The Determinants of Demand for Private Medical Insurance: Evidence from the British Household Panel Survey

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Abstract

This paper examines the determinants of demand for private medical insurance in Great Britain using data from the British Household Panel Survey (BHPS). The main focus is the impact of quality and supply of public health care and the availability of private alternatives on demand. The personal characteristics that determine the demand for private medical insurance are also investigated. The empirical analysis uses a random effects probit model to investigate the individual purchase decision using a six-year panel from the BHPS. The results here suggest that income, age, sex, political party support and employment status are key determinants of the demand for private medical insurance as are being a smoker and living in an owner occupied house. The key findings are that regional waiting lists and public expenditure on health are significant determinants of the demand for private medical insurance indicating that recent increases in health expenditure and reductions in waiting lists may have crowded out some private insurance.

JEL Classification: H4, I11, I18, C32

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1. Introduction

There is a widespread perception that health care is a merit good.[1] For this reason it is common for governments to intervene in the market for health care justifying this intervention on efficiency and equity grounds. In the UK this government intervention is large and the provision of health care is dominated by the publicly funded provider, the National Health Service (NHS). The NHS provides health care for the entire population that is 'free at the point of demand' and financed by taxation. In such a system allocation is thus based on need rather than willingness to pay.

Despite this intervention in the market for health care there is a common belief that public sector monopoly is not an optimal system for the provision of health care and thus private sector health care tends to accompany public provision. There is no general consensus as to the optimal balance between public and private provision and the extent of intervention in the health care market differs considerably across countries. This can be seen in Table 1 below which shows public expenditure on health care as a percentage of total expenditure on health care for a selection of OECD countries.

In 2001 only 44.4% of health care in the United States was publicly financed whilst in countries such as Denmark and Sweden public finance accounts for a much larger proportion of health expenditure, 82.4% and 85.2% respectively. The extent of public provision has also varied over time for some countries. The United States and Greece have seen a move towards a greater proportion of publicly financed provision over the

period 1970 to 2001 whilst the Netherlands and Czech Republic have seen a reduction in the proportion of publicly financed provision.

Table 1
Public Expenditure on Health Care as a Percentage of Total Expenditure on Health Care

Country	1970	1980	1990	1996	1997	1998	1999	2000	2001
Canada	69.9	75.6	74.5	70.8	70.0	70.7	70.4	70.9	70.8
Czech Republic	96.6	96.8	97.4	92.5	91.7	91.9	91.5	91.4	91.4
Denmark	-	87.8	82.7	82.4	82.3	82.0	82.2	82.5	82.4
France	-	-	76.6	76.1	76.2	76.0	76.0	75.8	76.0
Germany	72.8	78.7	76.2	76.8	75.3	74.8	74.8	75.0	74.9
Greece	42.6	55.6	53.7	53.0	52.8	52.1	53.4	56.1	56.0
Ireland	81.7	81.6	71.9	71.4	74.6	76.5	72.8	73.3	76.0
Italy	-	-	79.3	71.8	72.2	71.8	72.0	73.4	75.3
Japan	69.8	71.3	77.6	78.7	77.7	77.4	78.1	78.3	-
Netherlands	-	69.4	67.1	66.2	67.8	64.4	63.3	63.4	63.3
Spain	65.4	79.9	78.7	72.4	72.5	72.2	72.1	71.7	71.4
Sweden	86.0	92.5	89.9	86.9	85.8	85.8	85.7	85.0	85.2
United Kingdom	87.0	89.4	83.6	82.9	80.1	80.2	80.5	80.9	82.2
United States	36.4	41.5	39.6	45.6	45.3	44.5	44.2	44.2	44.4

Source: OECD Health Data 2003

Table 1 confirms the dominance of public provision of health care in the UK. However, it does not fully illustrate the growing importance of the private health care sector. Private-sector health care spending comes from two main sources; out-of-pocket payments, which are direct payments for independent medical services at the point of use, and claims from private medical insurance (PMI) to pay for medical services. The claims from PMI account for the majority of these independent medical services and the PMI sector has experienced rapid expansion in the past two decades. Compared to 1981 when only 4.1 million people were covered by PMI in 2001 some 6.7 million people were covered.[2]

[1] Health care can be argued to be a merit good on the grounds that consumers have limited knowledge about their need for expensive health treatments and thus are likely to underinvest in health insurance.

[2] Laing and Buisson (2002).

The aim of this paper is to examine which factors determine an individual's decision to purchase PMI despite the availability of free health care under the NHS. The focus will therefore be on individually purchased policies and not company policies that are a common feature of the PMI market. This paper will not attempt to answer questions about the optimal level of public provision but will investigate the links between quality and supply of public health care and the purchase of PMI. Of particular interest will be the effects of public expenditure on health care and NHS waiting lists on the demand for PMI and assessing whether the recent increases in NHS expenditure have crowded out private insurance. The paper will also investigate the importance of the availability of private services on the decision to purchase PMI; this will include the availability of private hospitals and private beds and also the cost of PMI.

The empirical analysis will be based on data from the British Household Panel Survey (BHPS) from 1996-1997 to 2001-2002[3]. The BHPS includes data relating to the purchase of PMI and also provides a large range of socio-economic, demographic and personal characteristic variables that may effect the purchase decision. Current health status is also recorded in the survey, which may play an important role given that the purchase of PMI may depend upon, *inter alia*, expected future consumption of health services. The BHPS also contains variables that can be used as proxies for attitude towards public provision of services; these include political party support and ownership of a private pension. The panel survey nature of the dataset allows tracking of individuals over time and so builds on recent studies that mostly use a

[3] From here onwards the year of the BHPS wave will be given by the calendar year the wave began.

pseudo-cohort panel to study the demand for PMI such as Propper *et al* (2001). The supply side variables mentioned above will be incorporated into the analysis by linking them to the BHPS. For most of the variables this is done at a regional level using the regional identifiers available in the BHPS. For those data only available at aggregate level the data will be matched simply by year. More details are given in Section 4 and the Appendix.

The paper is organised as follows. Section 2 provides an introduction to the existing literature and the empirical studies therein which have examined the determinants of demand for PMI. The methods used and datasets in these studies will also be mentioned. A theoretical model of the demand for PMI is presented in Section 3. The BHPS and other data sources will be discussed in Section 4. Section 5 provides some initial analysis of the dataset including an analysis of the incidence of PMI by various characteristics of individuals. Section 6 introduces the econometric specification to be used in this empirical analysis, the results of which are presented in Section 7. The policy implications of this work are discussed in Section 8 with limitations and possible extensions in Section 9. Section 10 concludes. Details of variable definitions and sources are given in the Appendix.

2. Existing Literature

This section will briefly discuss some of the results from the existing literature. A more detailed review can be found in King and Mossialos (2002).

There is a large volume of literature that investigates the determinants of demand for PMI with the main studies in this area by Propper (1989), Propper (1993), Besley *et al* (1999), Propper *et al* (2001), Emerson *et al* (2001), and King and Mossialos (2002). A common feature of these studies is that age and income are positively associated with the demand for PMI and that men are more likely to purchase PMI than women. Besley *et al* (1993) and Emerson *at al* (2001) found that PMI purchase increases with education and if the individual lives in an owner occupied home. Emerson *et al* (2001) also found that the self-employed were less likely to buy PMI.

Many of the studies have incorporated proxies for NHS quality and other supply side variables in their analysis. This is mostly in the form of waiting lists, which were found by Besley *et al* (1999), Propper *et al* (2001) and King and Mossialos (2002) not to have a significant effect on the purchase of PMI. Propper *et al* (2001) did however find that the number of private hospitals has a significant effect on the demand for PMI, as does NHS expenditure.

Studies by Propper (1989, 1993) have focused on current health status as a determinant of demand for PMI. These studies use variables such as GP visits and inpatients stays but find a lack of association between such variables and PMI purchase. These studies also find an insignificant effect of smoking on the likelihood of having PMI. In contrast King and Mossialos (2002) find a significant negative relationship between smoking and PMI purchase.

Besley *et al* (1999), Emerson *at al* (2001) and King and Mossialos (2002) found that Conservative Party supporters were more likely to be covered by PMI than Labour

Party supporters, however other studies have not found political preference to be important. In this context such a variable is essentially a proxy for attitude towards public/private provision of services with Conservatives in favour of private provision. Besley *et al* (1999) also found that an index of attitude towards the private sector had a significant positive effect on PMI coverage.

Propper *et al* (2001) found that there is a generational effect in PMI purchase; purchase not only increases with age, but older generations are less likely to purchase PMI than younger generations. This study also finds that there is only limited habit formation in the purchase of PMI despite the suggestion in the aggregate data that the impact of past purchase is strong.

The above discussion makes it clear that there are some consistent findings among the existing literature but also some inconsistencies. One of the reasons for these inconsistencies could be the use of different surveys when looking at the PMI purchase decisions. Propper (1989) uses the General Household Survey whilst Propper (1993) uses a cross-sectional survey of 1360 individuals in England and Wales that allow captivity to be assessed using a hurdle model. Besley *et al* (1999) use the British Social Attitudes Survey, Propper *et al* (2001) use the Family Expenditure Survey, Emerson *et al* (2001) use the Family Resources Survey and King and Mossialos (2002) use the BHPS.

One of the main differences in these surveys is that they do not all allow the separation of individual purchased and employer purchased policies. The Family Resources Survey for instance does not separate individual and corporate policies

where the respondent pays some of the cost towards the corporate policy. The results of Besley *et al* (1999) and King and Mossialos (2002) suggest that individual purchased policies and employer purchased policies should be treated separately. The other main differences between the existing empirical studies are that they cover different periods of time, some of the studies are static whilst others incorporate a dynamic element, they have different geographical coverage, and they adopt different modelling techniques.

This paper does not attempt to reconcile all the differences in the existing literature but does address some of the areas where those differences occur, such as the effect of waiting times, the availability of private care and other supply side variables. The availability of a lengthier panel of data from the BHPS and an improvement in the availability of supply side data should provide a clearer picture of the effect of these variables on the purchase decision. The use of the BHPS also means that any dynamic elements introduced into the purchase decision do not require pseudo-cohort techniques.[4] The other advantage of using a longitudinal dataset rather than a repeated cross section is that unobserved heterogeneity can be controlled for. The disadvantage is that they tend to be less representative than contemporary samples and so provide poorer population estimates.

3. Economic Model

[4] A downside to this is that, given the short period for which the BHPS covers the purchase of PMI, no examination of generational effects can be made. Such generational effects were found to be significant by Propper *et al* (2001) using cohort analysis on the Family Expenditure Survey. The ability to look at habit persistence will also be limited by the econometric specification of the model adopted in this paper. For more details see Section 6.

This section will present a basic static model of the demand for PMI. Although the purchase decision is likely to involve dynamic optimisation by individuals the discrete nature of the purchase decision and the availability of free public provided service requires a complicated dynamic model. Such a dynamic intertemporal model may provide useful insights into the purchase decision but given the econometric techniques adopted could not be fully tested. Just a simple static model is therefore presented to provide some background as to important determinants of PMI demand with the main focus of the paper on the empirical results from the econometric model. The model presented here is based on those of Besley *et al* (1999) and Propper *et al* (2001).

Consider an individual with a subjective probability $\theta \in [0,1]$ of requiring health care. Once ill an individual will require one unit of health care with health care available at different quality levels $q \in [\bar{q}, \underline{q}]$. Higher levels of quality could reflect shorter waiting times, more convenient location of the health care provider, 'hotel benefits'[5], or longer in-patient stays. We assume that there are two alternative types of health care; public health care and private health care. Public care of quality $q_0 < \bar{q}$ is available at zero cost to the individual. The quality of public care is assumed to be less than $\bar{q}$ or else no individual will wish to buy private health care. Private health care can be purchased at any level of quality. Let $U(y)$ be the utility of an individual with income y who is not ill and $U(y,q)$ be the utility of an individual who is ill and

[5] The term 'hotel benefits' is typically used to mean things such as having a private room, having a room with better facilities, or receiving better food. i.e. things typically associated with private hospitals.

receives health care of quality q. As in Besley *et al* (1999) it is assumed that the utility function is concave in income and the quality of treatment is a normal good.

We can now introduce a private insurance market by allowing individuals to purchaser PMI at a premium of p. It is assumed that the insurance market suffers from moral hazard and thus individuals who are insured receive full reimbursement of all private health care purchased. Under this assumption once the premium p has been paid the insured individual will demand a level of quality $q_1 = \bar{q}$ as the marginal cost of extra quality is zero. Utility for an individual who is ill and insured will now be given by $U(y-p, q_1)$ whilst for an individual who is not ill but is insured utility is given by $U(y-p)$.

Now for a given probability of being ill θ the individual will decide whether to purchase PMI by evaluating the following,

$$[\theta U(y-p, q_1) + (1-\theta)U(y-p)] - [\theta U(y, q_0) + (1-\theta)U(y)]$$

The term in the first square brackets is the expected utility if insured whilst the term in the second square brackets is the expected utility if not insured. The individual will purchase PMI if and only if the above expression is positive. The demand for PMI will therefore depend on income, the quality of public and private health care, the cost of the insurance premium, and the probability of requiring health care.

The determinates of demand outlined in the model above will be investigated in the empirical analysis of this paper together with other factors that might be expected to

be important. Theses include the individual's attitude towards public provision, the availability of the private alternatives, and various other personal and demographic characteristics.

4. The Data

The BHPS is an annual survey carried out by the Institute for Social and Economic Research (ISER) at the University of Essex. The survey began in 1991 and was designed to be a nationally representative sample of more than 5,000 households, with a total of 10,000 individual interviews each year. The same individuals are re-interviewed in successive years and those individuals that split from existing households remain in the sample by the inclusion of the new household they form. Thus all individuals enumerated in respondent households become part of the longitudinal sample. The initial sample of households for inclusion in the panel was made using a two-stage clustered probability design and systematic sampling. In wave nine in 1999 two additional samples were added to the BHPS in Scotland and Wales. These were included to increase the relatively small Scottish and Welsh samples. At wave 11 in 2001 an additional sample from Northern Ireland was added. The Northern Ireland sample will not be included due to a lack of a dynamic element, whilst the additional Scottish and Welsh samples will.[6]

The BHPS has included a health related section since the first wave, including questions on current health status and health services use, but only since the sixth

[6] King and Mossialos (2001) look at PMI prevalence only in England as they only use data to 1999 when the sample is not representative for Scotland and Wales.

wave in 1996 has it included questions relating to PMI coverage. Respondents are asked if they are covered by PMI, how the PMI is paid for (i.e. individual purchase, deducted from wages or employer paid) and the cost of the respective medical insurance[7]. Other variables that are available from the BHPS and may be of relevance to the PMI purchase decision include income, age, gender, employment status, marital status, socio-economic status, head of household indicators, political party support and newspaper readership.

In addition to the variables available in the BHPS a number of other supply side variables were linked to the dataset. Some of these variables act as proxies for public sector quality such as NHS waiting lists at the regional and national level, public expenditure on health, and NHS beds. The other variables linked to the BHPS provide information on the availability of private medical services such as the number of private hospitals, the number of private beds, and the cost of PMI premiums. Most of these variables are linked to the BHPS at a regional level using the regional identifiers within the BHPS and also deflated by population to ensure comparability between regions. An additional variable linked to the dataset, previously unused in such an analysis, is advertising by PMI providers. More details of these variables and their sources can be found in Table A1 in the Appendix.

5. Preliminary Analysis

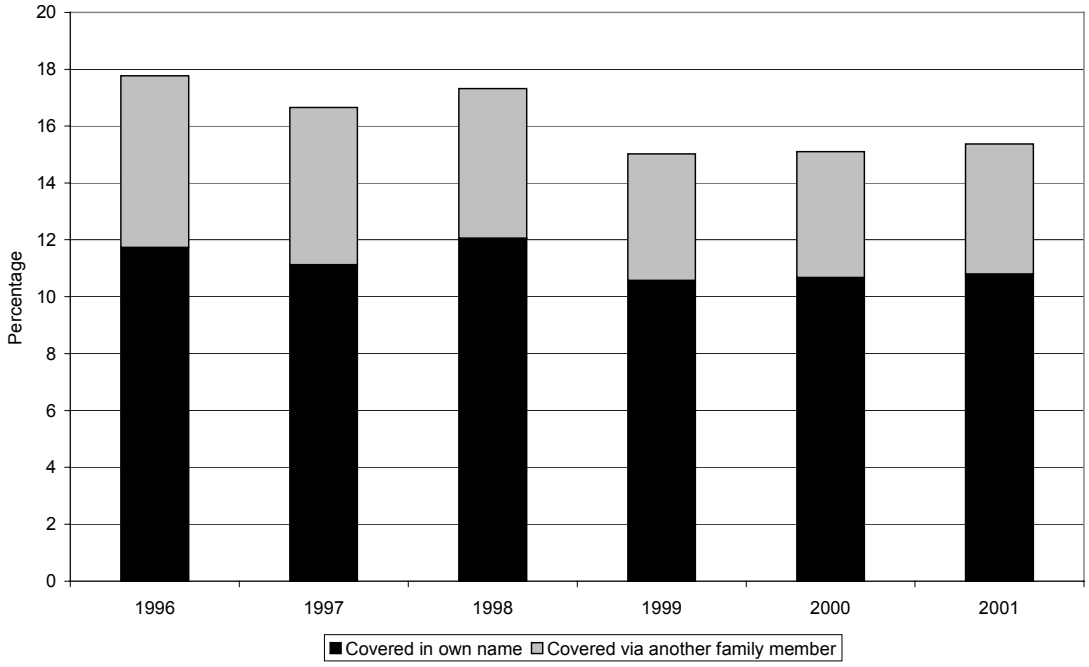
An initial analysis of the BHPS provides a clear picture of the characteristics of individuals covered by PMI. Although the empirical results in later sections focuses

[7] For detail of the specific PMI questions in the BHPS see Figure A1 in the appendix.

on individual purchased policies some analysis of employer purchased policies and also individuals covered by policies held by other family members is presented. This analysis will help to highlight the characteristics of those individuals who are covered by PMI, highlight differences between types of coverage and provide a context for later results.

In 1996 17.8 per cent of adults in the BHPS were covered by PMI, by 2001 this had fallen to 15.4 per cent. The breakdown of individuals covered into own name policies and those covered via another family member can be seen in Figure 1 below.

Figure 1
Percentage of Adults Covered by Private Medical Insurance, 1996-2001



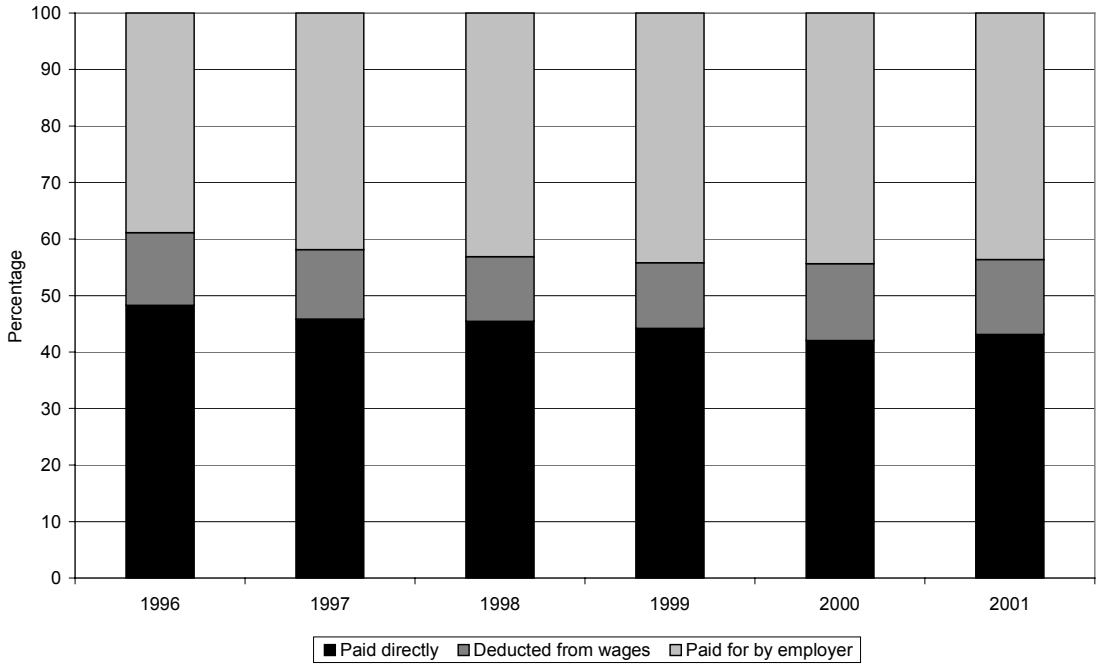
Source: British Household Panel Survey, 1996-2001; authors' calculations.

Figure 1 shows that the overall fall in PMI coverage has been both in terms of own name policies and coverage via another family member. It can be seen that around 11.7 per cent of adults in 1996 were covered by their own policies with a fall to 10.8 per cent in 2001. Most of this decline occurs between 1998 and 1999 where there is a

drop of around 1.5 per cent. The fall in coverage via another family member has been more consistent with a corresponding decline in every year except 2001. Overall those covered by another family member has fallen from 6.0 per cent of all adults to around 4.6 per cent of all adults in 2001.

The BHPS allows a further look at what underlies these changes in coverage. Looking at the breakdown of own name policies into company purchased policies and individual purchased policies outlines the underlying changes in the PMI market that are producing the results above. Figure 2 below shows a breakdown of policies into those paid directly by the individual, those paid for by deductions from wages and those paid for by the individual's employer.

Figure 2
Breakdown of Own Name Private Medical Insurance Policies, 1996-2001



Source: British Household Panel Survey, 1996-2001; authors' calculations.

There has been a reduction in the percentage of individually purchased policies and an increase in the percentage of employer paid policies. In 1996 about 48 per cent of policies were paid directly by the policyholder. By 2001 this had fallen to about 43 per cent. The percentage of policies paid for by employers increased from 39 per cent in 1996 to around 43.5 percent in 2001. The percentage of policies paid for out of wages has shown a slight increase of around 0.5 per cent from 1996 to 2001. This shift from individually purchased policies to employer paid policies is supported by figures produced by Laing and Buisson and also by Mintel. Both these sources report increased employer purchased policies and reduced individual purchased policies. Mintel (2002) reports that "the private medical insurance (PMI) market has divided into two distinct segments since 1996, with individually paid subscriptions declining while the corporate sector has thrived".

Table 2 below summarises the different types of PMI coverage for all adults. For individual purchased policies, which are the main focus of this paper, it can be seen that coverage has fallen from 7.2 per cent in 1996 to 6.1 per cent in 2001. Table 2 also provides a breakdown of PMI coverage by sex.

Table 2
Trends in Private Medical Insurance: Percentage of Adults Covered, 1996-2001

	1996	1997	1998	1999	2000	2001
Covered						
Male	19.7	18.8	19.9	17.2	17.5	17.6
Female	16.1	14.9	15.2	13.2	13.1	13.5
All Adults	17.8	16.7	17.3	15.0	15.1	15.4
Covered in own name						
Male	16.7	15.6	17.0	14.8	15.0	15.2
Female	7.5	7.4	7.9	7.1	7.0	7.1
All Adults	11.7	11.1	12.1	10.6	10.7	10.8
Covered via another family member						
Male	3.0	3.1	2.8	2.4	2.4	2.4
Female	8.6	7.5	7.3	6.1	6.1	6.4
All Adults	6.0	5.5	5.2	4.4	4.4	4.6
Individual Purchased						
Male	9.5	8.5	8.9	7.6	7.9	7.8
Female	5.2	4.8	5.2	4.5	4.4	4.7
All Adults	7.2	6.5	6.9	5.9	6.0	6.1
Employer Purchased						
Male	7.2	7.2	8.1	7.2	7.2	7.4
Female	2.3	2.5	2.7	2.6	2.7	2.5
All Adults	4.5	4.6	5.2	4.7	4.7	4.7

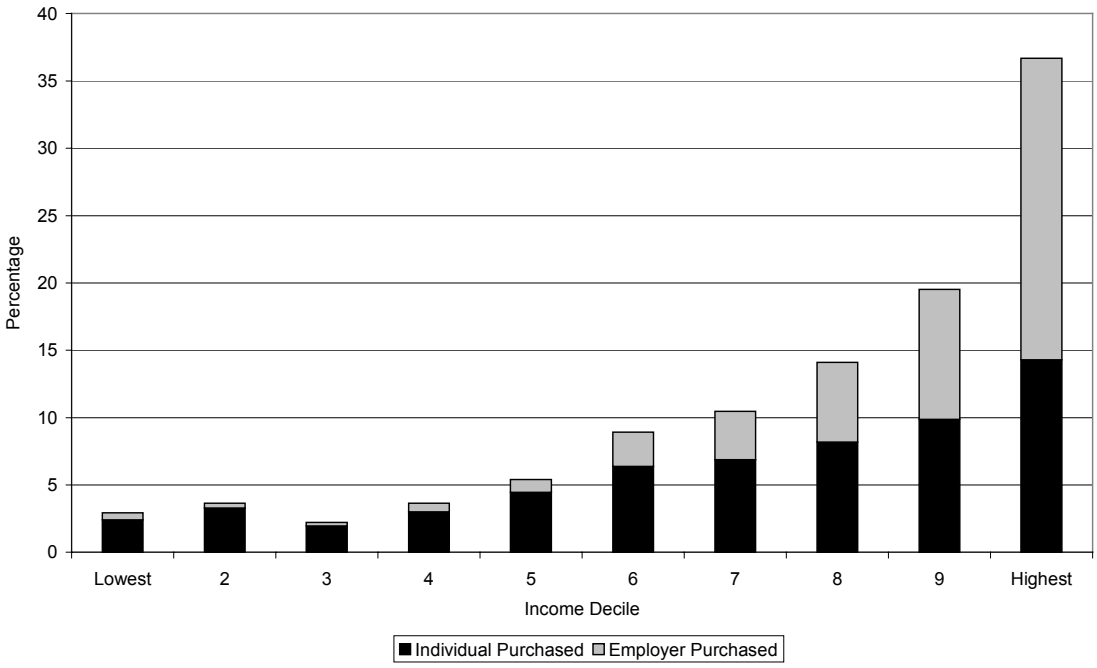
Source: British Household Panel Survey, 1996-2001; authors' calculations.

In terms of coverage Table 2 shows that more men are covered by PMI than women, although the level of coverage from 1996 to 2001 follow similar downward trends. The more interesting observation to be made is that there are a higher proportion of women covered via another family member. In 1996 only 3 per cent of men were covered via another family member compared to 8.6 per cent of women. This could be due to the fact that on average men tend to have jobs with higher income that are more likely to provide PMI as a benefit, such policies commonly cover other family

members. The situation is reversed when looking at employer purchased PMI, with only 2.5 per cent of women covered by employer purchased PMI in 2001 compared to 7.4 per cent of men. Employer purchased PMI is thus dominated by men as is individually purchased PMI; this explains the dominance of men in terms of overall coverage.

One of the consistencies in the existing literature looking at the demand for PMI was the positive and significant effect of income on PMI purchase. Initial analysis of the BHPS highlights that individuals with higher incomes are much more likely to have PMI than individuals with lower incomes. This statement is true for both individual purchased PMI and employer purchased PMI.

Figure 3
Percentage of Adults Covered by Private Medical Insurance by Income Decile, 2001

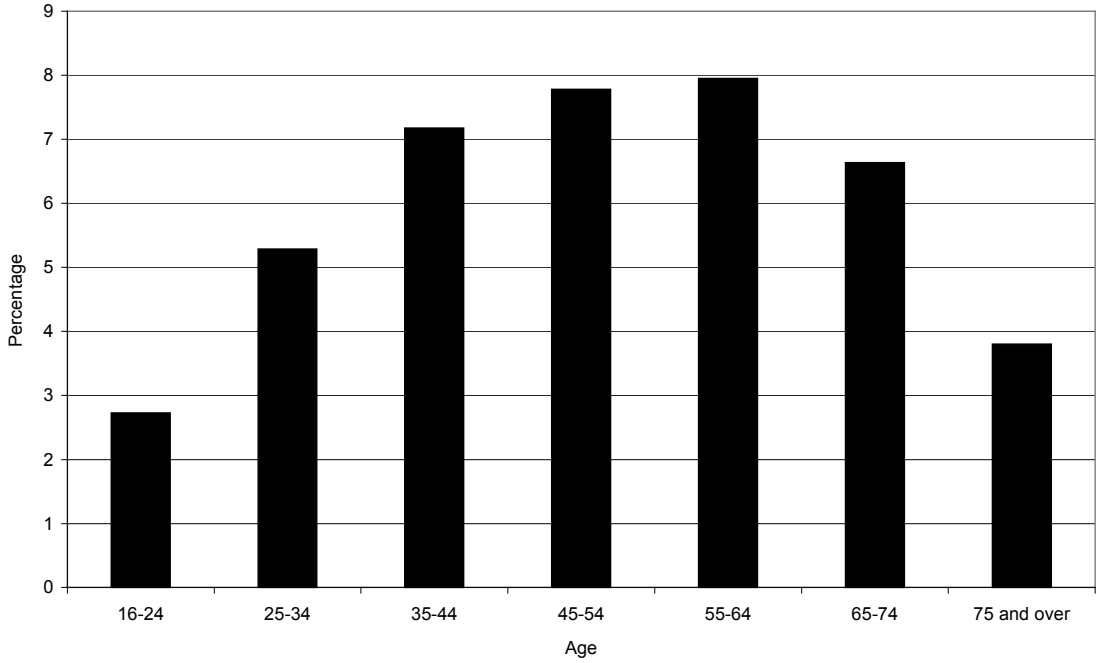


Source: British Household Panel Survey, 2001; authors' calculations.

Figure 3 above illustrates the large dispersion of PMI coverage by income decile for 2001. It can easily be seen that the dispersion of PMI by income is greater for employer purchased PMI than individually purchased PMI. For employer purchased PMI 22.4 per cent of the individuals in the top income decile are covered whilst for the bottom income decile only 0.5 per cent of the individuals are covered. The likelihood of being covered by employer paid PMI thus increases with income. This might be expected if jobs which offer better remuneration also tend to offer better benefit packages, of which PMI is a common feature. For individually purchased PMI the effect is similar but not as strong. Of those individuals in the top decile 14.3 per cent have purchased PMI whilst of those in the bottom income decile 2.4 per cent have purchased PMI. Data for previous years show a similar pattern across the income distribution.

The purchase of PMI has consistently been found to increase with age, however, the BHPS data suggests that age may have a hump shaped profile in terms of individual purchased PMI. This can easily be seen from Figure 4 below which shows data for 2001. Previous years show a similar pattern.

Figure 4
Percentage of Adults with Individual Purchased Private Medical Insurance by Age, 2001



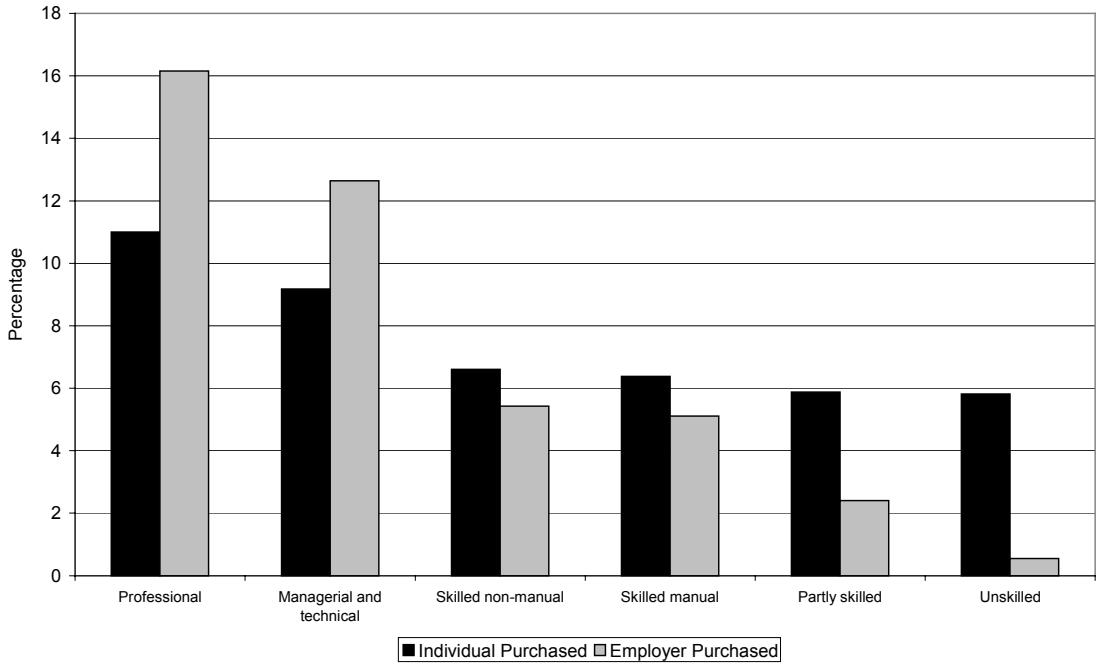
Source: British Household Panel Survey, 2001; authors' calculations.

From Figure 4 it can be seen that PMI purchase increases with age up to age 55-64, beyond which PMI purchase falls with age. Only 2.7 per cent of 16-24 year olds purchase PMI, there is an increase in individual purchased PMI for each age group up to 55-64 year olds of which almost 8 per cent are covered. The percentage of adults with PMI then drops for 65-74 year olds to 6.6 per cent and again for those aged 75 and over to 3.8 per cent. The BHPS data thus suggest that there may be a more complicated relationship between age and PMI purchase than simply that PMI purchase increases with age. This may be related to the generational effects found to be significant by Propper *et al* (2001) but is most likely due to the fact that the younger age group are in less need of health care whilst the older age group face supply side constraints within the PMI market in terms of high premiums. The latter argument is made by Propper (1993) who uses dummy variables for those aged less

than 35 and those aged 65 and over and finds that these age groups are less likely to have PMI, however the former is not significant at the 5% level. The results here suggest that age dummies may be a useful feature of a model for PMI purchase.

Initial results from the BHPS suggest that socio-economic group may be an important determinant of PMI coverage, both in terms of individual purchased policies and employer purchased polices. Figure 5 below shows a breakdown of PMI coverage by socio-economic group for 2001.

Figure 5
Percentage of Adults with Private Medical Insurance by Socio-Economic Group, 2001



Source: British Household Panel Survey, 2001; authors' calculations.
Armed forces are excluded due to limited sample size.

Looking at individual purchased policies it can be seen that those in professional, managerial and technical occupations are most likely to purchase PMI, whilst those in unskilled occupations are the least likely to purchase PMI. The effect of socio-economic group on individual purchased PMI is however less pronounced compared

to the effect on employer purchased PMI. Of those in professional occupations 16.2 per cent have employer purchased PMI, in contrast only 0.6 per cent of those in unskilled occupations have employer purchased PMI. Another interesting feature that can be seen in the graph is that employer purchased coverage is higher than individual purchased coverage among those in professional, managerial and technical occupations, but individual purchased coverage is higher among the other socio-economic groups. This suggests that professional, managerial and technical occupations are most likely to provide company purchased PMI as a benefit.

Most economic models that look at the demand for PMI contain some consideration of future consumption of health services and so current health status is likely to effect the PMI purchase decision. It would be expected that those reporting a poor health status are more likely to purchase PMI, as they would have a higher subjective probability of being ill in the future. However results from the BHPS do not support this idea as they show that those individuals reporting poor health are less likely to have PMI than those reporting good health. This can be seen in Table 3 below.

Table 3
Percentage of Adults with Individual Purchased Private Medical Insurance by Reported Health Status, 1996-2001

Health Status	1996	1997	1998	1999	2000	2001
Excellent	9.4	7.8	8.4	-	7.1	7.4
Good	7.2	7.1	7.4	-	6.5	6.2
Fair	5.8	4.9	5.8	-	5.4	5.6
Poor	4.9	4.1	4.1	-	3.0	4.2
Very poor	4.9	2.3	3.0	-	1.6	3.1

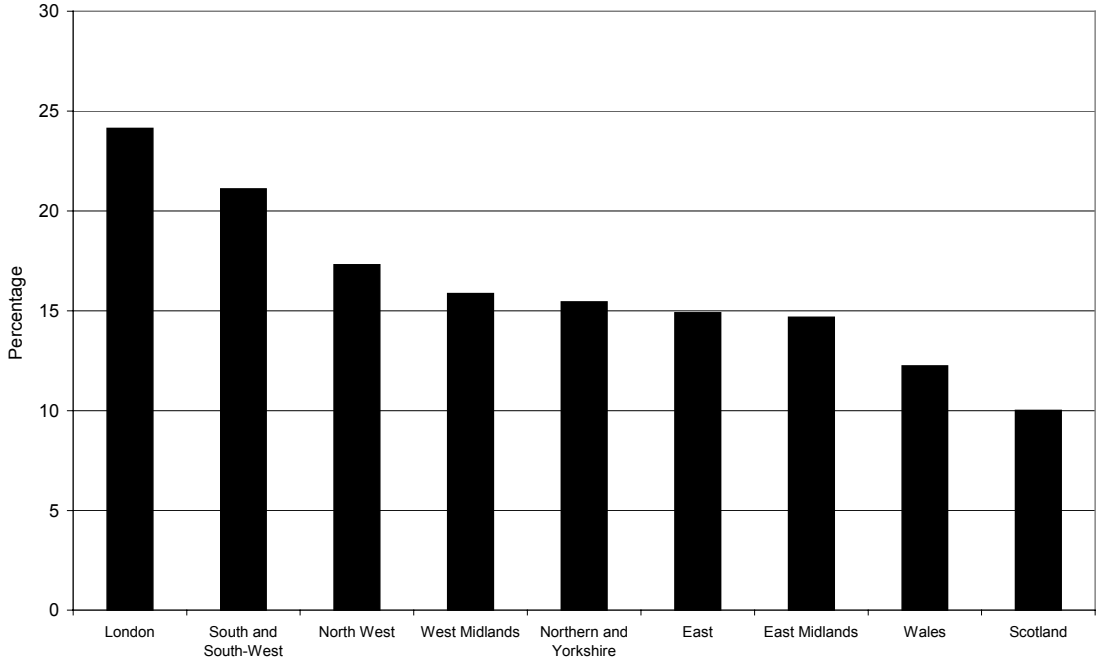
Source: British Household Panel Survey, 1996-2001; authors' calculations.
Question not asked in 1999.

Respondents in the BHPS are asked to rank their current health status on a scale of excellent to very poor. Table 3 shows that in 2001 only 3.1 per cent of those reporting their health status as very poor had purchased PMI, this compares to the 7.4 per cent of individuals who reported their health status as excellent and have purchased PMI. Similar results when looking at PMI coverage by those reporting health problems and long-term illness are found from the BHPS. Those with health problems and long-term illness are less likely to have purchased PMI. These results support earlier results from the General Household Survey[8]. An important point to note here is that when purchasing new PMI policies current health problems or long-term illnesses known at the time of purchase are not covered thus the consideration of future consumption of health services will include only those not related to current illness. In this context these results are less surprising as an individual who is currently of poor health may not expect further decline in the future and so has no incentive to purchase PMI. Those of poor health with also face constraints with the PMI market in the form of higher premiums.

Many empirical studies of PMI use regional dummies and also introduce regional measures, such as waiting times, into their analyses. A brief look at the breakdown of PMI coverage by region is thus useful in a preliminary analysis. Figure 6 below shows PMI coverage by region for 2001.

[8] See Office for National Statistics. (1997). *Living in Britain: Results from the 1995 GHS* and earlier publications.

Figure 6
Percentage of Adults Covered by Private Medical Insurance by Region, 2001



Source: British Household Panel Survey, 2001; authors' calculations.

PMI coverage varies quite significantly between regions. In London and the South and South-West PMI coverage is 24.1 and 21.1 per cent respectively whilst in Wales and Scotland PMI coverage is only 12.2 and 10.0 per cent respectively. In the North-West PMI coverage is 17.3 per cent whilst among the other regions coverage is around about 15 per cent. Results for other years are similar and looking at individual purchased or employer purchased polices produces a similar distribution across the regions.

As mentioned earlier respondents in the BHPS are asked the cost of any respective PMI. Table 4 below provides some summary statistics for the reported PMI monthly cost.

Table 4
Summary Statistics for Reported Monthly Cost of Private Medical Insurance, £

	1996	1997	1998	1999	2000	2001
Mean	29.93	32.31	35.85	39.71	46.78	44.89
Std.Dev	33.48	33.04	46.66	52.74	61.60	51.91
Minimum	1	1	1	1	1	1
Maximum	359	260	400	700	800	360

Source: British Household Panel Survey, 1996-2001; authors' calculations.

The mean reported cost of PMI rose from around 30 pounds in 1996 to about 47 pounds in 2000. 2001 saw a fall in the mean reported cost from the previous year to around 45 pounds. This reduction in the mean price of PMI in 2001 is not reflected in figures from Laing and Buisson (2002) or Mintel (2002) but could be a result of the introduction of healthcare cash plans, which are a cheaper form of PMI. These cash plans offer limited coverage for reduced premiums and have been developed by PMI companies in order to overcome the saturation among some socio-demographic sub-groups that is thought to exist. Table 4 also shows that there is considerable variation between premium prices with a high standard deviation relative to the mean. The minimum premium is one pound for every year whereas the maximum premium increases every year except in 2001 when there is a sharp drop of 440 pounds.[9]

Before proceeding with any econometric analysis some other features of the panel that will be used will be discussed. The panel, constructed from the BHPS dataset and other linked variables, consists of 16290 individuals observed over the period 1996 to 2001, hence a six-year panel. Not all individuals are observed for the full six years, indeed only 39 per cent of individuals are observed in every year. In the initial

[9] The figure in Table 4 were further investigated as they show a somewhat unusual pattern that raises data reliability issues. This work confirmed the reliability of these figures.

stages of work it was considered to just use those individuals with a full six years of observations, this would however automatically exclude the additional Welsh and Scottish samples and limit the analysis to England.[10]

Another feature of the data that raises modelling issues is the extent to which there are 'movers' in the panel. Movers are individuals who change from having individual purchased PMI to not having PMI or vice versa. Out of the sample of 16290 individuals there are only 1685 individuals who are movers, 14273 individuals who never have PMI and 332 individuals who buy PMI in every year of the panel that they are interviewed. Despite the limited amount of switching discussed it should be noted that this is to some extent due to the fact that a large proportion of the sample never buy PMI. Only 6-7 per cent of individuals in any year have individual purchased PMI. Table 5 below shows a Markov transition matrix that was estimated for individual purchased PMI.

Table 5
Markov Transition Matrix for Individual Purchased Private Medical Insurance

		Final	
	PMI	0	1
Initial	0	97.48	2.52
	1	37.38	62.62

Source: British Household Panel Survey, 1996-2001.

In Table 5 the value 0 indicates that the individual does not have PMI whilst the value 1 indicates that the individual has. In the table the row reflects the initial values and

[10] This reduction may also have introduced a bias if those individuals that are always willing to participate in the survey have common characteristics.

the columns reflect the final values. The transition matrix shows that each year around 97.5 per cent of those individuals without PMI remained without PMI in the next year, the remaining 2.5 per cent switch to purchasing PMI in the next year. Of those who purchase PMI in each year 62.6 per cent will continue to purchase PMI in the next year whilst 37.4 per cent will no longer purchase PMI in the following year[11]. These results add some support to the findings of Propper *et al* (2001) who find only limited habit persistence in PMI purchase. With strong habit persistence in PMI purchase we would expect less movement from purchasing to not purchasing than appears in the transition matrix.

With six years of data and a large number of possible explanatory variables for the PMI purchase decision summary statistics are numerous and so will not be presented here. A correlation matrix was also produced to see which variables may be important in the PMI purchase decision and also to highlight any possible problems of collinearity in later econometric modelling. Some obvious collinearity issues arise from the use of similar supply side variables, for instance national waiting times and regional waiting times are highly correlated. The correlation matrices produced are not reported here to save space but were considered during modelling. The next section outlines the econometric model to be used in the empirical analysis of this paper.

[11] These percentages can be interpreted as transition probabilities and so an individual who currently has PMI has a 37.4% chance of moving to (or returning to) not having PMI in each year.

6. Econometric Model

The dependent variable used in this empirical analysis is a binary choice variable taking the value 1 if the individual has purchased PMI and the value 0 if the individual has not. Such a choice of dependent variables means that the econometric analysis will require limited dependent variable panel data models. Initial theoretical work in this area focused on parametric approaches to such models whilst recent wok has used both parametric and semi-parametric approaches. The early parametric models that were developed are the random effects probit model and the fixed effects logit model. Both these models are limited in that they assume strict exogeneity of explanatory variables and so do not allow for lagged dependent variables to enter the model. The recent theoretical work has looked at allowing dynamic effects thus accounting for the fact that intertemporal relationships may exist between discrete choice variables.

The introduction of lagged dependent variables in limited dependent variable panel data models is an area of theoretical research that is in its infancy and its use generally requires simulation methods. For this reason the empirical analysis in this paper will use one of the standard parametric approaches. The model adopted in this paper will be a random effects probit model. A fixed effects logit model could easily be estimated but due to the limited number of movers, 10% of the total sample, the sample size for this estimation is somewhat restricted. The use of such an approach means that habit persistence cannot be fully investigated, as the assumption of strict exogeneity is required for the explanatory variables in such a model.

The rest of this section will present the theoretical model for the random effects probit and discuss estimation techniques. This will be followed by a brief discussion of the recent literature that has extended limited dependent variable panel data models to allow for lagged dependent variables and so allow habit formation to be considered. These techniques will be discussed as they present possible improvements that could be made in future work using the BHPS to look at the demand for PMI.

The random effects probit model was first used by Heckman and Willis (1976) and is the following latent variable model,

$$y_{it}^{*} = \beta x_{it}' + v_{it} \qquad i = 1,2,...,N \ , \ t = 1,2,...,T$$

$$y_{it} = \begin{cases} 1 & if \quad y_{it}^{*} > 0 \\ 0 & if \quad y_{it}^{*} \le 0 \end{cases}$$

where *i* indexes individuals, *t* indexes time periods, x_{it} is a $k \times 1$ vector of exogenous variables, and β is a $k \times 1$ vector of corresponding coefficients. y_{it}^{*} is an unobserved latent variable and y_{it} is an observed random variable. The disturbances are assumed to be generated by the following permanent-transitory process,

$$v_{it} = \alpha_i + u_{it}$$

where $\alpha_i \sim IN(0, \sigma_\alpha^2)$, $u_{it} \sim IN(0, \sigma_u^2)$ and α_i and u_{it} are mutually independent as well as independent of x_{it}. Define $\sigma^2 = \sigma_\alpha^2 + \sigma_u^2$, $\rho = \sigma_\alpha^2 / \sigma^2$, and impose the normalisation $\sigma^2 = 1$. The error terms $v_{it} = \alpha_i + u_{it}$ are thus independently normally distributed with mean α_i and variance σ_u^2, with probability density given by $\phi(v_{it} / \alpha_i)$ where $\phi(.)$ is the normal density function.

Let $y_i = [y_{i1}, y_{i2}, ..., y_{iT}]$, which is the observed sequence for individual *i*. We therefore have the following log-likelihood function *L*,

$$L = \sum_{i=1}^{N} \log \Pr(y_i) \tag{1}$$

where $$\Pr(y_i) = \int_{a_{i1}}^{b_{i1}} ... \int_{a_{iT}}^{b_{iT}} \prod_{t=1}^{T} \phi(v_{it} \mid \alpha_i)\phi(\alpha_i) d\alpha_i dv_{i1} .... dv_{iT} \tag{2}$$

$\therefore$ $$\Pr(y_i) = \int_{-\infty}^{\infty} \phi(\alpha_i) \prod_{t=1}^{T} [\Phi(b_{it} \mid \alpha_i) - \Phi(a_{it} \mid \alpha_i)] d\alpha_i \tag{3}$$

where $\Phi(.)$ is the normal cumulative distribution function, $a_{it} = -x'_{it}\beta$ and $b_{it} = \infty$ if $y_{it} = 1$, and $a_{it} = -\infty$ and $b_{it} = -x'_{it}\beta$ if $y_{it} = 0$. We therefore have a single integral whose integrand is a product of one normal density and *T* differences of a normal cumulative density function. For such an integral highly accurate approximations exist. Maximisation of (1) thus gives us the Maximum Likelihood Estimator (MLE) for the random effects probit model.

The evaluation of the integral in (3) does however still provide a major computational problem. Butler and Moffit (1982) suggested using a Gaussian quadrature to evaluate the integrand showing that this achieves gains in computational efficiency of several orders of magnitude. The Gaussian quadrature formula for the evaluation of the integral is given by the following Hermite integration formula,

$$\int_{-\infty}^{\infty} e^{-z^2} g(z) dz = \sum_{j=1}^{G} w_j g(z_j) \tag{4}$$

where G is the number of evaluation points, w_j denotes the quadrature weights (the weight given to the jth evaluation point), and $g(z_j)$ is $g(z)$ evaluated at the jth point of z. In terms of computational feasibility a key question is the number of points at which the integrand must be evaluated for accurate approximation. Butler and Moffit (1982) however show that even two-point integration is highly accurate.

The result from estimation of a random effects probit should be stable for different numbers of quadrature points although increasing the number of evaluation points as the likelihood approaches its maximum will increase accuracy. If the results are sensitive to the number of quadrature points then the quadrature approximation is not accurate and the results of the random effects probit model should not be interpreted. In order to interpret the result from estimation of a random effects probit model we therefore require that the quadrature technique is numerically stable.

As noted above the inability to look at habit persistence is the main drawback of the random effects probit model. A common approach in previous literature has been to use a random effect model with lags of the dependent variable treating them as exogenous. The assumption of exogeneity is somewhat untenable in the presence of unobserved heterogeneity and its violation will lead in general to inconsistent estimates of all coefficients in the model. Monte Carlo results by Heckman (1981) showed this to be the case with the estimate of the habit persistence parameter (the coefficient on the lagged dependent variable) especially sensitive to unobserved heterogeneity. This raises the issue of distinguishing between "true" state dependence, due to habit formation, and "spurious" state dependence, due to

unobserved heterogeneity.[12] The results of a random effects probit with lagged PMI purchase as an explanatory variable must therefore be interpreted with caution.

Recent literature has attempted to address the issues of allowing lagged choice into limited dependent variable panel data models and thus allowing the consideration of habit persistence. This recent literature will be discussed briefly here with a view towards future work once the theoretical work has been further developed.

Excellent reviews of discrete choice panel data models and recent advances in the theoretical literature are provided by Arellano and Honore (2001) and Hsiao (2003). The focus here will be on two recent papers that have included lagged dependent variables in the specification of discrete choice panel data models; Honore and Kyriazidou (2000) and Chintagunta *et al* (2001). Honore and Kyriazidou (2000) propose a parametric (logistic) estimator for panel data discrete choice models where the explanatory variable set includes lags of the endogenous dependent variable and also a semi-parametric estimator based on the conditional maximum score estimator developed by Manski (1987). The model they consider is the following,

$$y_{it}^{*} = \beta x_{it} + \gamma y_{it-1} + v_{it} \qquad i = 1,2,...,N\ ,\ t = 1,2,...,T$$

$$y_{it} = \begin{cases} 1 & if \quad y_{it}^{*} > 0 \\ 0 & if \quad y_{it}^{*} \le 0 \end{cases}$$

where $v_{it} = \alpha_i + u_{it}$

Parameters are defined as above and γ is the habit persistence parameter. The model thus allows a lagged dependent variable to enter the specification of the model.

[12] See Heckman (1981).

Honore and Kyriazidou (2000) argue that their estimator allows the econometrician to distinguish between dynamic responses to the exogenous variables ("true" state dependence), through the lagged dependent variable, and unobserved heterogeneity (Heckman's "spurious" state dependence). Their estimator converges at a rate slower than the usual inverse of the square root of the sample size but Monte Carlo results suggest that the estimator performs well. They also prove that the semi-parametric estimator is consistent but do not derive its asymptotic properties.

Chintagunta *et al* (2001) study yoghurt brand loyalty using A.C. Nielson data on yoghurt purchases in Sioux Falls, South Dakota between September 17, 1986 and August 1 1988. They estimate various models with lagged choice treated as exogenous and compare these against a model using the estimation method of Honore and Kyriazidou (2000). They find that the estimated parameters vary considerably across different estimation methods with the treatment of heterogeneity having a large effect on the value of the persistence parameter γ. They do however find that lagged choice has a positive and statistically significant effect on current purchase in all of the models they consider. They investigate these results further using Monte Carlo studies and find that conditional likelihood procedures are the most robust in estimating the coefficients on the exogenous variables, the coefficients on the lagged dependent variable is however significantly underestimated. Monte Carlo results also find that the estimator proposed by Honore and Kyriazidou (2000) performs quite satisfactorily.

The discussion above should highlight some of the advances that are being made in terms of discrete choice panel data models that allow for lagged dependent variables. The use of these techniques remains limited as the theoretical work is very new and

computer packages typically used for empirical work do not yet contain these new methods. Any use of these techniques requires programming knowledge and commonly requires simulation techniques to assess consistency of results. Advances in this area of the theoretical literature and the adoption of these estimators into statistical packages is likely to see increased use given the availability of longitudinal data sets with discrete response questions.

7. Results

The results are broken down into 4 Sections. Sections 7.1 and 7.2 investigate the importance of various supply side variables and variables that act as proxies for public health care quality. Section 7.1 considers current values whilst 7.2 looks at lagged supply side and quality variables. These Sections include a discussion of a core set of personal characteristics that had good explanatory power for the PMI purchase decision and provided a stable equation for testing the supply side and quality variables. Section 7.3 considers some additional personal characteristic variables and their importance in terms of the PMI purchase decision. Section 7.4 considers some further factors that might be significant determinants of PMI purchase, including use of health services and current health status. The issue of habit persistence in PMI purchase is also addressed but only tentative conclusions are drawn.

7.1. Personal Characteristic, Supply Side and Quality Variables

In order to assess the effects of supply side variables and variables that act as proxies for public sector quality a set of personal characteristic variables were first found that

provided a stable quadrature procedure and had high explanatory power in terms of the PMI purchase decision. The supply side and quality variables were then added to the equation containing these personal characteristic variables.

Table 6 below shows results for random effects probit models using the different supply side and quality variables. Equations 1 to 7 show the results using the different variables one at a time whilst equation 8 contains a set of these supply side and quality variables. All of the equations include regional and time dummies. The inclusion of time dummies helps eliminate any time trend in the data and so reduces the possibility of finding spurious relationships. The inclusion of regional dummies helped produce a stable quadrature procedure and the majority of the regional dummies were significant. The table includes the estimated coefficients, the log-likelihood, the number of observations, the number of individuals, the average number of observations per individual and a few diagnostic results.

The first blocks of variables in Table 6 are the personal characteristic variables. The first thing to note is the consistency of the estimates of the coefficients on these variables. The sex indicator variable, taking the value 1 for males and 0 for females, is positive and significant at the 1% level in all equations. This is no surprise given the existing literature that has consistently found men to be more likely to purchase PMI. The coefficient on the age variable is the only one that shows significant differences over the eight equations. The effect of age is always estimated to be positive but the coefficient ranges from 0.0029 to 0.0069 and the effect is not always significant. The obvious reason for these differing results across equations is the hump shaped profile of PMI purchase by age discussed in Section 5. Age dummies

were considered instead in order to account for this hump shaped profile but were also not always significant and made estimation sensitive to the number of points in the quadrature, thus making interpretation of the results impossible.

Table 6
Random Effects Probit of Private Medical Insurance Demand with Supply Side and Quality Variables

Equation	1	2	3	4	5	6	7	8
Sex	0.4373**	0.4346**	0.4552**	0.4723**	0.4636**	0.4563**	0.4346**	0.5093**
	(0.0532)	(0.0530)	(0.0572)	(0.0584)	(0.0627)	(0.0625)	(0.0530)	(0.0695)
Age	0.0044**	0.0043**	0.0029	0.0050**	0.0061	0.0062**	0.0043**	0.0069**
	(0.0015)	(0.0015)	(0.0016)	(0.0016)	(0.0018)	(0.0017)	(0.0015)	(0.0019)
Income £000	0.0160**	0.0161**	0.0177**	0.0170**	0.0174**	0.0176**	0.0161**	0.0189**
	(0.0013)	(0.0012)	(0.0015)	(0.0015)	(0.0017)	(0.0017)	(0.0012)	(0.0017)
Smoker	-0.1643**	-0.1639**	-0.2016**	-0.1760**	-0.1947**	-0.1835**	-0.1639**	-0.2158**
	(0.0514)	(0.0511)	(0.0561)	(0.0573)	(0.0613)	(0.0610)	(0.0511)	(0.0707)
Self Employed	0.6330**	0.6240**	0.6918**	0.7061**	0.6986**	0.7275**	0.6240**	0.8045**
	(0.0700)	(0.0696)	(0.0806)	(0.0793)	(0.0909)	(0.9003)	(0.0696)	(0.1056)
Unemployed	-0.5307**	-0.5232**	-0.6547**	-0.5067**	-0.6627**	-0.6201**	-0.5232**	-0.7435**
	(0.1265)	(0.1259)	(0.1508)	(0.1415)	(0.1624)	(0.1585)	(0.1259)	(0.1984)
Conservative Supporter	0.3651**	0.3619**	0.3899**	0.4201**	0.3814**	0.3684**	0.3619**	0.4570**
	(0.0477)	(0.0477)	(0.0546)	(0.0534)	(0.0582)	(0.0580)	(0.0477)	(0.0659)
Regional NHS Waiting Lists	0.0275**	-	-	-	-	-	-	0.0280**
	(0.0102)	-	-	-	-	-	-	(0.0156)
National NHS Waiting Lists	-	0.0002	-	-	-	-	-	-
	-	(0.0011)	-	-	-	-	-	-
Public Expenditure on Health	-	-	-0.0020	-	-	-	-	-0.0019
	-	-	(0.0027)	-	-	-	-	(0.0096)
NHS Beds	-	-	-	-0.0650	-	-	-	-0.0848
	-	-	-	(0.2182)	-	-	-	(0.3054)
Private Beds	-	-	-	-	1.1160	-	-	1.2238
	-	-	-	-	(1.3512)	-	-	(1.4790)
Private Hospitals and Clinics	-	-	-	-	-	0.2995	-	-
	-	-	-	-	-	(0.2338)	-	-
PMI Premium Inflation	-	-	-	-	-	-	-0.0105*	-0.0136*
	-	-	-	-	-	-	(0.0048)	(0.0062)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log Liklihood	-9698.44	-9742.20	-8395.56	-8347.06	-7334.95	-7398.90	-9742.20	-6083.26
Number of Obs	56436	56436	48232	47034	40117	40561	56710	31956
Number of Individuals	16258	16258	16282	16206	12835	12837	16288	12736
Average Obs per Individual	3.5	3.5	3.0	2.9	3.1	3.2	3.5	2.5
Wald χ^2	577.26**	573.32**	489.92**	517.68**	372.31**	380.14**	573.32**	399.83**
$\ln(\sigma^2)$	1.3020	1.3061	1.4045	1.3889	1.4762	1.4675	1.3061	1.5790
	(0.0483)	(0.0484)	(0.0542)	(0.0552)	(0.0589)	(0.0583)	(0.0484)	(0.0706)
σ	1.9174	1.9213	2.0183	2.0026	2.0919	2.0829	1.9214	2.2024
	(0.0464)	(0.0465)	(0.0547)	(0.0553)	(0.0616)	(0.0607)	(0.0465)	(0.0778)
ρ	0.7862	0.7869	0.8029	0.8004	0.8140	0.8127	0.7869	0.8291
	(0.0081)	(0.0081)	(0.0086)	(0.0088)	(0.0089)	(0.0089)	(0.0081)	(0.0100)
LR of $\rho = 0$	5905.36**	5942.86**	4555.44**	4511.76**	4353.19**	4421.71**	5942.86**	2969.49**

Standard Error in Parentheses
* Significant at the 5% level, ** Significant at the 1% level.

Equations 1-8 all show that income has a positive effect on PMI purchase with this effect significant at the 1% level. The conclusion that PMI purchase increases with income can thus easily be made, as in all previous studies. The smoker indicator variable, taking the value 1 if the individual smokes and 0 otherwise, has a negative coefficient in every equation. Smoking thus reduces the probability of purchasing PMI with the effect significant at the 1% level. It could be argued that a smoker will have a higher subjective probability of becoming ill in the future and so would be more likely to want to purchase PMI. The negative effect of smoking will however be picking up the supply side constraint facing smokers. Those individuals that smoke will face considerably higher premium prices than non-smokers and this may deter many potential purchasers.

All of the equations show that the self-employed are more likely to purchase PMI. This is not consistent with the previous literature with Propper (1989) finding self-employment insignificant and Besley *et al* (1999) finding that the self-employed were less likely to have PMI, however the result is stable across equations and is always significant at the 1% level. As would be expected unemployed individuals are less likely to purchase PMI with this effect always significant at the 1% level. The Conservative supporter indicator variable, taking the value 1 if the individual is a Conservative Party supporter and 0 otherwise, is significant at the 1 % level in all equations. The results confirm previous findings that Conservative Party supporters are more likely to purchase PMI than those individuals that support other political parties. This variable is essentially acting as a proxy for an individual's view of private provision with Conservative Party supporters generally favouring private provision over public provision.

The second block of variables in Table 6 above contains the supply side and quality of public care variables[13]. These variables were introduced one at a time in Equations 1-7 so as to consider their effect individually. Equation 8 includes a set of these variables. The results for waiting lists are the most interesting from a policy perspective. Equations 1 and 2 show that although national waiting lists have no effect on PMI purchase regional waiting lists have a significant effect at the 1% level. Both coefficients are estimated to be positive, indicating that increased waiting lists leads to increased PMI purchase, or conversely any reduction in waiting lists leads to a fall in PMI purchase. This is a little surprising given the press coverage given to national waiting lists and suggests that individuals do not consider such reported national waiting lists but actually consider the waiting times that are relevant to them i.e. their localised waiting lists[14].

Earlier results from King and Mossialos (2002) using the BHPS found no statistically significant relationship between waiting lists and PMI purchase. The different results here could be explained by the fact that King and Mossialos (2002) use data up to 1999, with 2 more years worth of data used in this analysis. Waiting lists have fallen in recent years and this fall is somewhat unprecedented for the NHS, which has experienced rising waiting lists in nearly every year since it's founding in 1946. These downward movements in waiting lists may account for their significance in

[13] For more details of these variables see the Appendix.

[14] It may be the case that even the waiting lists considered here are too 'aggregate' and that individuals actually consider waiting lists at an even lower level, such as local hospitals. This will be discussed further in Section 9 as a possibility for future work.

terms of the decision to purchase PMI, with falling waiting lists leading to a reduction in PMI purchase as perceptions of public sector health care quality increases.

Current public expenditure on health care is not significant although it has the expected sign. The coefficient is negative indicating that an increase in public expenditure on health leads to a fall in PMI purchase. The effect is not significant suggesting that increases in public expenditure do not crowd out private insurance. This conclusion will depend upon the link between public expenditure on health and waiting lists. If it is believed that increases in public expenditure can lead to reduced waiting lists then increases in public expenditure will crowd out private expenditure through the effect waiting lists have on PMI purchase.

Neither the number of NHS beds nor the number of private beds are significant determinants of PMI purchase. Both of the estimated coefficients are of the expected sign, with an increase in NHS beds having a negative effect and an increase in private beds having a positive effect, but neither of these effects is significant. The coefficient on private beds is greater than one as an increase of 1 private bed per thousand population would be a very large increase in the supply of private beds. The average number of private beds per thousand population in the entire panel is just 0.1768 with a maximum of 0.7321 in London. The number of private hospitals and clinics is also not statistically significant but the estimated coefficient is positive as would be expected. An increase in the number of private hospitals would be expected to increase PMI purchase as it corresponds to an increase in the supply of private medical care. These results suggest however that the supply of private hospitals and clinics is not a significant determinant of the demand for PMI.

The cost of PMI premiums purchased would be expected to be a significant determinant of demand for PMI with an increase in price leading to a fall in purchase. The results in Table 6 show that PMI premium inflation has a negative and significant effect on PMI purchase. Due to the specification of the variable this result is only significant at the 5 % level whilst it might be expected to be more significant. The variable used here is an aggregate price for PMI premiums paid for individual subscriptions and so does not include company paid polices, however it is not an individual specific premium price[15]. The same price is therefore used for all individuals. An ideal variable to capture the supply side price effect would consist of individual prices for a homogenous policy based on the personal characteristics used by PMI providers to set premium prices. This would provide a more realistic measure of the price faced by each individual when considering the purchase of PMI. The use of such a price measure is considered as a possibility for future work in Section 9.

A variable that was considered is advertising by PMI providers. The results are not included to save space and the variable was found not to be significant using either total advertising or advertising as a percentage of net premiums. Advertising might be expected to be important but these results suggest that it does not effect the purchase decisions. The effect of advertising might become significant once the individual has decided to purchase PMI and is deciding which provider to use.[16]

[15] The price variable used here is also an absolute level of price inflation, using relative price inflation by deflating by the GDP deflator did not effect the results.

[16] Lagged values of advertising were also not significant.

Equation 8 includes a selection of the supply side variables described above. Not all of the variables are included, as some are collinear. Only regional waiting lists are included and the number of private hospitals and clinics is not included. The results here support those of the other equations with only regional waiting times and PMI premium inflation being significant at the 1% and 5% level respectively. The signs of the estimated coefficients do not change from the previous equations.

The results in Table 6 suggest that only waiting lists and PMI premium inflation are significant determinants of the demand for PMI. The other supply side and quality variables are not significant. The number of private beds or the number of private hospitals and clinics does not affect PMI purchase and neither does the number of NHS beds. Public expenditure on health also does not affect the PMI purchase decision unless consideration is made of the effect of increased expenditure on waiting lists. Table 6 does however only contain current measures of these supply side and quality variables and it is possible that such measures effect PMI purchase with a lag. The effect of lagged supply side and quality variables will be considered after a discussion of the diagnostics and a brief discussion of the regional and time dummies.

The diagnostic results for each equation are presented at the bottom of Table 6. Results from checking the sensitivity of the models using different numbers of evaluation points for the quadrature are not presented here, as they are lengthy. These results did however show that changing the number of quadrature points has very little effect on the estimates above and does not affect the conclusions that can be made. The log-likelihood is given for each equation, as are the details of the

estimation sample, including the number of observations and the number of individuals.

The Wald χ^2 statistic is the Wald test of all the parameters in the regression equation being zero, this is a non-linear equivalent to the F-statistic. With 8 regional dummies in each equation and 5 time dummies the 1% critical values for this test are 38.93 for Equations 1 to 7 and 44.31 for Equation 8. The hypothesis that all coefficients are equal to zero is thus clearly rejected for all equations at all conventional significance levels. The additional panel-level variance component is given by $\ln(\sigma^2)$, which is the log of the variance, thus the standard deviation is given by σ. ρ is the proportion of the total variance that is contributed by the panel-level variance component. When ρ is equal to zero it means that the panel-level variance components is not important and thus the panel estimator is no different from the pooled estimator. If ρ is equal to zero we do not need to use a random effects probit model, instead we can simply treat different years for each individual as different individuals and estimate a pooled probit on all observations. It can be seen from Table 6 that for all equations ρ is equal to around 0.8 and so the pooled probit would give different results to the random effects probit model. The last entry in Table 6 gives the test statistic of a likelihood ratio test of the hypothesis that ρ is equal to zero. For all equations the hypothesis is rejected at the 1% level and thus the pooled probit would give different results and the panel-level variance component is important.

As noted above the regional dummies helped produce a stable quadrature procedure and most of them tended to be significant. The default was London and all estimated

coefficients were negative. This is not surprising given the results in Section 5, which showed London to have the highest percentage of adults covered by PMI. The estimated coefficients showed a similar picture as Figure 6 above with large negative coefficients for Scotland and Wales and smaller coefficients for the other regions.

In all of the equations above the time dummies were always jointly significant but only the time dummies for 1997 and 2000 were consistently individually significant. Both of these dummies were negative indicating a fall in PMI purchase in these years relative to the default 1996. The 1997 dummy may be picking up the effect of the new Labour Government, which came to power in May 1997 and had made strong policy statements about improvements in NHS. There were also major policy announcements in the 1997 Budget that could be producing the negative coefficient on this time dummy. In the 1997 Budget it was announced that tax relief on PMI to the over-60's was to be abolished and also that an extra £1.2 billion was to be made available to the NHS.

Emerson *et al* (2001) estimate that the abolishment of tax relief led to a 0.7 percentage point decrease in the number of people covered by PMI who previously benefited from the tax relief. They argue that despite the increased demand this may have put on the NHS the costs of treating these individuals will have been less than the annual cost of the tax relief. The effect of this tax relief and the announcement of increased NHS spending could be the reason for the significant and negative time dummy in 1996 with both of these announcements leading to reduced PMI purchase among some groups, especially the over-60's.

The significant and negative coefficient on the 2000 dummy could also be due to budgetary announcements. The March 2000 Budget contained a major budgetary boost for the NHS. It was announced that NHS funding in 2000/2001 would be £54.2 billion, up £2 billion from the previous plan of £52.2 billion and that in 2001/2002 NHS funding would be £58.6 billion up from £55.5 billion. This announcement of a large increase in NHS spending could account for the negative time dummy in 2000.

7.2. Lagged Supply Side and Quality Variables

Table 7 below reproduces Table 6 but with one-period lagged supply side and quality variables. The coefficient estimates for the personal characteristic variables are all, except for the age variable, of higher magnitude than the equations with current values of supply side and quality variables but are still of the same sign and as before are significant at the 1% level. For example, in Equation 1 the income coefficient is 0.0178 and the smoker coefficient is –0.1914, whilst in Equation 9 the corresponding estimates are lower in absolute value at 0.0160 and –0.1643. The significance of the age variable drops when using lagged supply side and quality variables with age only significant in Equations 13,14 and 16 at the 5% level. Again age dummies were investigated and these were not significant. The interpretation of the results for the personal characteristic variables is the same as that for Table 6, given that the results are so similar, and again the quadrature procedure was numerically stable.

Table 7
Random Effects Probit of Private Medical Insurance Demand with One-Period Lagged Supply side and Quality Variables

Equation	9	10	11	12	12	14	15	16
Sex	0.4625**	0.4586**	0.4642**	0.4459**	0.4783**	0.4653**	0.4586**	0.4846**
	(0.0595)	(0.0595)	(0.0654)	(0.0609)	(0.0712)	(0.0717)	(0.0595)	(0.0721)
Age	0.0027	0.0026	0.0018	0.0032	0.0045*	0.0046*	0.0026	0.0045*
	(0.0017)	(0.0017)	(0.0019)	(0.0017)	(0.0021)	(0.0021)	(0.0017)	(0.0021)
Income £000	0.0178**	0.0179**	0.0208**	0.0182**	0.0209**	0.0208**	0.0179**	0.0207**
	(0.0015)	(0.0015)	(0.0018)	(0.0016)	(0.0020)	(0.0019)	(0.0015)	(0.0020)
Smoker	-0.1914**	-0.1923**	-0.2531**	-.2000**	-0.2553**	-0.2323**	-0.1923**	-0.2538**
	(0.0589)	(0.0589)	(0.0664)	(0.0604)	(0.0730)	(0.0721)	(0.0589)	(0.0730)
Self Employed	0.7053**	0.7057**	0.6450**	0.7410**	0.6260**	0.6449**	0.7057**	0.6245**
	(0.0837)	(0.0838)	(0.0964)	(0.0876)	(0.1091)	(0.1092)	(0.0838)	(0.1090)
Unemployed	-0.7153**	-0.7119**	-0.8494**	-0.6947**	-0.9308**	-0.9330**	-0.7119**	-0.9317**
	(0.1673)	(0.1668)	(0.2139)	(0.1705)	(0.2479)	(0.2475)	(0.1668)	(0.2477)
Conservative Supporter	0.3806**	0.3815**	0.3950**	0.3917**	0.4063**	0.4043**	0.3815**	0.4019**
	(0.05675)	(0.0567)	(0.0653)	(0.0581)	(0.0707)	(0.0703)	(0.0567)	(0.0707)
Regional NHS Waiting Lists *t-1*	-0.0012	-	-	-	-	-	-	-0.0004
	(0.0104)	-	-	-	-	-	-	(0.0127)
National NHS Waiting Lists *t-1*	-	0.0005	-	-	-	-	-	-
	-	(0.0004)	-	-	-	-	-	-
Public Expenditure on Health *t-1*	-	-	-0.0111**	-	-	-	-	-0.0272**
	-	-	(0.0042)	-	-	-	-	(0.0095)
NHS Beds *t-1*	-	-	-	0.0542	-	-	-	-0.0758
	-	-	-	(0.1598)	-	-	-	(0.2018)
Private Beds *t-1*	-	-	-	-	0.0001	-	-	0.0008
	-	-	-	-	(0.0031)	-	-	(0.0032)
Private Hospitals and Clinics *t-1*	-	-	-	-	-	0.0072	-	-
	-	-	-	-	-	(0.1303)	-	-
PMI Premium Inflation *t-1*	-	-	-	-	-	-	-0.0051	0.0237
	-	-	-	-	-	-	(0.0051)	(0.0247)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log Liklihood	-7841.67	-7851.79	-6567.04	-7630.38	-5664.54	-5710.48	-7851.79	-5654.61
Number of Obs	44009	44107	35911	42574	29212	29617	44107	29114
Number of Individuals	15926	15945	15529	15768	12185	12200	15945	12154
Average Obs per Individual	2.8	2.8	2.3	2.7	2.4	2.4	2.8	2.4
Wald χ^2	466.92**	467.77**	420.33**	459.49**	240.57**	341.76**	467.77**	340.77**
$\ln(\sigma^2)$	1.4131	1.4127	1.5418	1.460	1.6597	1.6558	1.4127	1.6547
	(0.0561)	(0.0559)	(0.0698)	(0.0576)	(0.0805)	(0.0803)	(0.0559)	(0.0805)
σ	2.0270	2.0266	2.1618	2.0753	2.2930	2.2886	2.0266	2.2872
	(0.0568)	(0.0566)	(0.0754)	(0.0597)	(0.0923)	(0.0919)	(0.0566)	(0.0921)
ρ	0.8043	0.8042	0.8237	0.8116	0.8402	0.8397	0.8042	0.8395
	(0.0088)	(0.0088)	(0.0101)	(0.0088)	(0.0108)	(0.0108)	(0.0088)	(0.0108)
LR of $\rho = 0$	4201.71**	4211.04**	2856.29**	4187.97**	2711.58**	2771.13**	4211.04**	2699.65**

Standard Error in Parentheses
* Significant at the 5% level, ** Significant at the 1% level.

The equations for lagged supply side and quality variables show that only lagged public expenditure on health care is significant. The coefficient is negative as would be expected and is significant at the 1% level. The coefficient estimates on all other variables are very close to zero and are not always of the expected sign. The results

here suggest that although public expenditure on health does not have a contemporaneous effect on PMI purchase, as shown in Table 6, it affects PMI purchase with a lag. This may be due to the fact that increases in public expenditure on health may lead to reduced waiting lists in future periods, which are shown to reduce PMI purchase.

The diagnostics are as described above and again for all equations the hypothesis that all coefficients are equal to zero is clearly rejected by the Wald test at the 1% significance level for all equations. The likelihood ratio test of the hypothesis that ρ is equal to zero is also rejected at the 1% level for all equations indicating that pooled probit estimation would give different results to the random effects probit estimation. The estimated coefficients for the time and regional dummies were similar to those from the equations in Table 6 and so will not be discussed further here. One thing to note from Table 7 is the reduction in the sample size due to the inclusion of lags in the model. The estimation sample remains large however and so this is not an issue.

The equations in Table 6 were repeated for two-period lagged supply side and quality variables. The results will not be presented here as none of the two-period lagged supply side and quality variables were significant. The estimated coefficients on the personal characteristic variables were very similar to those reported in Tables 6 and 7 and again all but the age variable were statistically significant at the 1% level in all equations.

7.3. Additional Personal Characteristic Variables

The analysis will now turn to additional personal characteristic variables. The analysis will be based on a model with the personal characteristics used above and also two of the supply side and quality variables. These will be regional waiting times and PMI premium inflation. Table 8 below shows the results of 8 equations that include additional personal characteristic variables that were found to be significant.

Equation 17 shows the base equations with the personal characteristic variables used in the analysis above and also regional waiting lists and PMI price inflation. The results for the personal characteristic variables are very similar to above and so need no further discussion. The coefficient on regional waiting lists is positive and significant at the 1% level and the coefficient on PMI premium inflation is negative and significant at the 5% level. Lagged public expenditure on health found to be significant in Table 7 above is not included as the introduction of lags reduces the sample size, there are also issues of collinearity if there is a relationship between public expenditure on health and future waiting lists. For all equations the diagnostics are similar, the hypothesis that all coefficients are equals to zero is always rejected at the 1% level and the hypothesis that ρ is equal to zero is always rejected by the likelihood ratio test at the 1% level. The diagnostic will thus not be discussed further.

Table 8
Random Effects Probit of Private Medical Insurance Demand with Additional Personal Characteristic Variables

Equation	17	18	19	20	21	22	23	24
Sex	0.4373**	0.4371**	0.4460**	0.3759**	0.3595**	0.4188**	0.4376**	0.2384**
	(0.0532)	(0.0531)	(0.0537)	(0.0564)	(0.0548)	(0.0536)	(0.0536)	(0.0602)
Age	0.0044**	0.0044**	0.0043**	0.0031*	0.0041**	0.0051**	0.0038*	0.0018
	(0.0015)	(0.0015)	(0.0015)	(0.0015)	(0.0015)	(0.0015)	(0.0015)	(0.0016)
Income £000	0.0160**	0.0160**	0.0149**	0.0157**	0.0158**	0.0149**	0.0158**	0.0129**
	(0.0013)	(0.0012)	(0.0013)	(0.0013)	(0.0013)	(0.0013)	(0.0013)	(0.0014)
Smoker	-0.1643**	-0.1560**	-0.1073*	-0.1711**	-0.1402**	-0.1445**	-0.1524**	-0.0773
	(0.0514)	(0.0513)	(0.0527)	(0.0511)	(0.0515)	(0.0518)	(0.0521)	(0.0525)
Self Employed	0.6330**	0.6301**	0.5885**	0.6299**	0.6285**	0.5338**	0.6210**	0.4834**
	(0.0700)	(0.0699)	(0.0693)	(0.0698)	(0.0693)	(0.0717)	(0.0705)	(0.0702)
Unemployed	-0.5307**	-0.5314**	-0.4859**	-0.5268**	-0.4501**	-0.5094**	-0.5228**	-0.3778**
	(0.1265)	(0.1264)	(0.1294)	(0.1264)	(0.1276)	(0.1263)	(0.1267)	(0.1305)
Conservative Supporter	0.3651**	0.3670**	0.3299**	0.3665**	0.3530**	0.3612**	0.3663**	0.3137**
	(0.0478)	(0.0478)	(0.0477)	(0.0477)	(0.0476)	(0.0476)	(0.0478)	(0.0469)
Broadsheet Newspaper	-	0.1905*	-	-	-	-	-	0.1782*
	-	(0.0820)	-	-	-	-	-	(0.0811)
Owner Occupied House	-	-	0.4716**	-	-	-	-	0.4664**
	-	-	(0.0527)	-	-	-	-	(0.0543)
Head Of Household	-	-	-	0.1566**	-	-	-	0.2609**
	-	-	-	(0.0494)	-	-	-	(0.0520)
Recives Benefit Income	-	-	-	-	-0.2723**	-	-	-0.2445**
	-	-	-	-	(0.0484)	-	-	(0.0497)
Private Pension	-	-	-	-	-	0.3936**	-	0.3521**
	-	-	-	-	-	(0.0532)	-	(0.0497)
Married	-	-	-	-	-	-	0.1115*	0.0903
	-	-	-	-	-	-	(0.0477)	(0.0490)
Regional NHS Waiting Lists	0.0275**	0.0257**	0.0267**	0.0273**	0.0278**	0.0251*	0.0276**	0.0235*
	(0.0102)	(0.0103)	(0.0102)	(0.0102)	(0.0102)	(0.0102)	(0.0102)	(0.0102)
PMI Premium Inflation	-0.0054*	-0.0030	-0.0064*	-0.0054*	-0.0038	-0.0054*	-0.0053*	-0.0025
	(0.0025)	(0.0053)	(0.0029)	(0.0026)	(0.0052)	(0.0026)	(0.0025)	(0.0053)
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log Liklihood	-9698.44	-9695.77	-9656.88	-9693.42	-9682.42	-9671.19	-9695.70	-9605.14
Number of Obs	56436	56436	56436	56436	56436	56436	56436	56436
Number of Individuals	16258	16258	16258	16258	16258	16258	16258	16258
Average Obs per Individual	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Wald χ^2	577.26**	582.47**	639.60**	575.14**	608.83**	608.55**	568.39**	707.05**
$\ln(\sigma^2)$	1.3020	1.2970	1.2579	1.2945	1.2879	1.2835	1.3001	1.2269
	(0.0484)	(0.0484)	(0.0477)	(0.0480)	(0.0488)	(0.0486)	(0.0484)	(0.0473)
σ	1.9174	1.9127	1.8756	1.9193	1.9039	1.8998	1.9162	1.8468
	(0.0464)	(0.0463)	(0.0447)	(0.0459)	(0.0465)	(0.0462)	(0.0464)	(0.0436)
ρ	0.7862	0.7853	0.7787	0.7849	0.7838	0.7830	0.7859	0.7733
	(0.0081)	(0.0082)	(0.0082)	(0.0081)	(0.0083)	(0.0083)	(0.0081)	(0.0082)
LR of $\rho = 0$	5905.36**	5872.32**	5771.69**	5890.50**	5844.16**	5856.36**	5904.51**	5654.48**

Standard Error in Parentheses
* Significant at the 5% level, ** Significant at the 1% level.

Equation 18 includes a broadsheet newspaper indicator variable, taking the value 1 if the individual reads a broadsheet newspaper and 0 otherwise. The effect of reading a broadsheet is positive and significant indicating that individuals who read a

broadsheet newspaper are more likely to purchase PMI. The inclusion of this variable makes PMI premium inflation insignificant although the estimated coefficient is still negative.

Equation 19 introduces a indicator variable taking the value 1 if the individual lives in an owner occupied house and 0 otherwise. As in Besley *et al* (1999) the effect of living in an owner occupied house has a positive and significant effect on PMI purchase. The size of this effect is similar to that of being male instead of female, thus the effect is quite large in terms of the purchase decision. This variable may however be picking up more than simply the effect of living in an owner occupied house. The reduction in the income coefficient, which was generally stable across most specifications, suggests that the variable may be picking up an income effect with those individuals with higher incomes more likely to have owner occupied homes.

The head of household indicator variable taking the value 1 if the individual is regarded as the head of the household and 0 otherwise has a positive estimated coefficient that is significant at the 1% level. For individual paid policies this is to be expected.

Equation 21 includes an indicator variable taking the value 1 if the individual receives benefit income and zero otherwise. The estimated coefficient is negative and significant at the 1% level. There is a possible issue of collinearity here as the unemployment and benefit variables are strongly correlated. The estimated coefficient on the unemployed indicator variable is only slightly reduced and remains

highly significant, this will be due to the benefit variable including more than just unemployment benefit and so the separate variables are picking up separate effects.

It was argued above that the Conservative Party supporter variable was acting as a proxy for attitude towards private sector provision. Equation 22 uses an additional variable that may be used as a proxy for an individual's attitude towards private provision of services. The indicator variable private pension takes the value 1 if the individual has a private pension and 0 otherwise. The estimated coefficient is positive as expected and the effect is significant at the 1% level. Those individuals with a private pension are more likely to favour private provision of services and the results for Equation 22 show that those with a private pension are more likely to purchase PMI. Equation 23 shows that being married has a positive effect on PMI purchase with this effect significant at the 5% level.

Equation 24 includes all additional personal characteristic variables. All the variables except the married indicator variable remain significant but the inclusion of all these variables affects the estimated coefficients of the core personal characteristics. This is probably due to issues of collinearity. For Equations 17 to 24 regional waiting times remain significant suggesting that this result is not sensitive to different equation specifications. PMI premium inflation is not significant in all of the equations and is more sensitive to the specification of the equation. This may be due to the issues discussed above about not having an individual specific premium price and some of the personal characteristic variables picking up price effects.

7.4. Further Results

Current health status and use of health services were also investigated for their effect on PMI purchase. Having reported that health limits daily activities was found not to have a significant effect on the PMI purchase decision and dummies for reported health status were also not significant. These results were not affected when using lags of these variables. Results for use of health services, including private hospitals and NHS hospitals, differed. Use of a private hospital had a positive and marginally significant effect on PMI purchase but was not included in the analysis above due to issues of endogeneity. Those with PMI are more likely to have used a private hospital as this stay may have been paid for by a PMI claim. Use of an NHS hospital had a negative effect on PMI purchase but this effect was not significant.

Other health service use variables that were investigated include inpatient days and GP visits. Both of these variables were estimated to have a negative effect on PMI purchase, indicating that recent use of NHS services does not lead to increased probability of purchase. This suggests that those who use the publicly provided health service do not then 'opt out' of public provision and purchase PMI. However as in previous studies the effect of these variables was not significant.

As noted above in Section 6 the use of a random effects probit limits the ability to look at the effect of habit persistence on the PMI purchase decision. When including a lagged dependent variable in the random effects probit model it has to be assumed to be exogenous. The inclusion of lagged PMI purchase into the equations discussed above has a large effect on the estimated coefficients. These results do however have

to be interpreted with caution, given the discussion in Section 6, and so will not be produced here. The inclusion of lagged PMI does however highlight that there is likely to be some habit persistence. Although the random effects probit does not provide an efficient estimator for the habit persistence parameter γ the results suggest that habit persistence plays a role with the estimated coefficient highly significant. The estimate of γ tended to be around 2.2, which is of similar magnitude to the habit persistence parameter in yoghurt purchase estimated by Chintagunta *et al* (2001). The tentative conclusion to be made here is that past purchase does matter. A full investigation of the effect of past purchase will be left to future work using the BHPS.

8. Policy Implications

The result that waiting times and lagged public expenditure are significant determinants of the demand for PMI raises issues about crowding out of private insurance. Increases in public expenditure were shown to reduce PMI purchase, as were falls in regional waiting lists. The consistent increases in NHS expenditure in recent years, mentioned above, are therefore likely to reduce the demand for PMI and if these increases in expenditure lead to reduced regional waiting lists the effect on the demand for PMI will be even greater. These increases in NHS expenditure and the corresponding falls in waiting lists that have been seen may therefore have crowded out private insurance.

Despite this no conclusions can be made about the optimality of the policy of increasing NHS expenditure. As mentioned at the beginning of this paper no general consensus has emerged about the optimal degree of public provision of health care

and so the welfare implications of this crowding out cannot be measured. If a high level of public provision is optimal the increased NHS expenditure may lead to increased welfare despite the crowding out of private insurance. The main policy implication that the results suggest is that when considering the effect of increased NHS expenditure the impact on PMI should also be considered.

9. Further analysis and limitations

The main limitation of the analysis is the inability to obtain a complete picture of the dynamic process underlying the PMI purchase decision. The 6-year panel that the BHPS provides would allow an investigation of the dynamic process and more specifically an investigation of the importance of habit persistence in the PMI purchase decision. The econometric techniques that would be required for this are however quite advanced and are still being developed. Consequently a full analysis of the dynamic effects in the PMI purchase decision is not presented in this analysis but is left to future work.

Although regional waiting times were found to be significant the other regional measures of public health care quality and supply of private health care were insignificant. It may be the case that these regional variables, including waiting times, are not specific enough to individuals. When deciding to purchase PMI individuals are likely to consider more localised measures of public health care quality and supply of private care. For instance the number of private hospitals in the region where an individual lives may not be important but the availability of a private hospital within a given distance of the individual's home might be. The importance

here lies in the difference between the availability of services and the availability of services to which the individual has reasonable access. The BHPS identifies individuals' Local Authority District of residence and so provides more detailed information than region. Waiting lists are already available at this level of detail but an improvement in data availability would be needed to look at the other supply side and quality variables. These more specific supply side and quality variables may provide more insight into the determinants of demand for PMI.

The PMI premium prices used in this analysis are an average premium for all individuals with PMI. As a results the prices are not very representative of the cost of purchasing PMI to each individual. The cost of purchasing PMI will vary significantly depending on age, sex, previous health history and whether the individual smokes. PMI providers use these characteristics to assess the individuals health risks and provide a premium based on this. In order to assess the true effect of premium prices on the PMI purchase decision such a specific premium price needs to be used. By using a different premium price for a homogenous policy for each individual based on these characteristics it would be possible to look more closely at the effect of PMI premium prices on the purchase decision.

The Internet site Moneysupermarket.com allows a comparison of over 1539 online PMI policies. Price comparisons require you to enter your marital status, date of birth, sex, whether or not you smoke and your postal address. You also have to choose the level of cover you require and the required level of excess. Details of policies are then shown including the name of the provider, the types of coverage and the monthly premium. This could be used to produce specific prices for a

homogenous policy for individuals in the BHPS. The main problem with such an approach is that it would take a considerable amount of time and there are also issues about finding a homogenous policy that is available to all individuals. Further work using such a source for PMI premiums could group individuals in the BHPS and assign premium prices separately to these groups instead of obtaining individual premium prices.

Other possible lines of work with the BHPS include a closer look into the differences between individual paid and employer paid PMI and an investigation of interactions within households in terms of PMI purchase. The omission of employer paid policies in the analysis here may introduce a selection bias if there are individuals that are covered by company policies that would otherwise have purchased individual paid PMI. Looking more closely at interactions within households might provide insight into the different coverage among men and women that is observed.

10. Conclusions

The BHPS allows a unique look at the PMI purchase decision by allowing individuals to be tracked over time and by providing detailed information on individual characteristics, PMI purchase, current health status and health services use. The regional information in the BHPS and the availability of regional supply side data also allows a clearer look at the effect of such supply side measures. The dynamic potential in this dataset is not fully utilised here given the methods adopted in this paper but an investigation into the determinants of demand for PMI is provided.

The results reported here support the conclusion that income, age, sex, political party support and employment status are key determinants of the demand for PMI as are being a smoker, living in an owner occupied house, having a private pension and reading a broadsheet newspaper. Some of these results conflict with previous analyses of the PMI purchase decision but the majority support the existing findings.

In terms of supply side variables and variables that can be used as proxies for NHS quality the results presented in this study are somewhat different to the existing literature. NHS waiting lists are found to have a significant and positive effect on the demand for PMI but only at the regional level. Previous analyses, including earlier results from the BHPS, have found waiting lists to be insignificant. This new finding may be due to the increased coverage that waiting lists have received in the press in recent years and the historical falls in waiting lists since 1998. Lagged public expenditure on health was also found to be significant, having a negative effect on the demand for PMI. This result suggests that increases in public health spending may be crowding out private insurance. Whether this is optimal is an open question given than there is no consensus on the optimal level of public provision of health care.

Other supply side and quality variables, including the number of private hospitals and the number of NHS beds were found to be insignificant determinants of the demand for PMI. PMI premium inflation was found to be a significant determinant of the demand for PMI despite the use of an aggregate price variable instead of individual specific prices. As in previous studies current health status and recent health services use were found to be an insignificant determinant of the demand for PMI.

The results in this paper appear to indicate that there is some habit persistence in the PMI purchase decision and this is supported by the results of Propper *et al* (2001). This is however a tentative conclusion given the inefficient methods of estimating the habit persistence parameter that is used in this paper. Future work using the BHPS and more advanced econometric techniques would allow a more comprehensive look at the effect of habit persistence in the PMI purchase decision and would fully utilise the dynamic potential of the dataset.

The work in this paper highlights that a similar study in a few years might prove useful in understanding the determinants of demand for PMI. The availability of more advanced techniques would mean that the assumption of strict exogeneity of past purchase would not be required. It would also be interesting to look at the effects of the more recent spending increases for the NHS. In the April 2002 Budget it was announced that there would be an additional £2.4 billion to UK health spending in 2003/2004 and that health spending will grow by 7.4% a year after inflation over the 5 years to 2007/2008. These spending increases are a result of the Wanless Review that suggested such levels of additional resources in order to deliver a "world-class health service". Given the results above such increases could have a large effect on the level of PMI purchase with these expenditure increases crowding out a substantial amount of private insurance either directly or through their effect on waiting lists. The effect of such increases on the demand for PMI will not however be known for a few years.

References

Andersen, E. B. (1970). "Asymptotic Properties of Conditional Maximum-Likelihood Estimators". *Journal of the Royal Statistical Society*. Series B, Volume 32, Issue 2, 283-301.

Arellano, M. and Honore, B. (2001). "Panel Data Models: Some Recent Developments". *Handbook of Econometrics*, Volume 5, Chapter 53. Edited by Heckman, J. J. and Leamer, E. E.

Arrow, K. (1963). "Uncertainty and the Welfare Economics of Medical Care". *The American Economic Review*, Volume 53, Issue 5, 941-973.

Baltagi, B. H. (1995). *Econometric Analysis of Panel Data*. New York, Wiley.

Besley, T. and Coate, S. (1991). "Public Provision of Private Goods and Redistribution of Income". *The American Economic Review*, Volume 81, Issue 4, 979-984.

Besley, T., Hall, J. and Preston, I. (1998). "Private and Public Health Insurance in the UK". *European Economic Review*, Volume 42, 491-497.

Besley, T., Hall, J. and Preston, I. (1999). "The Demand for Private Health Insurance: Do Waiting Lists Matter?". *Journal of Public Economics*, Volume 72, Issue 2, 155-181.

Booer, T. (1994). "The Health Care System in the United Kingdom". *Financing Health Care*, Volume 2, Chapter 14. Edited by Hoffmeyer, U. K. and McCarthy, T.

Burchardt, T. and Propper, C. (1999). "Does the UK have a Private Welfare Class?". *Journal of Social Policy*, Volume 28, Issue 4, 643-665.

Butler, J. S. and Moffit, R. (1982). "A Computationally Efficient Quadrature Procedure for the One-Factor Multinomial Probit Model". *Econometrica*, Volume 50, Issue 3, 761-764.

Cameron, A.C., Milne, P. K., Trivedi, P. K. and Piggott, J. (1988). "A Microeconometric Model of the Demand for Health Care and Health Insurance in Australia". *Review of Economic Studies*, Volume 55, Issue 1, 85-106.

Chamberlain, G. (1984). "Panel Data". *Handbook of Econometrics*, Volume 2, Chapter 22, Edited by Griliches, Z. and Intrilligator, M.

Chintagunta, P., Kyriazidou, E. and Perktold, J. (2001). "Panel Data Analysis of Household Brand Choices". *Journal of Econometrics*, Volume 103, Issue 1, 111-153.

Culyer, A. J. (1993). *Current Issues in the Economics of Welfare*, Chapter 8. Edited by Barr, N. and Whynes, D.

Cutler, D. M. and Gruber, J. (1996). "Does Public Insurance Crowd Out Private Insurance". *The Quarterly Journal of Economics*, Volume 111, Issue 2, 391-430.

Deacon, R. T. and Sonstelie, J. (1985). "Rationing by Waiting and the Value of Time: Results from a Natural Experiment". *The Journal of Political Economy*, Volume 93, Issue 4, 627-647.

Deber, R., Gildiner, A. and Baranek, P. (1999). "Why not Private Health Insurance? 1. Insurance Made Easy". *Canadian Medical Association Journal*, Volume 161, Issue 5, 539-542.

Emmerson, C., Frayne, C. and Goodman, A. (2000). "Pressures in UK Healthcare: Challenges for the NHS". Institute of Fiscal Studies.
www.ifs.org.uk/health/nhsspending.pdf

Emmerson, C., Frayne, C. and Goodman, A. (2001). "Should Private Medical Insurance be Subsidised". *Health Care UK*. Institute of Fiscal Studies.
http://www.ifs.org.uk/health/pmi.pdf

Epple, D. and Romano, R. E. (1996). "Public Provision of Private Goods". *The Journal of Political Economy*, Volume 104, Issue 1, 57-84.

Farnworth, M. G. (2003). "A Game Theoretic Model of the Relationship Between Prices and Waiting Times". *Journal of Health Economics*, Volume 22, 47-60.

Gladstone, D. (Editor), Allsop, J., Goldsmith, M., Green, D. G. and Ham, C. (1997). *How to Pay for Health Care*. The Institute of Economic Affairs Health and Welfare Unit.

Goddard, M. and Smith, P. "Equity of Access to Health Care Services: Theory and Evidence from the UK". *Social Science and Medicine*, Volume 53, Issue 9, 1149-1162.

Gouveia, M. (1997). "Majority Rule and the Public Provision of a Private Good". *Public Choice*, Volume 93, 221-244.

Gravelle, H., Smith, P. and Xavier, A. (2003). "Performance Signals in the Public Sector: The Case of Health Care". *Oxford Economic Papers*, Volume 55, 81-103.

Guilkey, D. K. and Murphy, J. L. (1993). "Estimation and Testing in the Random Effects Probit Model". *Journal of Econometrics*, Volume 59, Issue 3, 301-317.

Heckman, J. J. (1981). "Heterogeneity and State Dependence". In Rosen, S. (eds.), *Studies of Labour Markets*. National Bureau of Economic Research, The University of Chicago Press, Chicago.

Heckman, J. J. and Willis, R. (1976). "Estimation of a Stochastic Model of Reproduction: An Econometric Approach". In Terleckyj, N. (eds.), *Household Production and Consumption*. National Bureau of Economic Research, New York.

Honore, B. E. and Kyriazidou, E. (2000). "Panel Data Discrete Choice Models with Lagged Dependent Variables". *Econometrica*, Volume 68, Issue 4, 839-874.

Hsiao, C. (2003). *Analysis of Panel Data*, Second Edition, Econometric Society Monographs, Cambridge University Press.

Iversen, T. (1997). "The Effect of a Private Sector on the Waiting Time in a National Health Service". *Journal of Health Economics*, Volume 16, Issue 4, 381-396.

Jofre-Bonet, M. (2000). "Health Care: Private and/or Public Provision". *European Journal of Political Economy*, Volume 16, Issue 3, 469-489.

King, D. R. and Mossialos, E. (2002). "The Determinants of Private Medical Prevalence in England". *LSE Health and Social Care Discussion Paper*, Number 3.

Koen, V. (2000). "Public Expenditure Reform: The Health Care Sector in the United Kingdom". *OECD Working Paper No.256*.

Laing W. Buisson. (2002). *Laing's Healthcare Market Review*, 15th Edition, 2002-2003. London: Laing & Buisson.

Maddala, G. S. (1983). *Limited Dependent and Qualitative Variables in Econometrics*, Econometric Society Monographs, Cambridge University Press.

Maddala, G. S. (1987). "Limited Dependent Variable Models Using Panel Data". *The Journal of Human Resources*, Volume 22, Issue 3, 307-338.

Manski, C. (1987). "Semiparametric Analysis of Random Effects Linear Models from Binary Panel Data". *Econometrica*, Volume 55, Issue 2, 357-362.

Martin, S. and Smith, P. C. (1999). "Rationing by Waiting Lists: An Empirical Investigation". *Journal of Public Economics*, Volume 71, Issue 1, 141-164.

McAvinchey, I. D. and Yannopoulos, A. (1993). "Elasticity Estimates from a Dynamic Model of Interrelated Demands for Private and Public Acute Health Care". *Journal of Health Economics*, Volume 12, Issue 2, 171-186.

Mintel. (2002). *Private Medical Insurance, Finance Intelligence*. Mintel, September 2002.

Office for National Statistics. (1997). *Living in Britain: Results from the 1995 GHS*. London: The Stationery Office.

Propper, C. (1989). "An Econometric Analysis of the Demand for Private Health Insurance in England and Wales". *Applied Economics*, Volume 21, 777-792.

Propper, C. (1993). "Constrained Choice Sets in the UK Demand for Private Medical Insurance". *Journal of Public Economics*, Volume 51, Issue 3, 287-307.

Propper, C. (2000). "The Demand for Private Health Care in the UK". *Journal of Health Economics*, Volume 19, Issue 6, 855-876.

Propper, C. (2001). "Expenditure on Health Care in the UK: A Review of the Issues". Centre for Market and Public Organisation (CMPO), Working Paper Series No. 01/030.

Propper, C. and Green, K. (1999). "A Larger Role for the Private Sector in Health Care? A Review of the Arguments". Centre for Market and Public Organisation (CMPO), Working Paper Series No. 99/009.

Propper, C., Rees, H. and Green, K. (2001). "The Demand for Private Medical Insurance in the UK: A Cohort Analysis". *Economic Journal*, Volume 111, C180-C200.

StataCorp. (2001). *Stata Reference Manual*: Release 7.0. College Station, TX: Stata Corporation.

Stiglitz, J. E. (1999). *Economics of the Public Sector*, Third Edition, Norton.

Stiglitz, J. E. (1974). "The Demand for Education in Public and Private School Systems". *Journal of Public Economics*, Volume 3, Issue 4, 349-385.

Van Doorslaer, E. and Wagstaff, A. (1992). "Equity in the Delivery of Health Care: Some International Comparisons". *Journal of Health Economics*, Volume 11, Issue 4, 389-411.

Wagstaff, A. and Van Doorslaer, E. (1992). "Equity in the Finance of Health Care: Some International Comparisons". *Journal of Health Economics*, Volume 11, Issue 4, 361-387.

Wooldridge, J. M. (2002). *Econometric Analysis of Cross Section and Panel Data*, MIT Press.

Appendix

Figure A1
The BHPS Private Medical Insurance Questions

M34. Are you covered by private medical insurance, whether in your own name or through another family member?

Yes, in own name ..... 1 **ASK M35**
Yes, through another family member..... 2 **GO TO**
No, not insured..... 3 **M37**
Don't know 8

M35. How is this insurance paid for?

You pay for all or a part of it directly..... 1 **ASK M36**
Your employer deducts it from your wages..... 2 **GO TO**
Your employer pays it fully as a benefit to you..... 3 **M37**

M36. How much do you pay per month for this insurance? Please include the contribution for all family members covered by an insurance in your name.
IF THE INSURANCE IS IN JOINT NAMES, PLEASE GIVE ONLY RESPONDENT'S SHARE

WRITE IN TO NEAREST £:…….
Don't know..... 8
Refused 9

Source: British Household Panel Survey User Documentation

Table A1
Supply Side and Quality Variables Linked to the BHPS

Variable	Variable Description	Source	Additional Notes
Regional NHS Waiting Lists	Number of people awaiting elective surgery per 1000 population, breakdown by region	DoH; ISD Scotland; Health Statistics for Wales	Inpatients and day cases. Figures are for 31st March each year and are population based.*
National NHS Waiting Lists	Number of people awaiting elective surgery per 1000 population, GB	DoH; ISD Scotland; Health Statistics for Wales	Inpatients and day cases. Figures are for 31st March each year and are population based.*
Public Health Expenditure	Total Public UK Health Expenditure, £bn	Office for National Statistics	Experimental total UK health expenditure, February 2003 release.
NHS Beds	Average Daily Number of Available NHS Beds per 1000 population	DoH, ISD Scotland, Health Statistics for Wales	All Acute Specialties, beds open overnight (i.e. 24hours)
Private Beds	Number of Bed in Private Hospitals and Clinics per 1000 population by Region	DoH; Health Statistics for Wales	
Private Hospitals and Clinics	Number of Private Hospitals and Clinics per 100'000 population by Region	DoH; Health Statistics for Wales	
PMI Premium Inflation	PMI Price Inflation, UK	Laing and Buisson; Laing's Health Care Market Review	Annual Change (%) of Subscription Income per Subscriber. Individual Paid Policies.
Advertising by PMI providers	Total advertising expenditure by PMI providers, £m	Mintel	Mintel; Private Medical Insurance, Finance Intelligence Report
Advertising by PMI providers	Advertising by PMI providers as a % of net premiums	Mintel	Mintel; Private Medical Insurance, Finance Intelligence Report

* See http://www.doh.gov.uk/waitingtimes/wthelp.htm#gt12
Population figures are from *Population Trends* and are mid-year estimates.