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Sick of work or too sick to work?

Evidence on health shocks and early retirement from the BHPS

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Abstract
We follow individuals as they retire using discrete-time hazard models applied to a stock sample from 12 waves of the British Household Panel Survey. Results confirm that health shocks are a determinant of retirement age and are quantitatively more important than pension entitlement. This is the case for both men and women and is observed for both a measure of health limitations and a measure of latent health status obtained from a generalized ordered probit model. Further, our results provide evidence that, for women, the health status of their partner impacts on their retirement decisions; and effect that is not evident for men.

Key words: Health, Retirement, Discrete-time duration models
JEL Classification: H55 I12 J26

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1. Introduction

Until recently, the UK (along with most developed countries) experienced a trend towards earlier retirement, especially among men. Along with more generous social security systems and the introduction of early retirement options in pension systems, early retirement plans were advocated to 'solve' unemployment problems, with early retirees making room for younger unemployed individuals. More generous health and disability insurance systems also contributed to the trend by enabling individuals in bad health to drop out of the labour market without facing severe financial consequences. This 'disability route' into retirement has been identified as an important phenomenon in the UK labour market (Blundell et al., 2002).

A recent survey for the UK Department for Work and Pensions (Humphrey et al., 2003) explored the factors affecting labour market participation among 2800 people aged between 50 and 69. 50% of the sample stated that they were not seeking work due to ill-health, and 20% reported that they had been forced to retire or leave a job because of ill-health. However, the relationship between health and retirement is a complex one. It is difficult to estimate a causal effect because health and work are jointly determined and there are problems finding an appropriate measure of health for use in this context. In order to usefully investigate the relationship it is necessary to use longitudinal data, and in this way we can track the same individuals from work into retirement, thus providing an appropriate counterfactual.

While there is a plethora of evidence on the importance of financial incentives for the retirement decision there is much less that considers the relationship between health and retirement and very little in the European context. The few studies that do exist have confirmed the importance of health but have rarely taken into account the dynamics of the relationship or the influence of health on retirement within couples, both of which are considered here. We use data from the first 12 waves, from 1991 to 2002, of the British Household Panel Survey (BHPS) to investigate the influence of health shocks on the age of retirement. We extend previous approaches by using a generalised ordered probit model to purge the self-reported measure of health of reporting bias. A further issue of interest is that the majority of people in this age group live as a couple and decisions on when to retire are often taken at the household level. Hence we also consider the effect of spousal health and labour market status on an individual's decision to retire.

We follow individuals as they retire using discrete time hazard models applied to a stock sample. This allows us to address the problems of endogeneity and unobservable individual heterogeneity.

Results confirm that health is an important determinant of the decision to retire. This is the case for both men and women and is observed for both a measure of health limitations and a measure of latent health stock, obtained from an innovative generalized ordered probit model of self-assessed health. As expected, negative shocks to health result in increases in the hazard of retirement. Further, our results provide evidence that, for women, the health status of their partner impacts on their retirement decisions. This effect is not evident for men.

2. Methodological issues

Economic theory on the relationship between retirement and health (for example Lazear, 1986) states that agents have preferences over current and future leisure which depend, *inter alia*, on current and expected health status. Poorer health reduces the probability of continued work because it may: increase the disutility of work; reduce the return from work (via lower wages); entitle the individual to benefits and other non-wage income that is contingent on not working. A possible counteracting affect is that poorer heath may increase consumption requirements (for example via increased health care costs) therefore necessitate higher income. However, if poorer health also reduces life expectancy then the annualised consumption available from existing wealth is raised, and this may still lead to earlier retirement.

There is a growing literature on health and work, and for older workers the retirement decision is a key part of this. Health effects operate alongside the effects of the pensions and benefits system, and there is an enormous literature on the importance of these financial incentives in determining retirement behaviour (see Lumsdaine and Mitchell, 1999 for a review). However Lindeboom (2006), in a comprehensive review of evidence on health and retirement, argues that a number of empirical studies have suggested that health is the most important determinant of an older persons labour supply; a finding rejected by other studies, which point to problems in finding an appropriate measure of health and problems arising from the endogeneity of health in models of retirement.

2.1 Self-reported health

In attempting to identify a causal effect of health on the retirement decision, the use of subjective measures of health has been a focus of much attention (see for example, Anderson and Burkhauser. 1985; Bazzoli, 1985; Stern, 1989; Bound, 1991; Kerkhofs and Lindeboom, 1995; Bound *et al.*, 1999;

Disney *et al.*, 2006). When using survey data, the researcher is usually limited to measures of self-reported health. In the BHPS for example, one health measure derives from the question:

> "Please think back over the last 12 months about how your health has been. Compared to people of your own age, would you say that your health has on the whole been excellent/good/fair/poor/very poor?"

This measure of self-assessed health (and many like it from similar surveys in other countries) provides an ordinal ranking of perceived health status that has been used widely in studies of the relationship between health and socio-economic status. However, some commentators have rejected the use of these subjective measures in favour of more objective measures of health status because of the potential biases that may result (for example, Myers, 1982, Stern, 1988 and Anderson and Burkhauser, 1985).

There are many reasons why one may expect biases to arise when modelling the impact of health on the timing of the retirement transition. First, self-reported measures of health are based on subjective judgements and there is no reason to believe that these judgements are comparable across individuals. Secondly, self-reported health may not be independent of labour market status. Thirdly, since ill-health may represent a legitimate reason for a person of working age to be outside the labour force, respondents who are not working may cite health problems as a way to rationalize behaviour. Fourthly, for individuals for whom the financial rewards of continuing in the labour force are low there exists a financial incentive to report ill-health as means of obtaining disability benefits, this is often cited as the 'disability route into retirement' (Riphahn, 1997; Blundell *et al.,* 2002). For example, in a study of social security benefit programmes in the Netherlands, Kerkhofs and Lindeboom (1995) show that recipients of disability insurance systematically overstated their health problems.

Bound (1991) identifies the bias that results from each of the above problems. Reporting heterogeneity resulting in a lack of comparability across individuals in self-assessed health (SAH) represents measurement error that leads to an underestimation of the impact of health on labour force participation. Conversely, endogeneity in the health-retirement relationship will lead to an overestimation of the impact of health. These biases will also have implications for the estimation of the impact of socio-economic characteristics that are correlated with SAH. Indeed, Bound argues that SAH is in part, determined by socio-economic factors and that should the impact of health on labour market activity be correctly estimated the impact of economic variables may still be biased.

Bound (1991) also points out, however, that we cannot be sure that objective measures are any better predictors of the relationship between health and labour market status; objective measures of health are unlikely to be perfectly correlated with the aspect of health that affects an individual's capacity for work. As such, objective measures of health will suffer from an error in variables problem leading to downwardly biased estimates of the impact of health on retirement. Whereas the biases involved in using self-assessed measures of health act in a way so as to counteract each other, the bias associated with objective measures of health operates in one direction only and hence may be more problematic in empirical applications.

Empirical studies on the role of health in retirement provide mixed conclusions about the endogeneity of SAH and the extent of the bias provided through measurement error. For example, while Kerkhofs *et al.* (1999) find that the choice of health measure (SAH versus more objective measures) does affect the estimates of health on labour market outcomes, Dwyer and Mitchell (1999) conclude that SAH is not endogenous and their models of labour market retirement do not suffer significantly from measurement bias. Further, by applying a direct test for measurement error Au *et al.* (2005) report significant error in their SAH variable. However, when this measure was used to predict retirement behaviour it gave similar results to those obtained from using a more objective measure of health and to those obtained through instrumental variable approaches.

Of further relevance is whether a change in labour market status (into retirement) is more influenced by 'shocks' to an individual's health or by a levels effect (for example, a slow deterioration in health status). It is often argued that modelling health 'shocks' is a convenient way to eliminate one source of potential endogeneity bias caused through correlation between individual-specific unobserved factors and health (see for example, Disney *et al.*, 2006). This is due to the identification of a health 'shock' through, for example, differencing the data over consecutive time periods which consequently implies eliminating unobserved individual effects. Disney *et al.* (2006) find that health shocks are an important determinant of retirement behaviour in the UK., and that positive and negative health shocks tend to have symmetric effects.

Riphahn (1999) has also investigated the dynamic effect of health shocks on the employment and income of older workers. She finds significant effects of a health shock on leaving employment and finds small reductions in individual and equivalent household income. Riphahn also shows that health shocks seem to happen more often to those individuals/households which are already at the lower end of the income distribution before the health shock occurs. For the US, Bound et al. (1999) use 3 waves of the Health and Retirement Study to consider the retirement behaviour of men and women aged 50-62. They find that changes in health are as important as the long-term level of health in determining the retirement age.

2.2 Joint decision making among couples

Predictions regarding the joint labour market decisions of older couples can be derived from the family labour supply model of Killingsworth and Heckman (1986). Couples maximise a single utility function subject to a household budget constraint in which income is pooled. This model assumes that spouses have the same preferences, which can therefore be aggregated, and while it has been used in many empirical studies (Blau and Riphahn, 1999) it has been criticised for this key assumption. Bargaining models that allow for spouses to have different preferences have been developed in an effort to overcome this limitation (Gustman and Steinmeier 2000; Lundberg and Pollak, 1996).

There is a weight of empirical evidence supporting the importance of the joint determination of the retirement decision of husbands and wives[4] (see for example Hurd, 1990; Jiménez-Martín *et al.,* 1999; Blau and Riphahn, 1999; Michaud, 2003; Wu, 2004). In a recent development Gustman and Steinmeier (2000) estimate a structural model of retirement in dual-career families motivated by the observed tendency of couples to retire together in the US. The model is based on a non-cooperative bargaining model, and allows for simultaneous determination of retirement behaviour dependent on age, birth cohort, health and the retirement status of the spouse. The results suggest that the primary reason for spouses retiring together is shared preferences for leisure, with each individual valuing retirement more highly when their spouse has also retired. Health is an important factor in the individual's decision to retire but the model does not allow estimation of the effect of say a husband's health on the wife's retirement decision.

3. Econometric methods

3.1 Duration models of retirement

The starting point for our analysis is the stock-sampling approach of Jenkins (1995). This method represents the transition to retirement as a discrete time hazard model enabling us to estimate the effect of covariates on the probability of retirement. The covariates will include health status and

[4] The use of the terms husband and wife does not imply anything about the legal status of the relationship and is also applied here to people living as couples who are not legally married.

various socio-economic characteristics such as age, sex, housing tenure, education and pension entitlement (see section 4.2).

The Jenkins (1995) approach relies on a reorganisation of the data so that the unit of analysis is changed from the *individual* to the *time at risk of an event* (in this case retirement). This allows a complex sequence likelihood to be simplified to standard estimation for a binary outcome. The approach also controls for 'stock sampling' since we sample only those people who are in the labour market at wave 1. These individuals can then either stay in the labour force or exit into retirement. The assumption here is of a single exit (retirement) from the initial state (working), modelled as a binary probit.

Adopting the notation of Jenkins (1995), we use data for a stock sample of all individuals who are working in wave 1 ($t = \tau$). $t = 1$ is the earliest year at which an individual is at risk of retirement (initially we assume this is at age 50). At the end of the time period for which we have data some people will still be working (censored duration data, $\delta_i = 0$), and some will have retired (complete duration data, $\delta_i = 1$). $t = \tau + s_i$ is the year when retirement occurs if $\delta_i = 1$ and the final year of our data period if $\delta_i = 0$. Each respondent, *i*, contributes s_i years of employment spell data from the interval between the start of the observation period and the final wave. Then define the discrete time hazard rate as $\rho_{it} = P\ [T_i = t \mid T_i \geq t\ ; x_{it}]$, where x_{it} is a vector of covariates which may vary with time and T_i is a discrete random variable representing the time at which the end of the spell occurs.

The main issue for modifying the sample likelihood function for this model to take account of stock sampling is that the probabilities for both those who complete spells (retire) and those who do not are conditioned on them not having retired at the beginning of the sample time period (wave 1). Jenkins (1995) shows that the log-likelihood for this kind of event history data can be simplified by defining:

$y_{it} = 1$ if $t = \tau + s_i$ and $\delta_i = 1$, $y_{it} = 0$ otherwise.

For stayers $y_{it} = 0$ for <u>all</u> spell periods.

For exiters $y_{it} = 0$ for <u>all</u> periods <u>except</u> the exit period.

The log-likelihood is then simplified to a more standard form for analysis of a binary variable y_{it} where the unit of analysis is now the spell period, i.e. actual estimation is a simple binary model for the reorganised data set. The reorganised data set consists of multiple rows of observations for each individual with as many rows as periods at risk. In this way the reorganised data set resembles panel data.

To complete the specification of the model, an expression for the hazard rate is required. We specify a complementary log-log hazard rate which is the discrete-time counterpart of the hazard for an underlying continuous-time proportional hazards model (Prentice and Gloeckler, 1978): $\rho_{it} = 1 - \exp(-\exp(X_{it}\beta + \theta(t)))$, where $\theta(t)$ is the baseline hazard. We complete the specification by modelling $\theta(t)$ as a step function, by using dummy variables to represent each period at risk. This non-parametric form for the baseline hazard leads to a semi-parametric specification of the discrete-time duration model[5]. The model can be generalised to account for unobserved heterogeneity uncorrelated with the explanatory variables (Narendrenathan and Stewart, 1993). All estimation is carried out in STATA. The discrete time proportional hazards models are estimated using the *pgmhaz* routine (Jenkins, 1997).

3.2 Models for self-reported health

The approach we use to dealing with the issues associated with measurement error (reporting bias) and endogeneity of the health-retirement relationship extends the principles set out in Bound (1991) and implemented in Bound et al (1999) and subsequently adopted by Au *et al.* (2005) and Disney *et al.* (2006). This involves estimating a model of SAH as a function of more objective measures of health to define a latent 'health stock' variable. This health stock variable is then used as an indicator of health in the model of retirement. The idea of constructing a health stock variable is analogous to using more objective measures of health to instrument the endogenous and potentially error-ridden SAH variable.

We use a latent variable model to construct an index of health (health stock) for individual i at time t. Specifically, consider the aspect of health that affects an individual's decision to retire, h_{it}^{R}, to be a function of a comprehensive set of objective measures of health, z_{it}[6], such that:

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[5] An alternative is to specify a parametric form for the baseline hazard, most commonly, to assume this has a Weibull distribution by specifying $\theta(t) = \log(t)$.

[6] Bound *et al.* (1999) and others consider objective measures of health together with socio-economic characteristics as predictors of self-assessed health. We only use objective measures of health and reserve the use of socio-economic characteristics as predictors of reporting bias, as described later in this section. This makes the stringent assumption that, conditional on the objective measures, any association between SAH and SES reflects reporting bias and not genuine variation in health. This assumption may be too strong if the objective of the analysis was to model the determinants of health, but our purpose is to provide a measure of

$$h_{it}^{R} = z_{it}\beta + \varepsilon_{it}, \qquad i = 1,2,\ldots,n; \quad t = 1,2,\ldots T_i \qquad (1)$$

where ε_{it} is a time varying error term uncorrelated with z_{it}.

We do not directly observe h_{it}^{R} but instead observe a measure of SAH, h_{it}^{S}. We can specify the latent counterpart to h_{it}^{S} as h_{it}^{*} such that:

$$h_{it}^{*} = h_{it}^{R} + \eta_{it} \qquad i = 1,2,\ldots,n; \quad t = 1,2,\ldots T_i \qquad (2)$$

where η_{it} represents measurement error in the mapping of h_{it}^{*} to h_{it}^{R} and is uncorrelated with h_{it}^{R}. Substituting (1) into (2) gives:

$$h_{it}^{*} = z_{it}\beta + \varepsilon_{it} + \eta_{it} = z_{it}\beta + v_{it} \qquad i = 1,2,\ldots,n; \quad t = 1,2,\ldots T_i \qquad (3)$$

The presence of η_{it} in (3) represents measurement errors and is the source of the bias that would be obtained if we were to use h_{it}^{*} directly when estimating the impact of health on retirement behaviour. If η_{it} were distributed randomly, it would represent classical measurement error. This would attenuate the effect of health on retirement. Alternatively, if η_{it} were a function of labour market status such that, for example, individuals rationalise early labour market exit through reporting ill-health, then this would lead to overestimates of the effect of health on retirement transitions (Bound, 1991). To avoid the biases associated with using h_{it}^{*} directly in our models of retirement, we use the predicted health stock, $\hat{h}_{it}^{*}$, which is purged of measurement error.

Combining (3) with the observation mechanism linking the categorical or dichotomous indicator, h_{it}, to the latent measure of health, h_{it}^{*}, and assuming a distributional form for v_{it} we can estimate the coefficients, β. For example, in the case of the categorical self-assessed measure of health the observation mechanism can be expressed as,

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exogenous variation in health that is purged of reporting bias. For that reason, it is better to err on the side of caution and use only the objective health indicators as 'instruments'.

$$h_{it} = j \quad if \quad \mu_{j-1} < h_{it}^* \le \mu_j \quad , j = 1,...,m \tag{4}$$

where, $\mu_0 = -\infty, \quad \mu_j \le \mu_{j+1}, \quad \mu_m = \infty$. Assuming v_{it} is normally distributed, model (3) can be estimated as an ordered probit using maximum likelihood.

A further problem arises if individuals with the same level of underlying health, h_{it}^*, apply different thresholds, μ_j, when reporting their SAH status. This systematic use of different thresholds reflects the existence of reporting bias (Kerkhofs and Lindeboom, 1995; Lindeboom and van Doorslaer, 2004). These differences may be influenced by, among other things, age, gender, education, income, language and personal experience of illness. In their analysis of reporting bias Lindeboom and van Doorslaer (2004) distinguish between *index shift* and *cut-point shift*. *Index shift* occurs if the shape of the distribution of SAH remains the same, but there is a change in its location such that there is a parallel shift in all of the reporting thresholds for particular sub-groups of the population. This parallel shift in the distribution may be due to a shift in the cut-points (reporting bias) or due to a shift in the underlying measure of "true health" (heterogeneity) and in general, it is not possible to separately identify the two reasons for index shift. If the reporting bias is due to *cut-point shift*, this implies that there is a change in the relative positions of the reporting thresholds for particular sub-groups of the population.

We extend model (3) to take into account reporting bias. This can be achieved by considering the generalised ordered probit model (GOP). The GOP model allows the relaxation of one of the restrictive characteristics of the ordered probit model: the constancy of the threshold parameters, μ, such that:

$$\mu_{ij} = \mu_j + \delta_j' x_{it} \qquad \text{for all j} \tag{5}$$

where x_{it} represent socioeconomic factors assumed to influence the threshold parameters. Given (3), (4) and (5) we have:

$$P(h_{it} = j \mid z_{it}, x_{it}) = \Phi ((\mu_j + \delta_j x_{it}) - \beta z_{it}) - \Phi ((\mu_{j-1} + \delta_j x_{it}) - \beta z_{it}) \tag{6}$$

This provides a specification in which the coefficients vary across categories of SAH, as a result of cut-point shift. The pooled GOP is estimated directly by full information maximum likelihood in STATA, with robust standard errors corrected for the clustering within-individuals[7].

The predicted values for the health stock can be used in the model of the impact of health on retirement. In our example, the predicted health stock would enter as a regressor in a discrete-time duration model of retirement. Adopting this instrumental variable-type procedure where a proxy with error (here, detailed health variables as an imperfect predictor for SAH) is used to instrument an endogenous and error-ridden variable (here, self-reported general health or health limitations) is a standard way of dealing empirically with errors-in-variables (see also, Griliches, 1974 and Fuller, 1987). Further, since our approach to estimation relies on sampling individuals who are 50 years or over and are active in the labour market at the first wave (these individuals are deemed `at-risk' of retirement) concerns surrounding the extent of measurement error in SAH are lessened. The motivation for such individuals to report worse than actual health is presumably less than for individuals who have already left the labour market (see McGarry (2002) as an example of how this `stock-sampling' approach is used to deal with the possibility of measurement error in SAH). As an alternative to the predicted health stock we also use an arguably more objective measure of health (health limitations), which is described more fully in Section 4.2.

3.3 Health shocks

To identify a health shock we include as variables in our duration model of retirement a lagged measure of health together with initial period health. For all model specifications the health variables are derived using the instrumental variables procedure outlined above. By conditioning on initial period health we can interpret the estimated coefficients on contemporaneous health as representing a deviation from some underlying health stock. In this way the parameter estimate represents the effect of a health shock. The relative effects of the estimated coefficient of initial period health and contemporaneous health is informative of whether it is a health shock that determines retirement or a levels effect observed through continual poor health (see Bound *et al.,* 1999). It also seems plausible that lagged health may be more informative about the decision to retire simply because transitions take time (it may take time to adjust fully to a health limitation to enable an individual to assess his/her ability to work or to learn whether an employer can or will accommodate a health limitation). The use of lags has the advantage of reducing fears of

[7] The Stata program for the GOP is available from the authors on request.

endogeniety bias by exploiting the `timing of events' by observing the effect of health shocks prior to the time of retirement.

4. Data

4.1 The stock sample

We exploit the panel data available in the first twelve waves (1991-2002) of the British Household Panel Survey (BHPS). This includes rich information on socio-demographic and health variables. The BHPS is a longitudinal survey of private households in Great Britain, and was designed as an annual survey of each adult (16+) member of a nationally representative sample of more that 5,000 households, with a total of approximately 10,000 individual interviews. The first wave of the survey was conducted between 1st September 1990 and 30th April 1991. The initial selection of households for inclusion in the survey was performed using a two-stage stratified systematic sampling procedure designed to give each address an approximately equal probability of selection. The same individuals are re-interviewed in successive waves and, if they split off from their original households are also re-interviewed along with all adult members of their new households.

We apply stock sampling methods to define our sample of respondents of interest. The stock sample is designed to treat the sample as all individuals at risk of retirement at the first wave of observation as a cohort of all those present at wave 1 who could then be followed-up over the subsequent eleven waves. The sample of interest consists of those individuals who were original sample members aged 50 or over *and* had provided a full interview *and* were in work (defined here as employed or self-employed) in the *first wave* of the survey.

The sample is of n = 1135 individuals, 494 women and 641 men, who are then followed through the twelve annual waves of the surveys to see if they leave the labour market due to retirement[8]. 661 individuals are present for all 12 waves, but others are lost due to sample attrition and death[9]. Our retirement models are estimated on complete sequences of observations such that should an individual leave the panel but then return at a later date, we only make use of information up to the wave of first exit.

[8] There is a potential selection issue that is not dealt with here since people in very poor health may not have been working in wave 1 and hence cannot be observed to retire in our sample.

[9] Attrition may be endogenous (related to retirement) and we test for this possibility (see Section 5).

4.2 Variables

Retirement and labour market status

As has already been noted in the literature (e.g. Bardasi *et al.,* 2002; Disney *et al.*, 1994) retirement is not a well-defined state. It is not always clear whether individuals in the relevant age group are economically inactive because they have retired or are simply unemployed for a period of time. This problem is exacerbated by pension entitlement because some individuals may associate retirement with the final and permanent exiting from work whereas others may not define themselves as retired unless they are actually in receipt of pension. Further, social norms and routes into retirement via disability and unemployment complicate the self-reporting of labour market status for older workers. Humphrey *et al.* (2003) noted that after State Pension Age people appear to redefine their status, with a sudden drop in the numbers of people defining themselves as long-term sick or disabled after State Pension Age – from 27% to 1% in men, and from 16% to 4% in women.

In line with previous work, the definition of retirement used here is self-reported, in answer to the question on job status in which individuals classify their status as one of the following: self-employed, employed, unemployed, retired, on maternity leave, caring for the family, in full-time education, long-term sick or disabled, or on a government training scheme. For the analysis reported here we assume that retirement is an absorbing (permanent) state, so that the model focuses on the first transition out of the labour market.

Health variables

The BHPS includes a number of health and health-related variables. Of particular interest to us is the measure of general SAH status described in section 2.1 and an alternative measure of health that refers to limitations in daily activities.

The simple five-point SAH variable is a subjective proxy for actual health, and is likely to be measured with error and endogenous to labour supply choices (as explained in Section 2.1). A continuity problem arises with this variable because in wave 9 (only) there was a change in the question together with a modification to the available response categories. The wave 9 question asks respondents about their 'general state of health' (without the age consideration of the original version) on the scale: excellent, very good, good, fair, poor. To achieve consistency over all 12 waves we follow the method of Hernandez-Quevedo *et al.* (2005) and recode SAH into the following 4-category scale where 1 represents *very poor or poor health*, 2 *fair health*, 3 *good or very good* *health* and 4 *excellent health*. In this way both the original SAH question asked of respondents in waves 1 to 8 and 10 to 12 and the wave 9 version of the SAH question are used.

In order to construct the index of health stock variable, described in section 3.2, we use questions on specific health problems. Individuals are asked whether or not they have any of a list of specific health problems from the following: arms, legs or hands, sight, hearing, skin conditions or allergies, chest/breathing, heart/blood pressure, stomach or digestion, diabetes, anxiety or depression, alcohol or drugs, epilepsy or migraine, or other. Hence we create a binary dummy for the presence of each specific problem.

Our alternative health measure is self-reported functional limitations, based on the question "does your health in any way limit your daily activities compared to most people of your age?[10]" This is arguably more objective that the general SAH question, and more directly related to ability to work hence we use it as an alternative to the health stock index in some of the models that we estimate.

Spousal/Partner variables

We model the impact of health on the timing of retirement separately for men and women. For both we include a variable representing the health status of the individual's spouse or partner (should they have one). This allows us to investigate the interaction between spousal or partner's health and an individual's decision to retire. We also include a variable representing whether a spouse or partner is employed. To reduce concerns over endogeneity bias this variable is lagged one period.

Income and wealth

The main income variable used is the individual specific mean of log household income[11] across all waves in which individual is observed. In the models reported here we adapt this to the mean across all waves prior to retirement, in order to minimise endogeneity problems (as income will normally change significantly at retirement). We also have information on pension entitlement, which distinguishes between people who have no occupational or private pension, an occupational pension, or a private pension. Data on housing tenure are also available, which distinguish between people who own their home outright, own with a mortgage, or live in privately rented or local authority rented housing.

[10] This question is not asked in wave 9. In our analysis we assume wave 8 values hold in wave 9.

[11] Household income consists of labour and non-labour equivalised real income, adjusted using the Retail Price Index and equivalised by the McClement's scale to adjust for household size and composition.

Other socio-demographic variables

Other covariates include age, sex, marital status, educational attainment, and regional dummies. We also include variables that indicate the employment sector of the individual in wave 1.

Variable names and definitions are summarised in Table 1.

{Insert Table 1 around here}

5. Results

Information on labour market status in each wave is shown in Table 2 for men and women together and Table 3 for men and Table 4 for women. The tables also illustrate the loss of observations due to attrition. Our sample consists of 1135 individuals reporting employment or self-employment status in wave 1 and this figure gradually decreases to 160 by the 12th wave. The number of people who classify themselves as retired increases from 82 in wave 2 to 475 in wave 12[12]. While the number of men retired at wave 12 represents a 5 fold increase on the number reported at wave 2, for women the increase is 7 fold, perhaps reflecting the lower state pension age for women compared to men.

{Insert Tables 2, 3 & 4 around here}

Descriptive statistics for both men and women are presented in Table 5. These are presented for all data and broken down by pre and post-retirement. For both men and women the majority of individuals report SAH status as good or very good. Similar proportions report excellent or fair health with by far the lowest reported category being poor or very poor health.[13] It is notable that the reporting of fair and poor/very poor health increases while the reporting of excellent health is lower post-retirement compared to pre-retirement. This is true for both men and women. Similarly the reporting of heath limitations increases post-retirement. Interestingly, the proportion of men whose partner, should they have one, reported fair or poor/very poor SAH is roughly the same pre and post-retirement. For women there is a marked increase in the proportion of partners

[12] As noted above retirement is not a permanent exit for some people so of the people classified as retired in each wave some may be working again in subsequent waves. However, in this analysis we treat first exit as an absorbing state and focus on the first transition into retirement.

[13] While not reported here, average SAH deteriorates through time. This might suggest that respondents are not rating their own health 'compared to other people of your own age …'.

reporting fair or poor/ very poor health post-retirement compared to pre-retirement. For both men and women the reporting of health limitations by partners increases post compared to pre-retirement.

{Insert Table 5 around here}

Of the other variables, the majority of individuals own their houses outright; this proportion increases after retirement and is accompanied by a decrease in the proportion of people with an outstanding mortgage. In the rental sector the share who live in local authority rented accommodation increases after retirement. The majority of individuals sampled do not have an educational qualification, (52% men and 60% women). Men are much more likely to have paid into either a private or occupational pension scheme (94%) compared to women (60%). Most individuals report working within the private sector (50% men and 48% women). Approximately an equal number of men and women have partners who are in employment (approximately 40%).

Attrition

Tables 2 to 4 show how our stock sample of men and women evolves over the twelve waves of observation. A total of 278 men have dropped out of the sample by the end of the twelfth wave. This represents 43% of the original sample of 641 men. The corresponding percentage for women is less at 38%, representing 186 non-responses from an original sample of 494 individuals. For the stock sample of individuals we are concerned with, much of the sample non-response is likely to be due to health-related attrition.[14] However, it may also be related to labour market status (for example, see Zabel (1998) and Ziliak and Kniesner (1998)). A systematic relationship between health and labour market participation and non-response may lead to attrition bias in our empirical models of the timing of the retirement decision. To test for attrition bias we use a simple variable addition test as proposed by Verbeek and Nijman (1992, p. 688). The test variable we use is an indicator for whether the individual responds in the subsequent wave (NEXT WAVE).[15] This is regressed, together with the set of conditioning variables depicted in Tables 9 and 10, on the retirement indicator using a random effects probit model. This provides a test for attrition bias. It should be noted that the test has low power and is not intended to correct for any observed attrition bias (Verbeek, 2000). Table 6 presents the variable addition tests for attrition bias

[14] See Contoyannis, Jones, and Rice (2004) and Jones, Koolman, and Rice, N. (2006) for a discussion of health-related attrition and the consequences for models of the determinants of health using the BHPS.

[15] Verbeek and Nijman (1992) also suggest using an indicator of whether the individual responds in all twelve waves and/or a count of the number of waves that are observed for the individual. However, in the context of the stock sample we employ where individuals are assumed to be at risk of retirement at the first wave (but have not already retired) then one would expect both of these indicators to be related to retirement – the longer an individual is observed, the more likely they are to have retired.

estimated using the random effects probit model. For models of health limitations and latent self-assessed health the tests do not reject the null-hypothesis of no attrition bias for both men and women.

{Insert Table 6 around here}

Kaplan-Meier Survival Curves

Figures 1 to 8 display Kaplan-Meier estimates of the probability of survival (not retiring) by health status. These are shown for men and women separately and are presented for self-assessed health (SAH), health limitations (HLLT), partner's self-assessed health and whether a partner suffers health limitations. In general men reporting very poor/poor or fair SAH have a higher probability of retiring than men in good/very good or excellent health (Figure 1). Men reporting health limitations are also associated with a greater probability of retiring compared to men not reporting limitations (Figure 2). Similar results can be found for women for SAH (Figure 5) and health that limits daily activities (Figure 6), although the effect of the latter is less than that estimated for men. Figures 3 and 4 show Kaplan-Meier estimates for the probability of not retiring for men by the reported health status of their partner, should they have a partner. Analogous results for women are displayed in Figures 7 and 8. Whilst the difference between the effects appear small, in general, individuals with partners reporting poor health status (very poor/poor or fair for SAH, or health limitations) are associated with an increased probability of retiring compared to individuals with partners reporting better health status.

{Insert Figures 1-8 around here}

Health stock

Tables 7 and 8 show results for the generalised ordered probit models for men and women respectively. These models are estimated on all available data for men and women and are not restricted to the stock sample used in the discrete-time hazard models. We do this to derive the latent health of a spouse or partner who may be younger than the stock sample will allow.[16] Accordingly, our models consist of approximately 65,000 observations on 12,631 men and 76,000 observations on 14,490 women.

{Insert Tables 7 & 8 around here}

[16] Our stock sample consists of individuals aged 50 years or over at the first wave. It is possible that a respondent's partner is younger than 50 years.

The first column of each table provides results of the latent health index obtained by regressing the self-assessed health (SAH) on objective measures of health problems (HLTHPRB). For both men and women the estimated coefficients display the expected negative sign – health problems are associated with lower reporting of self-assessed health. All effects are highly statistically significant. For men the dominant effects (in terms of the size of coefficients) are problems with arms, legs or hands, problems with chest and breathing, problems with heart or blood pressure, problems with stomach or digestion, problems with anxiety or depression, and problems reported as other. A similar set of dominant effects are observed for women, with problems with heart and blood pressure having a lesser effect than for men and diabetes and problems with alcohol or drugs having a larger relative effect than for men.

The other columns of the tables present the results for the measurement model relating the linear index to the categories of self-assessed health. This specification of the model allows for differences in the relative positions of the reporting thresholds (cut-points) for sub-groups of the population. In particular, we allow for the thresholds to vary by age and socio-economic status. In general, the coefficients, δ_j, are positive for the set of age categories and negative for the socio-economic variables. Recall that, in order to construct a proxy for latent health that is purged of latent health, we are making the stringent assumption that any association between SES and SAH, after conditioning on the indicators of health problems, reflects reporting bias. This errs on the side of caution when we construct the proxy variable. Under this interpretation negative coefficients are associated with greater 'optimism' in reporting health status – for example, individuals with greater educational attainment report higher health status for a given level of underlying latent health compared to respondents with lower educational attainment. For both men and women and for each of the cut-points in Tables 7 and 8 we observe a gradient across educational status with the coefficients decreasing with increasing education. These are significant across all cut-points. The coefficients on the labour market status variables are all negative compared to the baseline of "other". Most notably, the employed (SELF-EMPLOYED and EMPLOYED) appear to be the most optimistic in reporting their health status. Respondents who are unemployed, retired or occupied with family care have similar estimated coefficients. Respondents with higher levels of household income also report better health categories for a given level of underlying latent health compared to individuals with lower levels of income.

The positive coefficients on the age categories is interesting given that the baseline category is over 75 for men and over 65 for women. The implication is that, conditional on the socio-economic variables, younger age groups appear less optimistic about their health status compared to older age groups. This may be a consequence of the wording of the self-assessed health question which is age benchmarked by asking respondents to assess their health compared to people of their own age. It may be that older respondents are more optimistic when reporting health using an age benchmark than younger age groups. This would generate the observed gradient in reporting thresholds by age.

There is no overall pattern across the coefficients on the year dummies. However, it is worth noting that the Yr9900 coefficient stands out over the other coefficients. This represents the ninth wave of the BHPS dataset where the wording and response categories available for the self-assessed health question change. The absolute size of this coefficient compared to the other coefficients would suggest that the change of wording leads to reporting bias at wave 9. This has the effect that respondents with lower health status tend to report higher levels of health at wave 9 than at other waves and that respondents with higher underlying levels of health tend to report lower health status at wave 9 compared to their reporting at other waves. This would appear to be a consequence of the response categories available at wave nine compared to other waves. At wave 9 three response categories are available to individuals who rate their health highly: good, very good and excellent health. At other waves only good and excellent health are available. Accordingly, individuals who rate their health as excellent at waves other than wave 9 may rate their health as very good when offered this option at wave 9. Our recoded, four-category version of self-assessed health combines good and very good into a single category. This scenario is consistent with the observed positive coefficient on the Yr9900 dummy variable. Similarly, respondents reporting poor health status (the second lowest category) at waves other than wave 9 may report fair health at wave 9 (corresponding to the second lowest category available at wave 9). Respondents reporting fair health at waves other than 9 (middle available category) may report good health at wave 9 (middle available category). This change in reporting at wave 9 would be consistent with a negative coefficient on the Yr9900 dummy variable and gives the appearance of respondents being more optimistic in reporting health status at wave 9.

The effects of socio-economic characteristics on reporting bias appear to vary across the cut-points. The effect of labour market status is greatest for the first threshold making the transition between very poor /poor health and fair health. The effects diminish across the three thresholds. This implies that, for example, employed individuals in poorer health report more optimistically than individuals in better health. The effect of educational attainment is greatest for the second cut-point representing the threshold between fair and good/very good health, whilst the effect of income is greatest for the third cut-point for women and the second for men.

Discrete-time survival analysis

Results of the discrete-time hazard models of retirement are presented in Tables 9 and 10. Each table presents results for health limitations in the first set of columns and self-assessed latent health in the second set of columns. For each health model, the estimated coefficients and standard errors are shown together with the hazard ratio, which shows the proportional effect on the underling (instantaneous) probability of retiring, for a one unit change in the variable in question. All models were estimated in STATA using the *pgmhaz* routine (Jenkins, 1998). The models account for unobserved heterogeneity using a Gamma mixture distribution (Meyer, 1990). For all models log-likelihood ratio tests reject the null hypothesis of no heterogeneity.

{Insert Tables 9 and 10 around here}

Models for men and women show the expected gradient over age categories. The age categories are compared to a baseline of over 69 years for men and over 64 years for women. The hazard for retiring is negative for all categories except for ages 65 to 69 for men. This covers the state retirement age and accordingly is positive. For men, there is a gradient across educational attainment such that higher levels of education are associated with a decreasing hazard of retiring. However, the effects are significant for degree or higher degree (DEGHDEG) only. These effects are compared to the baseline category of no qualifications. None of the educational attainment dummies are significant for women. For men, the employment sector variables (measured at the first wave) are positive and significant and contrast against a baseline of self-employment. Accordingly, the hazard of retirement is greater for employees compared to the self-employed. The largest effect is observed for individuals employed within civil and local government (CIVLOCGOV), who have around three times the retirement hazard of men who work in either the private (PRIVCOMP) or 'other' (JBSECT0) sectors. The effects are reversed for women where the hazard is greater for the self-employed, however the effects are not significant.

We also observe a significant effect of pension entitlements. These variables represent whether an individual has made a contribution into a private pension plan (or an employer has made a contribution on behalf of the individual) during the observation period (PRIVPEN) and whether an individual has been a member of an employers pension scheme during the observation period (EMPPEN). Compared to the baseline of state only pension entitlement, having a private pension is associated with around a 70% decrease in the likelihood of retiring for men (85-85% for women). In contrast, having an employer pension increases the likelihood of retiring for men by almost two-fold but this is not significant for women.

For men if the spouse as a job the probability of retirement is decreased by around 40% but this variable is not significant for women. The effects of housing tenure (HSEMORT, HSEAUTH and HSERENT), mean logged household income (MLNHINC) and marital status are not significant in any of the models.

The primary focus of this paper is the role of health in determining retirement behaviours. To this end we consider both the measure of health limitations (HLLT) and the measure of underlying latent health stock (LATSAH) constructed from the generalised ordered probit model. Both of these variables are lagged one period to avoid problems of simultaneity. We also condition on the first periods health status so that the estimated effect of lagged health can be interpreted as a health shock. Further we consider the health of a respondent's spouse or partner. Clearly, this can only be defined should a respondent have a spouse or partner and therefore needs to be interpreted alongside the estimated effect of the marital status variable (MARCOUP).

For men we observe a large, positive and highly significant effect for health limitations. This implies that the hazard of retiring is greater for individuals experiencing a shock to health that leads to a health limitation. For our constructed measure of underlying latent health (which is increasing in health) we observe a negative and significant coefficient implying that the retirement hazard increases as health decreases. Again this is interpreted as a shock to health. For both models, while we observe the expected signs, the estimated coefficients on spousal health are not significant.

Results for the health variables for women are similar to the results observed for men. While health limitations have a much larger effect for men than women, the latent health variable attracts a similar coefficient estimate for both sexes and is associated with a 30% decrease in the probability of retirement. The effect of spousal health is negative in both models but while it is insignificant for health limitations, it is significant at the 6% level for latent health.

6. Discussion

The results reported above show that whichever way we measure own health in these models (either negatively via health limitations or positively via latent health stock) it is a key determinant of the retirement hazard for both men and women. The size of the health effect in these models is large compared to the other significant variables, and in particular is larger than the pension entitlement effects.

For men the important variables are own health, age, education, pension entitlement, sector of employment and whether or not the spouse has a job. Health measured as health limitation is quantitatively more important than pension entitlement in terms of its hazard ratio. For women the important variables are own health, spouse health, age and having a private pension. Health limitations have the largest hazard ratio of all variables in the models estimated for women. The significance of spouse health for women and spouse job for men may reflect the different factors underlying retirement decisions and the different sex roles within the household. It seems that for men having a working spouse increases the chance that they will remain economically active, which may provide evidence for the synchronisation of retirement decisions. While for women having a spouse in poor health increases the retirement hazard and one possible explanation is the increased need to act as a carer for their spouse.

Our models do not contain detailed information on pensions and this is common in the literature that focuses on health effects, since detailed health and pension information is rarely available in the same data sets. A recent DWP survey found that people had a very low level of knowledge about their pensions, which may cast doubt on the need for detailed pension information for our modelling objectives (Humphrey et al 2003). Our main finding in relation to pensions is that for both men and women the probability of retirement is reduced for people with a private pension. This result is possible explained by the fact this group of older workers may have acquired private pensions at a relatively late stage in their working life in order to top up the state pension which they realised would be inadequate. Consequently as the benefits of private pensions are heavily dependent on the length of contribution period they encourage longer working lives for this group. In contrast occupational pensions are usually more generous and can be drawn at an earlier stage (Meghir and Whitehouse, 1997) thus explaining the significance of this variable for men. It is also the case that to a certain extent our employment sector variables will reflect pension benefits and early retirement arrangements. So that the large positive effect of the civic or local government variable for men is explained by arrangements in that sector that are conducive to early retirement.

7. Conclusion

For older workers, health status may be an important factor in the decision to retire and this has been the primary focus of this paper. The few studies that do exist in this area have confirmed the importance of health; however they rarely take into account the dynamics of the relationship between health and retirement or joint decision making by couples, and both of these issues are tackled here.

Like the vast majority of the literature we have only subjective information on health status and our methods are designed to reduce as far as possible the problems of endogeneity, reporting bias and reporting heterogeneity that arise from using this type of information to unravel the causal relationships between health and labour market status. We use two alternative indicators of health status. Firstly, we estimate a model of SAH as a function of more objective measures of health to define a latent 'health stock' variable. This model is extended to allow for different reporting thresholds in SAH via the use of generalised ordered probits. Secondly, we use a measure of health limitations which is arguably more objective that SAH and thus less prone to the problems of the former. For both measures the causal effect is estimated via a health shock by conditioning on initial period health.

Our findings confirm those of a number of other studies; own health is an important determinant of the decision to retire and its effect is larger than that of the pension entitlement and income variables we include in our models. This is the case for both men and women and is observed for both health limitations and latent health status measures. As expected, negative shocks to health result in increases in the hazard of retirement. Further, our results provide evidence that for women the health status of their partner has an impact on their retirement decisions. This effect is not evident for men, but men's probability of retirement is reduced if they have a working spouse.

The trend towards increasing early retirement has obvious fiscal implications as increasing numbers of older people become dependent on a shrinking working population. It can also be considered a waste of human capital if people with education and skills are leaving the labour force prematurely. Designing financial incentives to encourage people to work for longer may not be sufficient as a policy tool if people are leaving the labour market involuntarily due to health problems. Instead this points to a need for improving the health of the work force and putting resources into facilitating continued work for people with health problems and disabilities. In the UK there is little or no communication between primary health care providers and employers so an integrated approach to is virtually impossible within the current system. This is exacerbated by the fact that the UK has very poor provision of occupational health professionals - about 12 for every 43000 employees (CBI, 2004). While the New Deal 50 Plus[17] is designed to help older people on benefits get back into work, unlike Pathways to Work (DWP 2002) for people on Incapacity Benefit, the New Deal does not provide specific health advice and evidence suggests that this is perceived as a shortcoming by potential clients (Kodz and Eccles 2001). Instead the integrated approach of Pathways might extended more generally to help older workers with health problems to remain

[17] www.**newdeal**.gov.uk/

economically active. However, even this programme only targets those workers who have already left the labour force whereas it may be more effective to design policy that helps older workers to remain economically active.

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Table 1: Variable names and definitions

Variable	Description
RETIRED	Binary dependent variable, = 1 if respondent states they are retired, 0 otherwise.
HLLT	Self-assessed health limitations: 1 if health limits daily activities, 0 otherwise
SAH	Self-assessed health; 1: very poor or poor, 2: fair, 3: good or very good, 4: excellent
SAHEX	Self-assessed health: 1 if excellent, 0 otherwise
SAHGVG	Self-assessed health: 1 if good or very good, 0 otherwise
SAHFAIR	Self-assessed health: 1 if fair, 0 otherwise
SAHPVP	Self-assessed health: 1 if poor or very poor, 0 otherwise (baseline category)
MLNHINC	Individual-specific mean of log equivalised real household labour and non-labour income.
HSEOWN	1 if house owned outright, 0 otherwise (baseline category)
HSEMORT	1 if house has outstanding mortgage, 0 otherwise
HSERENT	1 if house is rented, 0 otherwise
HSEAUTH	1 if house is owned by housing authority / association, 0 otherwise
MARCOUP	1 if married or living as a couple, 0 otherwise
DEGHDEG	1 if highest educational attainment is degree or higher degree, 0 otherwise.
HNDALEV	1 if highest educational attainment is HND or A level, 0 otherwise.
OCSE	1 if highest educational attainment is O level or CSE, 0 otherwise.
NOQUAL	1 if no qualifications, 0 otherwise (baseline category).
PRIVPEN	1 if respondent has made contributions to a private pension plan during observation period, 0 otherwise.
EMPPEN	1 if respondent has been a member of an employers (occupational) pension plan during observation period, 0 otherwise
PRIVCOMP	1 if respondent's sector of employment is within the private sector, 0 otherwise
CIVLOCGOV	1 if respondent's sector of employment is within civic or local government, 0 otherwise
JBSECTO	1 if respondent's sector of employment is other to above, 0 otherwise
SELFEMP	1 if respondent is self-employed, 0 otherwise (baseline category)
JOB	1 if respondent's spouse / partner has a job, 0 otherwise
AGE5054	1 if respondent is aged 50 to 54 (inclusive), 0 otherwise
AGE5559	1 if respondent is aged 55 to 59 (inclusive), 0 otherwise
AGE6064	1 if respondent is aged 60 to 64 (inclusive), 0 otherwise
AGE6569	1 if respondent is aged 65 to 69 (inclusive), 0 otherwise
NORTHW	1 if respondent resides in North West, Merseyside or Greater Manchester, 0 otherwise
NORTHE	1 if respondent resides in North, South Yorkshire, West Yorkshire, North Yorkshire, Humberside or Tyne & Wear, 0 otherwise.
SOUTHE	1 if respondent resides in South East or East Anglia, 0 otherwise (baseline category)
SOUTHW	1 if respondent resides in South West, 0 otherwise
LONDON	1 if respondent resides in Inner or Outer London, 0 otherwise
MIDLAND	1 if respondent resides in East or West Midlands or West Midc , 0 otherwise
SCOTLAND	1 if respodent resides in Scotland, 0 otherwise.
WALES	1 if respondents resides in Wales, 0 otherwise.
HLTHPRB	Self-reported health problems: 1 if problem reported, 0 otherwise. There are also individual dummies for problems with: arms, legs or hands (arms), sight (see), hearing (hear), skin conditions or allergies (skin) chest/breathing (chest), heart/blood pressure (heart), stomach or digestion (stomach), diabetes (diabetes), anxiety or depression (anxiety), alcohol or drugs (alcohol), epilepsy (epilepsy), migraine (migraine) or Other (other).

Table 2: Labour market status by wave

	1	2	3	4	5	6	7	8	9	10	11	12
Attrition		122	193	247	296	331	347	365	391	418	441	464
Self-employed	214	169	153	134	116	111	94	83	62	54	59	47
Employed	921	691	559	470	394	344	302	260	215	175	144	113
Unemployed		26	24	29	22	16	13	7	6	8	0	3
Retired		82	152	190	239	269	320	359	400	442	462	475
LT sick, disabled		13	28	30	33	33	33	30	23	15	15	10
Other		26	18	26	23	25	17	22	25	16	10	13
Deaths		6	8	9	12	6	9	9	13	7	4	10
Total	1135	1135	1135	1135	1135	1135	1135	1135	1135	1135	1135	1135
In work*	1135	860	712	604	510	455	396	343	277	229	203	160

* Employed and self-employed

Table 3: Labour market status by wave – men

	1	2	3	4	5	6	7	8	9	10	11	12
Attrition		68	116	146	176	199	209	222	235	248	262	278
Self-employed	162	138	124	105	97	89	76	68	53	46	49	38
Employed	479	349	270	228	193	169	147	129	104	93	78	62
Unemployed		19	20	23	13	10	9	5	6	5	0	2
Retired		50	80	105	125	141	168	187	214	226	233	241
LT sick, disabled		11	23	25	27	28	25	22	19	13	14	10
Other		2	2	2	1	1	3	1	4	5	1	1
Deaths		4	6	7	9	4	4	7	6	5	4	9
Total	641	641	641	641	641	641	641	641	641	641	641	641
In work*	641	487	394	333	290	258	223	197	157	139	127	100

* Employed and self-employed

Table 4: Labour market status by wave - women

	1	2	3	4	5	6	7	8	9	10	11	12
Attrition		54	77	101	120	132	138	143	156	170	179	186
Self-employed	52	31	29	29	19	22	18	15	9	8	10	9
Employed	442	342	289	242	201	175	155	131	111	82	66	51
Unemployed		7	4	6	9	6	4	2	0	3	0	1
Retired		32	72	85	114	128	152	172	186	216	229	234
LT sick, disabled		2	5	5	6	5	8	8	4	2	1	0
Other		24	16	24	22	24	14	21	21	11	9	12
Deaths		2	2	2	3	2	5	2	7	2	0	1
Total	494	494	494	494	494	494	494	494	494	494	494	494
In work*	494	373	318	271	220	197	173	146	120	90	76	60

* Employed and self-employed

Table 5: Descriptive statistics

	Men			Women		
	All	Pre - Retirement	Post - Retirement	All	Pre – Retirement	Post - Retirement
RETIRED	.324	0	1	.365	0	1
Own Health						
HLLT	.156	.127	.216	.139	.110	.190
SAHEX	.238	.257	.197	.209	.241	.153
SAHGVG	.486	.485	.488	.521	.514	.535
SAHFAIR	.213	.200	.240	.209	.193	.238
SAHPVP	.064	.058	.075	.061	.053	.075
Spousal Health						
HLLT	.180	.166	.207	.149	.140	.164
SAHEX	.156	.171	.126	.157	.183	.113
SAHGVG	.431	.437	.419	.338	.356	.307
SAHFAIR	.191	.192	.191	.171	.161	.187
SAHPVP	.085	.084	.088	.062	.059	.068
Covariates						
HSEOWN	.522	.421	.732	.563	.484	.699
HSEMORT	.320	.415	.122	.247	.322	.116
HSERENT	.046	.054	.027	.044	.055	.024
HSEAUTH	.112	.109	.118	.147	.139	.160
MARCOUP	.867	.886	.827	.744	.774	.691
DEGHDEG	.084	.087	.078	.061	.064	.057
HNDALEV	.180	.188	.164	.113	.114	.110
OCSE	.217	.214	.223	.235	.243	.221
PRIVPEN	.402	.454	.274	.224	.266	.142
EMPPEN	.539	.527	.563	.372	.380	.359
PRIVCOMP	.503	.488	.534	.483	.494	.465
CIVLOCGOV	.137	.123	.167	.205	.202	.210
JBSECTO	.100	.098	.105	.209	.204	.217
JOB	.413	.528	.174	.369	.493	.153

Table 6: Verbeek and Nijman test for attrition bias: based on random effects probit models of retired against health limitations or latent self-assessed health and set of conditioning variables that appear in Tables 9 & 10

	NT	β	S.E.	z-test	p-value
NEXT WAVE					
Men					
Health limitations	4016	.097	.175	.55	.582
Latent self-assessed health	3968	.149	.180	.83	.409
Women					
Health Limitations	3210	-.089	.183	-.49	.625
Latent self-assessed health	3133	-.142	.194	-.73	.465

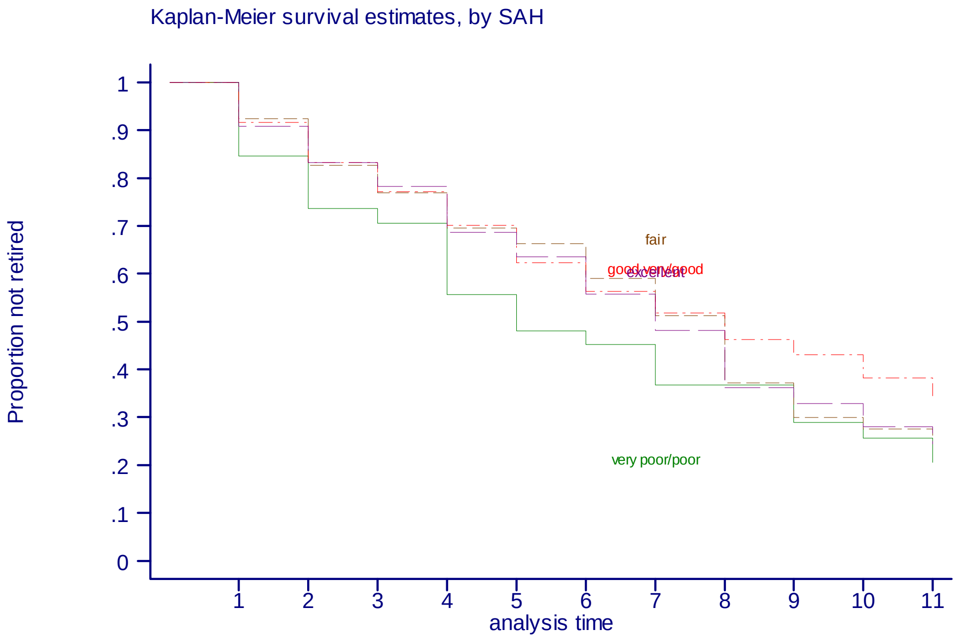

Figure 1: Kaplan-Meier estimate of the proportion of men not retired by self-assessed health (SAH).

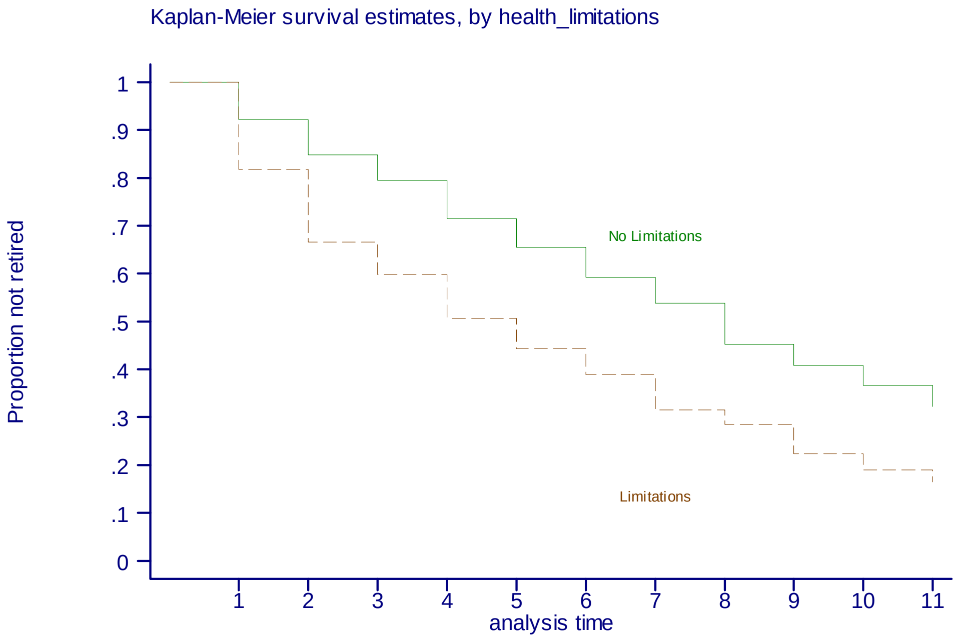

Figure 2: Kaplan-Meier estimates of the proportion of men not retired by health limitations

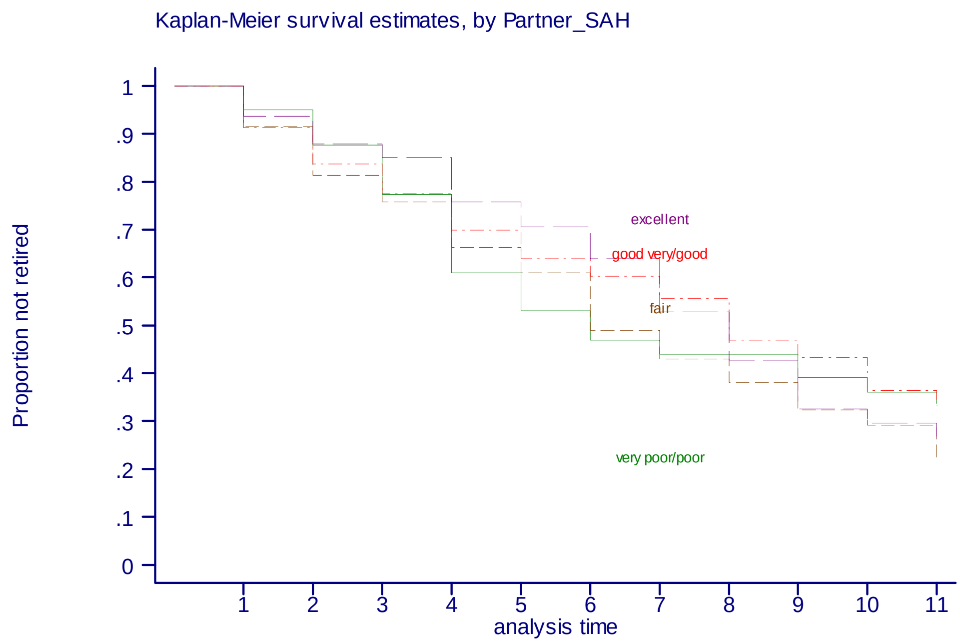

Figure 3: Kaplan-Meier estimates of the proportion of men not retired by partner's self-assesed health status

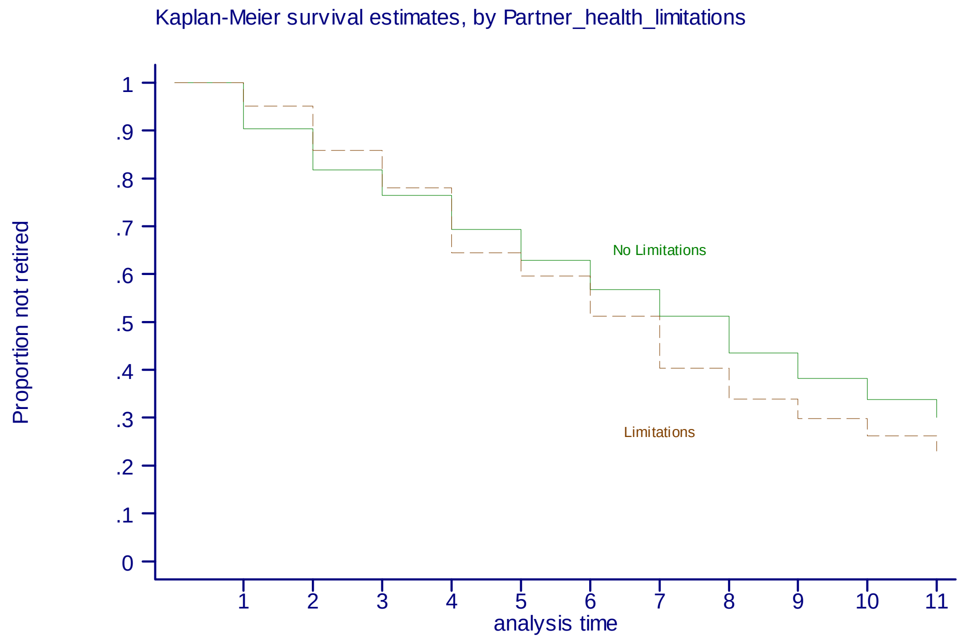

Figure 4: Kaplan-Meier estimates of the proportion of men not retired by partner's health limitations

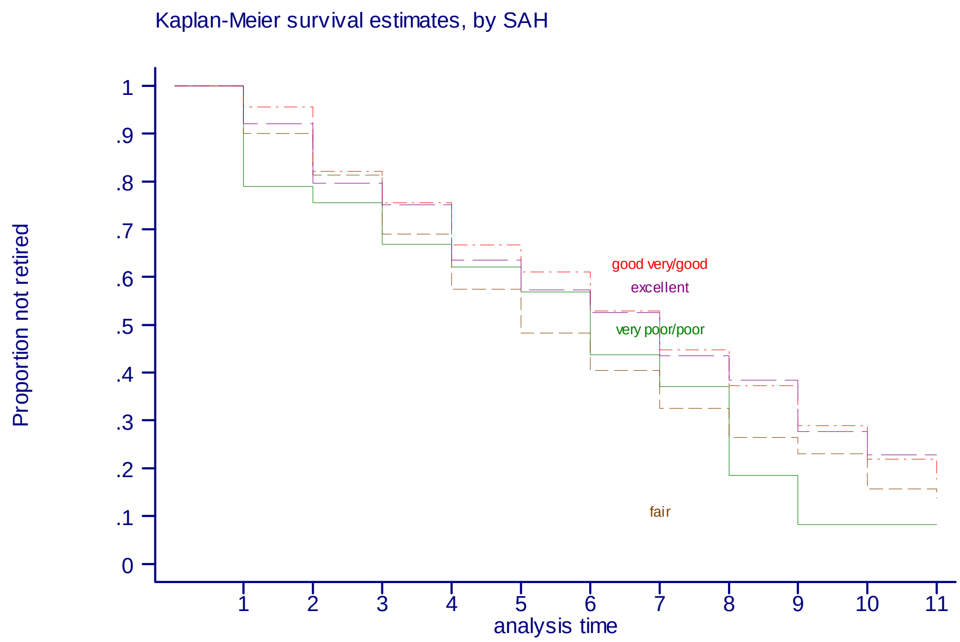

Figure 5: Kaplan-Meier estimate of the proportion of women not retired by self-assessed health (SAH).

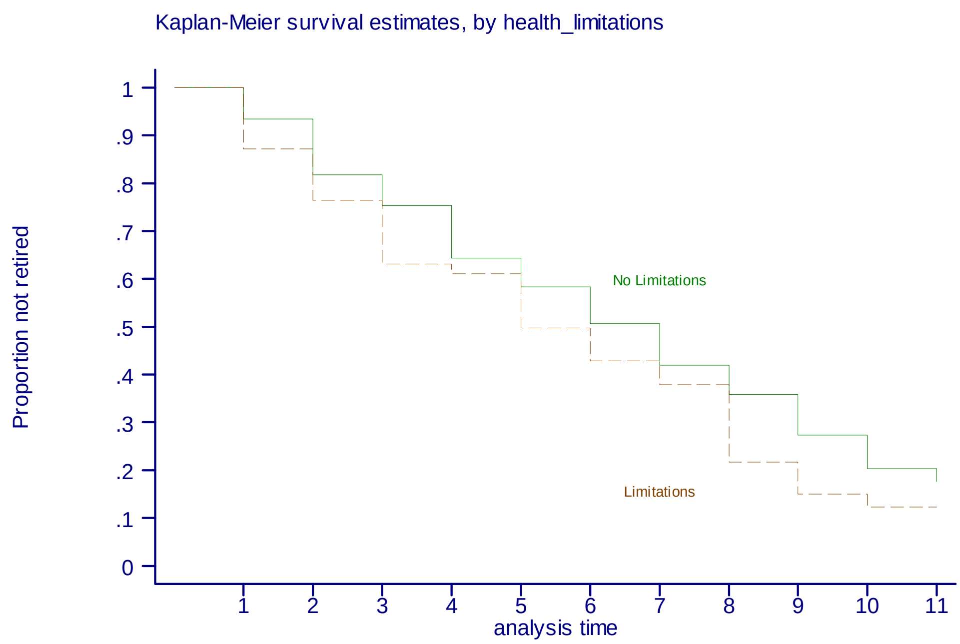

Figure 6: Kaplan-Meier estimates of the proportion of men not retired by health limitations

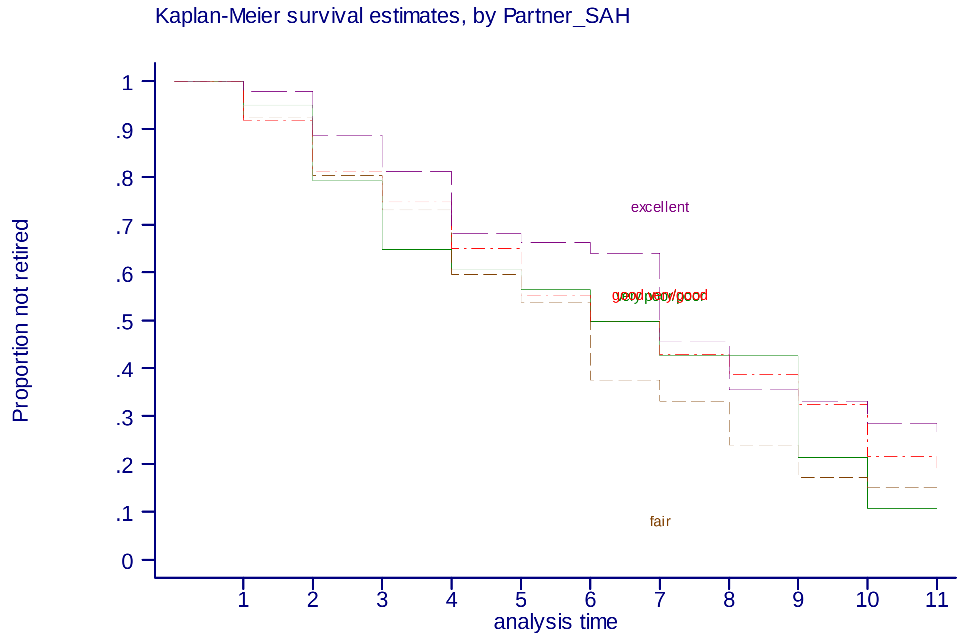

Figure 7: Kaplan-Meier estimates of the proportion of women not retired by partner's self-assesed health status

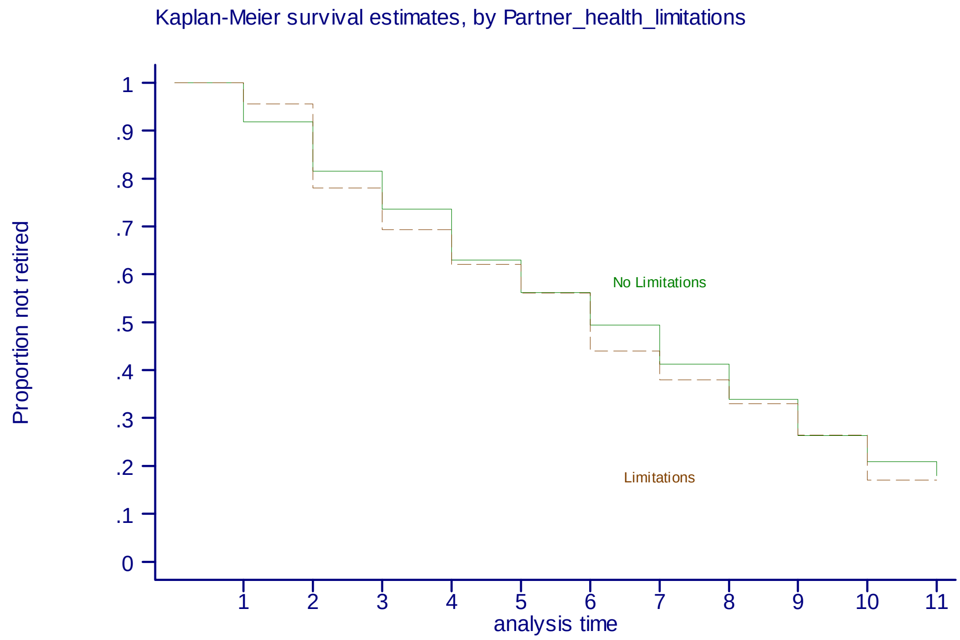

Figure 8: Kaplan-Meier estimates of the proportion of women not retired by partner's health limitations

Table 7: Generalised Ordered Probit model for SAH – Men

Men NT = 64,802 N = 12,631				Cut-Point 2		Cut-Point 3		Cut-Point 4	
Latent Health Index	Coef.	S.E.	Measurement Model	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Health Problems									
(HLTHPRB):			Age Groups:						
Arms, Legs or hands	-.640	(.017)	15-19	.128	(.090)	.111	(.064)	.124	(.073)
Sight	-.236	(.030)	20-24	.501	(.084)	.395	(.061)	.179	(.071)
Hearing	-.118	(.024)	25-29	.530	(.084)	.419	(.060)	.151	(.070)
Skin condition or allergies	-.075	(.023)	30-34	.564	(.082)	.409	(.059)	.167	(.070)
Chest / Breathing	-.640	(.022)	35-39	.513	(.082)	.416	(.059)	.192	(.070)
Heart / Blood pressure	-.597	(.023)	40-44	.514	(.082)	.354	(.059)	.159	(.070)
Stomach or digestion	-.679	(.027)	45-49	.539	(.080)	.327	(.058)	.137	(.070)
Diabetes	-.522	(.044)	50-54	.445	(.079)	.302	(.057)	.117	(.070)
Anxiety / Depression	-.754	(.032)	55-59	.281	(.078)	.273	(.055)	.112	(.068)
Alcohol or Drugs	-.450	(.085)	60-64	.065	(.073)	.167	(.052)	.004	(.064)
Epilepsy	-.484	(.093)	65-69	-.005	(.059)	.114	(.045)	-.035	(.057)
Migraine	-.302	(.031)	70-74	-.035	(.054)	.090	(.042)	-.013	(.053)
Other	-.743	(.033)	MARCOUP	-.039	(.030)	-.014	(.023)	.010	(.024)
			DEGHDEG	-.372	(.055)	-.442	(.036)	-.287	(.035)
			HNDALEV	-.170	(.038)	-.321	(.028)	-.183	(.029)
			OCSE	-.115	(.039)	-.222	(.027)	-.080	(.029)
			SELF-	-.845	(.062)	-.633	(.040)	-.260	(.040)
			EMPLOYED	-.777	(.040)	-.548	(.031)	-.187	(.031)
			EMPLOYED	-.507	(.048)	-.291	(.036)	-.053	(.039)
			UNEMPLOYED	-.382	(.061)	-.375	(.046)	-.099	(.053)
			RETIRED	-.525	(.120)	-.291	(.077)	-.038	(.079)
			FAMILY CARE	-.059	(.018)	-.092	(.012)	-.082	(.012)
			LNINC	-	(.180)	.016	(.126)	1.065	(.133)
			CONSTANT	1.270					
			Year Dummies		(.042)	.034	(.027)	.106	(.024)
			Yr 9293	.004	(.045)	.032	(.028)	.138	(.026)
			Yr 9394	-.048	(.045)	.063	(.029)	.168	(.027)
			Yr 9495	.011	(.046)	.093	(.029)	.221	(.027)
			Yr 9596	-.008	(.045)	.076	(.029)	.187	(.027
			Yr 9697	-.013	(.044)	.086	(.029)	.108	(.026)
			Yr 9798	-.042	(.044)	.111	(.029)	.212	(.027)
			Yr 9899	.068	(.046)	-.269	(.029)	.500	(.027)
			Yr 9900	-.467	(.041)	.131	(.027)	.226	(.026)
			Yr 0001	-.003	(.041)	.063	(.027)	.113	(.025)
			Yr 0102	-.090	(.042)	.058	(.027)	.131	(.026)
			Yr 0203	-.087					
Likelihood	-66745.9								

Table 8: Generalised Ordered Probit model for SAH – Women

Men NT = 75,980 N = 14,490				Cut-Point 2		Cut-Point 3		Cut-Point 4	
Latent Health Index	Coef.	S.E.	Measurement Model	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Health Problems									
(HLTHPRB):			Age Groups:						
Arms, Legs or hands	-.649	(.015)	15-19	.095	(.066)	.128	(.052)	.251	(.060)
Sight	-.192	(.026)	20-24	.309	(.061)	.317	(.049)	.233	(.058)
Hearing	-.113	(.026)	25-29	.408	(.061)	.326	(.048)	.152	(.058)
Skin condition or allergies	-.098	(.017)	30-34	.385	(.059)	.302	(.047)	.102	(.057)
Chest / Breathing	-.594	(.020)	35-39	.337	(.059)	.251	(.048)	.120	(.057)
Heart / Blood pressure	-.482	(.019)	40-44	.257	(.060)	.194	(.048)	.044	(.058)
Stomach or digestion	-.617	(.024)	45-49	.255	(.060)	.215	(.047)	.074	(.058)
Diabetes	-.630	(.044)	50-54	.110	(.059)	.110	(.046)	.091	(.057)
Anxiety / Depression	-.738	(.021)	55-59	-.030	(.058)	.056	(.045)	.009	(.056)
Alcohol or Drugs	-.671	(.122)	60-64	-.154	(.053)	-.098	(.042)	-.102	(.052)
Epilepsy	-.527	(.080)	65-69	-.177	(.050)	-.117	(.040)	-.062	(.050)
Migraine	-.253	(.019)	70-74	-.099	(.044)	-.069	(.036)	-.025	(.049)
Other	-.827	(.024)	MARCOUP	.044	(.025)	.040	(.019)	.061	(.021)
			DEGHDEG	-.410	(.044)	-.465	(.033)	-.304	(.036)
			HNDALEV	-.229	(.036)	-.352	(.027)	-.217	(.030)
			OCSE	-.196	(.030)	-.279	(.024)	-.176	(.028)
			SELF-EMPLOYED	-.679	(.068)	-.501	(.051)	-.235	(.053)
			EMPLOYED	-.718	(.036)	-.473	(.028)	-.068	(.030)
			UNEMPLOYED	-.445	(.054)	-.207	(.039)	.048	(.046)
			RETIRED	-.484	(.047)	-.305	(.038)	-.025	(.046)
			FAMILY CARE	-.500	(.038)	-.285	(.031)	-.007	(.035)
			LNINC	-.040	(.015)	-.092	(.011)	-.105	(.012)
			CONSTANT	-1.215	(.149)	.082	(.108)	1.328	(.123)
			Year Dummies						
			Yr 9293	-.022	(.034)	.002	(.023)	.064	(.024)
			Yr 9394	-.082	(.037)	.023	(.025)	.135	(.025)
			Yr 9495	-.123	(.038)	.048	(.025)	.200	(.026)
			Yr 9596	-.098	(.038)	.075	(.026)	.217	(.026)
			Yr 9697	-.091	(.039)	.073	(.026)	.203	(.027)
			Yr 9798	-.055	(.036)	.081	(.026)	.132	(.026)
			Yr 9899	-.053	(.037)	.068	(.026)	.205	(.027)
			Yr 9900	-.630	(.040)	-.364	(.026)	.446	(.026)
			Yr 0001	-.066	(.034)	.079	(.024)	.194	(.025)
			Yr 0102	-.080	(.035)	.041	(.024)	.068	(.024)
			Yr 0203	-.065	(.035)	.053	(.025)	.079	(.025)
Likelihood	-78958.1								

Table 9: Hazard model for retirement transition – Men

Men	Health Limitations N = 3006			General Health N = 2967		
	Coef	S.E.	Hazard ratio	Coef	S.E.	Hazard ratio
Own Health:						
HLLT(t-1)	1.490	(.319)	4.437			
HLLT(0)	.217	(.545)	1.242			
LATSAH(t-1)				-.487	(.185)	.614
LATSAH(0)				.053	(.253)	1.054
Spousal Health:						
HLLT	.201	(.251)	1.223			
LATSAH				-.077	(.150)	.925
Spousal Job:						
JOB(t-1)	-.441	(.220)	.643	-.520	(.214)	.595
Covariates:						
AGE5054	-4.269	(.761)	.014	-3.868	(.751)	.021
AGE5559	-3.639	(.645)	.026	-3.240	(.642)	.039
AGE6064	-2.726	(.580)	.066	-2.408	(.596)	.090
AGE6569	.466	(.420)	1.594	.586	(.417)	1.797
MARCOUP	-.471	(.368)	.625	-.450	(.375)	.637
DEGHDEG	-1.165	(.505)	.312	-1.015	(.481)	.362
HNDALEV	-.299	(.341)	.742	-.290	(.326)	.748
OCSE	-.116	(.337)	.891	-.118	(.327)	.889
HSEMORT(t-1)	.110	(.258)	1.116	.186	(.257)	1.204
HSEAUTH(t-1)	-.239	(.410)	.787	-.203	(.394)	.816
HSERENT(t-1)	-.234	(.527)	.791	-.280	(.515)	.756
MLNHINC	.530	(.289)	1.699	.461	(.277)	1.585
PRIVPEN	-1.282	(.332)	.278	-1.239	(.338)	.290
EMPPEN	.782	(.371)	2.185	.703	(.361)	2.019
PRIVCOMP(0)	1.015	(.387)	2.759	.933	(.367)	2.542
CIVLOCGOV(0)	2.065	(.544)	7.886	1.960	(.526)	7.097
JBSECTO(0)	.861	(.522)	2.366	.889	(.505)	2.433
Log Likelihood	-711.1			-712.6		
Chi-squared(1 df)†	43.1			31.35		
P – value	<0.001			<0.001		

† LR test of model with gamma distributed heterogeneity (H1) against model without controlling for heterogeneity (H0).
All models contain a set of regional area dummies to control for differences in labour market conditions – results not shown to conserve space.

Table 10: Hazard model for retirement transition – Women

Women	Health Limitations N = 2196			General Health N = 2141		
	Coef	S.E.	Hazard ratio	Coef	S.E.	Hazard ratio
Own Health:						
HLLT(t-1)	.810	(.295)	2.248			
HLLT(0)	-.258	(.550)	.773			
LATSAH(t-1)				-.475	(.203)	.622
LATSAH(0)				-.021	(..370)	.980
Spousal Health:						
HLLT(t-1)	-.105	(.297)	.900			
LATSAH				-.402	(.211)	.670
Spousal Job:						
JOB(t-1)	-.213	(.273)	.808	-.130	(.300)	.878
Covariates:						
AGE5054	-3.485	(.668)	.031	-3.823	(.780)	.022
AGE5559	-3.337	(.627)	.036	-3.865	(.743)	.021
AGE6064	-1.357	(.424)	.257	-1.652	(.492)	.192
MARCOUP	.038	(.373)	1.038	-.282	(.466)	.754
DEGHDEG	.055	(.615)	1.057	.034	(.740)	1.035
HNDALEV	.236	(.488)	1.266	.162	(.589)	1.175
OCSE	-.304	(.360)	.738	-.419	(.429)	.658
HSEMORT(t-1)	-.387	(.279)	.679	-.467	(.320)	.627
HSEAUTH(t-1)	.128	(.437)	1.136	.001	(.517)	1.001
HSERENT(t-1)	-.313	(.623)	.731	-.346	(.680)	.707
MLNHINC	.386	(.349)	1.472	.641	(.423)	1.899
PRIVPEN	-1.642	(.492)	.194	-1.931	(.633)	.145
EMPPEN	.554	(.338)	1.740	.682	(.404)	1.978
PRIVCOMP(0)	-.671	(.632)	.511	-1.352	(.931)	.259
CIVLOCGOV(0)	-.941	(.709)	.390	-1.621	(1.020)	.198
JBSECTO(0)	-.827	(.671)	.437	-1.380	(.937)	.252
Log Likelihood	-672..7			-648.7		
Chi-squared(1 df)†	20.93			44.89		
P – value	<0.001			<0.001		

† LR test of model with gamma distributed heterogeneity (H1) against model without controlling for heterogeneity (H0).

All models contain a set of regional area dummies to control for differences in labour market conditions – results not shown to conserve space.