Health and Work of the Elderly

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Subjective Health Measures, Reporting Errors and the Endogenous Relationship between Health and Work

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Abstract

In empirical studies of retirement decisions of the elderly, health is often found to have a large, if not dominant, effect. Depending on which health measures are used, these estimated effects may be biased estimates of the causal effect of health on the dependent variable(s).Research indicates that subjective, self-assessed health measures may be affected by endogenous reporting behaviour and even if an objective health measure is used, it is not likely to be strictly exogenous to labour market status or labour income. Health and labour market variables will be correlated because of unobserved individual-specific characteristics (e.g., investments in human capital and health capital). Moreover, one's labour market status may be expected to have a (reverse) causal effect on current and future health. In this paper we analyse the relative importance of these endogeneity and measurement issues in the context of a model of early retirement decisions. We state assumptions under which we can use relatively simple methods to assess the relative importance of state dependent reporting errors in individual responses to health questions. The estimation results indicate that among respondents receiving disability insurance allowance, reporting errors are large and systematic and that therefore using these measures in retirement models may seriously bias the parameter estimates and the conclusions drawn from these. We furthermore found that health deteriorates with work and that the two variables are endogenously related.

1   Introduction

Though there may be some controversy about the relative importance of financial incentives in explaining trends in retirement in the U.S., the larger part of the European studies appear to more conclusive[1]. Most European studies point at strong incentive effects from Social Security and Early Retirement schemes. This may be due to the strong disincentive effects that characterise most of these European systems. Both the availability of alternative routes to retirement and the (relative to the U.S.) generosity of these routes provide these disincentive effects.

The Netherlands may be an extreme case, both in terms of observed retirement patterns as well as in terms of the characteristics of the institutional setting. Since the mid-seventies Labour force participation rates of elderly males (55 years and older) have dropped about 50% points to a current level of less 30%. Employer provided Early Retirement (ER) schemes allow for retirement at the age of 60, or sometimes even earlier[2]. In addition to these schemes there are Unemployment Insurance schemes (UB) and Disibility Insurance schemes (DI) to protect workers from income losses due to (involuntary) unemployment and poor health. It has been argued that notably the DI system, though not designed for this purpose, has been used explicitly as an alternative route for retirement, with the consent of worker, employer and the DI administrators (see for instance, Aarts & de Jong (1992)). Kerkhofs, Lindeboom & Theeuwes (1999) find strong incentive effects for Early Retirement schemes and that there is evidence that income streams in alternative exit routes (DI, UI and ER) are compared in the retirement decision and that these alternative exit routes act as substitutes.

The Netherlands may be an extreme case in this respect, but strong incentive effects have also been found for other countries. With respect to Disability application behaviour in other countries like the United States, Germany and Sweden, it has been argued that labour supply (and labour demand) considerations may have taken place in the decision to apply for benefits. To quote Bound and Burkhauser (1999): "the prevalence of disability transfer recipients per worker has increased at all working ages over the last quarter of the century in the United States and in the Netherlands, Sweden and Germany. This coincides with an increase in both access to and the generosity of publicly provided social insurance and social welfare programs targeted at people with disabilities in the industrialised world." This implies that in all countries the stock of DI recipients may consist of workers who are in poor health as well as those who are in good health. The extent to which this occurs will differ for different countries and it will depend on the accessibility and generosity of the programmes in these countries.

The above has also direct consequences for applied econom(etr)ic research. The majority of non-participating elderly report that health rather than financial incentives played an important role in their retirement behaviour. And indeed, inclusion of subjective health measures in retirement models generally led to large and dominant effects of health, and relatively small effects of financial incentives on retirement behaviour. This phenomenon generated a large number of contributions to the retirement literature (see for instance Parsons (1982), Anderson & Burkhauser (1985), Bazzoli (1985), Butler, Burkhauser, Mitchell &

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[1] See for instance Perrachi en Welch (1996) and Krueger and Pischke (199?) for advocates of the propostion that incentive effects have accounted for a relatively small part of the drop in the retirement rates. See for instance Fields and Mitchell (1986), Stock and Wise (199?) and rust & Phelan (1997) for studeis that find relatively large incentive effects from pensions and/or Social security.

[2] The average age of entitlement in our survey is 60.

Pincus (1987), Stern (1990) and Bound (1991), Kerkhofs & Lindeboom (1995), Dwyer & Mitchell (1998) and Kreider (1999). The basic argument of these studies is that health must be treated as an endogenous variable in retirement models. Health may be endogenous in the 'classical' sense that it is correlated with unobserved factors (e.g. an individuals time preference, previous investments in human capital and health capital), that affect both health and labour supply decisions (Fuchs (1982)), or there may run a direct causal effect from work to health. With respect to the latter, work, or stress associated with work may put a strain on an individual's health, causing it to deteriorate faster over time. In addition to this, health measures typically used in empirical studies may be affected by endogenous reporting behaviour. The outcome of a direct question to an individual's health status may depend on the labour market status of the respondent. There may be economic motives or it may be the case that individual's are inclined to give their answer conform to social norms. Reporting health as a major determinant for inactivity is socially more accepted, and eligibility conditions for some Social Security Benefits, notably Disability Insurance Benefits, are contingent upon bad health. So, individuals out of work may be inclined to overstate health problems.

This systematic bias in the reporting behaviour of some individuals implies that it may be dangerous to use subjective health measures to characterise the health condition of the respondents in the sample. It also implies that, used in empirical models of labour supply, these measures tend lead to an overestimate of the effect of health and an underestimate of the effect of economic incentives.

This paper focuses on the issue of reporting errors in subjective health measures. We state assumptions under which we can use relatively simple methods to assess the relative importance of state dependent reporting errors in individual responses to health questions. The methods proposed in this paper could be used directly to purge reporting biases from the subjective health responses to generate unbiased measures of health that can be used in subsequent analyses. The methods are applied on Dutch data[3], It may be clear from the discussion in the beginning of this section that we expect this phenomenon to be particularly relevant for data of countries were DI schemes are relatively easy to access and relatively generous.

In order to eliminate the subjective nature of responses to questions about health, various authors have used measures that are believed to be more objective, for instance observed future death of respondents in the sample (Parsons (1982), Anderson and Burkhauser (1985)) or sickness absenteeism records (Burkhauser (1979)). As pointed out by Bazzoli (1985) and Bound (1991), health as far as it is associated with work is of importance and parameter estimates in retirement models are subject to errors in variable bias if these objective measures are not perfectly correlated with work related health. The use of lagged responses to health questions or an instrumental variable method as proposed by Stern (1990) or Aarts & de Jong (1991), Dweyer & Mitchell (1998) are also of little help, since that in itself does not eliminate the state dependent reporting errors. Our work is closely related to the work of Kerkhofs and Lindeboom (1995) and Kreider (1999).

Kerkhofs & Lindeboom (1995) and Kreider (1999) take a very similar approach. In both studies the group of workers is taken as a benchmark and more objective health measures, such as observed chronic

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[3] This is the CERRA household survey, a survey held among elderly workers in 1993 and 1995. The survey is specifically designed for the analyses of labour market behaviour of elderly workers. In contents and structure this survey is very similar to the Health and Retirement Survey (HRS).

health disorders (Kreider), or a more objective medical test score (Kerkhofs & Lindeboom), are used to filter out the bias relative to the group of workers. The general idea is that workers have no incentives to report with error. The fundamental assumption is that the observed more objective health measure acts as a sufficient statistic for the effect of work on health, and that therefore remaining systematic differences between the subjective and objective measures across the labour market states can be attributed to reporting errors. Both approaches allow for different response behaviour across the different labour market states, and therefore differ from studies that use an instrumenting procedure that does not exploit the information from different groups on the labour market explicitly (such as Stern (1990), Aarts & de Jong (1992) and Dweyer & Mitchell (1998).

The main problem with the approaches taken by Kerkhofs & Lindeboom and Kreider is that their approaches will fail to produce correct estimates of the bias in the health responses, in the case that there are unobservables that affect both health and work. The unobservables make included labour market variables in thresholds of the ordered response models in Kerkhofs & Lindeboom effectively endogenous. In principle the same critic applies to Kreider's paper. He estimates the reporting errors model on workers alone and distillates the reporting errors from a comparison of the results of this (limited information) model with the outcome of a model based on the full sample (i.e. workers and non-workers). In the case that there are unobservables that affect both health and work, differences may reflect differences in reporting behaviour and other behavioural differences that may exist between workers and non-workers. Moreover, the presence of unobservables makes the objective health measure(s) included in their models effectively endogenous.

A way to deal with this form of ('classical') endogeneity is to extent the health-reporting model with a model for the dynamics in health and the way in which work decisions affect health outcomes. Estimates of this part of the model serve the literature on retirement behaviour of elderly and public policy. To start with the latter, health and productivity are strongly related and policies to fight early withdrawal from the labour force all aim at postponing retirement. In the context of a rapidly ageing society it is important to understand that postponement of retirement ages has direct consequences for the health condition of the population. It is of direct importance for the retirement literature, as it implies that health, but also instruments based on objective health measures, should be treated as endogenous variables in retirement models. Up to now this is mostly ignored[4].

Subjective health measures obtained from data of elderly will always be contaminated by biased responses. The extent to which this occurs will crucially depend upon the institutional set up, and the way in which (notably) Disability Insurance schemes allow for retirement for other reasons then health. We therefore briefly discuss in section 2 the main elements of the Social Security and pension system in the Netherlands. Section 3 presents a model for health and work decisions of the elderly. In section 4 we formulate our health reporting model and state conditions under which our model could be used to identify the relative importance of reporting behaviour in survey data. Section 5 describes the data. The empirical implementation of the model and results are presented in section 6. Section 7 summarises and concludes.

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[4] An exception is Sickless and Taubmann (1986), who estimate a model for retirement behaviour, where health is treated as an endogenous variable. They do, however, not consider the issue of reporting errors.

2   A brief introduction to the Dutch system

Dutch benefit programmes can be divided into Social Security benefit programmes and employer provided Early Retirement (ER) programmes. Social Security programmes consists of Unemployment Insurance (UI) and Disability Insurance (DI) programmes. Unemployment Insurance programmes can be divided into Unemployment Benefit (UB) programmes, to provide a safety net for those who lose their income due to involuntary unemployment, and social assistance (SA) provisions.

The UB entitlement period depends upon previous job tenure and work experience and lasts up to a maximum of 5 years. Benefit replacement rates are a fixed percentage (70%) of previous gross earnings. Benefit recipients have to be in active search for employment to maintain (full) benefits. Recipients 57,5 years and older are exempted from the active search requirement. As a result UB is often a source of pre-pension retirement income for elderly workers. At the conclusion of the UB entitlement period, the unemployed can apply for SA. However, the drop in unemployment benefit levels may be substantial as SA benefits are seventy percent of minimum wages (the monthly gross minimum wage was 2,163 Dutch guilders in 1994). SA benefits are provided up to the mandatory retirement age (65 years).

Disability Insurance (DI) is provided to protect those who have a physical and/or mental inability to perform gainful employment. Up to the summer of 1993, benefit levels were 70 percent of gross earnings and in practice were provided up to the mandatory retirement age. Though not designed for that purpose, in the past, DI schemes have been used as an exit route for elderly workers (healthy and unhealthy) with consent of the employer, the worker and the DI administrators (see for instance, Aarts & de Jong (1992)). To reduce the number of DI beneficiaries the government tightened DI regulations in the summer of 1993 and introduced a limited benefit entitlement period and medical examinations at regular times to assess the disability status of the recipient. Due to political pressure beneficiaries 45 years and older were exempted from the tighter rules. Since 1993 the DI entitlement period depends on age and ranges from 0 to 6 years. After this initial entitlement period benefits levels are lowered, according to a function of previous wages, minimum wages and age.[5])). For workers of 58 years and older, full DI benefits are provided up to the mandatory age of retirement (age 65). Despite the efforts to reduce the inflow into DI schemes, the number of DI claimants continued to grow. In 1970 about 200,000 were enrolled in the DI scheme, in 1980 this has grown to 650,000 and continued to grow to about 900,000 now. Since the mid nineteen eighties the economic recovery has led to a growth of the number of jobs and a steady decline in the number of unemployed (currently about 250,000), but over these years the number of DI recipients continued to grow at a constant speed.

Early Retirement (ER) schemes, introduced in the late seventies, are employer provided schemes and were initially designed as programmes to induce the elderly to retire early in order to make room for young unemployed workers. ER replacement rates vary by sector or even by firm, but are generally financially very attractive. The average replacement rate is eighty percent of previous gross earnings and in some cases net replacement rates may be close to one. ER eligibility typically depends on age and/or job tenure. Since 1957 all residents of the Netherlands are entitled to a flat rate social security benefit at age 65. The monthly benefit amount is tied to the government-mandated minimum wage. Almost all workers can supplement

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[5] Details on the specifics of the UI and DI benefits are available upon request.

these basic social security benefits with mandated employer pension benefits. Kapteyn and De Vos (1997) report that almost all occupational pension plans are defined benefit plans (usually with pension benefits depending on final year's earnings) and that, together with social security benefits, they replace between 60 and 69 percent of the median retiree's pre-tax earnings.

Lindeboom (1999) calculated implicit tax rates for ER, UI and DI schemes in the Netherlands[6]. These calculations showed that it is financially most attractive to apply for ER benefits at the very moment that a worker becomes eligible for ER benefits. Implicit tax rates of these ER schemes are about 70%[7]. Straightforward calculations based on our data indicate that individual behaviour is consistent with the incentive structure. About 80% of the workers who become eligible for an ER scheme retire once they become eligible. This is reflected in Dutch participation rates. At age 60 around only 20% of the workers is observed to be in paid work. It is important to note that already at age 55 a significant fraction is observed to be out of work (30%). At this age workers are rarely eligible for ER benefits and therefore the larger part of these non-workers are in either UI (47%) or DI (53%) schemes. Maximum implicit tax rates of UI and DI schemes are about 60% and peak at age 58. Outflow rates from the stock of non-working individuals appear to be extremely low for Dutch elderly. For elderly UI and DI recipients active search for (re)employment is not a requirement for eligibility, and ER recipients actually loose retirement benefits upon re-entering employment. This makes UI, DI and ER effectively absorbing retirement states for elderly workers.

3   A conceptual model for health and retirement

This section describes a model for health and retirement decisions of elderly workers that fit the institutional set-up of section 2. We briefly describe estimation of the model in case one has access to perfect information on individual histories of health and work decisions of elderly workers. We next discuss difficulties with the implementation of the model in case one has access to survey data that one usually has to rely on.

Retirement behaviour is viewed as a dynamic process in which the decision to stop or continue working depends on a comparison of retirement options that become available over time. Retirement options are characterised by retirement date (age) and route (ER, DI, UI) and consists of packages of retirement years of leisure and the present discounted value of retirement income streams. Health enters the model because it directly affects individual utility (for instance, health limitations may change individual tastes). As ER, DI and UI are practically absorbing non-working states the optimisation problem is essentially an optimal stopping problem.

More specifically, we assume that individuals start thinking about retirement at age (age) $a=0$. The end of the horizon is fixed and taken at $a=T$. For each labour market state we define $U_a^k = U(Y_k(a), H(a), a)$ as the per period utility flow of being in labour market state k at age a. U_a^k depends on income, Y, health, H, and leisure. Leisure is implicitly defined by the age at retirement a. Relative preferences for income and leisure

[6] Defined as the ratio of the growth in the present discounted value of the retirement income and the yearly gross wages. See also the project by Gruber & Wise (1997).
[7] These numbers differ from Kapteyn and De Vos, who report imnplicit tax rates of about 140%. There calculations are based on

may depend on health. Note that retirement income of a specific route r, $r\in\{ER,DI,UI\}$, depends upon the age of retirement, as entitlement regulations and replacement rates vary with age. Access to specific retirement routes at different points in time is determined by eligibility conditions. To allow for observed heterogeneity in retirement patterns, observed individual characteristics and unobserved (random) components (ξ^r) may enter the model. The may be included to account for, individual heterogeneity, optimisation errors, and/or uncertainty about future events.

Given the model structure, the workers optimisation problem can be written as a sequence of per period decisions based on a comparison of the value of to stop work ($V^r(a) = U^k_a + \beta\, V^r(a+1)$, $r\in A_a$, for a given set of options $A_a \subseteq \{ER, UI, DI\}$) and the value of continued ($V^w(a) = U^w_a + \beta\, E \max\{V^r(a+1), V^w(a)\}$, with $r\in A_{a+1}$). β is the discount factor and E the expectations operator. Assumptions regarding the nature of unobservables determine the essentials of the model. Suppose we assume perfect foresight about future retirement options, and take the unobservables to account for optimisation errors and/or utility specific shocks known to the individual worker, but not to the researcher. Under these assumptions the model boils down to a single optimisation problem concerning retirement date and exit route taken at the starting date. Alternatively, uncertainty concerning future stopping dates and routes may enter the model and we effectively have a dynamic program/optimal stopping model such as for instance as in Daula and Moffitt (1995).

Decisions regarding work affect an individual's health. We summarise the work decision at age a by $S(a)$. Furthermore, some people may be intrinsically more healthy than others. We denote this usually unobserved factor by γ. Individual decisions regarding health related behaviour (Z) would also have an affect on an individual's health. Z will typically contain elements such as smoking, drinking, exercising etc. Health related behaviour depends on the individual's attitude towards risk and the individual's time discount rate. Note that these variables may be unobserved in practice. In line with this we may specify a health production function $H(a)$ as $H(a)=F(H(0),S(0),..S(a),Z(0),...Z(t),\gamma)$.

The retirement model may be solved by the individual, subject to the health production function $H(a)$. Each period the individual worker will make decisions regarding work and non-work, considering the alternative available exit routes and the income streams attached to each of these options. The worker takes into account his or her present health condition and will recognise the effect of work choices on current and future health.

Suppose that one has access to data that fully cover the relevant time period, $a=0,...,T$, then the likelihood function associated with an observed sequence of work decisions ($S(0),\ldots, S(T)$) and health outcomes ($H(0),\ldots,H(T)$) can be written as the product of a series of conditional transition probabilities. More specifically, $Pr[S(0),S(1),...,S(t), H(0),H(1),.....,H(T)] =Pr[S(t)|H(a),\ldots,S(a-1),\ldots,]*Pr[H(t)|H(t-1),\ldots,S(a-1),\ldots]*\ldots\ldots*Pr[S(1)|H(1),H(0),S(0)] *Pr[H(1) |H(0),S(0)]$. This likelihood function consist of a series of independent transition probabilities, in the case that we observe H and S without error and if all relevant explanatory variables are observed in the data. In practice these conditions will be violated. It will be difficult to fully observe all relevant factors for the health and retirement decision, or stated differently, γ and ξ^r , $r=UI,DI,ER$, are likely to be generated by non-degenerate distributions and are likely to be correlated. This issue boils down to standard problems for which solutions are readily available. More importantly, for the present paper is that we do not observe the true work related health (H) and that we

net wages.

therefore need a model that relates usually observed health indicators to *H*. We do this below in section 4.

4   A model for Health Reporting

Reported, subjective, health measures will be denoted H^{SG}, for general health, and H^{SW}, for health related to work activities. Examples of these measures are responses to questions like "How good would you rate your health? Good, fair..." or "Does your health limit you in your ability to work? Not at all, a little....". For applications in Labour supply and retirement models, a work-related measure like H^{SW} would be most appropriate as this measure directly relates to the restrictions an individual perceives in performing his job. Though these health measures are typically observed as discrete indicators, we formulate our model in terms of latent variables assumed to generate the observed indicators. This facilitates the discussion below. We introduce the latent variables representing the true value of general health, $H*^{G}$, and the true value of work related health, $H*^{W}$. Rather then one measure for each type of health, $H*^{G}$ and $H*^{W}$ could refer to sets of health measures. For ease of exposition we restrict ourselves to single measures. The key idea of our approach to analyse reporting errors is to compare the subjective health measures to an objective measure of health.

A physician-diagnosed report would be the ideal measure of the respondent's health condition. This diagnosis is, however, usually not available in survey data and we have to rely on other sources of more objective information. With respect to a respondent's general health status a more objective measure may be derived from an extensive questionnaire on various (chronic) health conditions and/or health related impediments in performing a large number of daily activities. One of such questionnaires is the Hopkins Symptoms Checklist (HSCL). A score from that list will be used as a more objective measure for general health in the empirical applications of section 6. We denote this more objective measure as H^{OG}. It may be argued that this measure will probably still be subject to systematic mis-reporting. If H^{OG} also suffers from state dependent reporting errors, then our model will only provide a lower bound of the extent of mis-reporting. Other more objective measures that could be used are observed mortality rates in the panel or the number of visits to the doctor in the past 12 months. Though all of these measures are clearly more objective then direct questions to an individual's health status, it is likely that they are to specific to serve as a measure of general or work related health.

H^{OG} may be an imperfect instrument for $H*^{G}$. For that purpose an additional set of exogenous variables X_1 may be used to describe $H*^{G}$ sufficiently well. Typically, X_1 will contain variables such as age, education, and gender. If H^{OG} and $H*^{G}$ are dissimilar, the role of the exogenous variables in X_1 will become more important. We expect a minor role of X_1 when one aims to use the HSCL-score as a measure for of general health H^{OG} to describe true general health $H*^{G}$. Modelling work related health measures, in X_1 will gain in importance, we will return to this later.

As documented in the introduction, the basic argument in the literature considering the peculiar relationship between subjective health measures and retirement is that commonly used responses to health questions are subject to roughly two forms of possible biases. First, true health may be related to labour market status *S* (S=Employed, Unemployed, Disabled or Early Retired). This can be a direct causal relationship, or health and labour market status could be indirectly related through unobservables. One way

in which this type of ('classical') endogeneity emerges if an individual's health and career are considered to result from simultaneous investment decisions regarding education, work and health. We refer to this kind of dependence of health on labour market status as type I endogeneity. Secondly, state dependent reporting behaviour could relate the observed subjective measures to the labour market status S. This kind of endogeneity will be denoted as type II endogeneity. Below we will state assumptions that allow us to deal with type II endogeneity, without needing to consider type I endogeneity directly. It will, however, turn out that classical, type I, endogeneity problems returns in the empirical implementation of the health reporting model. We will deal with that in section 6.

We start with a model for reporting behaviour of general health. Of interest for this model are the observed subjective health measure (H^{SG}), the observed objective measure (H^{OG}), the true unobserved health measure (H^{*G}), the labour market state (S) and a set of control variables (X_1). We start with an assumption:

Assumption 1 *the conditional probability density function (pdf) of H^{*G} conditional on H^{OG} and S, is independent of S. Or more formally:*

$$\text{pdf} (H^{*G}/ H^{OG}, X_1, S) \cong \text{pdf} (H^{*G}/ H^{OG}, X_1)$$

Essentially this assumption states that the objective health measure, if necessarily assisted by the set of control variables X_1, is a sufficient statistic for the impact of S on H^{*G}. This simply means that added to H^{OG} and X_1, S does not add information about the latent true health variable H^{*G} and therefore any effect of S on H^{*G} (type I endogeneity) is assumed to be sufficiently captured by the objective measure H^{OG} and additional exogenous variables. This is equivalent with stating that, with respect to type I endogeneity, S affects H^{*G} and H^{OG} (conditional on X_1) in the same way. As by assumption pdf ($H^{*G}/ H^{OG}, X_1$) is identical for all respondents, irrespective of their value of S, any effect of S on the observed subjective measure (H^{SG}), controlling for H^{OG} and X_1, must come from reporting behaviour.

It is good to note that apart from the labour market state S, other exogenous variables such as for instance education may also affect reporting behaviour. A higher educated worker may attach a different meaning to the label "good" then a non-skilled worker. This sort of differences in expression or language will be captured by a set of exogenous variables X_2. This set of variables is assumed to affect the reported health and not the unobserved true value of health. In practice it will, however, be difficult to distinguish between, X_1 and X_2. We will return to this later. We first return to the health-reporting model.

Using the arguments supplied above, we can now specify our health-reporting model as follows:

$$H^{*G} = f_1(H^{OG}, X_1, \varepsilon_1; \omega_1) \tag{1a}$$
$$H^{SG} = f_2(H^{*G}, S, X_2, \varepsilon_2; \omega_2) \tag{1b}$$

The variables ε_1 and ε_1 are random disturbances, f_1 describes the relationship between true health and its instruments and f_2 represents reporting behaviour. Those out of work are more inclined to bias their response towards poor health because this is a socially more accepted reason for inactivity or because receipt of benefits are contingent upon bad health. In Bound (1991) and Stern (1990) reporting errors are modelled as a relationship between H^{SG} and the wage rate rather than the labour market status S. In the

Netherlands the unemployment benefits, early retirement income and disability allowances are closely linked to previous earnings. As a matter of fact, for most benefits schemes, benefits are a fixed fraction of last wages. So, conditional on S little additional effects of wages or income streams are expected. We will nevertheless include income in the vector X_2, to see if it affects response behaviour.

Since we do not observe the true health H^{*G} we substitute equation (1a) into (1b) to obtain:

$$H^{SG} = f_3(H^{OG}, S, X, \varepsilon; \omega) \hspace{3cm} \text{(1c)}$$

Equation (1c) is an expression in terms of observables, X and S, unobservables, ε; and a parameter vector ω. In our empirical application we will use a binary indicator for the subjective health measure and it will therefore not be possible to distinguish whether an exogenous variable affects reporting behaviour (the assumed effect X_2) or true health differences (the assumed effect of X_1). This distinction is in principle possible in ordered response models and we refer for a discussion of this to Kerkhofs and Lindeboom (1999). For this reason we just refer to the set of exogenous regressors X. The HSCL measure used in the empirical application is known to be a excellent validated instrument of general health and is used widely in the medical sciences. We therefore expect that the effect of X will largely represent the effect of reporting differences due to individual differences.

Under assumption 1 the effect of S will represent reporting errors and in this respect it is important that H^{OG} is an objective measure of true health. If not, the model will tend to underestimate the true effect of state dependent reporting errors. In case it is objective (i.e. its dependence on S does not differ from the dependence of H^{*G} on S) but it is inaccurately measured, then this will be captured by X. Identification of the reporting errors in subjective health variables requires a normalisation. We believe that as a natural choice the group of employed respondents could be considered since there is for this group neither financial incentives nor any social legitimisation to report with error[8].

Equation (1c) can be used to assess the relative importance of reporting errors in health responses and estimates from this equation could be used to generate cleansed health measures that could be used in additional analyses. However, for analyses in labour supply models a work related health measure rather then a general health measure is required. Below we reformulate assumption 1 to obtain a procedure to eliminate the state dependent reporting errors from subjective health related to work measures.

Denote H^{OW} as the objective work related health measure. Then the analogue of assumption 1 is as follows:

Assumption 1' *the conditional probability density function (pdf) of H^{*W} conditional on H^{OW} and S, is independent of S. Or more formally:*

$$\text{pdf } (H^{*W} / H^{OW}, Y_1, S) \cong \text{pdf } (H^{*W} / H^{OW}, Y_1)$$

This again states that the objective health measure, if necessarily assisted by the set of control variables Y_1, is a sufficient statistic for the impact of S on H^{*W} and that as a consequence S affects H^{*W} and H^{OW}

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[8] This assumption would be violated in case currently employed workers respond in anticipation to future non-participation.

(conditional on X_1) in the same way. And again, by assumption pdf ($H*^W$/ H^{OW}, Y_1) is identical for all respondents, irrespective of their value of S, and therefore any effect of S on the observed subjective measure (H^{SW}), controlling for H^{OW} and Y_1, must come from reporting behaviour.

This assumption does not add much the solution of the 'health and retirement puzzle' (Anderson and Burkhauser (1985)) as the core of the problem in the retirement literature is that H^{OW} is in general not observed. To make this assumption of use for practical purposes, a 'key' is required that translates H^{OW} to commonly observed objective measures of general health. We therefore assume in addition:

$$H^{OW} = f_4(H^{OG}, Y_2, v_1 ; \varphi_1) \tag{2}$$

This assumption states that H^{OW} can be described completely by H^{OG}, a set of exogenous variables (Y_2) and random, non-systematic errors. Equation (2) does not hold in the case that S affects H^{OW} in a different way then H^{OG}. We will return later to the issue of dealing with this. If (2) holds, then, similar to the derivation of equation 1c, using assumption 1' and equation (2), we obtain:

$$H^{SW} = f_5(H^{OG}, S, Y, v ; \varphi) \tag{3}$$

Equation (3) is a simple relationship that can be estimated directly from observed data. The relative importance of the effect Y in (3) will depend strongly on the dissimilarity between H^{OW} and H^{OG}. In the case that both assumption 1' and equation (2) hold, S will represent the efffect of reporting errors on the subjective work related health measure. Next, estimates of (3) can be used directly to assess the importance of reporting errors and to produce cleansed (from reporting errors) work related health measures that can be used in additional analyses.

In case that (2) fails to hold, Y may capture much of the effect of S, but it will not prevent biased estimates of the effect of S. Equation (2) may fail to hold, for instance because S is omitted wrongly from the right hand side of the equation. If this is the case, the effect of S from (3) will include both the causal effect from labour market status on work-related health and the effect of reporting errors. In this situation it may be desirable to obtain the effect of reporting errors from equation (1c). If one is willing to believe that H^{SW} and H^{SG} are affected in the same way by individual reporting behaviour, then it may be desirable to jointly estimate equation (1c) and (3) and impose this restriction directly. As a matter of fact, under the 'equal response error' restriction it can be tested whether S is wrongly omitted from (2).

Equation may also fail to hold in practical situations because we are not able to fully observe all relevant factors Y_2. These omitted factors from Y_2 may be correlated with labour market staus and the objective general health meausre H^{OG}. These unobservables will show up in the error term of equation (3) (v) and will cause non-orthogonality of the included variables (H^{OG} and S) and the error term. Direct estimation of (3) will result in biased estimates. A similar argument may hold for model (1c). In practical situations we may not be able to accurately observe all relevant factors of , X_1 and these omitted variables may be correlated with H^{OG} and S and show up in the error term of (1c). In essence type I endogeneity problems (through unobservables) return into the model (1c) and (3) and we have to see how to handle with these problems in practical situations. We will do this later in section 6. We first give a brief description of our data.

5   Data

Data are obtained from the first two waves of the CERRA panel survey. The CERRA panel survey is a Dutch survey that is designed specifically for the analysis of health and retirement issues and resembles the Michigan Survey Centre's well known Health and Retirement Survey (HRS). The first wave was fielded in the fall of 1993 and consists of 4727 households in which the head of the household (i.e., the main income earner) was between 43 and 63 years of age at the date of the interview. In each household both head and partner, if present, were interviewed. In the fall of 1995 the same respondents were contacted for a second interview. Approximately 74% of the first wave respondents participated in the second wave, which resulted in about 3500 households. For each wave extensive information is obtained on labour history and current labour market status, sources of income, attitude towards retirement, housing, health and a variety of socio-economic variables.

Internal evaluations of item non-response and representativeness of the first wave of data show them to be of high quality. In general, item non-response was not a problem. Non-response was, however, relatively high for the income questions, with a non-response rate of up to 30 percent for some income sources. The CERRA data were compared to data from the Netherlands Central Bureau of Statistics and found to be comparable based on age, sex, labour market status, and education.

The health variables in the sample contain, among others, commonly used subjective measures such as answers to the questions 'how good would you rate your health' and 'does your health limit you in your ability to work'. Less subjective measures like the number of visits to a physician in the past 12 months, whether one was hospitalised in the past 12 months, whether one has experienced a chronic condition and the outcome of the Hopkins Symptom Checklist (HSCL). The HSCL is a validated objective test of general health used in the medical sciences to assess the psycho-neurotic and somatic pathology of patients (respondents). The HSCL consists of 57 items and is known to have an excellent rate of internal consistency, meaning that the test results are highly correlated with objective medical reports on the patients' health status. The responses to these 57 questions result in a mental score, a physical score and a total health score. In our analyses we will use the total health score. The advantage of this HSCL measure over a subjectively, self-assessed health measures is that it is free of (or at least less sensitive to) reporting errors that may depend upon the respondent's labour market status. Table A1 of the appendix provides summary statistics of our sample.

6   Empirical implementation of the model and results

At time/age t, the responses of individual i to subjective health measures h_{it}^{SW} and h_{it}^{SG} are measured as dichotomous variables. It is therefore natural to take the specification of f_3 and f_5 of equations (1c) and (3), respectively along the lines of a probit model. So:

$$H_{it}^{SG} = f^4(H_{it}^{OG}; \omega^{OG}) + f^2(S_{it}; \omega^S) + X_{it}'\omega^Y + \delta_i^{SG} + \varepsilon_{it} \qquad (4)$$

$$H_{it}^{SW} = g^1(H_{it}^{OG}; \varphi^{OG}) + g^2(S_{it}; \varphi^S) + Y_{it}'\varphi^Y + \delta_i^{SW} + v_{it} \tag{5}$$

And the health response is defined as $h_{it}^K = 1$ if $H_{it}^K > 0$ and $h_{it}^K = 0$ otherwise, $K=SG, SW$. Equation (4) and (5) are considered jointly. In case one is solely interested in the importance response bias, model (4) would suffice alone. In case the objective is to construct a work related health measure that is free of reporting errors, equation (5) needs to be added. As suggested in section 4, a joint model will also be of help in validating the results obtained from separate analyses and that it therefore will add to our understanding of the reproting mechanisms.

In the empirical analyses we will take f^1 and g^1 as a quadratic function and f^2 and g^2 as dummies for the different labour market states (Work, ER, DI and UI). As discussed in section 4, X_{it} and Y_{it} are sets of exogenous (time-varying and time-constant) variables included to correct for differences between the true health concepts (H^{*G} respectively H^{*W}) and the observed objective measure (H^{OG}) and to account for non-comparability of respondents.

Our empirical specification of the health-reporting model of section 4 includes individual specific components δ_i^{SG} and δ_i^{SW}. Assumption 1 and 1' are relatively weak assumptions, but is conceivable that we may not be able to fully observe all relevant factors (X and Y)of the health-reporting model. The classical endogeneity problem re-enters the empirical model as it is conceivable that these omitted variables are correlated with included (functions of) H^{OG} and S. A natural way to deal with this problem, is to extend the model (4) and (5) with a model for health (H^{OG}) and retirement (S). We will present the full model below and discuss what can be learned from it. It will be argued that joint estimation of the three models will be cumbersome and that for our purposes, where we want to construct a model to distillate reporting errors from subjective data, such an approach would go far beyond the scope of this paper. We therefore focus on alternative ways of estimating relevant parts of the model.

To start with the retirement model, as stated in section 3, the workers retirement decicion is essentially an optimal stopping model, where the optimal age of retirement results from a comparison of alternative retirement options that come available over time. A convenient way of incorporating the structure sketched in section 3 is by means of a competing risk model for employment duration. The "risks" are retirement through the alternative exit routes: ER, DI and UI. The hazard rate out of work to retirement can be written as:

$$\theta(t; H_{it}^{*W}, X_{it}, \theta, \xi_i) = \sum_{K \in At} \theta^K(t; H_{it}^{*W}, X_{it}, \theta^K, \xi_i^K) \tag{6}$$

The summation is taken over the set of retirement options $A_a \subseteq \{UI, DI, ER\}$ that are available to the individual at age a. To capture some of the structure of the theoretical model, the hazards, $\bullet_{ER}$, $\bullet_{DI}$ and $\bullet_{UI}$, may depend on the set of retirement options open to the individual at age a and in the future[9]. The hazards include the true, normally unobserved, work related health concept. Equation (6) can be used to generate an unbiased work related health concept. The dependence of δ_i^{SG} and/or δ_i^{SW} on state S may be specified as the dependence of these terms with the individual componenent from the retirement

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[9] One way to deal with this is to calculate route and date specific retirement income streams and add these to the specification in all hazards. This approach is for instance taken in Borsch-Supan (1998). Alternatively, a structural approach can be taken (see for instance Daula and Moffitt (1996)).

model to ξ^K

The dependence of δ_i^{SG} and δ_i^{SW} on H_{it}^{OG} can be made explicit by the emprical counterpart of the health production function of section 3. In this function obsevred health at a point in time H_{it}^{OG} is a function of the history of work decisions ($_0\int^t S_{iu}\,\mathrm{d}u$), a set of observed characteristics (X_{it}) and unobservables (γ). We only observe health at two points in time and the survey lacks information on the history of health related decisions (the vector Z of section 3). We therefore have to assume that $\bullet$ encompasses elements of the initial stock of health and decisions made in the course of the life cycle regarding health. More specifically:

$$H_{it}^{OG} = \alpha_0 + \alpha_1\,{_0}\int^t S_{iu}\,\mathrm{d}u + \alpha_2'X_{it} + \gamma_i + \mu_{it} \tag{7}$$

where μ_{it} is an iid error term that is independent of $_0\int^t L_{iu}\,\mathrm{d}u$, X_{it} and γ_i. Clearly, when health related decisions and work related decisions are considered simultaneously (as in the model of section 3), then γ_i will be correlated with $_0\int^t S_{iu}\,\mathrm{d}u$.

The full model (4)-(7) is very useful. It enables one to establish the extend to which subjective health measures are biased, and provides us a model to generate cleansed work related health measures that could be used in the retirement model (6). This retirement model gives us the effect of health and financial incentives on the retirement decision. Finally, equation (7) could be used to assess the effect of work (history) on general health. Note furthermore, that in case one is willing to assume that the reporting bias in H_{it}^{SG} and H_{it}^{SW} is equal, that in that case the assumption underlying equation (2) could be tested. In case equation (2) does not hold, the effect of φ^S in equation (5) includes the effect of reporting bias and the causal effect of labour market states on work related health. Joint estimation of (4) and (5) facilitates identification of both effects.

To consistently estimate the parameters of the health-reporting model ((4) and (5)), estimation of the full model could be considered. The likelihood contributions consist of probabilities associated with the joint event of observing labour market states, subjective health indicators and observed objective health, for each individual at different points in time. The standard approach is to specify these contributions to the likelihood function conditional on the unobservables of the model ($\delta_i^{SG}, \delta_i^{SW}, \gamma_i, \xi_i^{ER}$,ξ_i^{DI}, ξ_i^{UI}) and to integrate these out from the likelihood function. In general the analyses becomes cumbersome as simulation methods are required to numerically integrate these (6) unobservables out of the likelihood function. Alternatively, we can see under which conditions relatively simple methods could be employed, without needing to estimate equation (4)-(7) jointly.

Let's consider estimation of equation (4). A naïve approach would be to assume that δ_i^{SG} is orthogonal to the included regressors (X_{it}, $f^1(H_{it}^{OG};\omega^{OG})$, $f^2(S_{it};\omega^S)$). In this case simple random effect probit models could be employed to estimate (4) (and (5)) separately from the other equations of the model. In case δ_i^{SG} is correlated with either X_{it}, $f^1(H_{it}^{OG};\omega^{OG})$ or $f^2(S_{it};\omega^S)$ alternatives need to be considered. One of these alternatives is to use a fixed effect logit specification for (4). This approach may be appealing as it requires no assumptions on the distribution of the unobservables nor does it restrict the unobservables to be correlated with the included regressors. A clear drawback is that a large number of observations may be lost in the estimation procedure. The fixed effects are effectively identified on observed changes in individual response behaviour. Our survey only consists

of two waves and it is conceivable that of those already out of work at wave 1, only a few would change their response in the next wave.

The correlation between δ_i^{SG} and the potentially endogenous variables could also be specified directly, for instance as $\delta_i^{SG} = Z_i'\eta + \psi_i$. The vector Z needs to include a set of instruments that capture the correlation between δ_i^{SG} and $f^1(H_{it}^{OG};\omega^{OG})$ and $f^2(S_{it};\omega^S)$. ψ_i is additional random noise that is independent of Z_i. A straightforward application of Mundlak (1974) would be to take Z as the averages over time of the potential endogenous variables. Especially with relatively short panels as ours, it may be the case that Z is strongly correlated with $f^1(H_{it}^{OG};\omega^{OG})$ and $f^2(S_{it};\omega^S)$. The function $f^2(S_{it};\omega^S)$ represents the effect of state-dependent reporting behaviour and it may be difficult to obtain a precise estimate of this if it is too strongly correlated with Z.

To circumvent this problem we could alternatively, exploit the information that is available in the health stock equation (7) to consistently estimate equation (4) (and (5)). H_{it}^{OG} is measured as the outcome of the HSCL score and ranges from 0 to 171. Therefore (7) could be estimated using fixed effect regression techniques. In this way dependence of γ_i with the included regressors, of which current labour market status and history are the most prominent variables, is dealt with in the most flexible way. Clearly, the fixed effect γ_i is directly related to S_{it} and H_{it}^{OG} and it would therefore serve as a perfect instrument to be included to capture the correlation between δ_i^{SG} and $f^1(H_{it}^{OG};\omega^{OG})$ and $f^2(S_{it};\omega^S)$ in equation (4) (and (5))[10]. So we could specify the dependence as follows: $\delta_i^{SG} = \eta\,\gamma_i + \psi_i$, and substitite this into (4) and estimate this modified equation (4) equation with standard random effect methods[11].

Below we discussed results from various models. In table 1 we present the results of different specifications of the health-reporting model. The tables present results for the subjective measure of general health and the subjective work related health measure. Specification I of each table give the results of simple probit analyses, where absence of unobservables is assumed. Specification II presents the results of a random effect probit specification. Specification III, gives the "Mundlak-specification of the model ($\delta_i^K = Z_i'\eta^K + \psi_i^K$, $K=SG, SW$) and specification IV, the specification where ($\delta_i^K = \eta^K\gamma_i + \psi_i^K$, $K=SG, SW$). Table 2 presents the results of the fixed effect specification of the H_{it}^{OG} equation. This supplementary table provides the results of the model underlying the instrument γ_i. In addition the results have merit on their own, as it the results give us direct insight into the effect of work and work history on health outcomes. We start with a discussion of table 1a.

<Table 1a and 1b around here>

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[10] More specifically,the fixed effect γ_i can be expressed as $H_{i\cdot}^{OG} - \alpha_1\,f_{i\cdot}(S) - \alpha_2'X_{i\cdot} - \mu_{i\cdot}$. The symbol $f_{i\cdot}(S)$ represents the average over time of $\int_0^t S_{iu}\,du$, $H_{i\cdot}^{OG}$ represents the average over time of $H_{it\cdot}^{OG}$, and $X_{i\cdot}$ and $\mu_{i\cdot}$ are defined similarly (see for instance Hsiao (1986)).

[11] There are different ways of including the fixed effect γ_i in the specification subjective health models. It is important to note that inclusion of an estimate of the fixed effect introduces additional noise that will certainly be correlated with the labour market status and objective health variables in equation (4) and (5). Alternatively, one could use the expression of the previous footnote in terms of the true parameters α's and include the separate components of the fixed effect expression as extra explanatory variables in model (4) and (5). So include, $H_{i\cdot}^{OG}$, $f_{i\cdot}(S)$ and $X_{i\cdot}$ as extra regressors in (4) and (5). The random effects of the resulting equation (4) (and (5)) includes the term $\eta\mu_{i\cdot}$.

The first part of table 1a includes the results for the control variables. These are mainly included to correct for the dissimilarity between the true health the objective measure (X_1)and to correct for differences in meanings that individuals might have to different labels (X_2). The second panel of the table is the part that controls for the instrument for true health. If assumption 1 holds, no additional effect of S may be expected, unless people in different states report differently (state-dependent reporting errors). The third panel of the table reports on this. In this panel the employed workers are taken as the reference group.

To start with the core of the table: it can be seen directly that people in disability overstate their health problems and people in ER tend to understate their health problems. No differences in reporting behaviour are found for people on UI. The size of the effect differs across the various specifications. The naïve specification (I) gives the smallest effects, for all labour markets state dummies. In specification II (standard random effects approach) the size of the effect for DI and ER are more pronounced. The results of specification II are biased in case that the unobservables are correlated with the included labour market state dummies. Specification III and IV indicate that one needs to correct for correlation between the unobservables and the included variables, in order to avoid biases. I

The results of the first panel of the reveals that there are little effects found from the included exogenous variables. At the very least this indicates that the objective health measures (H_{it}^{OG} and its squared value) are capable of correcting for existing differences between individuals in health status. This holds for all specification, though the size of effect of the control variables differs across the specifications.

The results for the work related health measure (table 1b) is to some extend similar: people on DI benefits tend to overstate their health problems. The size of the effect is, however, more pronounced then the results found in table 1a and the results vary more strongly across the different specifications. To start with the latter: this is plausible, as it will be more difficult to cover work related health with observed exogenous variables and an objective measure of general health (cf $H^{OW} = f_4(H^{OG}, Y_2, v_1 ; \varphi_1)$. This dissimilarity between the work related health concept and the true health concept and H^{OG} and Y_2 will be included in the error term and it is likley that it is correlated with S and/or H^{OG}. It is therefore to be expected that a naïve specification (I or II) differs much from a specification where one controls for this (specification III and IV). It is interesting to note that the size of the reporting errors is much more pronounced in specifications I and II as compared to specifications III and IV. The results of the last two columns are less extreme and, as in the results of table 1a, allowing for correlation suppresses the effect of the DI dummie.

This table indicates that disabled tend to overstate their health problems in case one asks them if they can perform their work. Reporting behaviour does not significantly differ between UI recipients, ER recipients and employed workers. This differs from the results of table 1a. It is conceivable that individuals report differently if they respond to questions concerning health as far as it is related to work.

The results of specifcation Iv in tables 1a and 1b depend on the instrument derived from the fixed effect of the health stock equation (7). We briefly return to the results of a fixed effects panel data model. The results indicate is health deteriorates faster for people at work then for people out of work (see the dummies for labour market status). It is important to note that these results are completely

overturned in case one uses a simple regression model where one does not correct for unobservables, possibly correlated with unobservables. In this specification an opposite effect was found. Work improves health. Clearly this reflects the fact that those observed to be working are in better health. This has two implications. First, when estimating retirement models, one has to take into account that health and work are endogenously related and that work affects health directly. Secondly, mostretirement policies are aimed at directly increasng the age of retirement. This result may indicate that this has an effect on the health condition of the population.

7   Conclusions

In empirical studies of retirement decisions of the elderly, health is often found to have a large, if not dominant, effect. Depending on which health measures are used, these estimated effects may be biased estimates of the causal effect of health on the dependent variable(s).Research indicates that subjective, self-assessed health measures may be affected by endogenous reporting behaviour and even if an objective health measure is used, it is not likely to be strictly exogenous to labour market status or labour income. Health and labour market variables will be correlated because of unobserved individual-specific characteristics (e.g., investments in human capital and health capital). Moreover, one's labour market status may be expected to have a (reverse) causal effect on current and future health. In this paper we analyse the relative importance of these endogeneity and measurement issues in the context of a model of early retirement decisions. We state assumptions under which we can use relatively simple methods to assess the relative importance of state dependent reporting errors in individual responses to health questions. The estimation results indicate that among respondents receiving disability insurance allowance, reporting errors are large and systematic and that therefore using these measures in retirement models may seriously bias the parameter estimates and the conclusions drawn from these. We furthermore found that health deteriorates with work and that the two variables are endogenously related.

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Table 1a Subjective general health measure (H^{SG}) and reporting errors. Maximum likelihood probit models: alternative specifications [1,2]

	I		II		III		IV	
i) Control variables								
Constant	-0.336	(0.1)	-0.647	(0.2)	-0.828	(0.3)	1.122	(0.3)
Age	-0.051	(0.6)	-0.058	(0.5)	-0.113	(0.9)	-0.600	(1.6)
Age2	0.001	(0.5)	0.001	(0.5)	0.001	(0.9)	0.005	(1.5)
Female	0.034	(0.4)	0.028	(0.2)	-0.081	(0.6)	-1.202	(1.2)
White collar worker	-0.114	(1.8)	-0.151	(1.8)	-0.130	(1.5)	-0.128	(1.5)
Partner	-0.107	(1.3)	-0.153	(1.4)	-0.103	(0.9)	0.170	(0.3)
Education, intermediate general	-0.148	(1.7)	-0.210	(1.8)	-0.164	(1.4)	-0.146	(1.2)
Education, intermediate vocational	-0.101	(1.2)	-0.152	(1.4)	-0.114	(1.0)	-0.107	(1.0)
Education, higher general	-0.353	(2.3)	-0.488	(2.4)	-0.401	(1.9)	-0.390	(1.8)
Education, higher, vocational	-0.286	(3.1)	-0.406	(3.3)	-0.316	(2.4)	-0.308	(2.3)
Education University degree	-0.072	(0.5)	-0.147	(0.8)	0.030	(0.1)	0.047	(0.2)
#months worked in past 10yrs	-0.002	(1.6)	-0.002	(1.8)	0.004	(0.8)	0.003	(0.5)
ii) Objective health measure								
HSCLscore	0.430	(13.3)	0.558	(10.9)	0.302	(3.1)	0.367	(5.6)
(HSCLscore)^2	-0.024	(6.4)	-0.031	(5.5)	-0.024	(2.1)	-0.032	(5.3)
iii) Labour market states (reporting errors)								
DI	0.818	(7.7)	1.071	(7.4)	0.831	(2.5)	0.908	(2.7)
UI	0.034	(0.3)	0.010	(0.1)	-0.402	(1.4)	0.343	(1.1)
ER	-0.318	(3.1)	-0.454	(3.1)	-0.755	(2.7)	-0.619	(2.2)
-Log Likelihood	1532.62		1507.19		1489.56		1476.64	
# Observations	3460		3460		3460		3460	

1 Absolute t-values in parentheses.
2 Specification I: no unobserved heterogeneity. Two waves are pooled.
   Specification II: random effects probit model.
   Specification III: $\delta_i^{SG} = Z'\eta + \psi_i$, with Z taken as the time averages of the potentially endogenous variables (HSCL score variables, #months worked in the past 10 years and the labour market state dummies) and ψ_i random noise that is independent of Z.
   Specification IV: $\delta_i^{SG} = \eta \gamma_i + \psi_i$, where γ_i is the fixed effect of the health dynamics specification (7).

Table 1b Subjective general health measure (H^{SW}) and reporting errors. Maximum likelihood probit models: alternative specifications [1,2]

	I		II		III		IV	
i)Control variables								
Constant	-1.505	(0.5)	-2.061	(0.6)	-2.327	(0.6)	-0.903	(0.2)
Age	-0.0421	(0.4)	-0.054	(0.4)	-0.060	(0.4)	0.025	(0.1)
Age^2	0.0006	(0.7)	0.0008	(0.7)	0.0009	(0.7)	0.000	(0.0)
Female	0.321	(3.2)	0.406	(3.1)	0.465	(3.3)	-0.288	(0.3)
White collar worker	0.009	(0.1)	0.031	(0.4)	0.031	(0.4)	0.015	(0.2)
Partner	0.132	(1.5)	0.173	(1.5)	0.171	(1.4)	-0.213	(0.5)
Education, intermediate general	-0.258	(1.7)	-0.342	(2.8)	-0.343	(2.7)	-0.323	(2.6)
Education, intermediate vocational	-0.061	(0.7)	-0.087	(0.8)	-0.092	(0.8)	-0.071	(0.6)
Education, higher general	-0.210	(1.5)	-0.283	(1.6)	-0.321	(1.7)	-0.269	(1.4)
Education, higher, vocational	-0.228	(2.5)	-0.310	(2.6)	-0.333	(2.6)	-0.306	(2.4)
Education University degree	-0.247	(1.7)	-0.347	(1.6)	-0.386	(1.7)	-0.354	(1.6)
#months worked in past 10yrs	-0.005	(5.5)	-0.007	(5.6)	-0.010	(2.2)	-0.009	(1.6)
ii)Objective health measure								
HSCL score	0.257	(7.5)	0.348	(7.1)	0.321	(3.2)	0.345	(5.0)
(HSCL score)^2	-0.017	(3.8)	-0.023	(3.8)	-0.019	(1.7)	-0.023	(3.7)
iii)Labour market states (reporting errors)								
DI	2.000	(20.5)	2.623	(14.8)	1.284	(4.1)	1.376	(4.3)
UI	0.802	(8.3)	1.025	(6.8)	0.362	(1.3)	0.417	(1.4)
ER	0.361	(3.9)	0.454	(3.4)	0.208	(0.8)	0.218	(0.8)
-Log Likelihood	1586.34		1556.20		1543.29		1522.64	
# Observations	3460		3460		3460		3460	

3   Absolute t-values in parentheses.

4   Specification I: no unobserved heterogeneity. Two waves are pooled.

Specification II: random effects probit model.

Specification III: $\delta_i^{SW} = Z'\eta + \psi_i$, with Z taken as the time averages of the potentially endogenous variables (HSCL score variables, #months worked in the past 10 years and the labour market state dummies) and ψ_i random noise that is independent of Z.

Specification IV: $\delta_i^{SW} = \eta \gamma_i + \psi_i$, where γ_i is the fixed effect of the health dynamics specification (7).

Table 2 Fixed effect regression model for HSCL scores (high is unhealthy)[1].

Variable	Param.	(t-stat)
Const	8.522	(2.3)
Age	-0.362	(2.4)
Age^2	0.004	(3.1)
Partner	-0.200	(1.1)
Family size	0.059	(1.4)
Female*Age	-0.048	(1.4)
# months ever worked	0.002	(0.5)
# months past 10 yrs	0.0158	(2.7)
# months past 10 yrs squared	-0.00009	(3.4)
Income stream/1000	-0.000	(0.7)
DI	-0.301	(2.0)
UI	-0.227	(2.1)
ER	-0.223	(2.5)
DI (2 yrs lagged)	0.444	(2.4)
UI (2 yrs lagged)	-0.002	(0.0)
ER (2 yrs lagged)	0.102	(0.9)

R^2 0.0257

1 A Hausman test of the random effect versus the fixed effect specification turned out to strongly support the fixed effect specification.