3i}^k, 0; s_2^k)\,. \tag{4}$$

Period 2

At the beginning of period 2, given a particular health state vector s_2^k, and given insurance policy i, the individual chooses whether to use a private or public hospital and allocates wealth between the consumption good, hospital services, and lending / borrowing to maximize discounted utility.

***Private Hospital*:** Given a private hospital is chosen, the individual's wealth allocation problem is

$$\max_{c_{2i}^k, a_{2i}^k, h_{2i}^k} U_2^k = u(.) + \frac{u(.)}{(1+\rho)} + \ldots + \frac{u(.)}{(1+\rho)^{t(s_2^k)-1}} + \frac{V_{3i}^k(.)}{(1+\rho)^{t(s_2^k)}}, \tag{5}$$

subject to

$$p_c c_{2i}^k + p_i^k h_{2i}^k + a_{2i}^k = y + (1+r)a_{1i}, \tag{6}$$

where hospital service k is the appropriate hospital service to return the health state vector to its initial level, h_{2i}^k is the quantity of private hospital service k, and ρ is the subjective discount rate. The first order conditions to this problem are given in the Appendix.

These conditions have the usual interpretation. Income is allocated between the consumption good, private hospital services, and lending / borrowing so that, (1) the within period marginal rate of substitution of the consumption good and private hospital service k equals the price ratio, (2) the across period marginal utilities for the consumption good are equal after appropriate discounting, and (3) the across period marginal utilities per dollar spent of private hospital services and the consumption good are equal after appropriate discounting.

The solution to this problem for c_{2i}^k, a_{2i}^k, and h_{2i}^k are all functions of

$$(\rho, t(s_2^k), p_c, p_i^k, y, r, a_{1i}, s_2^k)\,. \tag{7}$$

Substitute this solution into the objective function to obtain private hospital maximized discounted utility conditional on health state, s_2^k, and insurance policy i. Denote this by

$$V_{2i}^k(\rho, t(s_2^k), p_c, p_i^k, y, r, a_{1i}; s_2^k)\,. \tag{8}$$

***Public Hospital*:** Given a public hospital is chosen, the individual's wealth allocation problem is identical to (5) except for the omission of h_{2i}^k, the quantity of private hospital services consumed. In the solution to this problem consumption is allocated across periods so that marginal utilities of the consumption good across periods are equal after appropriate discounting. The solution to this problem for c_{2i}^{k} and a_{2i}^{k}, are all functions of

$$(\rho, t(s_2^k), p_c, y, r, a_{1i}, s_2^k)\ . \qquad (9)$$

Substitute this solution into the objective function to obtain public hospital maximized discounted utility conditional on health state, s_2^k, and insurance policy i. Denote this by

$$V_{2i}^{k*}(\rho, t(s_2^k), p_c, p_i^k, y, r, a_{1i}; s_2^k)\ , \qquad (10)$$

where the asterisk denotes public hospital utility.

***Private Hospital – Public Hospital Choice*:** A private hospital is chosen for treatment if

$$V_{2i}^{k}(\cdot) > V_{2i}^{k*}(\cdot) \qquad (11)$$

and a public hospital is chosen if the inequality is reversed. This choice depends on all the variables in (7) and (8). Assume that the realization of the health state vector in period 2, s_2^k, requires hospital service k to return it to its initial state. The individual faces a tradeoff in period 2. The health state vector could be improved (moved closer to its initial realization) instantaneously through treatment in a private hospital at a cost $p_i^k h_{2i}^k$ or in $t(s_2^k)$ periods through treatment in a public hospital at zero costs.

Let $\hat{V}_{2i}^{k} = \max\{V_{2i}^{k}, V_{2i}^{k*}\}$. Follow the above hospital choice procedure for every possible health state vector and then multiply maximized discounted utility conditional on the health state, $\hat{V}_{2i}^{k}$, by the probability of that health state being realized. This yields period 2 expected maximized discounted utility in period 1, given insurance policy i, and is given by

$$EV_{2i}(\rho, p_c, y, r, a_{1i}, t, p_i, f(s_2)) = \int \hat{V}_{2i}(.) f(s_2) ds_2\ , \qquad (12)$$

where $t = (t^1, ..., t^k, ...)$ and $p_i = (p_i^1, ..., p_i^k, ...)$ are vectors whose elements are waiting times and net prices for all hospital services, respectively. All health states are possible and so all net prices and waiting times are relevant in determining period 2 expected maximized discounted utility in period 1.

Period 1

In period 1, the individual does not know which health state vector will be realized in period 2. The individual allocates income between the consumption good, lending / borrowing, and insurance to maximize period 1 discounted expected utility. Given insurance policy i with premium π_i, the individual's problem is

$$\max_{c_{1i}, a_{1i}} \ U_{1i} = u(.) + \frac{EV_{2i}(.)}{1+\rho} \qquad (13)$$

subject to

$$p_c c_{1i} + a_{1i} + \pi_i = y \ . \qquad (14)$$

The first order conditions to this problem are given in the Appendix.

As for period 2, these conditions have the usual interpretation. Given insurance policy i, income is allocated between the consumption good and lending / borrowing so that the marginal utility of the consumption good in period 1 is equated to the expected marginal utility of the consumption good in period 3 and so that this is equal to the expected marginal utility in period 2 after appropriate discounting.

The solutions for c_{1i} and a_{1i} are both functions of

$$(p_c, \pi_i, y, \rho, r, t, p_i, f(s_2)) \ . \qquad (15)$$

These solutions are substituted into the objective function to get period 1 maximizes discounted expected utility conditional on insurance policy i. This is denoted

$$V_{1i} \ (p_c, \pi_i, y, \rho, r, t, p_i, f(s_2)) \ . \qquad (16)$$

This procedure is followed for all insurance policies and policy i is chosen if

$$V_{1i}(.) \geq V_{1j}(.) \ \ \forall \ \ j \neq i \ . \qquad (17)$$

Assume that policy i has been chosen in period 1. In period 1 the individual does not know which health state vector will be realized in period 2, but there is some probability of a bad health outcome. As a result, in order to equate marginal utilities between periods, the individual transfers wealth from period 1 to period 2 and has an expectation of transferring wealth from period 3 to period 2. This is achieved via lending in period 1 and borrowing in period 2 and / or through the purchase of private hospital insurance in period 1. The insurance premium reduces disposable wealth in period 1 and increases disposable wealth in period 2 through reducing the net price of private hospital services. In period 2, the health state vector is realized. If the health outcome is good, and the individual has lent in period 1, then the individual will lend in period 2 to satisfy (A.4) of the Appendix. On the other hand, if the health outcome is bad the individual will transfer wealth from period 3 to period 2 through borrowing in order to satisfy (A.4). In this analysis, assumption (2) is playing a crucial role. If the inequality in (2) was reversed, then there would be no role for insurance or lending to transfer wealth to period 2.

From (17), the insurance policy that is chosen is the one that maximizes discounted expected utility. When making this choice all insurance premiums and all net prices under all policies are relevant.

Let $p = (p_1,..., p_i,...)$ be the vector of net price vectors and let $\pi = (\pi_1,...,\pi_i,...)$ be the vector of insurance premiums. The choice of insurance policy depends on

$$(p_c, \pi, y, \rho, r, t, p, f(s_2)) . \qquad (18)$$

Note that the individual might choose not to purchase private hospital insurance and transfer wealth between periods through lending and borrowing alone.

2.2 Many Person Income Units

In the analysis above it has been assumed that the income unit is an individual. This assumption is now relaxed and the theory is amended to allow for income units that consists of more than one individual. The income unit's utility function is

$$U(u_1(\cdot),...u_j(\cdot),...) , \qquad (19)$$

where $u_j(\cdot)$ is the utility function of individual j in the income unit and takes the form given in (1) above. At the beginning of period 2 individual j in the income unit realizes a particular health state vector, s_2^{kj}. Hospital service k is the appropriate service to return the vector to its initial settings. The vector of these individual health state vectors is denoted S_2^K, where the superscript K signifies the vector of appropriate hospital services to return all the individuals' health state vectors to there initial settings. The vector of waiting times for these hospital services under insurance policy i is denoted $T_i^K(S_2^K)$ and the vector of net prices for these services is denoted P_i^K. The solution to the period 2 problem for individual j's consumption of the consumption good and consumption of private hospital services is not formally stated but are all functions of

$$(\rho, T_i^K(S_2^K), p_c, P_i^K, y, r, a_{1i}, S_2^K). \qquad (20)$$

as is the solution for income unit lending / borrowing.

Whether the income unit chooses a private or public hospital for treatment and how much wealth the income unit allocates to private hospital services for an individual depends on the health state of all members of the income unit, the waiting time associated with all the appropriate hospital services, and the net prices of these private hospital services.

For example, if only one member of an income unit realizes a poor health outcome, the income unit might purchase the appropriate private hospital service. However, if two individuals in the income unit have poor health outcomes the income unit might purchase the appropriate private hospital service for one individual, but wait and obtain treatment for the other individual in a public hospital.

In period 1, the income unit does not know which health state vector, S_2, will be realized. The choice of insurance policy depends on

$(p_c, \pi, y, \rho, r, t, p, g(S_2))$, (21)

where $g(S_2)$ gives the probability that the income unit will attain health state vector S_2 in period 2. As in (18) above, all net prices of all private hospital services under all insurance policies are relevant as are the waiting times for all services.

2.3 Discussion

The model developed in this section has demonstrated the interdependence between the insurance decision and the hospital service use decision. Individuals with extensive insurance coverage face lower net prices for private hospital services and *ceteris paribus* are expected to use more of these services if a poor health state is realized. This is moral hazard. On the other hand, individuals who have a high probability of a poor health state being realized and who require significant hospital services to improve their health are expected ceteris paribus to have extensive insurance coverage. This is adverse selection. The empirical sections of this paper attempt to ascertain the extent of moral hazard and the existence of adverse selection in the provision of private hospital services and insurance in Australia in 1989-90.

3. THE AUSTRALIAN HEALTH INSURANCE SYSTEM AND THE DATA

The Health Insurance System

In 1984, a universal system of health care subsidies, known as Medicare, was introduced into Australia. These subsidies are based on a schedule of fees known as the Medical Benefits Schedule (MBS). The MBS is adjusted annually by the government. Under Medicare, individuals who choose to be treated in a public hospital as a public (Medicare) patient are treated by doctors and specialists nominated by the hospital. These services are free of charge whether or not the individual has private hospital insurance.

Individuals who choose to be treated as a private patient in a private or public hospital have choice of doctor and Medicare pays 75% of the MBS for services and procedures provided by the doctor. The remaining 25% (the gap) can be covered by private hospital insurance.[6] If the doctor charges more than the MBS, these additional charges are the responsibility of the patient and can not be covered by insurance. Hospital accommodation charges, theatre fees, recovery ward charges, dressings etc. are the responsibility of the patient, but can be covered totally by private hospital insurance. This system was in operation in 1989-90.

The Data

The data used in the empirical sections of this paper is from the 1989-90 National Health Survey released by the Australian Bureau of Statistics. The data contains 54,241 fully completed individual questionnaires. This represented about one in 300 of the population. For the purposes of this paper a number of individuals and income units were deleted from the sample. Reasons for deletion are given in the Appendix.

After deletions there were 22,913 income units left in the sample. Of these 10,350 were singles, 5221 were couples, and 6067 were couples with dependants.[7] Associated with these income units were a total of 45,249 individuals. Of these 10,350 were in singles income units, 10,442 were in couples income units, and 24,457 were in couples with dependants income units.

Questions asked of individuals in the survey included

(a) whether they had private hospital insurance,

(b) whether they had existing medical conditions and what they were

[6] When the gap amount exceeds a certain amount in a calendar year, Medicare covers any further gap amounts completely.
[7] The remaining 1,275 income units were singles with dependants which are not used in this study.

(c) whether they visited a hospital in the last 12 months, and whether it was a private or public hospital,

(d) the reason for visiting hospital and length of stay in hospital,

and many other socio-economic questions.

In the survey, approximately 104 conditions and reasons for hospital use were listed. To make the number more manageable these were aggregated into 27 main groups, with 3 sub groups in each (major, serious, minor). These groups were chosen on the basis of the type of doctor who would normally attend to the condition. As will be seen later, this basis for grouping fits nicely with the theory and the empirical implementation of the theory.[8] The variables used in the empirical analysis are defined in the Appendix.

About 13.5% of individuals in the sample used hospital services in the previous 12 months. This percentage by income unit type was, 13.9% for individuals in single person units, 15.7% for individuals in couples units, and 12.2% for individuals in couples with dependants units. Table 1, which shows the percentages of individuals using private and public hospitals and insurance status for each type of income unit, suggests that most individuals who use a private hospital have private hospital insurance while most individuals who use a public hospital do not have private hospital insurance. It should be noted that some individuals who do not have private hospital insurance choose to be treated in a private hospital. For example, 25% of single private hospital users did not have private hospital insurance.

[8] The grouping of the conditions and reasons for use were undertaken at the Centre for Health Economics Research and Evaluation at the University of Sydney.

TABLE 1 : PRIVATE HOSPITAL INSURANCE STATUS OF PRIVATE AND PUBLIC HOSPITAL USERS BY TYPE OF INCOME UNIT

	Hospital Type	*% Insured*	*Observations*
Singles	Private	75.0	459
	Public	23.06	977
Couples	Private	84.6	629
	Public	36.2	1005
Couples with Dependants	Private	89.5	1020
	Public	42.5	1955

4. THE EMPIRICAL MODELING STRATEGY

The primary aim of this paper is to ascertain the extent of moral hazard in the provision of private hospital services in Australia.[9] In the process the existence of adverse selection is ascertained as well. Reduced form hospital service use equations (7) and (20) list the variables on which hospital service use depends. It is important to note that the 'net' prices in these equations are contingent on the insurance policy held by the individual. Different individuals have different insurance coverage and so face different 'net' prices. As a result the relationship between insurance coverage and hospital service use can be estimated.

In Australia, in 1989-90, there was basically one type of private hospital insurance policy. Therefore, there are only two sets of 'net' prices to consider in estimating private hospital service use, 'net' prices with insurance and prices without insurance. Unfortunately, the NHS data does not contain information on 'net' prices, but it does provide information on whether an individual had private hospital insurance or not. Therefore, a private hospital insurance dummy variable, which takes on the value 1 if the individual has private hospital insurance and zero if not, can be used in the hospital service use equations to account for different 'net' prices. A positive coefficient on the insurance dummy would be evidence of moral hazard. However, there is a problem with this dummy variable because it is endogenous. Whether an individual has insurance or not depends on, among other things, expected private hospital use. This endogeneity creates a potential covariance between the insurance dummy and the disturbance term in equations (7) and (20) so that single equations estimates of the coefficients attached to the regressors are inconsistent.

To produce consistent estimates of the moral hazard effect of insurance a procedure suggested by Dubin and McFadden (1984) is adopted. A probit model of insurance choice is estimated and the estimated probability of having private hospital insurance is substituted for the insurance dummy when estimating the hospital service use equation.[10] A Wu-Hausman (1973-1978) test is then performed to ascertain whether insurance choice is endogenous. If it is endogenous, then individuals who expect to be large users of hospital services have more insurance coverage and so the Wu-Hausman test is a test for adverse selection.

4.1 Private Hospital Insurance Choice

The theory in section 2 provides reduced form equations for estimating models of insurance choice. Insurance choice is an income unit decision, couples and couples with dependants pay the same

[9] To be precise, this paper investigates the extent of moral hazard in private hospital service use, given a users is treated in a private hospital. No attempt is made to extrapolate to the population of all hospital users.
[10] Rather than estimating insurance choice and hospital service use simultaneously, this two-step procedure is adopted for reasons of tractability.

premium for family cover regardless of the number of dependants in the income unit. Therefore, separate probit models are estimated for income units with different compositions.

***Singles*:** In equation (18) of section 2, the variables on which the private hospital insurance choice hinges are given. Unfortunately the National Health Survey 1989-90 (NHS) does not include data on private hospital insurance premiums, net prices of private hospital services, nor waiting times for these services. However, proxies for these variables exist in the data.

The data contains information on health status, in particular, it contains information on long-term (chronic) medical conditions.[11] Chronic medical conditions give an indication of the individual's health status and so the probability of different health state vectors being realized in some future period. In addition, as different conditions require different treatments and these different treatments have different waiting times and net prices, an individual's chronic conditions are proxies for t, p, and $f(s_2)$ as well.[12] Since chronic medical conditions are proxies for a number of variables in (18) it is impossible to separate the effects of waiting time, net prices, and health state probabilities on insurance choice. However, given the data, this is the best that can be done.

As well as income and chronic medical conditions, other variables are included in the probit analyis. These variables capture a combination of the probability of various health states being realized in the future and the heterogeneity of individuals in the data. These variables include age, sex, region, employment status, education, and country of birth.

Condition 17 in section 2 states that private hospital insurance will be purchased if period 1 maximized discounted expected utility is greater with insurance than without. Let V_1^* be the difference between period 1 maximized discounted expected utility with insurance and without. This difference is not observed, but is assumed to arise from the model

$$V_1^* = A'\delta + \mu, \qquad (22)$$

where μ has a normal distribution with mean zero and variance one. What is observed is whether private hospital insurance was purchased, that is

$$V_1 = 1 \text{ if } V_1^* > 0$$

$$V_1 = 0 \text{ if } V_1^* \leq 0.$$

This gives rise to the probit model

$$\text{Prob}[V_1 = 1] = \Phi(A'\delta), \qquad (23)$$

[11]Chronic medical conditions are ones which have lasted at least six months, or are expected to last for six months or more.

[12] This provides the rationale for grouping conditions and reasons for hospital use by doctor usually seen for this condition. Different types of doctors charge different net prices and have different waiting times for their services.

where $\Phi(\cdot)$ denotes the standard normal distribution function and A includes chronic medical condition dummies and the other explanatory variables mentioned above. The aggregation of chronic conditions into 27 main conditions meant that an individual may have two or more chronic conditions in the same main group. It can be presumed that an individual with two or more orthopaedic conditions is more likely to realize a poor health state than an individual with one orthopaedic condition, so dummy variables for one or more, two or more, three or more etc.chronic conditions are employed.[13]

Couples and Couples with Dependants**:** For income units that do not consist of a single individual, the variables on which the insurance choice hinges are given in (21). The difference between (18) and (21) is that the individual's probability density is replaced by the income unit's joint probability density over the vector of health state vectors. The chronic conditions of the income unit are the appropriate proxy for this. Income unit chronic condition dummy variables are created in the same way as they were for singles except the conditions of each member of the income unit are aggregated. So if one member of a couple has two chronic neurological conditions and the other member has one chronic neurological condition then the one or more, two or more, and three or more neurological condition dummy variables take the value 1.

4.2 Private Hospital Use

Equations (7) and (20) are the reduced form private hospital use equations of individuals. They specify the variables on which use depends. As already mentioned, the National Health Insurance Survey 1989-90 does not include data on the net prices of private hospital services nor the actual realization of the individual's health state vector. However, data is available on the reason for use of hospital services. This variable is used as a proxy for the realized health state. It also serves as a proxy for the 'net' price of the appropriate hospital service which returns the health state vector to its initial settings. Different services have different 'net' prices. Reason for use also controls for the fact that some health states necessarily involve the use of more hospital services than others.[14]

The quantity of hospital service k is not given in the NHS survey. The only quantity variable on which there is data is the duration of stay in hospital. Let the duration of stay in a private hospital be given by the continuous random variable, T, which has distribution function, $F(t;X)$ and probability density function, $f(t;X)$, where X is a vector of time-invariant covariates. The probability of a duration of stay being greater than t, is given by the survivor function $S(t;X)=1-F(t;X)$. The hazard function,

[13] For some conditions, not all of these dummies are relevant. For example no single person has more than 2 conditions usually attended to by a cardiologist.
[14] Open heart surgery requires more hospital services than a broken leg.

$$h(t;X) = \frac{f(t;X)}{S(t;X)}, \qquad (24)$$

is the probability that the patient will leave hospital in the short interval of length dt after t, conditional on the patient still being in hospital at time t. Note that

$$h(t;X) = -\frac{d \log S(t;X)}{dt} \text{ and so } S(t;X) = \exp\{-H(t;X)\}, \qquad (25)$$

where $H(t;X) = \int_0^t h(u;X)\,du$ is known as the cumulative or integrated hazard. The above relations imply that once one of the probability density function, the survivor function, or the hazard function are known, the others can be deduced.[15]

In accelerated failure time models the effect of the covariates, X, is to rescale the time axis multiplicatively so that

$$T = T_0 \cdot \theta(X), \qquad (26)$$

where hospital duration of an individual with covariates, X, is accelerated or decelerated relative to T_0 according to whether $\theta < 1$ or $\theta > 1$, and T_0 is a random variable with a distribution independent of X. Define $S_0(t) = prob\{T_0 \geq t\}$ as the baseline survivor function, then

$$S(t;X) = prob\{T \geq t; X\} = prob\{T_0 \geq t \cdot \frac{1}{\theta(X)}\} = S_0\{t \cdot \frac{1}{\theta(X)}\} \qquad (27)$$

is the survivor function for the random variable, T. The corresponding probability density function and hazard function are

$$f(t;X) = \frac{1}{\theta(X)} \cdot f_0(t \cdot \frac{1}{\theta(X)}) \text{ and } h(t;X) = \frac{1}{\theta(X)} \cdot h_0(t \cdot \frac{1}{\theta(X)}), \qquad (28)$$

where $f_0(t)$ and $h_0(t)$ are the probability density function and hazard function associated with $S_0(t)$.

As the acceleration factor $\theta(X)$ must be non-negative it is usual to let $\theta(X) = e^{X'\beta}$ and estimate it using the linear regression

$$\log T = X'\beta + \log T_0. \qquad (29)$$

Different parametric specifications for the distribution of $\log T_0$ give different probability density functions, survivor functions, and hazard functions for T.[16]

[15] These relationships are derived in Lancaster (1990).

The regression model above, (29), is estimated with the NHS data. The log of length of stay is the dependent variable and the covariates (regressors) are reason for hospital stay, the estimated probability that an individual has private hospital insurance (obtained from the insurance choice probit analysis), and some socio-economic variables. The latter includes region of residence. In Australia, health expenditure is a state rather than federal responsibility so that different states can have different treatment regimes that may also differ within the state.

The estimated coefficient on the estimated probability of insurance variable gives an indication of moral hazard. If this coefficient is positive, then $\theta(X) > 1$ and time is decelerated, that is, if an individual has insurance then their expected duration in a private hospital is longer.

Before estimation, however, one further econometric issue must be dealt with, namely, interval censored duration data.

Interval Censored Data: In the NHS, the data on duration of stay is grouped into 5 intervals: 0 nights, 1-6 nights, 7-14 nights, 15 nights-1 month, and more than 1 month. As the regression model requires the log of duration of stay, these intervals are converted to hour intervals with the lowest bound made greater than zero. The translation is given in Table 2 where interval j has bounds given by $a_j - a_{j+1}$.

TABLE 2: LENGTH OF PRIVATE HOSPITAL STAY IN NIGHTS CONVERTED TO HOURS

Interval, j	*1*	*2*	*3*	*4*	*5*
Nights	0	1 - 6	7 - 14	15 - 1 month	> 1 month
Hours, $a_j - a_{j+1}$	2-8	8 - 152	152 - 344	344 - 728	>728

In Table 2, 0 nights has become 2 - 8 hours. The rationale for this is that 2 hours is about the minimum stay in hospital for a procedure and if a patient stays longer than 8 hours then usually they would stay over night.[17]

Assume that the latent structure of the hospital use equation to be estimated is given by

$$\log T_i^* = X_i' \beta + \varepsilon_i \quad i = 1,\dots,N \tag{30}$$

where $\log T_i^*$ is the unobserved dependent variable for observation *i* (in our case the log of the actual length of hospital stay) and the error term, ε_i, is distributed the same as $\log T_{0i}$.What is observed is the interval in which the actual length of stay falls, that is

[16] Lancaster 1990 shows that if $LogT_0$ is distributed as a Type 1 Extreme Value distribution, then the probability density function of T is the exponential probability density with constant hazard rate given by $\frac{1}{\theta}$.

$\log T_i = j$ if $\log a_j < \log T_i^* < \log a_{j+1}$.

For an observation that lies in interval j, the appropriate probability is

$$\text{Prob}[\log T_i = j] = F_0(\log a_{j+1} - X_i^{'}\beta) - F_0(\log a_j - X_i^{'}\beta) \qquad (31)$$

where $F_0(t) = 1 - S_0(t)$ and estimation proceeds using maximum likelihood estimation.[18]

Model (29) is estimated for individuals in single, couple, and couple with dependants income units. Although (20) suggests that the health state vectors of all individuals in the income unit should be included as regressors, only the individual's own reason for use is used in the estimation because few income units in the sample had more than one hospital user in the last 12 months.

[17] The lower bound in intervals 2-5 are actually, 8.0001, 152.0001, 344.0001, and 728.0001, respectively.
[18] The SAS Lifereg procedure is used to estimate the model.

5. RESULTS

5.1 Private Hospital Insurance Choice

The single and couple income units were separated into young (head aged less than 50 years) and old partitions and separate probit models were estimated for each, the rationale being that young and old, singles and couples are very distinct groups with different behaviour.[19] Regressors included variables related to health status, region, country of birth, and presence of a veteran's affairs health card. A summary of results is given in Table 3. For the continuous variables, income and family size, the entries in the table give the estimated coefficients and the marginal probabilities calculated at data means. For the dummy variables, the marginal probabilities denote the change in probability associated with changing the dummy variable from 0 to 1.

For young singles and couples these probabilities are relative to an income unit with a male head aged under 35 years of age, and for old singles and couples these probabilities are relative to a male head aged under 50 years. For couples with dependents the reference head is aged under 35 years. For singles the reference income unit head is also not in the labor force, only has a school qualification, was born in Australia, lives in metropolitan Sydney, and has no chronic conditions. For couples, the reference income unit has a head born in Australia, lives in metropolitan Sydney, has both the head and spouse not in the labor force, has both the head and spouse with only a school qualification, and has a head and spouse with no chronic conditions.

[19] The results on insurance and duration confirm this.

TABLE 3 **:**SELECTED COEFFICIENT ESTIMATES AND MARGINAL PROBABILITIES FROM MODELS OF HOSPITAL INSURANCE CHOICE

	YOUNG SINGLES					*YOUNG COUPLES*					*COUPLES WITH DEPENDANTS*					*OLD COUPLES*					*OLD SINGLES*				
	Coef.	*Std.Err*	*P>|z|*	*dF/dx*	*x-bar*	*Coef.*	*Std.Err*	*P>|z|*	*dF/dx*	*x-bar*	*Coef.*	*Std.Err*	*P>|z|*	*dF/dx*	*x-bar*	*Coef.*	*Std.Err*	*P>|z|*	*dF/dx*	*x-bar*	*Coef.*	*Std.Err*	*P>|z|*	*dF/dx*	*x-bar*
intcept	-1.029	0.128	0.000			-1.102	0.309	0.000			-0.713	0.150	0.000			-0.401	0.119	0.001			-0.996	0.117	0.000		
hdinc	0.018	0.002	0.000	0.006	21.306	0.019	0.003	0.000	0.008	30.221	0.016	0.002	0.000	0.006	31.088	0.027	0.003	0.000	0.011	0.001	0.051	0.005	0.000	0.019	0.002
sdinc						0.015	0.005	0.002	0.006	18.806	0.005	0.003	0.035	0.002	11.467	0.007	0.004	0.057	0.003	9.799					
size											-0.075	0.020	0.000	-0.030	4.022										
hsex	0.176	0.160	0.270	0.063	0.387																0.090	0.086	0.294	0.033	0.699
hmvet	0.350	0.447	0.433	0.133	0.001	0.515	0.622	0.408	0.193	0.003	0.243	0.206	0.237	0.093	0.008	-0.665	0.079	0.000	-0.258	0.126	-0.697	0.152	0.000	-0.212	0.043
hfvet	-0.029	0.728	0.969	-0.010	0.000	0.553	0.682	0.417	0.205	0.001	0.141	0.563	0.802	0.055	0.001	-0.289	0.198	0.145	-0.115	0.019	-0.773	0.106	0.000	-0.232	0.069
Age dummies																									
dh3550	0.181	0.048	0.000	0.066	0.184	0.313	0.088	0.000	0.124	0.425	0.190	0.044	0.000	0.075	0.577										
dh5065											0.262	0.077	0.001	0.101	0.096										
dh65											0.552	0.290	0.057	0.199	0.005	-0.045	0.069	0.514	-0.018	0.437	-0.180	0.067	0.007	-0.065	0.353
Country of birth																									
hnzuk	-0.445	0.064	0.000	-0.142	0.087	-0.375	0.114	0.001	-0.148	0.127	-0.427	0.058	0.000	-0.169	0.118	-0.508	0.074	0.000	-0.200	0.143	-0.397	0.080	0.000	-0.135	0.122
hseur	-0.462	0.121	0.000	-0.144	0.022	-0.413	0.178	0.020	-0.163	0.042	-0.227	0.071	0.001	-0.090	0.080	-0.543	0.088	0.000	-0.213	0.096	-0.190	0.111	0.088	-0.067	0.051
hweur	-0.410	0.188	0.029	-0.130	0.009	-0.488	0.258	0.059	-0.190	0.020	-0.343	0.117	0.003	-0.136	0.025	-0.472	0.143	0.001	-0.185	0.027	-0.213	0.161	0.185	-0.074	0.022
hasia	-0.426	0.103	0.000	-0.135	0.033	-0.604	0.220	0.006	-0.232	0.025	-0.740	0.107	0.000	-0.284	0.034	-0.639	0.222	0.004	-0.246	0.013	-0.030	0.194	0.877	-0.011	0.015
hotherc	-0.289	0.096	0.002	-0.096	0.041	-0.598	0.173	0.001	-0.231	0.057	-0.661	0.079	0.000	-0.257	0.068	-0.672	0.106	0.000	-0.259	0.061	-0.315	0.117	0.007	-0.108	0.053
Health status																									
hmsmok	-0.010	0.002	0.000	-0.004	5.473	-0.005	0.003	0.057	-0.002	11.485	-0.004	0.001	0.001	-0.002	12.316	-0.000	0.001	0.797	-0.000	12.664	-0.001	0.003	0.657	-0.000	3.847
hfsmoke	-0.016	0.003	0.000	-0.006	2.740	-0.008	0.003	0.027	-0.003	7.645	-0.013	0.002	0.000	-0.005	7.190	-0.005	0.002	0.049	-0.002	5.885	-0.011	0.003	0.000	-0.004	3.865
hmalc	-0.002	0.001	0.012	-0.001	17.769	-0.002	0.001	0.068	-0.001	25.557	0.000	0.001	0.882	0.000	22.156	-0.002	0.001	0.107	-0.001	18.122	-0.001	0.001	0.508	-0.000	6.441
hfalc	-0.001	0.002	0.589	-0.000	4.483	-0.004	0.003	0.228	-0.002	8.379	0.000	0.002	0.814	0.000	5.515	0.001	0.002	0.565	0.001	6.183	0.009	0.003	0.006	0.003	2.861

	YOUNG SINGLES	YOUNG COUPLES	COUPLES WITH DEPENDANTS	OLD COUPLES	OLD SINGLES
LogL	-3896.0	-911.0	3493.2	1995.0	-1897.5
Pseudo R^2	0.106	0.184	0.162	0.198	0.175
Observations	6806	1614	6067	3597	3528
LR test statistic	184.236	99.624	278.508	85.602	76.074
Number chronic conditions	40	48	63	52	39
Critical χ^2	$\chi^2_{40} = 55.8$	$\chi^2_{50} = 67.5$	$\chi^2_{60} = 79.1$	$\chi^2_{50} = 67.5$	$\chi^2_{40} = 55.8$

NOTE: Other explanatory variables in the model not reported in the Table are dummies for regions, employment status, education, and chronic conditions

In all cases, income has a significant, though small, positive impact on the probability of having private hospital insurance. This is consistent with the findings of Ngui, Burrows and Brown (1989), who used the 1983 ABS Australian Health Survey to estimate a logit model of private hospital insurance choice for individuals. It is also consistent with the findings of Cameron, Trivedi, Milne and Piggott (1988), who used the 1977-78 ABS Australian Health Survey to estimate a logit model of private hospital choice for singles over the age of 18. Propper (1989) obtained similar results for families in England and Wales as did Hurd and McGarry (1997) for the elderly in the United States of America. In addition, Table 3 reveals that the marginal probability attached to the income of the head is similar to that of the spouse in young couples, less similar for couples with dependants, and dissimilar for old couples. It would appear that the spouse's income is less important in the insurance decision the older is the couple.

As in Ngui *et al* and Cameron *et al*, age (except for the very old) tends to have a positive impact on the probability of having private hospital insurance. This is reflected in the marginal probabilities on the age dummy variables which tend to increase for higher age bands. If the head of an income unit was born outside Australia, this has a negative impact on the probability of having private hospital insurance for all income unit types except old singles. The institutional setting in the country of origin may explain this result, a result that was also found in Cameron *et al*. A veteran's affairs health card lowers the probability of purchasing private hospital insurance for old singles and old couples. This is not surprising as holders of veteran's affairs health cards were eligible for free treatment in designated veterans' hospitals in 1989-90. Nicotine and alcohol consumption are included as health status variables. Both reduce the probability of having private hospital insurance. This might be related to risk preferences.

As in Cameron *et al*, living in Queensland has a strong negative impact on the likelihood of having private hospital. This seems to be a remnant of the fact that even prior to the introduction of Medicare in 1984, the Queensland state government provided public hospital services free to all. There is a general tendency for employment, whether full or part-time, to increase the probability of having private hospital insurance while unemployment tends to lower this probability. This is a standard result, see Ngui *et al* and Propper. The same is true of post school education as in Cameron *et al*.

Unlike previous studies, in this paper health status is captured by a detailed breakdown of chronic conditions. Many of these conditions are found to be individually and jointly significant[20]. This provides some initial evidence of adverse selection in that income units that purchase private hospital insurance are ones with poor health status. Most of the conditions found to be significant are categorised as minor reflecting the importance of general health status rather than the presence of major conditions for insurance choice. Previous studies have failed to model detailed health status variables so it is not surprising that health status is rarely found to be significant. [21] In this study different conditions are found to be significant for different types of income units. This suggests it is heterogeneity between income units that is being captured rather than waiting time or ‘net’ price as these would be constant across income unit types.

5.2 Private Hospital Duration of Stay

A breakdown of the duration of stay by income unit is presented in Table 4. Individuals in young income units tend to stay in private hospitals for shorter durations than individuals in older income units. This is evident from Table 4, since as we move across a row, from young to old, the percentage of an income unit type with a particular duration, falls for short durations (1 and 2), but increases for long durations (3, 4 and 5).

[20] Likelihood ratio test statistics presented in Table 3 indicate that the inclusion of chronic condition dummy variables significantly improve the explanatory power of the insurance models for all income unit types.

[21] Ngui *et al* use a dummy variable for doctor visits in the last two weeks and number of prescribed medications taken and found them to be significant. Cameron e*t al* use number and severity of chronic conditions and find no significance.

TABLE 4: PERCENTAGE OF PRIVATE HOSPITAL USERS BY DURATION INTERVAL AND TYPE OF INCOME UNIT

Duration Interval	% Single Young	% Couple Young	% Couples with dependants	% Couple Old	% Single Old
1	21.0	23.2	19.1	17.4	9.6
2	68.3	65.5	63.5	56.8	51.3
3	7.3	5.4	14.9	19.5	18.8
4	3.4	6.0	2.0	5.9	13.7
5	0.0	0.0	0.1	0.0	6.6
Total	100.0	100.0	100.0	100.0	100.0

A summary of specification tests for model selection is presented in Table 5.

TABLE 5 : MODEL SELECTION

	YOUNG SINGLES		*YOUNG COUPLES*		*COUPLES WITH DEPENDANTS*		*OLD COUPLES*		*OLD SINGLES*	
GAMMA										
Insurance variable	Dummy	Prediction	Dummy	Prediction	Dummy	Prediction	Dummy	Prediction	Dummy	Prediction
Scale parameter	0.334	0.335	0.290	0.287	1.141	1.163	1.292	1.306	0.382	0.375
Shape parameter	-3.822	-3.766	-3.961	-3.979	0.236	0.209	0.054	0.165	3.997	4.072
Log L	-225.144	-225.302	-131.658	-131.375	-955.672	-968.195	-521.041	-526.638	-226.426	-226.289
AIC	536.288	536.604	345.316	344.75	2005.344	2030.39	1126.082	1137.276	538.852	538.578
Wu-Hausman $(\chi_1^2 = 3.84)$	7.095*		8.948*		8.589*				-0.416	
LOGNORMAL										
Insurance					Dummy	Prediction	Dummy	Prediction		
Scale					1.158	1.177	1.293*	1.313*		
Log L					-957.372	-969.48	-521.084	-526.94		
AIC					2006.744	2030.96	1124.168	1135.88		
Wu-Hausman $(\chi_1^2 = 3.84)$							5.167*			

Regressors in the duration model include reason for hospital stay, region, age, income, sex, and the estimated probability of having private hospital insurance (obtained from the probit analysis of private hospital insurance choice) or a private hospital insurance dummy variable.[22]

Model (29) was estimated using the insurance dummy variable and the insurance prediction from the probit analysis. It is assumed that T_0 is distributed according to the Gamma distribution. This distribution nests the Log-normal (shape parameter = 0), Weibull, (shape parameter = 1), and Exponential distributions (Weibull with scale parameter = 1). In Table 5 it is seen that the Log-normal and Weibull distributions are rejected for young singles, young couples and old singles, therefore, Gamma is the preferred distribution for these income units.

For old couples, the null hypothesis that the shape parameter equaled zero could not be rejected, suggesting the appropriate distribution for T_0 is Log-normal. To confirm this result, the Akaike (1974) information criterion (AIC) is calculated for the Gamma and Log-normal models.[23] The Log-normal model has the lower AIC so Log-normal is the preferred distribution for old couples. For couples with dependants, the null hypothesis that the shape parameter equaled zero is rejected at the 5% level and marginally rejected at the 10% level. The AIC was calculated and found to be lower for the Gamma than the Log-normal distribution. As a result Gamma is the preferred distribution for couples with dependants.

Adverse Selection: A Wu-Hausman test is applied to the preferred model to test whether the endogeneity of insurance choice leads to inconsistent parameter estimates. The test statistic is

$$w = (\beta_D - \beta_P)'[Var(\beta_D) - Var(\beta_P)]^{-1}(\beta_D - \beta_P),$$

where B_D and β_P are the vectors of parameter estimates with the insurance dummy and the probit prediction, respectively, and the middle term is the inverse of the variance-covariance matrix. This statistic is distributed chi-squared with 1 degrees of freedom. Under the null hypothesis (insurance exogenous), both B_D and β_P are consistent while under the alternative hypothesis (insurance endogenous), β_P is

[22] This dummy variable takes on the value 1 if the individual is covered by private hospital insurance and 0 otherwise.
[23] AIC is defined as $AIC = -2(\log L) + 2(c + p + 1)$, where c is the number of covariates and p is the number of model-specific ancillary parameters that need to be estimated.

consistent, but β_D is inconsistent. The test statistic is given in Table 5 and the null is rejected at the 5% and 10% level for young singles, young couples, old couples, and couples with dependants.

An interpretation of this rejection is that those income units for which the null is rejected take expected private hospital use into account when making their insurance decision, that is, there is adverse selection. Old singles have the highest proportion of income units over 65 years of age and are the only income units that do not behave strategically when making their insurance decisions. That the very old behave differently than other income units was suggested by the insurance choice probit analysis where the coefficient on the dummy variable for those over 65 years of age, in old singles income units, was negative and significant.

The appropriate model for young singles, young couples, and couples with dependants is Gamma with the insurance prediction from the probit analysis, for old couples the appropriate model is Log-normal with the insurance prediction, while for old singles the appropriate model is Gamma with the insurance dummy variable.

General Results: Detailed results of the duration of stay regressions for the preferred models are given in Table 6. The effect of income on hospital stay duration is in general negative. Perhaps the opportunity cost of time is greater for individuals in income units that have higher income. Cameron *et al* obtained mixed results for the relationship between income and health service use while Hurd and McGarry (1997) found no relationship between income and number of nights stayed in hospital. Many reasons-for-use-variables are statistically significant indicating that different reasons have different durations associated with them. Since all individuals have a reason for use the duration of stay regressions do not have an intercept. As a result, the mean of the baseline distribution of $LogT_0$ is absorbed into the reason for use parameter estimates.

TABLE 6: COEFFICIENT ESTIMATES FROM MODELS OF HOSPITAL DURATION

	YOUNG SINGLES			*YOUNG COUPLES*			*COUPLES WITH DEPENDANTS*			*OLD COUPLES*			*OLD SINGLES*		
	Estimate	*Std Err*	*Pr>Chi*	*Estimate*	*Std Err*	*Pr>Chi*	*Estimate*	*Std Err*	*Pr>Chi*	*Estimate*	*Std Err*	*Pr>Chi*	*Estimate*	*Std Err*	*Pr>Chi*
INSURANCE	1.021	0.668	0.127	0.506	0.553	0.360	0.633	0.308	0.040	1.171	0.491	0.017	0.148	0.232	0.524
SEX	0.070	0.133	0.600	-0.226	0.179	0.206	0.305	0.111	0.006	0.247	0.159	0.121	-0.207	0.203	0.308
DEP							-0.513	0.124	0.000						
DH3550	0.208	0.172	0.226	0.108	0.194	0.580	0.121	0.104	0.243						
DH5065							0.168	0.170	0.321						
DH65							-0.639	0.644	0.321	0.426	0.167	0.011	0.489	0.186	0.009
HDINC	-0.012	0.008	0.148	-0.011	0.006	0.040	-0.007	0.004	0.042	-0.029	0.006	0.000	0.004	0.006	0.534
SDINC				-0.011	0.007	0.111	-0.008	0.004	0.070	0.010	0.006	0.101			
Regions															
HNSWCNT	-0.307	0.222	0.167	-0.546	0.326	0.095	0.514	0.167	0.002	0.076	0.243	0.756	0.281	0.406	0.489
HVICMET	-0.143	0.159	0.369	-0.118	0.208	0.572	0.207	0.138	0.133	-0.052	0.219	0.814	0.231	0.249	0.354
HVICCNT	1.387	0.750	0.064	3.301	0.481	0.000	0.567	0.198	0.004	-0.277	0.385	0.472	-0.466	0.380	0.220
HQLDMET	-0.081	0.266	0.761	-0.425	0.290	0.142	0.524	0.202	0.010	0.423	0.303	0.163	0.166	0.394	0.673
HQLDCNT	0.140	0.243	0.565	0.165	0.271	0.543	0.428	0.170	0.012	0.266	0.255	0.298	0.551	0.350	0.116
HSAMET	-0.139	0.203	0.494	0.230	0.326	0.481	0.301	0.178	0.091	0.037	0.315	0.907	0.558	0.274	0.042
HSACNT	0.293	0.365	0.422	-1.404	0.490	0.004	0.985	0.359	0.006	0.818	0.424	0.054	-0.962	0.850	0.257
HWAMET	0.046	0.201	0.818	0.148	0.249	0.553	0.340	0.177	0.055	0.422	0.391	0.281	0.150	0.312	0.631
HWACNT	0.278	0.516	0.591	-0.168	0.664	0.800	0.135	0.324	0.677	0.724	0.567	0.202	-0.288	0.790	0.715
HTASMET	-0.459	0.445	0.302	0.356	1.875	0.849	0.281	0.320	0.380	0.379	0.503	0.451	0.309	0.439	0.482
HTASCNT	0.096	0.988	0.923	0.169	0.465	0.717	0.068	0.312	0.828	-0.011	0.502	0.983	0.382	0.419	0.363
HNT	-0.673	0.428	0.116	0.062	0.536	0.908	-0.484	0.479	0.312			.			.
HACT	-0.605	0.423	0.153	-0.814	0.821	0.321	-0.222	0.557	0.691	-0.042	0.615	0.946	0.172	0.594	0.772
Reasons															
NEUROLH	2.443	0.665	0.000				2.533	0.760	0.001	3.726	0.511	0.000	7.112	0.631	0.000
PSYCHH	2.349	0.500	0.000	6.465	0.467	0.000	4.966	0.703	0.000	2.746	2.002	0.170	6.735	0.515	0.000
SURGEOhH	1.798	0.275	0.000	2.147	0.424	0.000	3.114	0.290	0.000	3.260	0.434	0.000	4.481	0.484	0.000
VASCLRH	2.450	0.660	0.000	2.394	0.480	0.000	3.376	0.408	0.000	4.032	0.528	0.000	5.261	0.353	0.000
UROLOGH	1.037	1.030	0.314	1.731	0.631	0.006	2.995	0.353	0.000	3.402	0.419	0.000	4.159	0.487	0.000
GENERALH	1.384	0.393	0.000	1.689	0.430	0.000	2.497	0.226	0.000	1.553	0.484	0.001	5.481	0.698	0.000
CARDH	0.640	0.945	0.498	1.651	0.677	0.015	3.886	0.527	0.000	3.909	0.455	0.000	5.532	0.423	0.000
RESPRTRH	1.917	0.292	0.000	3.042	0.569	0.000	3.314	0.269	0.000	3.863	0.492	0.000	5.537	0.511	0.000
GASTROH	1.355	0.341	0.000	1.985	0.508	0.000	3.212	0.264	0.000	3.156	0.364	0.000	6.155	0.412	0.000
NEPHROL	0.958	0.523	0.067	3.701	1.000	0.000	3.586	0.540	0.000	3.300	0.701	0.000	4.572	0.466	0.000
DERMATH	1.777	0.349	0.000	2.543	0.590	0.000	2.112	0.353	0.000	3.083	0.535	0.000	5.130	0.504	0.000
IMMUNOH			.				3.296	1.660	0.047	4.566	0.971	0.000	4.624	0.767	0.000
ONCOLH	1.572	0.357	0.000	2.718	0.941	0.004	3.360	0.355	0.000	2.853	0.373	0.000	5.715	0.446	0.000
RHEUMATH	2.318	0.673	0.001						.	2.894	1.562	0.064			.
OPHTHALH	2.492	0.522	0.000	3.041	0.735	0.000	2.385	0.418	0.000	2.380	0.384	0.000	4.162	0.434	0.000
OPTOMH	1.826	0.795	0.022	2.071	0.714	0.004			.			.	0.000	0.000	.
ENTH	2.223	0.428	0.000	2.716	0.703	0.000	2.345	0.261	0.000	3.498	0.679	0.000	4.151	0.767	0.000
ORALH	1.982	0.233	0.000	2.687	0.393	0.000	2.455	0.295	0.000	2.038	0.914	0.026	4.173	0.747	0.000
OGH	1.357	0.315	0.000	2.464	0.415	0.000	3.647	0.221	0.000	2.798	0.395	0.000	4.894	0.492	0.000
PHYSH	1.140	0.615	0.064				2.400	0.588	0.000	2.906	1.786	0.104	4.907	0.515	0.000
PLASTICH	2.133	0.652	0.001	3.053	0.653	0.000			.			.			.
ORTHOH	2.026	0.206	0.000	2.478	0.327	0.000	3.622	0.231	0.000	3.797	0.345	0.000	5.909	0.438	0.000
PATHOLH	1.005	0.440	0.022	1.896	0.476	0.000	1.820	0.371	0.000	2.257	0.498	0.000	2.791	0.936	0.003
RADIOLH			.				0.518	1.229	0.673			.			.
ENDOH	2.063	0.729	0.005	2.778	0.865	0.001	2.931	0.577	0.000	2.481	0.716	0.001	5.134	0.467	0.000
SCALE	0.335	0.081	Gamma	0.287	0.099	Gamma	1.163	0.033	Gamma	1.313	0.048	LNormal	0.382	0.130	Gamma
SHAPE	-3.766	0.910		-3.979	1.373		0.209	0.130					3.997	1.392	
LogL		-225.302			-131.375			-968.195			-526.940			-226.426	

Moral Hazard: The main variable of interest is the estimated coefficient on the insurance variable. This coefficient is statistically significant for couples with dependants, old couples, and almost significant at the 10% level for young singles. The coefficient on the insurance variable gives an indication of the extent of moral hazard. A positive coefficient implies that insurance decelerates time, that is, individuals with private hospital insurance have a longer expected stay in private hospitals. For example, for couples with dependants private hospital insurance decelerates time by $e^{0.633} = 1.88$, that is, an individual with private hospital insurance has an expected stay 1.88 times longer than an individual with no insurance regardless of reason for use. For old couples time is decelerated by $e^{1.171} = 3.23$ which is a large increase in the expected duration of hospital stays. Table 7 presents the acceleration factors for the predicted and dummy insurance variables for each income unit type. It reveals the importance of performing the Wu-Hausman test as the acceleration factors for predicted and dummy insurance variables are quite different.

TABLE 7 :ACCELERATION FACTORS BY INSURANCE VARIABLE AND INCOME UNIT TYPE

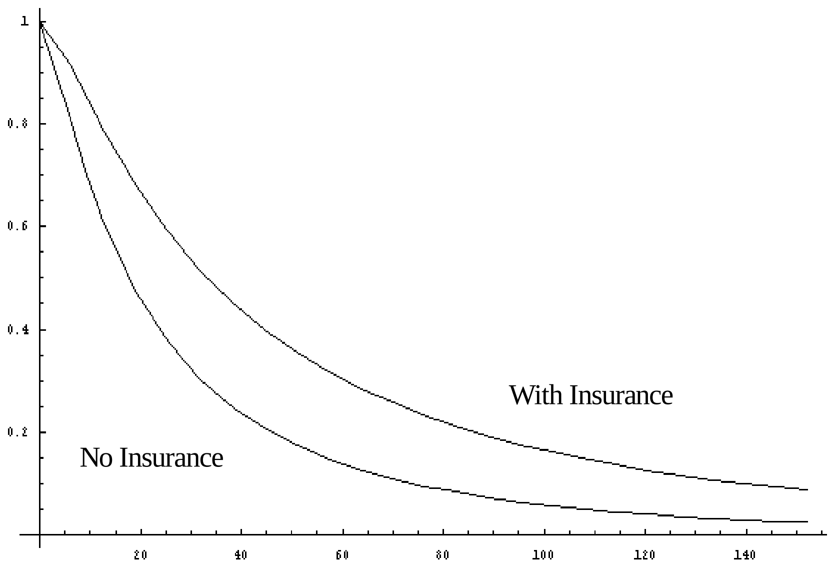
Income unit type	$\theta_{predicted}$	θ_{dummy}	*Sample size*	*Preferred distributio n*	*Preferred insurance variable*
Young single	2.78**	1.25**	262	gamma	predicted
Young couple	1.66	1.14	168	gamma	predicted
Couple with deps	1.88*	2.17*	1020	gamma	predicted
Old couple	3.23*	2.39*	461	lognormal	predicted
Old single	1.54	1.16	197	gamma	dummy

* significant at the 5% level
** almost significant at the 10% level

No evidence of moral hazard across all income units was found, however, there is quite strong evidence for moral hazard amongst old couples and couples with dependants and weak evidence for moral hazard amongst young singles. To some extent, this is consistent with the findings of Cameron *et al* who found that singles with more insurance used more health services. Manning, Newhouse, Duan, Keeler, Leibowitz, and Marquis (1987), Manning and Marquis (1996) and Lee (1993) also found evidence of moral hazard in the U.S., however only Lee modelled the interaction between insurance choice and hospital service use. None of these papers distinguished between public and private hospital use.

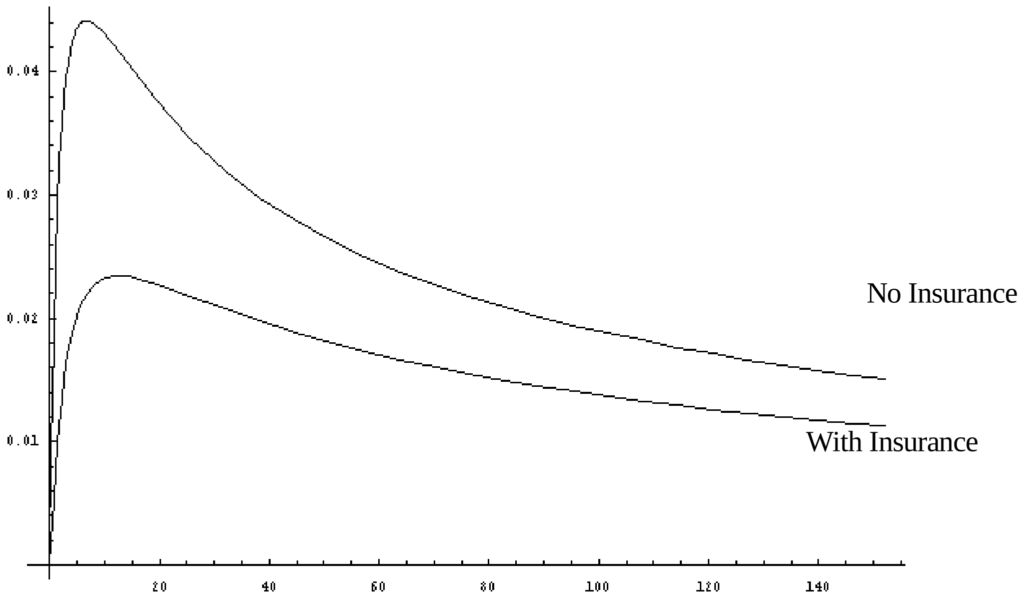
A survivor function for an individual from an income unit consisting of a couple with dependants, with and without insurance, is shown in Figure 1. The characteristics of the individual are: male head, aged between 50-65, living in metropolitan NSW, having surgeon as reason for use, and residing in an income unit with mean income . In the absence of insurance, the expected hospital stay for this individual is $e^{2.95} = 19.1$ hours. The same individual with insurance would have an expected stay of 36 hours. As expected the survivor function with insurance is located above and to the right of the survivor function without insurance so that individuals with insurance have a higher probability of their duration of staying being greater than t, for all t.

FIGURE 1: SURVIVOR FUNCTION



The hazard function for this individual, with and without insurance, is shown in Figure 2.

FIGURE 2: HAZARD FUNCTION



The shape of this particular hazard function is indicative of the shape of the hazard functions for all the income units. The shape indicates an initially increasing, but eventually decreasing hazard. Therefore, once an individual has stayed in hospital around 10 hours the probability that they will leave hospital in the next hour decreases the longer they stay. The effect of insurance is to reduce the hazard, that is, given the individual has stayed say 10 hours, the probability that they will leave in the next hour is lower if they have insurance than if they do not.

6. CONCLUSION

The appropriate size of private and public health sectors and the design of insurance policies depend on the extent of adverse selection and moral hazard. Adverse selection was found to be present for all but one income unit type. Except for the very old, income units act strategically in purchasing insurance in the sense that, if they expect to be heavy users of private hospital services, they purchase private hospital insurance.

Given the existence of adverse selection, consistent estimation of the moral hazard effect requires the interdependence between the insurance choice and hospital use decision to be explicitly recognized. This is achieved in this paper by using the predicted probability of being insured as a regressor in the hospital duration regressions. It was found that the consistent estimate of the extent of moral hazard may be greater or smaller than the inconsistent estimate, though it was more common for the consistent estimate to be associated with a larger moral hazard effect. This highlights the need for using estimation methods that take into account the endogeneity of insurance choice when estimating the extent of moral hazard.

Where significant, the moral hazard effect was found to be substantial. For income units consisting of a couple with dependants, insurance increased the expected length of stay by a factor of nearly 2, while for old couples this factor was over 3. Moral hazard effects of this magnitude have important implications for the design of private hospital insurance policies and cost control in the hospital sector. In Australia in 1989-90, there was basically one type of private hospital insurance policy and it did not include a deductible (an amount the insured individual has to pay in any claim). Perhaps this explains the extent of moral hazard in private hospitals. In 1999, private hospital insurance policies vary and can include substantial deductibles. If detailed data were collected on insurance policy type and hospital service use, both private and public, then future research could be directed at ascertaining the relationship between deductibles and use and how this varies between hospital types.

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APPENDIX

The Period 2 Problem

Assuming $r = p$, the solution to the period 2 problem satisfies the following conditions

$$\lambda_{2i}^{k} = \frac{\partial u(.)}{\partial c_{3i}^{k}} \cdot \frac{1}{p_c} \,, \tag{A.1}$$

$$\frac{\partial u(.)/\partial c_{2i}^{k}}{\partial u(.)/\partial h_{2i}^{k}} = \frac{p_c}{p_i^{k}} \,, \tag{A.2}$$

$$\frac{\partial u(.)}{\partial c_{2i}^{k}} \cdot \delta(t(s_2^{k})) = \frac{\partial u(.)}{\partial c_{3i}^{k}} \,, \tag{A.3}$$

and

$$\frac{\partial u(.)/\partial h_{2i}^{k}}{p_i^{k}} \delta(.) = \frac{\partial u(.)/\partial c_{3i}^{k}}{p_c} \,, \tag{A.4}$$

where λ_{2i}^{k} is the Lagrange multiplier attached to constraint (6) and

$$\delta(t(s_2^{k})) = (1 + \frac{1}{1+\rho} + \frac{1}{(1+\rho)^2} + ... + \frac{1}{(1+\rho)^{t(s_2^{k})-1}}) \tag{A.5}$$

is a discounting factor.

The Period 1 Problem

Assuming $r = \rho$, the solution to the period 1 problem satisfies the following conditions,

$$\lambda_{1i} = \frac{\partial EV_{2i}(.)}{\partial a_{1i}} \cdot \frac{1}{(1+\rho)} = \frac{1}{(1+\rho)} \cdot \int \frac{\partial V_{2i}(.)}{\partial a_{1i}} . f(s_2) ds_2 = \int \lambda_{2i}(.) \cdot f(s_2) ds_2 \,, \tag{A.6}$$

and

$$\frac{\partial u(.)}{\partial c_{1i}} = p_c \int \lambda_{2i}(.) \cdot f(s_2) ds_2 = \int \frac{\partial u(.)}{\partial c_{3i}} \cdot f(s_2) ds_2 = \int \frac{\partial u(.)}{\partial c_{2i}} \cdot \delta(.) \cdot f(s_2) ds_2 \,. \tag{A.7}$$

Reasons for Deletion [24]

(i) they were a non-dependant living with their parents and mistakenly believed they were covered by their parents private hospital insurance (naidel,181,181)

(ii) they were visitors to a private dwelling (fiudel,157,157)

(iii) they were living in a special dwelling, for example, a hotel or a hostel (sdwell,643,643)

(iv) they received income, but did not state how much (diudel,1420,1420)

(v) they were employed by the armed forces (dfiudel, 63, 63)

(vi) they visited hospital in the last 12 months , but duration not given (iudel12, 122,122)

(vii) they had insurance, but they did not know its type (iiudel,56,56)

(viii) they visited a hospital in the last 12 months, but did not know whether it was a public or private hospital (tiudel,18,18)

(ix) they were employed, but did not state their usual hours of work (wiudel,68,68).

(x) they were the head of an income unit, but stated their health insurance type was not applicable (hnappins, 20iu)

(xi) they were heads and spouses who stated their type of private hospital insurance was different (clash, 623iu)

(xii) they were dependants who stated they had private health insurance while their parents had none (clash3,13iu)

In addition to these deletions, 626 non-dependants who are between the ages of 15-20, are living at home, and have an income <$10,000 are reclassified as dependants, since they are covered by their parents private health insurance policy.

[24] The name in brackets is the name given to the deleted variable in the data program, the first number is the number of individuals deleted, and the second number is the number of income units deleted.

Variable Descriptions

H = head of income unit, S = spouse in income unit, M = male, F = female

HDINC = income, given by mid-point of a range

HSEX, female=1, male=0

HMVET, male with veteran affairs health card=1, otherwise=0

HFVET, female with veterans affairs health card=1, otherwise=0;

SIZE, number of individuals in the income unit

INSURANCE, estimated probability of having private insurance obtained from the probit model of insurance choice

DEP, if dependant=1, otherwise=0

For couples and couples with dependants, H=Head, S=Spouse

Age Dummy Variables *– omitted group, age less than 35 years*

DH3550, age greater than or equal to 35, but less than 50=1, otherwise=0

DH5065, age greater than or equal to 50, but less than 65=1, otherwise=0

DH65, age greater than or equal to 65=1, otherwise=0

Country of Birth Dummy Variables *- omitted group, born in Australia*

HNZUK, born in NZ or UK=1, born elsewhere=0

HSEUR, born in Southern Europe=1, born elsewhere=0

HWEUR, born in Western Europe=1, born elsewhere=0

HASIA, born in Asia=1, born elsewhere =0

HOTHERC, born in other country than above and not Australia=1,born elsewhere=0

Education Dummy Variables *- omitted group, school qualification*

HMBACH, male with bachelor degree=1, otherwise =0

HFBACH, female with bachelor degree=1, otherwise=0

HMDIP, male with diploma=1, otherwise=0

HFDIP, female with diploma=1, otherwise=0

HMTRADE, male with trade qualification=1, otherwise =0

HFTRADE, female with trade qualification=1, otherwise=0

For couples and couples with dependants, H=Head, S=Spouse

Employment Status Dummy Variables *- omitted group, not in the labour force*

HMFULL, male full-time employed=1, otherwise=0

HFFULL, female full-time employed=1, otherwise=0

HMPART, male part-time employed=1,otherwise=0

HFPART, female part-time employed=1,otherwise=0

HMUNEMPL, male unemployed=1, otherwise=0

HFUNEMPL, female unemployed=1, otherwise=0

For couples and couples with dependants, H=Head, S=Spouse

Region Dummy Variables – *omitted group, living in metropolitan New South Wales*

HNSWCNT, living in country New South Wales=1, otherwise=0

HVICMET, living in metropolitan Victoria=1, otherwise=0

HVICCNT, living in country Victoria=1, otherwise=0

HQLDMET, living in metropolitan Queensland=1, otherwise=0

HQLDCNT, living in country Queensland=1, otherwise=0

HSAMET, living in metropolitan South Australia=1, otherwise=0

HSACNT, living in country South Australia=1, otherwise=0

HWAMET, living in metropolitan Western Australia=1, otherwise=0

HWACNT, living in country Western Australia=1, otherwise=0

HTASMET, living in metropolitan Tasmania=1, otherwise=0

HTASCNT, living in country Tasmania=1, otherwise=0

HNT, living in Northern Territory=1, otherwise=0

HACT, living in Australian Capital Territory=1, otherwise=0

Health Status Variables

HMSMOKE = average daily consumption of cigarettes

HMALC = average daily consumption of alcohol in mls.

Health Status Dummy Variables

Chronic condition dummy where normally see a particular doctor: the first variable is for a major condition which normally requires hospital treatment, the second variable denoted with an S is a serious condition, and the third variable denoted with an M is a minor condition. The index $i = 1,...n$ *denotes that the income unit has* i *or more of this particular condition.*

DHNEUROLi, DHSNEUROLi, DHMNEUROLi, if normally see neurologist for chronic condition =1, otherwise =0

DHPSYCHi, DHSPSYCHi, DHMPSYCHi, if normally see psychiatrist for chronic condition =1, otherwise =0

DHSURGEONi, DHMSURGEONi, if normally see general surgeon for chronic condition =1, otherwise =0

DHVASCLRi, if normally see vascular surgeon for chronic condition =1, otherwise =0

DHMUROLOGi, if normally see urologist for chronic condition =1, otherwise =0

DHMGENERALi, if normally see general practitioner for chronic condition =1, otherwise =0

DHCARDi, DHSCARDi, DHMCARDi, if normally see a cardiologist for chronic condition =1, otherwise =0

DHMRESPRTi, if normally see a respiratory physician for chronic condition =1, otherwise =0

DHGASTROi, DHMGASTROi, if normally see a gastroenterologist for chronic condition =1, otherwise =0

DHMNEPHROi, if normally see a nephrologist for chronic condition =1, otherwise =0

DHMDERMATi, if normally see a dermatologist for chronic condition =1, otherwise =0

DHSHAEMi, if normally see a haemotologist for chronic condition =1, otherwise =0

DHMIMMUNOi, if normally see a immunologist for chronic condition =1, otherwise =0

DHONCOLi, if normally see a oncologist for chronic condition =1, otherwise =0

DHMRHEUMAi, if normally see a rheumatologist for chronic condition =1, otherwise =0

DHSOPHTHAi, if normally see an ophthamologist for chronic condition =1, otherwise =0

DHMOPTOMi, if normally see an optometrist for chronic condition =1, otherwise =0

DHMENTi, if normally see ENT for chronic condition =1, otherwise =0

DHMORALi, if normally see oral surgeon for chronic condition =1, otherwise =0

DHOGi, DHSOGi, DHMOGi, if normally see a O&G for chronic condition =1, otherwise =0

DHPLASTICi, if normally see a plastic surgeon for chronic condition =1, otherwise =0

DHORTHOi, DHMORTHOi, if normally see an orthopaedic surgeon for chronic condition =1, otherwise =0

DHMPATHOLi, if normally see a pathologist for chronic condition =1, otherwise =0

DHMRADIOLi, if normally see a radiologist for chronic condition =1, otherwise =0

DHSENDOi, DHMENDOi, , if normally see an endocrinologist for chronic condition =1, otherwise =0

DHSRETARDi, if condition was retardation for chronic condition =1, otherwise =0

Reason for Last Hospital Use Dummy Variables: The reasons are grouped according to the particular doctor who usually treat these reasons.

NEUROLH, usually treated by a neurologist

PSYCHH, usually treated by a psychiatrist

SURGEONH, general surgeon

VASCLRH, vascular surgeon

UROLOGH, urologist

GENERALH, general practitioner

CARDH, cardiologist

RESPRTRH, respiratory physician

GASTROH, gastroenterologist

NEPHROLH, nephrologist

DERMATH, dermatologist

IMMUNOLH, immunologist

ONCOLH, oncologist

RHEUMATH, rheumatologist

OPHTHALH, opthalmologist

OPTOMH, optometrist

ENTH, ear, nose and throat

ORALH, oral surgeon / dentist

OGH, obstetrician / gynaecologist

PHYSH, physician

PLASTICH, plastic surgeon

ORTHOH, orthopaedic surgeon

PATHOLH, pathologist

RADIOLH, radiologist

ENDOH, endocrinologist