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The Effect of Health Changes and Long-term Health on the Work Activity of Older Canadians

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SEDAP Research Paper No. 134

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The Effect of Health Changes and Long-term Health on the Work Activity of Older Canadians*

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Summary: Using longitudinal data from the Canadian National Population Health Survey (NPHS), we study the relationship between health and employment among older Canadians. We focus on two issues: (1) the possible problems with self-reported health, including endogeneity and measurement error, and (2) the relative importance of health changes and long-term health in the decision to work. We contrast estimates of the impact of health on employment using self-assessed health, an objective health index contained in the NPHS - the HUI3, and a "purged" health stock measure. Our results suggest that health has an economically significant effect on employment probabilities for Canadian men and women aged 50 to 64, and that this effect is *under*estimated by simple estimates based on self-assessed health. We also corroborate recent U.S. and U.K. findings that changes in health are important in the work decision.
Key words: Health, Health Changes, Employment, Older Workers
JEL codes: I12, J26
Résumé: Au moyen des données longitudinales de l'Enquête nationale sur la santé de la population canadienne (ENSP), nous étudions le lien entre l'état de santé et l'emploi des personnes âgées au Canada. Nous examinons deux questions: 1) les problèmes potentiels de la variable de santé subjective liés, en particulier, à l'endogénéité et aux erreurs de mesure, et 2) l'importance relative des variations de l'état de santé à court et à long terme sur la décision de travailler. Nous examinons la sensibilité de nos estimations au choix de la variable de santé, en utilisant alternativement, la variable de santé subjective, l'indice objectif de la santé inclus dans l'ENSP -- HU13 --, ainsi qu'une mesure 'purgée' de l'état de santé dans nos régressions. Nos résultats suggèrent que la santé exerce un effet économique significatif sur la probabilité d'exercer un emploi parmi les Canadiens et les Canadiennes entre 50 et 64 ans, et que cet effet est *sous*-estimé par la mesure de santé subjective. Nos résultats corroborent les conclusions d'études récentes aux É.U. et en G.B démontrant que l'état de santé joue un rôle déterminant sur la décision de travailler.

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1. Introduction

The population of most developed countries is aging. The increasing share of older persons in the population may put a severe strain on public pensions. It may have important labour market and macroeconomic consequences as well, including labour shortages and slower growth. If there is to be continued growth in labour supply over the coming years, it must come in part from older workers. Thus the determinants of work activity among older persons are of considerable concern among policy makers.

A potentially important determinant of work activity among older persons is the financial incentives provided by social security systems. In particular, the introduction of early retirement options in public pension systems is often cited as one potential cause of the decreasing average retirement age observed in many developed countries. The financial incentives in public pension systems have been the object of considerable recent research attention, both internationally (Gruber and Wise [1]), and in Canada (Baker et al. [2]). Another potentially important determinant of the work activity of older workers is private wealth. Current older workers are, of course, wealthier than earlier cohorts.

While such financial considerations are surely important in the work decisions of older workers, they are almost equally surely not the entire story. There is a great deal of heterogeneity in the work and retirement decisions of older workers, and other factors are certainly at play. One of the most important of these is health. For example, Table 1 summarizes self-reported retirement reasons (from retired persons over 55 years of age) in three Canadian cross-sectional surveys: the 1975 Retirement Survey, the 1989 General Social Survey, and the 1994 General Social Survey. In each year, among both men and women, “Poor Health” is the most frequently cited retirement reason for those aged 55-64. For retired persons aged 65 and over (the official retirement age in Canada), mandatory retirement was more often cited in the earlier surveys, but by 1994, health was the most cited retirement reason for this group as well. Health may also be a factor in the trend towards earlier retirement observed in many countries. In particular, more generous health and disability insurance systems may have contributed to this trend by enabling individuals in poor health to drop out of the labour market without facing severe financial consequences.

In this study we employ longitudinal data from the Canadian National Population Health Survey (NPHS) to study the relationship between health and employment among older Canadians. The literature on retirement in Canada has focused, with a few exceptions, on the financial incentives in Canada’s public pensions (for example, Baker et al., [2]). Thus, the first contribution of this study is to help redress that relative imbalance in the Canadian literature.

The international literature, in contrast, contains considerably more evidence on the relationship between health and retirement (or employment at older ages). We contribute to that literature by providing additional evidence on two issues that have figured prominently: (1) biases in estimates that are based on self-reported health, that may arise because that variable is endogenous and/or measured with error, and (2) the role of health changes and long-term health in the decision to work.

A particular novelty of the current study is that the NPHS contains the Health Utilities Index Mark 3 (HUI3), an "objective" health index that has been gaining popularity in empirical work. We compare estimates of the impact of health on employment using self-assessed health to estimates that use the HUI3, either in place of or as an instrument for self-assessed health. We also compare the use of the HUI3 to other ways of using the information on specific health conditions that the HUI3 aggregates. These include estimating a single "purged" health measure (or estimated health stock) similar to that employed by Bound et al. [3] and Disney et al. [4], or, alternatively, using all of the data items on individual health conditions directly as instruments for self-assessed health. The "purged" health measure or estimated health stock is the set of predicted values obtained from an econometric model that relates self-assessed health to information on specific health conditions.

Our principal findings are as follows. First, health has an economically significant effect on employment probabilities for Canadian men and women aged 50 to 64. Second, this effect is *under*estimated by simple estimates based on self-assessed health, suggesting that the latter suffer from attenuation bias (random measurement error) rather than justification bias. Third, the HUI3 provides estimates of the effect of health on employment that are similar to estimates based on a "purged" health measure. Finally, we corroborate recent U.S. and U.K. findings that changes in health are important in the work decision.

The rest of the paper is organized as follows. In Section 2 we briefly summarize the two strands of literature which are most relevant to the current study: studies of retirement in Canada, and the international literature on health and employment at older ages. In Section 3, we describe the NPHS data which forms the basis of our study, and the characteristics of our sample. Section 4 presents our main empirical results. Finally, section 5 concludes and discusses possible directions for future research.

2. Previous Research

2.1 Determinants of Retirement in Canada

The literature on retirement decisions in Canada has largely focused on the financial incentives in the public pension system. The Canadian public pension system has three components. One component, the Canada Pension Plan/Quebec Pension Plan (CPP/QPP) offers flexibility with respect to retirement age. For each month deviating from the "official" retirement age 65, the pension is reduced or increased by 0.5%. Benefits from CPP/QPP can be claimed starting from age 60 and will start at age 70 at the latest. Up to age 65 individuals have to prove that they actually retired, but that test is thought not to be very strictly applied.

A second component of the pension system - the Old Age Security benefit (OAS) - is a lump-sum benefit that is payable to all individuals who meet certain residency requirements. It equals roughly one fifth of median monthly earnings of 20-64 year old males and offers no choice of the retirement age. The Guaranteed Income Supplement (GIS) - a means-tested income supplement to the OAS - also offers no choice on the retirement age due to the way it is linked to the OAS. For spouses of OAS beneficiaries between the ages of 60 and 64 the allowance provides some incentive for early retirement. It is a means-tested benefit and its maximum is equal to the OAS pension plus the maximum GIS pension

In their analysis of early retirement provisions on the labour force behaviour of older Canadian men, Baker and Benjamin [5, 6] show that the option of early retirement is mainly taken up by individuals who are only loosely attached to the labour market. Based on data from the Survey of Consumer Finances (SCF) they reject the hypothesis that the provision of early retirement options causes large effects on labour supply but find that the new pension beneficiaries are those who would not have been working anyway.

Tompa [7] also analyzes the determinants of the transition to retirement in Canada. Using data from the Longitudinal Administrative Databank (LAD) he estimates hazard-rate models for CPP take-up among Canadians over 59. The LAD is a longitudinal data set constructed from income tax records. These data have very limited information on health status. Tompa includes in his analysis a dummy for an individual having a disability tax deduction in a particular year, and a continuous variable of medical expenses which are claimed as a tax deduction. He finds that an early take-up (exit from the labour force) is most often observed for low labour income earners, unemployed individuals, receivers of private pensions and individuals with retired spouses. Overall, Tompa concludes (like Baker and Benjamin) that many who take up early retirement are only loosely attached to the labour force.

Baker et al. [2] use administrative data compiled from a variety of sources to investigate the incentive effects of the full spectrum of income security programs available to older Canadians.

They find significant effects of financial incentives on retirement decisions, but also note that failure to control for lifetime earnings leads to over-estimates of these effects.

The Canadian literature on the relationship between health and retirement or health and employment at older ages is brief. Two early papers, Breslaw and Stelener [8], Maki [9] document a significant association between health and employment in Canadian data. Neither pursues the issues of endogeneity of health status and the dynamic relationship between health and work that have been the focus of the subsequent literature. Campolieti [10] takes up the issue of endogenous health status in a paper that focuses on disability status. He estimates various labour force participation models and finds that the coefficient on the disability measure tends to be underestimated when that variable is not properly instrumented.

Baker, Stabile, Deri [11] match survey data to administrative records to investigate the reliability of self-reports of specific conditions. Their results suggest that reporting error and justification bias are not just characteristic of general SAH: many specific self-reported conditions suffer from similar reporting problems as well.

All of these papers employ a single cross section and so cannot explore dynamic aspects of the relation between health and labour force participation.

2.2 International evidence on health and retirement

There is a much larger international literature on health and retirement, as surveyed by Currie and Madrian [12]. One key issue in the broader area of health and retirement (and health and employment more generally) is the possible endogeneity of SAH and, in particular, "justification bias". It is possible that associations between SAH and employment occur because employment actually causes good health (reverse causality). Alternatively, it could be that, for a given level of "true" health, individuals who are not working report poorer health in order to "justify" their employment status. Another problematic aspect in the estimation of health effects in the retirement decision is that "true" health is difficult to observe and usually only a noisy measure of health status is available. General strategies to solve the problems of attenuation bias caused by measurement error are discussed in Bound et al. [13]. Bound [14] discusses the effects of endogeneity and measurement error in the context of health and labour. We return to his discussion in the section describing our empirical framework.

Facing the aforementioned problems, researchers have looked to "more objective" measures of health. These typically include self reports of specific medical conditions and functional limitations. Such measures can then be used in lieu of SAH or as instruments for SAH. This, it is hoped, provides more reliable estimates of the effects of health on employment/retirement. Moreover, comparisons of estimates using SAH and more objective measures, or comparisons of estimates in which SAH is or is not instrumented, provide one kind of test of the justification bias hypothesis. The results in the literature are mixed. For example, Kerkhofs and Lindeboom [15] find evidence for state dependent reporting in SAH. Kerkhofs et al. [16] and Lindeboom and Kerkhofs [17] find that the choice of health measure does matter for their estimates, and conclude that SAH is endogenous. In contrast, Dwyer and Mitchell [18] compare OLS and IV estimates and conclude that SAH is not endogenous and does not suffer from significant justification-bias. McGarry [19] takes an alternative approach to dealing with the possibility of justification bias. Using data from the U.S. Health and Retirement Survey HRS, she focuses on employed workers, and the effect of health on their retirement expectations. Because the individuals in her sample are employed, they presumably have no motive to misreport their health (justify their employment status). She finds significant effects of SAH on retirement expectations.

A closely related set of papers consider biases in self-reports of disability status. Here again, the evidence is mixed. For example, Benitez-Silva et al. [20] and Stern [21] find little evidence of bias in reported disability status while Kreider [22] and Kreider and Pepper [23] do find evidence of justification bias.

A second issue that has received attention is the dynamics of the health and employment relationship, and the relative roles of long run health and health changes. Two recent papers that have investigated this issue are Bound et al. [3] using the HRS, and Disney et al. [4] using the British Household Panel Survey. Both sets of authors take the possibility of measurement problems in self-assessed health seriously. They create "purged" health measures, which are the predicted values from an estimated model of SAH. The predictors are "more objective" measures of health (reports of specific medical conditions and functional limitations) and demographics. The idea is that, by using only more objective health measures and demographics (but not employment status) to predict self-assessed health, the effect of employment status on reporting behaviour is removed; this is the sense in which the resulting predictions are "purged" of potential justification bias. The authors then use these purged health measures to estimate the effects of health on retirement. The common finding in the two studies is that *changes* in health play an important role in retirement decisions: health dynamics are important. An implication of this finding is that panel data are required to model the relationship between health and retirement or health and employment.

3. Data and Descriptive Statistics

3.1 Data and Sample

Our data are drawn from the National Population Health Survey (NPHS) which is a Canadian longitudinal (panel) survey, with interviews conducted every two years. The currently available data consists of the following four cycles (interviews): 1994-1995, 1996-1997, 1998-1999, and 2000-2001. The NPHS includes responses from all 17,276 panel members, though not every respondent is present in every cycle.

In this study, we focus on the subset of respondents aged 50 or over at the time of cycle 1 (1994-1995). We separately analyze four subgroups as we split our sample by gender and by the official retirement age (of 65 years). Our sample contains 1182 (701) men and 1365 (972) women aged 50 to 64 (aged over 65) in the first cycle. Table 2 summarizes the socioeconomic characteristics of our sample.

The main strength of the NPHS is that it collects very detailed health information. Table 3 gives the distribution of Self-Assessed Health (SAH) and of the Health Utilities Index Mark 3 (HUI3) in our four subgroups. The HUI3 is a generic health status index which is generally considered to be more objective than SAH. It is based on a comprehensive set of (self-reported) medical conditions and functional limitations, which are aggregated using preference scores (Feeney et al. [24]). In principle it describes (assigns a utility level to) thousands of distinct health states. A score of 1 indicates perfect health, while a score of 0 indicates death. Health states worse than death are admissible. The HUI3 has now been used in a large number of studies. Previous applications of the HUI3 range from providing quality of life/functional limitation measures for clinical trials, to monitoring the health of populations, and to studying the determinants of health.

Two features of Table 3 stand out. First, while there is considerable attrition between the first and fourth cycle in the 65+ age group, attrition in the 50-64 age group is much less. The sharp decrease in observations in the 50-64 age group between first wave and last wave is mainly caused by the fact that all observations aged between 57 and 64 in 1994/95 are 65 and older in 2000/01 – and thus have “aged out” of this group. Second, for all subsamples, the median HUI3 improves slightly as the panel ages. This is especially surprising in the subsamples aged 50 to 64 as the subsamples only include 58 to 64 year olds in the fourth cycle. This suggests that attrition (although small in numbers for the 50-64 group) is correlated with poor health. The association between health and panel wave is less stark when health is measured by self-assessed health status. Nevertheless, we will return to the issue of potential attrition bias below.

Further detail regarding the health of our sample is provided in Table 4, which reports summary statistics for a wide range of medical conditions, functional limitations, and health measures.

3.2 The association between SAH and employment

Table 5 shows the raw association between SAH and employment status for our samples of men and women, aged 50 to 64 and 65 and older in 1994-5 and 2000-1. Employment is defined as working for pay at the time of the interview. In every cycle, and for both men and women, there is a strong, positive, monotone relationship between health and employment. For the men aged 50 to 64, those in excellent health are twice as likely to be employed as those in poor or fair health. In the post-retirement age group the health gradient is even steeper.

Tables 6a and 6b present "naïve" estimates of the effect of health on employment. For the four groups defined by age and gender groups we estimate linear probability models for employment (by OLS with Huber-White robust standard errors and by linear fixed effects). We have also estimated logits and conditional logits but report the results from the linear models because the coefficients are easily interpreted as marginal effects. While marginal effects are easily calculated for logits, this is not the case for conditional logits. Since fixed effect estimates are an important part of our empirical strategy and because results from the linear and non-linear estimation approaches looked similar, we report estimates from linear models throughout. The results from the non-linear models are available from the authors. Explanatory variables include age, education, region, household size and home ownership, and SAH. In order to be comparable with the (almost) continuous and cardinal HUI3 and estimated health stock variables that we use subsequently, we convert the categorical SAH into a single cardinal variable. In particular we use the empirical cumulative distribution of the HUI3 to cardinalize SAH, following a recent paper by van Doorslaer and Jones [25]. They have demonstrated how the empirical distribution of the HUI3 can be used to cardinalize SAH by mapping the cumulative proportions of the SAH categories to the respective quantiles of the HUI3 distribution. The basic idea is that if X% of the population report a SAH of "poor", we look at the cumulative distribution of the HUI3 up to X% and assign the median value of HUI3 between 0 and X% to all those reporting a SAH of "poor". We then proceed in an analogous way for other categories of SAH. Van Doorslaer and Jones allow the cutoffs to differ for different demographic/socioeconomic groups. We are only allowing the cutoffs to vary by gender. We then standardize this cardinal SAH variable to have a mean of zero and standard deviation of one.

In this simple framework (which ignores the endogeneity of SAH, unobserved heterogeneity and dynamics in the health-employment relationship) we find a significant association between SAH and employment (as the raw numbers would suggest). For the pre-retirement age groups the size of the coefficient is similar for men and women: a one standard deviation improvement in health is associated with an increase in employment probabilities of about eleven percentage points. When we move to the fixed effects estimates, we are estimating the association between changes in health and changes in employment. Here again we find significant associations, and again they are similar for men and women. Health changes are associated with changes in employment, but the magnitudes are somewhat smaller than those that we find in levels.

The coefficients for the post-retirement groups are only significant in the OLS model and indicate that a one standard deviation improvement in health is associated with a three percentage point higher employment probability for men (one and a half percentage points for women). As most of the transition to retirement happens before legal retirement age and health effects seem to be more substantial for individuals younger than 65 as well we focus on this group in the remainder of the paper.

We carry out tests for attrition bias in the spirit of Verbeek and Nijmann [26]. To do this, we limit the data to the first two waves. Then, we estimate employment models which include the same variables as described above and a dummy variable indicating attrition in wave four as an additional regressor. The results are displayed in appendix tables A1 & A2. While there appears to be no attrition bias in our fixed effects specifications, the attrition variables have almost significant coefficients in the levels estimations. However, the estimations appear to be quite robust as, compared to Tables 6a and 6b, the estimated coefficients and their standard errors are practically unchanged.

4. Estimates of the Effect of Health on Employment

4.1 Empirical Framework

This section largely draws on the ideas laid out by Bound [14]. The simplest model that captures our concerns with self-assessed health, and the motivation behind our empirical strategy, is as follows. We assume that the probability of employment, E_{it}, is a linear function of unobserved true health H_{it} and of other variables Z_{it}, which capture the returns to work and other factors affecting employment probabilities.

$$E_{it} = Z_{it}\beta + H_{it}\alpha + e_{it} \quad (1.1)$$

The error term e_{it} is assumed to be mean zero and for the moment we assume that it is uncorrelated with both H_{it} and Z_{it} (although in our empirical implementation below we will sometimes allow for a time-invariant individual effect that is potentially correlated with regressors.) The parameter of interest in this paper is α, and the presumption is that α is non-negative: if good health has an impact on the probability of employment, it is a positive one.

Self-assessed health, SAH_{it}, measures true health with error:

$$SAH_{it} = H_{it} + v_{it} \tag{1.2}$$

The measurement error v_{it} may be random, or it may correlated with E_{it}. The latter possibility is the endogeneity (or justification bias) referred to above. In the case that v_{it} is correlated with E_{it}, note that this implies that it is correlated with e_{it}, Z_{it} or both. Inverting equation (1.2) and substituting into (1.1) gives:

$$E_{it} = Z_{it}\beta + SAH_{it}\alpha + (e_{it} - \alpha v_{it}) \tag{1.3}$$

If equation (1.3) is estimated by OLS, two kinds of biases can arise, depending on the nature of the errors in self-assessed health. If the measurement error in self-assessed health is uncorrelated with employment status, then SAH_{it} is uncorrelated with e_{it}, but it is negatively correlated with $-\alpha v_{it}$ by construction. This correlation will lead to an underestimate of α, which is the usual attenuation bias caused by random measurement error. On the other hand, if self-assessed health is endogenous, and in particular the non-employed underreport their true health (justification bias), then SAH_{it} is also positively correlated with e_{it}. This will impart a bias in the opposite direction, tending to overestimates of α. As Bound [14] notes, these two biases may offset each other to a degree. Note also that in the case of justification bias, v_{it} may be correlated with Z_{it}; measurement error of this type can mean that both SAH_{it} and Z_{it} are correlated with the error term in equation (1.3).

OLS estimation of equation (1.3) can also lead to biased estimates of β, both because any correlation of SAH_{it} with the error term "contaminates" the estimate of β (except in the special case that Z_{it} and SAH_{it} are uncorrelated) and because (in the case of justification bias) Z_{it} itself may be correlated with the error term. However, because the financial variables in the NPHS are very limited, this is not a primary concern in this paper. Our objective is to estimate the effect of health on employment (α).

The idea behind our empirical work, which follows the existing literature, is that responses to detailed and specific questions about health can be used to construct a superior measure or index of health, HI_{it}. This index of health likely measures true health with error:

$$HI_{it} = H_{it} + u_{it} \tag{1.4}$$

but the usefulness of the index rests on two propositions. First, because of the specific nature of the underlying questions (referring, for example, to particular medical conditions), the components of the index and hence the index itself do not suffer from justification bias (u_{it} is uncorrelated with E_{it}). Second, because of the comprehensiveness of the index the degree of measurement error is minimized, and, in particular, it may be less than the measurement error in self-assessed health. The latter point is of course debatable, but there is a growing literature that considers the HUI3 to be a very good measure of health.

Such an index can be employed in two ways. First, it can be used as an alternative proxy for health. Inverting equation (1.4)) and substituting into (1.1) gives:

$$E_{it} = Z_{it}\beta + HI_{it}\alpha + (e_{it} - \alpha u_{it}) \tag{1.5}$$

Note that under our assumptions OLS estimation of this "proxy regression" will lead to estimates of α that suffer only from attenuation bias. If the degree of measurement error in the index is limited, then this attenuation bias may be small. Nevertheless, whether the bias that results from this procedure is greater or less than the bias that results from using self-assessed health depends on the amount of measurement error in each, and on the degree to which attenuation bias and justification bias cancel out when self-assessed health is used as the proxy.

Alternatively, one can estimate equation (1.3) by instrumental variables, with HI_{it} as the instrument for SAH_{it}. If self-assessed health suffers only from attenuation bias, this procedure results in a consistent estimate of α. If self-assessed health suffers from justification bias, the situation is more complicated. As Bound [14] points out, this procedure does not address the potential correlation between v_{it} and Z_{it}. If the correlation between SAH_{it} and the error in E_{it} (justification bias) arises (at least in part) through a correlation between v_{it} and Z_{it}, then both Z_{it} and SAH_{it} are correlated with the error term in equation 1.3, and instrumenting only for the latter will not result in consistent estimates of α (except in the special – and implausible case that Z_{it} and SAH_{it} are uncorrelated).

If the correlation between SAH_{it} and the error in E_{it} (justification bias) arises only through a correlation between reporting error (v_{it}) and unobservable determinants of work (e_{it}), then instruments for self-assessed health deliver a consistent estimate of α (because only SAH_{it} is correlated with the error term in equation 1.3.) If justification bias arises because of departures from social norms (for employment), then it may be plausible that misreporting of health is correlated with unobservable determinants of work (such as tastes for leisure) rather than with demographics such as age or education. The bottom line is that using an "objective" health index (HI_{it}) as an instrument for self-assessed health delivers a consistent estimate of α if self-assessed health suffers from attenuation bias (random measurement error) or some (but not all) kinds of justification bias.

We consider two possible variables for HI_{it}. The first is the HUI3, described in section 3.1 above. As noted above, the HUI3 is gaining popularity as an "objective" health measure in applied work, and one of its strengths is its comprehensiveness (Feeney et al. [17]).

Our second strategy is to estimate, for each individual, at each cycle, the health stock. This is done by modeling SAH as a function of more "objective" health information, in particular the answers to questions about specific medical conditions and functional limitations (as well as demographics). This is the strategy employed by Bound et al. [3] and Disney et al. [4] in recent studies using U.S. and U.K. data respectively. Because the predicted values are functions only of the more objective health measures, they constitute a "purged" health measure.

Note that the estimated health stock and the HUI3 are functions of a similar set of medical conditions and functional limitations. Thus they differ primarily in the way the information in those responses is aggregated. Comparison of the empirical distribution functions of the HUI3 and our estimated health stock are provided in appendix Figures 1 (for men) and 2 (for women).

With respect to the estimated health stock, our exact procedure is to estimate an ordered probit for SAH, and to use the predicted (linear) index from this model as the measure of the health stock. We do this separately for men and women and for each cycle. The estimates for the first cycle are reported in Table 6. Estimates for the other cycles are similar and are available from the authors. Many of the individual health measures have significant effects, as do demographics, particularly education. The results are broadly similar to those reported by Disney [4]. The estimated health stock improves with education and wealth and declines with most of the reported health conditions. Interestingly, the estimated health stock declines up to age 58 for both genders and then starts to increase again.

Finally, before leaving this subsection we should note that the paucity of financial information in our data may mean that all of our estimates suffer from omitted variable bias (because the financial incentives for retirement are not properly captured in our empirical work). We return to this issue in our conclusion.

4.2 Results

We now turn to estimates of the effect of health on employment among older Canadians. Results for models estimated in levels are presented in Tables 6a (for men) and 6b (for women). The outcome variable we are modeling is employment, defined as work for pay at the time of the interview (as in Tables 4a and 4b). Time varying control variables are a polynomial in age, household size, and dummies for married, the household owns the home, and the household receives capital income. These estimates in levels also control for time invariant variables race, region of residence and education (modelled by dummies). Note that all health measures are standardized, so that the coefficients represent the effect of a one standard deviation change in health

For comparison purposes, the first column of each table repeats the "naïve" estimates of Tables 4a and 4b (OLS estimates of equation 1.3). An addition here is that we report (at the bottom of column 1), Hausman tests for the exogeneity of self-assessed health. These tests are based on IV estimates of the same equation, using the HUI3 as an instrument for self-assessed health. The exogeneity of the self-assessed health is strongly rejected. These tests were repeated using the estimated health stock as an instrument, and using the responses to the underlying specific questions about health conditions as an instrument set. The results were very similar, and are available from the authors.

The remaining columns of Tables 6a and 6b explore the use of the detailed health information available in the NPHS in different ways. Columns 2 and 4 report estimates that use the estimated health stock and HUI3 respectively as alternative proxies for true health (that is, estimates of equation (1.5) with alternative choices of HI_{it}). Columns 3 and 5 report IV estimates of equation (1.3) that use the estimated health stock and HUI3 respectively as instruments for self-assessed health. Finally, in the 6^{th} column we use all of the specific conditions as instruments for self-assessed health (without aggregating them into an index.).

In all specifications, for both men and women, we find statistically significant effects of health on employment. Depending on the sample and specification, a one standard deviation improvement in health raises employment probabilities by between thirteen and twenty-six percentage points for men, and twelve and twenty percentage points for men. We view these effects as being very economically significant. For example, for women, the employment effect of a one standard deviation improvement in health is generally greater than the effect of a postsecondary education.

Comparing across columns, using either the HUI3 or the health stock as proxy for health leads to slightly larger estimates than using self-assessed health to measure health. However, all of our instrumental variables estimates are approximately double the size of the non-IV estimates (OLS with either self-assessed health, the HUI3, or the estimated health stock as a proxy for true health.) This is true for both men and women. These comparisons suggest that attenuation bias, rather than justification bias, is the main problem with self-assessed health. It does not seem to matter how the detailed information in the data are used. Instrumenting self-assessed health with the HUI3, with the estimated health stock, or with the full set of specific conditions all give very similar estimates of the effect of health on employment.

With IV estimates, one is always concerned with the exogeneity and relevance of instruments. Test statistics pertaining to these concerns are given at the bottom of Tables 6a and 6b. Conditional on other control variables, the HUI3, the estimated health stock, and the full set of specific conditions each have very strong explanatory power for self-assessed health, so that instrument relevance is not a concern.

When we use a single instrument (HUI3 or estimated health stock) for self-assessed health, we cannot perform an over-identification test. However, when we use all of the specific conditions as instruments, the effect of health on employment is over-identified. In this case, tests for over-identifying restrictions show that they cannot be rejected for men at conventional levels of statistical significance but can be rejected for women. One very plausible interpretation of this rejection is that various aspects of health captured by the different indicators have different impacts on labour force participation. We leave the analysis of the varying effects of specific health aspects on labour force participation for future research as the focus of this paper is on the effect of overall health.

In columns 1 through 5 and 7 of Tables 7a and 7b, we estimate the same set of models but now allowing for individual fixed effects. For both men and women we find smaller effects when we model changes (in health and employment) than when we model levels. It is well known that measurement error problems can be exacerbated by allowing for fixed effects (if true health is more serially correlated than the measurement error, the signal-to-noise ratio is lower in changes than in levels). However, health effects are smaller in changes than in levels even when we instrument.

Nevertheless, the effects of health changes are statistically and economically significant. This suggests that individual health changes (and not just cross sectional differences in long run health) are important in the work decision.

Our final specification is reported in column 6 of Tables 7a and 7b. Here we include both the level and change in self-assessed health, instrumented by levels and changes in the HUI3. Controlling for the level of health, the change in health (or equivalently the first lag of health) is strongly significant, for men, though only statistically significant at the 10% level for women.

Taken as whole, the results presented in Tables 7a and 7b suggest that changes in health, and health dynamics more generally, are important in the work decision. This finding echoes Bound et al. [3] and Disney et al. [4]. There are a number of reasons why this may be the case. First, conditional on current health, lagged health may have predictive power for future health (for example if the dynamics of health are richer than AR(1)). Table 10 provides some rough evidence on this point: for both men and women, the three lags of health (the maximum we can investigate with our data) are significant predictors of current health. Lagged health may therefore affect the retirement behaviour of forward looking agents through their expectation of future health. Alternatively, changes in health may be important for "psychological" reasons.

Although we have reported estimates of linear probability models throughout, we have also estimated all of the models that use alternative health indices directly as a proxy for true health by logit and conditional logit. The results are broadly similar to our linear estimates, and are omitted here for brevity.

With regard to the effects of the other variables in the employment models we find relatively few results which are stable across specifications. We generally find more significant effects in the levels estimations than in the fixed effects specifications. his general finding can be explained by the fact that most of the time-varying variables only vary in relatively few households. We find a positive effect on staying in the labour market for men for household size which can be explained by the greater need for income if children have to be provided for. We find some weak evidence that higher educated women work longer. This could be associated with higher wages which in turn would increase the opportunity cost of leisure. We get an opposing effect for being married for men and women. While being married increases the probability of working for men, the opposite is observed for women. This might reflect the classical family structure with one bread-earner (typically the husband) and the higher need for single/divorced/ widowed women to provide income for themselves.

5. Conclusions

In many developed countries the aging of the population poses serious challenges for public pension systems and for the economy generally. It is important therefore to understand the determinants of work activity among older workers.

Using longitudinal data from the Canadian National Population Health Survey (NPHS), we have studied the relationship between health and employment among older Canadian workers. This helps to fill a gap in the Canadian literature on retirement, which, with a few exceptions, has focused on the financial incentives in public pensions.

Our analysis also contributes to the international literature by shedding new light on two issues: (1) possible problems with self-reported health, particularly measurement error and endogeneity, and (2) the relative importance of health changes and long-term health in employment decisions. With respect to the latter, our analysis supports recent U.S. and U.K. findings that changes in health are important in the work decision.

With respect to the former, we have investigated the use of the HUI3 in modeling employment. The HUI3 is an "objective" health index that has been gaining popularity in empirical work. We compared estimates of the impact of health on employment using self-assessed health to estimates that use the HUI3, either in place of self-assessed health or as an instrument for self-assessed. We also compared the use of the HUI3 to other ways of using the information on specific health conditions that the HUI3 aggregates. These included using predicted values from an empirical model of self-assessed health as a "purged" health measure (as has recently been proposed in the literature) and using all individual conditions as instruments for self-assessed health.

For both men and women, estimates of the effect of health on employment that use the HUI3 or estimated health stock as a proxy for health are larger than those based on self-assessed health. Estimates that use the HUI3 or estimated health stock as an instrument for self-assessed health are larger still. These results suggest that estimates based on self-assessed health suffer from attenuation bias rather than justification bias. Across samples and specifications, we consistently find that allowing for fixed individual effects diminishes the estimated effect of health on employment. However, when we both allow for individual effects and instrument self-assessed health, we still get estimates of the effect of health that are larger than estimates from the simple OLS regression of employment on self-assessed health. Our overall conclusion is that there is fairly robust evidence of an economically significant effect of health on employment among Canadian men and women, aged 50 to 64. For both genders, a one standard deviation increase in health seems to raise employment probabilities by 15 to 20 percentage points.

Finally, on a methodological point, our analysis also suggests that the HUI3 provides estimates that are similar to those achieved with a “purged” health measure, or by using all of the underlying health conditions as instruments.

Our work suggests several promising areas of future research. First, our analysis of work activity has been limited to paid employment. It would be useful to extend the analysis to other measures of activity, possibly including hours or part-time/full-time status, job search, and unpaid (volunteer) work.

Second, both our estimated health stock and the HUI3 are based on self-reports about specific medical conditions and functional limitations. Many researchers consider such self-reports to be much more objective than self reports of overall health status. However, by matching a cross section of survey data (from the NPHS) to administrative (medical) records, Baker, Stabile, Deri [11] have recently shown that these self-reports may still suffer from mismeasurement and justification bias. We repeated our analysis with a health stock measure based on fewer health conditions by dropping those conditions which Baker, Stabile and Deri reported to be particularly unreliable. However, our results did not change substantially. Obviously, if longitudinal survey employment data could be matched to longitudinal administrative health records, estimates of the employment effects of health could be obtained that are potentially superior to the ones we have reported.

Third, it would be desirable to model jointly the impacts of financial incentives and health changes on the employment and retirement decisions of older workers. There may be important interactions between the two, and modelling only one or the other (as we have done here) may result in important (omitted variable) biases. The data requirements of an analysis that jointly models the impacts of financial incentives and health changes on the employment of older workers are high, but such research is now being undertaken in some countries (see, for example, Kerkhofs et al., [16] using Dutch data). Among currently available Canadian longitudinal data sets, the Survey of Labour and Income Dynamics contains the necessary detailed information on income and earnings, but only self-assessed health. On the other hand, the National Population Health Survey, used in this study, has detailed health information but very limited income information. Thus the joint modelling of financial incentives and health effects in the Canadian retirement decisions awaits new data sources.

Fourth, a more in-depth analysis of the dynamics of health status could add considerable insights in the interactions of health and employment. One current constraint in this regard is that we have at most four observations on each individual in the NPHS. However, as the panel lengthens over time, there will naturally be greater scope to investigate dynamics.

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Table 1: Self-reported reason for retirement

	Men					
	Age 55-64 (in %)			**Age 65 and over (in %)**		
(Sample Size)	**1975 (70)**	**1989 (132)**	**1994 (254)**	**1975 (423)**	**1989 (446)**	**1994 (738)**
Mandatory retirement	1.4	3.8	8.7	36.4	39.9	17.2
Early retirement incentive		15.0	14.2		9.1	6.7
New technology		2.7	0.8		2.0	1.4
Poor health	**65.7**	**51.7**	**28.5**	**33.6**	**28.3**	**27.2**
Spouse retired	1.4		0	3.3		0
Unemployment	7.1		14.2	5.7		7.9
Family responsibilities	7.1		3.2	4.0		1.6
Personal choice			25.7			23.6
Old enough			3.6			12.3
More leisure time	8.6			5.0		
Relax	4.3			14.2		
Better for health	21.4			18.4		
Enough work	5.7			17.3		
Enough money	5.7			5.7		
Sold business	7.1			11.1		
Other reason	5.7	39.7	3.6	4.7	27.6	3.3

	Women					
	Age 55-64 (in %)			**Age 65 and over (in %)**		
	1975 (335)	**1989 (84)**	**1994 (160)**	**1975 (567)**	**1989 (370)**	**1994 (588)**
Mandatory retirement	1.5	1.2	4.4	7.8	27.0	11.4
Early retirement incentive		11.8	10.1		1.9	1.9
New technology		0	0		0.7	0.7
Poor health	**14.9**	**37.0**	**24.1**	**14.3**	**24.1**	**20.9**
Spouse retired	4.8		5.1	5.3		5.5
Unemployment	2.1		15.2	1.6		7.6
Family responsibilities	6.9		15.2	2.6		15.2
Personal choice			20.9			19.7
Old enough			1.9			11.2
More leisure time	3.9			1.6		
Relax	3.9			4.9		
Better for health	10.2			7.4		
Enough work	3.9			6.0		
Enough money	2.4			1.4		
Sold business	1.8			2.3		
Other reason	7.5	59.7	5.7	7.1	52.2	7.1

Source: Authors' calculations on the 1975 Retirement Survey, 1989 General Social Survey, and 1994 General Social Survey. Calculations only include respondents aged 55 and over because the 1975 Retirement survey only sampled individuals 55 and over.

Table 2: Socioeconomic Characteristics of the Sample, 1994-5

	Male (%)		Female (%)	
	50-64	65+	50-64	65+
Age	6.0	6.4	6.1	6.4
Married	82.5	82.7	65.5	64.0
Household Size	87.1	85.6	77.1	73.9
Household owns home	81.2	83.7	74.5	76.3
Household capital income	30.7	30.6	32.6	28.6
White	93.2	93.0	93.3	92.6
Atlantic	8.4	8.2	8.0	8.5
Quebec	24.5	25.9	27.6	27.2
Ontario	38.2	39.4	37.4	37.1
Prairies	15.5	14.8	14.5	14.7
British Columbia	13.2	11.5	12.2	12.2
Less than high school	41.0	35.8	42.1	36.0
High school	11.9	11.4	15.1	15.1
Some postsecondary	19.1	22.1	19.7	23.2
Postsecondary graduate	27.8	30.5	23	25.5

Notes: Sample Aged 50 to 75 in 1994-5
Sample sizes: 50-64 - male 1883, female 2337
65+ - male 1180, female 1483

Table 3: Self-Assessed Health (SAH) and the Health Utilities Index Mark 3 (HUI3) in the NPHS

	Men			
	Aged 50 to 64		Aged 65+	
	1994-5	2000-1	1994-5	2000-1
(Sample Size)	(1182)	(619)	(701)	(561)
	SAH (%)			
Poor	0.04	0.04	0.06	0.04
Fair	0.12	0.14	0.19	0.19
Good	0.30	0.30	0.34	0.34
Very Good	0.35	0.35	0.29	0.30
Excellent	0.20	0.17	0.13	0.13
	HUI3			
Mean	0.86	0.88	0.82	0.86
SD	0.20	0.19	0.22	0.21
Min	-0.21	-0.07	-0.28	-0.19
P25	0.84	0.88	0.74	0.84
P50	0.93	0.97	0.91	0.97
P75	0.97	0.97	0.97	0.97
Max	1.00	1.00	1.00	1.00
	Women			
	Aged 50 to 64		Aged 65+	
	1994-5	2000-1	1994-5	2000-1
(Sample Size)	(1365)	(703)	(972)	(780)
	SAH (%)			
Poor	0.04	0.04	0.05	0.04
Fair	0.13	0.14	0.18	0.18
Good	0.33	0.31	0.35	0.41
Very Good	0.30	0.38	0.30	0.27
Excellent	0.20	0.13	0.12	0.11
	HUI3			
Mean	0.83	0.87	0.78	0.85
SD	0.22	0.19	0.26	0.20
Min	-0.22	-0.14	-0.31	-0.19
P25	0.78	0.84	0.70	0.83
P50	0.91	0.97	0.91	0.91
P75	0.97	0.97	0.97	0.97
Max	1.00	1.00	1.00	1.00

Note: Ages are in 1994-5.

Table 4: Health Characteristics of the Sample

	Male (%)		Female (%)	
	50-64	65+	50-64	65+
Mental	10.5	9.04	7.07	5.47
Problems with activities of daily life	10.0	19.4	18.1	31.3
Disability	25.1	21.8	22.5	17.4
Food allergy	3.3	3.0	5.6	7.8
Other allergy	10.1	12.8	16.6	27.0
Asthma	4.1	5.8	5.2	7.7
Arthritis	22.2	26.3	34.5	38.4
Other back problems	20.3	17.2	18.5	18.1
High blood pressure	18.7	29.9	23.9	35.9
Migranes	3.5	2.7	7.9	9.0
Bronchitus	5.2	3.6	4.6	4.3
Diabetes	8.2	11.1	6.1	8.7
Heart Disease	10.7	14.5	6.6	8.7
Other chronic conditions	11.8	8.6	15.3	9.9
Ulcer	4.9	2.9	5.0	5.3
Cancer	2.9	4.4	4.2	3.0
Stroke	2.2	3.7	1.9	1.9
Urinary	1.2	1.9	2.6	7.1
Cataract	3.4	6.6	5.9	10.6
Glaucoma	1.8	2.1	2.6	4.6
Insufficient weight (BMI)	2.3	3.1	6.5	5.7
Some excess weight (BMI)	21.8	22.2	15.7	18.3
Overweight (BMI)	43.1	44.6	36.7	38.8
Had chronic condition	67.6	75.6	72.7	81.6

Notes: Sample Aged 50 to 75 in 1994-5
Sample sizes: 50-64 - male 1883, female 2337
65+ - male 1180, female 1483

Table 5: Employment and Self-Assessed Health (SAH) in the NPHS

	Men			
	Aged 50 to 64		Aged 65+	
	1994-5	2000-1	1994-5	2000-1
Overall	0.66	0.61	0.14	0.17
By SAH:				
Poor/ Fair	0.42	0.39	0.07	0.07
Good	0.64	0.57	0.13	0.10
Very Good	0.70	0.67	0.17	0.24
Excellent	0.83	0.78	0.26	0.39
	Women			
	Aged 50 to64		**Aged 65+**	
	1994-5	**2000-1**	**1994-5**	**2000-1**
Overall	0.45	0.38	0.05	0.04
By SAH:				
Poor/ Fair	0.17	0.13	0.03	Not Disclosed by Statistics Canada
Good	0.45	0.37	0.03	0.03
Very Good	0.53	0.47	0.07	0.06
Excellent	0.54	0.48	0.07	0.07

Note: Ages are in 1994-5
Employment is defined as work for pay at the time of the interview.

Table 6a: Employment and Cardinalized Self-Assessed Health in the NPHS: Men

	OLS		Linear Fixed Effects Model	
Ages	50-64	65+	50-64	65+
	Coef	Coef	Coef	Coef
Age/10	8.691	-22.169	8.197	-7.274
	(12.396)	(40.434)	(9.811)	(26.977)
$(Age/10)^2$	-1.326	3.115	-1.296	0.968
	(2.168)	(5.787)	(1.718)	(3.861)
$(Age/10)^3$	0.062	-0.147	0.064	-0.044
	(0.126)	(0.276)	(0.100)	(0.184)
Married	**0.073**	-0.018	-0.054	0.001
	(0.030)	(0.030)	(0.050)	(0.049)
Household Size	**0.097**	0.034	0.075	-0.016
	(0.033)	(0.031)	(0.044)	(0.042)
Household owns home	**0.056**	-0.002	-0.016	-0.013
	(0.022)	(0.018)	(0.035)	(0.031)
Household capital income	**-0.039**	-0.024	-0.030	-0.007
	(0.017)	(0.014)	(0.017)	(0.012)
White	-0.039	0.001		
	(0.031)	(0.040)		
Atlantic	**-0.085**	**-0.084**		
	(0.021)	(0.018)		
Quebec	**-0.133**	**-0.078**		
	(0.022)	(0.021)		
Prairies	**0.084**	0.035		
	(0.021)	(0.019)		
BC	-0.015	**-0.060**		
	(0.027)	(0.025)		
High school	-0.022	0.037		
	(0.024)	(0.022)		
Some postsecondary	-0.036	0.026		
	(0.020)	(0.018)		
Postsecondary Graduate	0.017	**0.043**		
	(0.018)	(0.018)		
Cardinalized SAH	**0.119**	**0.032**	**0.024**	-0.001
	(0.007)	(0.007)	(0.009)	(0.007)
R^2	0.235	0.054	0.144	0.017

Notes:

Pooled data from 4 waves of the NPHS (aged 50 to 75 in 1994-5)

Samples sizes: 65+ men(2540) 50-64 men (3599)

Coefficients in bold are significant at the 5% level.

The outcome variable is a binary indicator of employment, defined as work for pay at the time of the interview.

The cardinalization of SAH is derived from the empirical cumulative distribution of the HUI3 (following Van Doorslaer and Jones, 2003) and standardized to have mean zero and s.d. 1. See text for further details.
Additional controls: Region Dummies

Table 6b: **Employment and Cardinalized Self-Assessed Health in the NPHS: Women**

	OLS		Linear Fixed Effects Model	
Ages	50-64	65+	50-64	65+
	Coef	Coef	Coef	Coef
Age/10	**27.493**	-18.589	**27.390**	-3.743
	(12.176)	(21.551)	(9.288)	(17.127)
$(Age/10)^2$	**-4.726**	2.584	**-4.729**	0.424
	(2.128)	(3.083)	(1.626)	(2.450)
$(Age/10)^3$	**0.266**	-0.120	**0.268**	-0.016
	(0.124)	(0.147)	(0.095)	(0.117)
Married	**-0.076**	**-0.062**	-0.076	-0.032
	(0.024)	(0.013)	(0.046)	(0.025)
Household Size	0.009	**0.050**	-0.013	0.028
	(0.026)	(0.013)	(0.033)	(0.020)
Household owns home	-0.004	0.005	0.007	-0.001
	(0.019)	(0.594)	(0.035)	(0.019)
Household capital income	**-0.059**	-0.007	**-0.046**	-0.009
	(0.016)	(0.008)	(0.016)	(0.008)
White	-0.041	**0.053**		
	(0.036)	(0.022)		
Atlantic	**-0.081**	**-0.034**		
	(0.020)	(0.010)		
Quebec	**-0.115**	**-0.038**		
	(0.021)	(0.011)		
Prairies	**0.050**	-0.002		
	(0.020)	(0.010)		
BC	-0.00001	-0.007		
	(0.026)	(0.013)		
High school	0.024	**-0.023**		
	(0.022)	(0.011)		
Some postsecondary	0.036	**0.028**		
	(0.019)	(0.010)		
Postsecondary Graduate	**0.102**	**0.027**		
	(0.019	0.010)		
Cardinalized SAH	**0.109**	**0.016**	**0.030**	-0.001
	(0.007)	(0.004)	(0.009)	(0.005)
R^2	0.190	0.041	0.141	0.017

Notes:

Pooled data from 4 waves of the NPHS (aged 50 to 75 in 1994-5)

Samples sizes: 65+ Female (3543) 50-64 Female (4058)

Coefficients in bold are significant at the 5% level.

The outcome variable is a binary indicator of employment, defined as work for pay at the time of the interview.

The cardinalization of SAH is derived from the empirical cumulative distribution of the HUI3 (following Van Doorslaer and Jones, 2003) and standardized to have mean zero and s.d. 1. See text for further details.

Additional controls: Region Dummies

Table 7: Health Stock Estimimates in the 1994-5 NPHS
Ordered Probits for Self-Assessed Health (SAH) on Demographics and Health Measures (Age 50-64)

	Men	Women
	Coef	Coef
	(std err)	(std err)
Age/10	-3.221	**-4.282**
	(2.181)	(2.013)
$(Age/10)^2$	0.277	**0.366**
	(0.192)	(0.177)
Married	0.254	0.126
	(0.130)	(0.098)
Household Size	-0.196	**-0.292**
	(0.144)	(0.107)
Household owns home	0.061	**0.210**
	(0.095)	(0.082)
Household capital income	**0.193**	0.077
	(0.075)	(0.068)
White	0.046	0.229
	(0.150)	(0.152)
High school	**0.340**	**0.207**
	(0.107)	(0.092)
Some postsecondary	**0.247**	**0.313**
	(0.087)	(0.080)
Postsecondary graduate	**0.441**	**0.442**
	(0.083)	(0.080)
Mental	0.001	**-0.006**
	(0.001)	(0.002)
Problems with activities of daily life	**-0.558**	**-0.470**
	(0.133)	(0.105)
Disability	**-0.738**	**-0.823**
	(0.089)	(0.091)
Food allergy	-0.123	0.026
	(0.176)	(0.123)
Other allergy	0.116	-0.053
	(0.107)	(0.081)
Asthma	**-0.457**	**-0.589**
	(0.183)	(0.133)
Arthritis	**-0.249**	**-0.316**
	(0.083)	(0.071)
Other back problems	-0.070	**-0.256**
	(0.082)	(0.082)
High blood pressure	**-0.249**	**-0.210**
	(0.087)	(0.078)

Migranes	**-0.478**	-0.182
	(0.176)	(0.102)
Bronchitus	**-0.511**	-0.107
	(0.171)	(0.149)
Diabetes	**-0.402**	**-0.586**
	(0.141)	(0.143)
Heart Disease	**-0.723**	**-0.401**
	(0.122)	(0.137)
Other chronic conditions	**-0.269**	**-0.312**
	(0.096)	(0.081)
Ulcer	**-0.314**	**-0.505**
	(0.143)	(0.138)
Cancer	**-0.554**	**-0.346**
	(0.253)	(0.163)
Stroke	-0.248	-0.356
	(0.275)	(0.284)
Urinary	-0.343	0.126
	(0.318)	(0.199)
Cataract	0.347	-0.078
	(0.237)	(0.191)
Glaucoma	-0.028	-0.139
	(0.301)	(0.245)
Insufficient weight (BMI)	-0.338	-0.178
	(0.217)	(0.132)
Some excess weight (BMI)	-0.106	0.048
	(0.089)	(0.092)
Overweight (BMI)	-0.094	**-0.157**
	(0.076)	(0.069)
Pseudo R^2	0.150	0.174

Samples sizes:1182 Men and 1365 Women.

(Aged 50 to 64 in 1994-5)
Bold coefficients are statistically significant at the 5% level.
Results for other waves are similar, and available from the authors.
Additional controls: region dummies

Table 8a: Employment Levels Models, Men, 50-64

	Cardinalized SAH	Estimated Health Stock		HUI3		Unrestricted
	Linear	Linear	IV Linear	Linear	IV Linear	IV Linear
Age/10	8.691	17.557	7.109	11.579	8.458	7.011
	(12.396)	(12.144)	(12.941)	(12.376)	(13.015)	(13.01)
$(Age/10)^2$	-1.326	-2.844	-1.030	-1.854	-1.261	-1.011
	(2.168)	(2.124)	(2.263)	(2.165)	(2.277)	(2.275)
$(Age/10)^3$	0.062	0.149	0.044	0.094	0.057	0.043
	(0.126)	(0.123)	(0.132)	(0.126)	(0.132)	(0.132)
Married	**0.073**	0.052	0.061	**0.074**	**0.063**	0.060
	(0.030)	(0.029)	(0.031)	(0.030)	(0.031)	(0.031)
Household owns home	**0.056**	0.023	0.020	**0.045**	0.017	0.018
	(0.022)	(0.021)	(0.023)	(0.022)	(0.023)	(0.023)
Household capital income	**-0.039**	**-0.069**	**-0.068**	-0.035	**-0.069**	**-0.070**
	(0.017)	(0.017)	(0.018)	(0.017)	(0.018)	(0.018)
Household size	**0.097**	**0.092**	**0.094**	**0.084**	**0.095**	**0.093**
	(0.033)	(0.033)	(0.035)	(0.033)	(0.035)	(0.035)
Health Measure	**0.119**	**0.161**	**0.252**	**0.128**	**0.253**	**0.260**
	(0.007)	(0.008)	(0.013)	(0.007)	(0.015)	(0.013)
White	-0.039	-0.042	-0.041	-0.022	-0.044	-0.041
	(0.031)	(0.030)	(0.032)	(0.031)	(0.033)	(0.033)
High school	-0.022	**-0.062**	**-0.053**	-0.004	**-0.057**	**-0.059**
	(0.024)	(0.024)	(0.025)	(0.024)	(0.025)	(0.025)
Some postsecondary	-0.036	**-0.059**	**-0.059**	-0.019	**-0.060**	**-0.063**
	(0.020)	(0.019)	(0.020)	(0.020)	(0.021)	(0.021)
Postsecondary graduate	0.017	**-0.039**	-0.023	0.024	-0.030	-0.029
	(0.018)	(0.018)	(0.019)	(0.018)	(0.020)	(0.020)
R^2	0.235	0.267	0.167	0.224	0.164	0.158
Hausman Test	t=-10.88 p<0.001					
Instrument Relevance			t=44.04 p<0.001		t=35.31 P<0.001	$F_{(23,4019)}$=79.04 p<0.001
Overidentification Test			(just identified)		(just identified)	$\chi^2_{(22)}$ = 29.87 p=0.12

Notes:
Aged 50 to 64 in 1994-5
Sample Size: 3599 Men in Health stock case, 3559 Men in HUI3 case, 2291 in HUI Level & Changes
Bold coefficients are statistically significant at the 5% level.
Additional controls: region dummies.
Health measures have been standardized to have mean zero and s.d. 1
Results for logit are similar to linear and linear and are available from the authors.
The outcome variable is a binary indicator of employment, defined as work for pay at the time of the interview.

Table 8b: Levels Employment Models, Women 50-64

	Cardinalized SAH	Estimated Health Stock		HUI3		Unrestricted
	Linear	Linear	IV Linear	Linear	IV Linear	IV Linear
Age/10	**27.493**	**28.752**	23.530	**32.504**	24.321	23.02
	(12.176)	(12.142)	(12.363)	(12.203)	(12.527)	(12.41)
$(Age/10)^2$	**-4.726**	**-4.917**	-4.005	**-5.629**	-4.134	-3.913
	(2.128)	(2.122)	(2.161)	(2.132)	(2.189)	(2.169)
$(Age/10)^3$	**0.266**	**0.275**	0.222	**0.320**	0.229	0.217
	(0.124)	(0.123)	(0.126)	(0.124)	(0.127)	(0.126)
Married	**-0.076**	**-0.082**	**-0.094**	**-0.068**	**-0.100**	**-0.097**
	(0.024)	(0.024)	(0.025)	(0.024)	(0.025)	(0.025)
Household owns home	-0.004	-0.025	-0.036	0.010	**-0.043**	-0.040
	(0.019)	(0.020)	(0.020)	(0.019)	(0.020)	(0.020)
Household capital income	**-0.059**	**-0.072**	**-0.070**	**-0.057**	**-0.074**	**-0.071**
	(0.016)	(0.016)	(0.016)	(0.016)	(0.017)	(0.016)
Household size	0.009	0.017	0.019	-0.006	0.020	0.020
	(0.026)	(0.026)	(0.027)	(0.026)	(0.027)	(0.027)
Health Measure	**0.109**	**0.122**	**0.188**	**0.109**	**0.210**	**0.198**
	(0.007)	(0.008)	(0.012)	(0.007)	(0.014)	(0.012)
White	-0.041	-0.065	**-0.076**	-0.015	**-0.084**	**-0.080**
	(0.036)	(0.036)	(0.036)	(0.036)	(0.037)	(0.036)
High school	0.024	0.009	0.003	0.028	0.002	0.0009
	(0.022)	(0.022)	(0.023)	(0.022)	(0.023)	(0.023)
Some postsecondary	0.036	0.008	0.020	**0.045**	0.016	0.018
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Postsecondary graduate	**0.102**	**0.065**	**0.074**	**0.106**	**0.067**	**0.070**
	(0.019	(0.019)	(0.019)	(0.019)	(0.020)	(0.019)
R^2	0.190	0.194	0.166	0.192	0.151	0.160
Hausman Test	t=-8.72 p<0.001					
Instrument Relevance			t=48.30 p<0.001		t=39.53 p<0.001	$F_{(23,4019)}$=98.76 p<0.001
Over-identification Test			(just identified)		(just identified)	$\chi^2_{(22)} = 53.56$ P<0.001

Notes:
Aged 50 to 64 in 1994-5
Sample Size: 4034 Women in HUI3 case, and 4058 Women in health stock case
Bold coefficients are statistically significant at the 5% level.
Additional controls: region dummies
Health measures have been standardized to have mean zero and s.d. 1
Results for logit are similar to linear and available from the authors.
The outcome variable is a binary indicator of employment, defined as work for pay at the time of the interview.

Table 9a: Employment Models with Fixed Effects, Health Changes, Men, 50-64

	Cardinalized SAH	Estimated Health Stock		HUI3			Unrestricted
	Linear FE	Linear FE	IV Linear FE	Linear FE	IV Linear FE	IV Level & Change	IV Linear FE
Age/10	8.197	12.624	10.117	8.438	9.271	9.659	10.388
	(9.811)	(9.793)	(10.166)	(9.914)	(10.257)	(24.989)	(10.271)
$(Age/10)^2$	-1.296	-2.051	-1.607	-1.331	-1.452	-1.510	-1.651
	(1.718)	(1.715)	(1.780)	(1.737)	(1.796)	(4.306)	(1.798)
$(Age/10)^3$	0.064	0.107	0.081	0.066	0.071	0.074	0.083
	(0.100)	(0.100)	(0.104)	(0.101)	(0.105)	(0.247)	(0.105)
Married	-0.054	-0.052	-0.064	-0.042	-0.063	0.032	-0.065
	(0.050)	(0.050)	(0.052)	(0.051)	(0.052)	(0.039)	(0.053)
Household owns home	-0.016	-0.027	-0.019	-0.019	-0.019	-0.011	-0.019
	(0.035)	(0.035)	(0.036)	(0.035)	(0.037)	(0.029)	(0.037)
Household capital income	-0.030	**-0.041**	-0.023	-0.030	-0.024	-0.081	-0.022
	(0.017)	(0.017)	(0.017)	(0.017)	(0.018)	(0.022)	(0.018)
Household size	0.075	0.073	0.081	0.071	0.079	0.099	0.082
	(0.044)	(0.044)	(0.046)	(0.044)	(0.046)	(0.044)	(0.046)
Health Measure	**0.024**	**0.065**	**0.141**	**0.036**	**0.134**	**0.298**	**0.158**
	(0.009)	(0.011)	(0.026)	(0.009)	(0.035)	(0.019)	(0.028)
Change in Health Measure						**-0.131**	
						(0.044)	
White						-0.059	
						(0.040)	
High school						-0.061	
						(0.032)	
Some postsecondary						-0.051	
						(0.026)	
Postsecondary graduate						-0.046	
						(0.024)	
R^2	0.144	0.198	0.181	0.162	0.182	0.188	0.178
Hausman Test	t=-3.50 p<0.001						

Notes:
Aged 50 to 64 in 1994-5
Sample Size: 3599 Men in Health stock case, 3559 Men in HUI3 case, 2291 in HUI Level & Changes
Bold coefficients are statistically significant at the 5% level.
Additional controls: region dummies
Health measures have been standardized to have mean zero and s.d. 1
Results from conditional logits are similar to linear FE and available from the authors.
The outcome variable is a binary indicator of employment, defined as work for pay at the time of the interview.

Table 9b:	**Employment Models with Fixed Effects, Health Changes, Women 50-64**						
	Cardinalized SAH	Estimated Health Stock		HUI3			Unrestricted
	Linear FE	Linear FE	IV Linear FE	Linear FE	IV Linear FE	IV Level & Change	IV Linear FE
Age/10	**27.390**	**27.655**	**25.053**	**27.816**	**23.637**	6.264	**24.375**
	(9.288)	(9.269)	(9.530)	(9.314)	(9.821)	(23.62)	(9.676)
$(Age/10)^2$	**-4.729**	**-4.760**	**-4.291**	**-4.810**	**-4.029**	-1.007	**-4.164**
	(1.626)	(1.623)	(1.669)	(1.631)	(1.721)	(4.066)	(1.695)
$(Age/10)^3$	**0.268**	**0.269**	**0.241**	**0.273**	**0.225**	0.049	**0.233**
	(0.095)	(0.094)	(0.097)	(0.095)	(0.100)	(0.233)	(0.099)
Married	-0.076	-0.085	-0.084	-0.078	-0.094	**-0.092**	-0.086
	(0.046)	(0.046)	(0.047)	(0.047)	(0.049)	(0.031)	(0.048)
Household owns home	0.007	-0.004	0.001	0.005	-0.003	-0.040	0.001
	(0.035)	(0.035)	(0.036)	(0.035)	(0.037)	(0.025)	(0.036)
Household capital income	**-0.046**	**-0.054**	**-0.048**	**-0.045**	**-0.047**	**-0.114**	**-0.048**
	(0.016)	(0.016)	(0.016)	(0.016)	(0.017)	(0.021)	(0.017)
Household size	-0.013	-0.011	-0.001	-0.019	-0.001	0.008	-0.002
	(0.033)	(0.033)	(0.034)	(0.033)	(0.035)	(0.034)	(0.036)
Health Measure	**0.030**	**0.052**	**0.134**	**0.039**	**0.179**	**0.214**	**0.164**
	(0.009)	(0.011)	(0.030)	(0.009)	(0.043)	(0.017)	(0.035)
Change in Health Measure						-0.097	
						(0.054)	
White						-0.119	
						(0.047)	
High school						0.008	
						(0.029)	
Some postsecondary						0.020	
						(0.024)	
Postsecondary graduate						**0.067**	
						(0.024)	
R^2	0.141	0.156	0.162	0.147	0.151	0.169	0.156
Hausman Test	t=-3.78 p<0.001						

Notes:
Aged 50 to 64 in 1994-5
Sample Size: 4034 Women in HUI3 case, and 4058 Women in health stock case
Bold coefficients are statistically significant at the 5% level.
Additional controls: region dummies
Health measures have been standardized to have mean zero and s.d. 1
Results for conditional logits are similar to linear FE and available from the authors.
The outcome variable is a binary indicator of employment, defined as work for pay at the time of the interview.

Table 10: Health Dynamics (HUI3)

	Men 50-64			Women 50-64		
	1 lag	2 lags	3 lags	1 lag	2 lags	3 lags
Lagged HUI3	**0.60**	**0.45**	**0.42**	**0.60**	**0.44**	**0.38**
	(0.02)	(0.03)	(0.04)	(0.01)	(0.03)	(0.04)
2nd Lag		**0.25**	**0.20**		**0.24**	**0.23**
		(0.03)	(0.05)		(0.02)	(0.05)
3rd Lag			**0.15**			**0.12**
			(0.04)			(0.04)
Adjusted R-square	0.33	0.35	0.41	0.38	0.39	0.40
Observations	2291	1313	548	2585	1479	632

Notes:
(Aged 50 to 64 in 1994-5)

Figure 1: Empirical CDF of HUI3 and predicted health stock, men aged 50-64

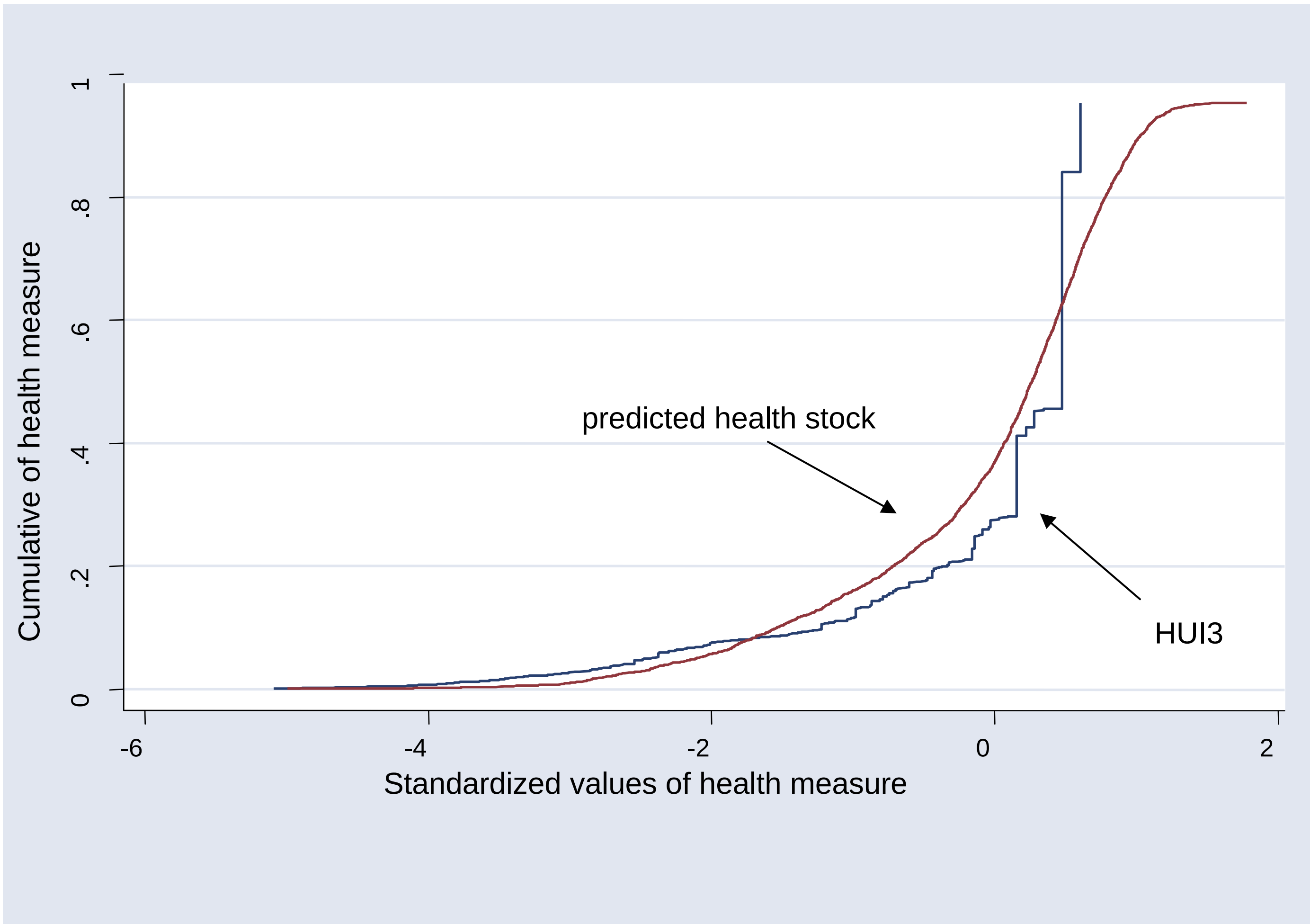
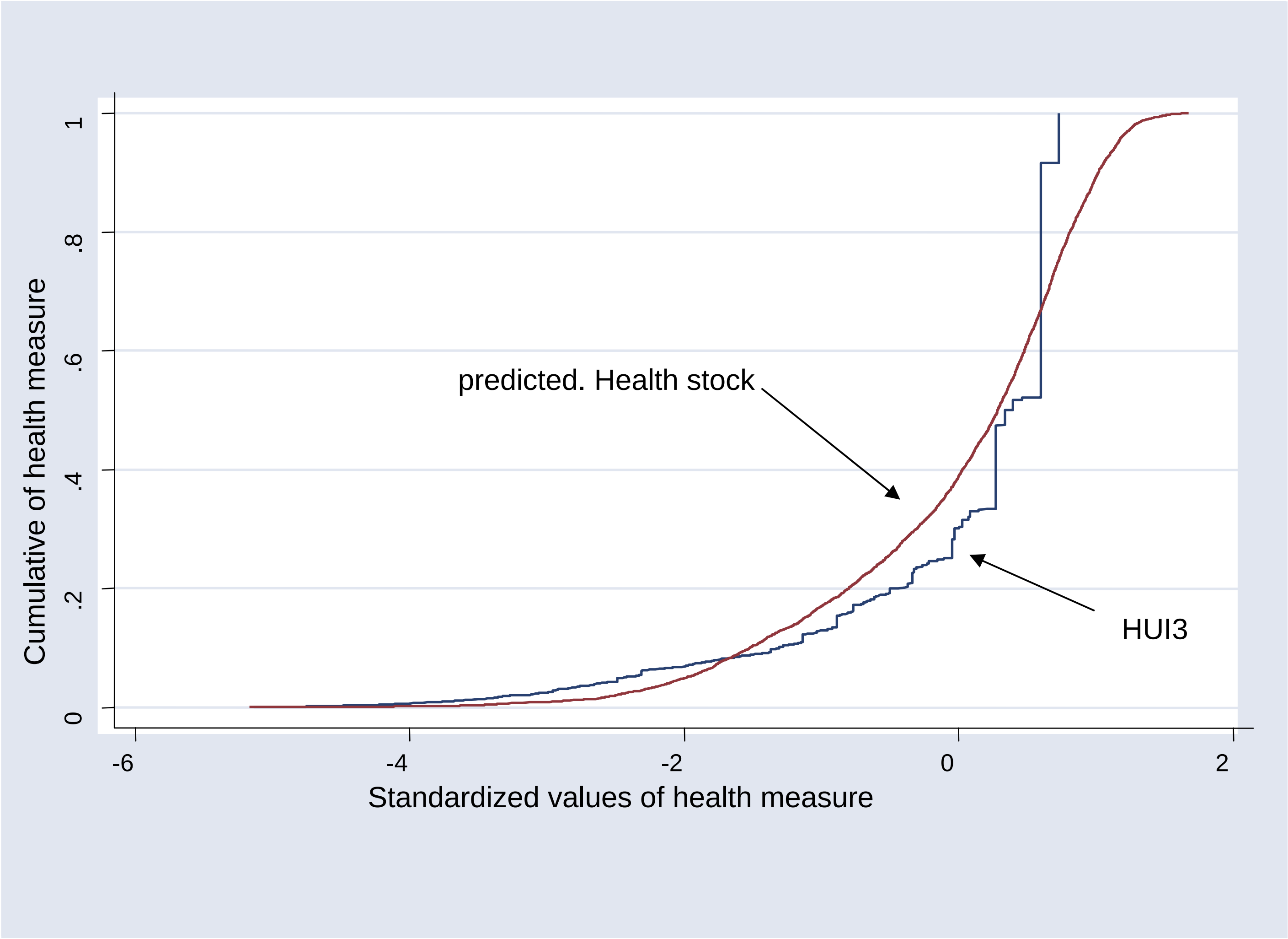


Figure 2: Empirical CDF of HUI3 and predicted health stock, women age 50-64



Appendix Tables

Table A1: **Testing for attrition bias - employment models for men; using waves 1 (& 2); attrition dummy for wave 4**

	OLS		Linear Fixed Effects Model	
Ages	With Attrition	Without Attrition	With Attrition	Without Attrition
	Coef	Coef	Coef	Coef
Age/10	1.766	1.951	21.305	21.309
	(19.03)	(19.06)	(16.93)	(16.92)
$(Age/10)^2$	-0.144	-0.170	-3.545	-3.549
	(3.355)	(3.359)	(2.989)	(2.987)
$(Age/10)^3$	-0.005	-0.004	0.192	0.192
	(0.197)	(0.197)	(0.175)	(0.175)
Married	0.101	0.106	-0.061	-0.060
	(0.050)	(0.050)	(0.096)	(0.096)
Household owns home	**0.073**	0.075	-0.002	-0.002
	(0.036)	(0.036)	(0.056)	(0.056)
Household capital income	-0.047	-0.043	-0.041	-0.041
	(0.029)	(0.029)	(0.026)	(0.026)
Household Size	0.092	0.094	0.042	0.042
	(0.055)	(0.055)	(0.070)	(0.070)
Cardinalized SAH	**0.104**	0.106	0.010	0.010
	(0.012)		(0.014)	(0.014)
Attrition Dummy	**0.061**		-0.004	
	(0.030)		(0.035)	

Notes:

Data from 2 waves of the NPHS (aged 50 to 64 in 1994-5)

Samples sizes: 1182 Linear model with wave 1; 2165 FE model (wave 1 & 2)

Coefficients in bold are significant at the 5% level.

The cardinalization of SAH is derived from the empirical cumulative distribution of the HUI3 (following Van Doorslaer and Jones, 2003) and standardized to have mean zero and s.d. 1. See text for further details.

Additional controls: Region Dummies, race, education

Table A2: Testing for attrition bias - employment models for women; using waves 1 (& 2); attrition dummy for wave 4

	OLS		Linear Fixed Effects Model	
Ages	With Attrition	Without Attrition	With Attrition	Without Attrition
	Coef	Coef	Coef	Coef
Age/10	32.193	32.782	**36.157**	36.284
	(19.04)	(19.05)	(15.25)	(15.22)
$(Age/10)^2$	-5.634	-5.736	**-6.250**	-6.268
	(3.353)	(3.354)	(2.687)	(2.684)
$(Age/10)^3$	0.324	0.330	**0.355**	0.356
	(0.196)	(0.196)	(0.157)	(0.157)
Married	**-0.106**	**-0.106**	-0.142	-0.141
	(0.040)	(0.040)	(0.093)	(0.093)
Household owns home	-0.015	-0.014	-0.032	-0.032
	(0.033)	(0.033)	(0.052)	(0.052)
Household capital income	0.009	0.011	-0.016	-0.016
	(0.028)	(0.028)	(0.023)	(0.023)
Household Size	0.045	0.045	-0.019	-0.020
	(0.043)	(0.043)	(0.053)	(0.053)
Cardinalized SAH	**0.115**	**0.116**	0.002	0.002
	(0.012)	(0.012)	(0.014)	(0.014)
Attrition Dummy	0.050		0.006	
	(0.033)		(0.034)	
			0.023	

Notes:

Data from 2 waves of the NPHS (aged 50 to 64 in 1994-5)

Samples sizes: 1365 Linear model with wave 1; 2466 FE model (wave 1 & 2)

Coefficients in bold are significant at the 5% level.

The cardinalization of SAH is derived from the empirical cumulative distribution of the HUI3 (following Van Doorslaer and Jones, 2003) and standardized to have mean zero and s.d. 1. See text for further details.

Additional controls: Region Dummies, race, education

Appendix Methods:

A) Health Stock Models:

We estimate ordered probit models for SAH which are defined in the following way:

$$\Pr(\text{SAH}=i)=\Pr(\kappa_{i-i}<\sum_j \beta_j x_j + u \le \kappa_i)$$
$$=\Phi(\kappa_i-\sum_j \beta_j x_j)-\Phi(\kappa_{i-1}-\sum_j \beta_j x_j) \qquad i=1,...,5$$

with $\kappa_0=-\infty$ and $\kappa_5=\infty$

The explanatory variables include age, gender, socio-demographic characteristics, regional dummies and specific health conditions (see Table 5.)
We use the predicted value of the index function $SAH^*=\sum_j \hat{\beta}_j x_j$ as our purged health stock measure (after standardizing it to be distributed with a zero mean and standard deviation of 1 in the population)

B) Employment models:

We estimate linear probability models for employment of the form

$I(\text{employment}_{it}=1)=E_{it}=x'_{it}\beta+u_{it}$ with OLS (with Huber-White heteroskedasticity consistent standard errors).

In the case of the fixed effects models $u_{it}=\eta_i+\varepsilon_i$

For the IV estimates the estimator of the parameter vector is given by
$\beta=\left(X'Z(Z'Z)^{-1}(X'Z)'\right)^{-1}X'Z(Z'Z)^{-1}Z'I(\text{emp}=1)$ where *X* are the explanatory variables age, gender, education, region, cardinalized SAH; *Z* is the same as *X* except for cardinalized SAH which is replaced by the objective health measure (HUI3 or the purged health stock).

C) Software used

All models are estimated using STATA 8.0

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