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Health and retirement in Europe

Abstract

Internationally comparable panel data from the full eight waves of the ECHP are used to study the effects of health on retirement in nine EU countries. Self-reported retirement is compared to a broader measure of inactivity. Measures of health include two latent stock measures, one that is normalised, and graduated health shocks. Discrete-time mixed proportional hazard models show an increase in the hazard of retiring due to ill-health. The magnitude of the effects varies with the size of shock and across countries. The effects of financial factors are robust across different health measures but depend on the definition of retirement. **(100 words)**

I. Introduction

The developed world is facing an ageing population as life expectancy increases and birth rates decrease. The average age of retirement has been decreasing in Europe and ranges from 58.2 years in Luxembourg to 63.1 years in Sweden (Eurostat, 2006). These factors have important implications for the labour market and will increase demands on both the health system and the public provision of pensions and other benefits (Kerkhofs, Lindeboom & Theeuwes, 1999; Tanner, 1998). Countries differ in the systems of financial incentives provided by their social security systems, in the nature of pension and incapacity benefits, and in how the system drives early retirement (Gruber & Wise, 1997; Blundell & Johnson, 1998). There are differences in life expectancy, activity rates for older workers, retirement age and projected dependency rates between European countries. Within the European Union (EU) the old-age dependency rate is forecast to double between 2000 and 2040 (Banks et al., 2002). These pressures vary between member states but will become a major political issue in all countries.

The decision to retire or continue in the workforce involves the choice of the optimal balance of consumption and leisure with the goal of maximising personal and household utility subject to the usual budget and time constraints. The degree of health or ill-health will influence this balance and ill-health is frequently cited as the cause for retirement (see e.g., Bazzoli, 1985; Tanner, 1998). Many studies have explored the relationship between level of health and retirement, with the earlier work summarised by Currie & Madrian (1999) and more recent work summarised by Deschryvere (2004) and Lindeboom (2006).

The relationship between the measure of health used and 'true' health has been a constant concern for researchers. The commonest measure of health used in early studies was the subjective measure of Self -assessed health (SAH) which is asked both in general terms and in relation solely to the ability to perform work activities. This has obvious potential problems of both accuracy and endogeneity. Those who are inactive have an incentive to report worse than actual health to justify their inactivity (justification bias). Health itself may be endogenous to the labour market status of the individual, depending on the degree of self-esteem generated by the job or the amount of stress associated with the job or work environment.

However the literature is conflicting on the state-dependent nature of this subjective measure (Bazzoli, 1985; Kerkhofs et al., 1999; Dwyer & Mitchell, 1999; McGarry, 2004). Faced with this uncertainty, measures of health that are believed to be more objective have been proposed and used. These have included self reports on specific medical conditions and functional limitations, or the use of various symptom checklists. Again, the published evidence is conflicting (Stern, 1989; Kreider, 1999) and these measures have also been shown to have some measurement bias (Baker, Stabile & Deri, 2004).

More recent studies have constructed an underlying 'health stock' for each individual and tracked temporal changes in this measure as a proxy for individual 'health shocks' that might influence retirement behavior (Bound et al., 1999; Disney et al, 2003; Au et al., 2005; Disney et al., 2006; Roberts et al., 2006). These latent measures of health are created using predicted values from estimated models of SAH, using as predictors health indicators that are related to reports of specific medical conditions and functional limitations. Demographic variables, but not employment status, have also been used with the belief that this removes the effect of employment status on reporting behavior. Hence the resulting predictions are claimed to be free of any justification bias. This however will only be true if the health indicators and demographic variables are themselves not directly related to the measurement error. These recent studies have looked at the dynamics of the health and retirement relationship focusing on the relative contributions of long-run health and of acute changes in an individual's health stock. Using longitudinal data from individual countries including the USA, UK and Canada they show that the dynamics of health are important and that changes in health play an important role in retirement decisions. These studies have underlined the necessity of having good panel data available to model the relationship between health and employment status.

A range of alternative outcome measures have been used as regards the definition of retirement. The most direct is self-reported retirement, though this may be vulnerable to recall bias and may not accurately define observed prolonged work inactivity (Disney, Grundy & Johnson, 1997). More commonly, labour force participation has been assessed as regards transitions from being active to various forms of inactivity. These have included early retirement programs, disability insurance programs or unemployment programs (Bound et al., 1999; Kerkhofs et al., 1999) . Additional outcome measures have included the expected age of retirement (Dwyer & Mitchell, 1999) and the expected probability of being in full-time work at age 62 years (McGarry, 2004). Health may have different effects depending on the outcome variable chosen (Bound et al., 1999; Kerkhofs et al., 1999) and how other covariates behave may depend on the outcome and health measures used. This has been commented on in the literature but with conflicting results (Au et al., 2005; Kerkhofs et al., 1999).

A basic requirement for studies on the impact of health on retirement decisions is the availability of good data sources. The USA has had a long tradition of gathering data on older members of the community with European countries only recently establishing similar datasets with the Survey of Health, Ageing and Retirement in Europe (SHARE) and the English Longitudinal Study of Ageing (ELSA). Data incompatibility problems have resulted in almost all published studies relating to data from an individual country hence making comparisons between countries difficult. Some preliminary results have been presented using two European datasets with work from Kalwij & Vermeulen (2005) on the first wave of the SHARE data and from Garcia et al. (2005) on comparisons of retirement decisions of older European couples using one wave of the European Community Household Panel (ECHP) data.

At an analytical level, recent applications of discrete-time proportional hazard models have provided a flexible dynamic structure within which to examine these relationships in appropriately structured panel data. This approach has been used, with 'stock samples' of individuals within a target age range (Jenkins, 1995), with data from the British Household Panel Survey (Disney et al., 2006; Roberts et al., 2006).

In this paper we use discrete-time proportional hazard models with longitudinal data from the full eight waves of the European Community Household Panel (ECHP) to study the relationship between retirement, health stock and health shocks in nine European countries. The stock sample approach conditions on individuals within a set age range and in employment at the first wave. A variety of health measures, including self assessed health (SAH), a latent health stock and graduated acute health shocks, are used as are alternative definitions of retirement. The availability of panel data allows us to exploit the timing of events to identify the impact of health shocks on retirement (see e.g., Abbring and van den Berg, 2003). Self-reported health shocks are recorded prior to the individual's date of exit from the labour market and this should help to mitigate the influence of justification bias, although anticipation effects may still be a factor.

Our work provides comparisons of the effects of health across a range of European countries based on comparable panel data. It provides further evidence on the relationship between health and health shocks and the retirement decision. Additionally it provides evidence that acute changes in health are of more significance and that the graduated health shocks show a gradient in their effects. The results show that the effects of other covariates in the models, especially financial factors, are robust across specifications using different measures of health and health shocks. Finally, we demonstrate the effect of using alternative definitions of retirement as the outcome measure when assessing the effects of individual factors. There is consistency in the effects of the health measures across the two definitions of retirement but this is not so for other factors especially financial factors, sex and education.

II. Data

Data drawn from the full eight waves (1994–2001) of the European Community Household Panel (ECHP) dataset are used. The ECHP is a standardized annual longitudinal survey carried out among the pre-enlargement member countries of the European Union (EC-15). The ECHP was designed and coordinated by the Statistical Office of the European Communities (Eurostat) covering, at the level of households and individuals, information on demographics, participation in the labour market, income, health, education and training, housing etc. The first wave was conducted in 1994 and the User's Data Base (ECHP-UDB), which is an anonymised and user-friendly version of the data, has been available since December 1998. The version containing the complete eight waves (December '03) is used in this study. Nine countries were selected for study, listed in alphabetical order: Belgium, Denmark, France, Greece, Ireland, Italy, Portugal, Spain and the UK. All had data from the first wave in relation to health variables and employment activity

A. Selection and creation of variables

1. Health variables

The ECHP has a variety of health-related questions. These include a measure of general self-assessed health (SAH) status as well as more specific questions related to limitations in daily activities, the presence of recent illness due to physical, emotional or mental health problems as well as admission to hospital.

The SAH variable is a simple five-point scale based on answers to the question "How is your health in general?"[1] The available answers were very good/ good/ fair/ bad/ very bad. This variable was recoded to be increasing in good health. Binary dummy variables were created for each health state i.e. sahvgood, sahgood, sahfair, sahbad, sahvbad.

The remaining health questions predominantly focus on impairment or limitation in normal daily activities. These consist of a set of self-report questions firstly based on the question "are you hampered in your daily activities by any physical or mental problem, illness or disability? - coded: 1 yes, severely; 2 yes, to some extent; 3 no ; -9 missing.[2] Binary dummy variables for each of the three possible answers had been created i.e. hampsev for answer = 1; hampsome for = 2; hampnot for = 3. The next two questions were yes/no answers related to recent health problems and again binary dummy variables had been created. The questions were worded "during the past two weeks, have you had to cut down things you usually do about the house, at work or in free time because of illness or injury?" and "during the past two weeks, have you had to cut down things you usually

[1] The question wording in France was "Pourriez vous indiquer, sur une échelle allant de 1 (pas satisfait du tout) à 6 (très stisfait) votre degree de satisfaction en ce qui concerne les points suivants? …… Votre santé -> the answer was on a 6 point scale and has been recoded in the UDB to a five point scale.

[2] In France the question was worded "gene par une maladie chronique, un handicap?"

do about the house, at work or in free time because of an emotional or mental health problem?". The final health indicator, also coded as a binary dummy variable, was worded "during the past 12 months, have you been admitted to a hospital as an in-patient?" [3].

2. Employment and retirement status

The ECHP asked a broad range of questions related to employment. The one used in this study is based on the self-defined main activity status with individuals classifying their status as one of the following: (1) working with an employer in paid employment (15+ hours / week); (2) working with an employer in paid apprenticeship (15+ hours / week); (3) working with an employer in training under special schemes related to employment (15+ hours / week); (4) self-employment (15+ hours / week); (5) unpaid work in a family enterprise (15+ hours / week); (6) in education or training; (7) unemployed; (8) retired; (9) doing housework, looking after children or other persons; (10) in community or military service; (11) other economically inactive; (12) working less than 15 hours. A binary dummy variable was created based on whether the individual had selected the 8th category, "retired". In addition this question on the individual's main activity status was used to generate another binary dummy variable based on whether options 1-5, 7 or 12 were selected.

This second variable uses the transition between reported activity in the labour market and inactivity as a measure of retirement. This was chosen because of doubts raised about the accuracy of the self-reported 'retired' (Disney et al., 1997) and also because transitions from activity to inactivity have been used frequently as outcome measures in analysing the effect of health on retirement (Bound et al., 1999; Kerkhofs et al., 1999). Retirement was taken as an absorbing or permanent state so that individuals were followed from work to when they first reported retirement, thus any subsequent transitions back to work were ignored.

3. Income and wealth

A range of income variables are used. The starting point is household income from all sources which is used across all waves in which an individual is observed. This is then split into personal and other income. To permit comparisons across countries and across time the income variables are adjusted for the consumer price index (CPI) and purchasing power parities (PPPs), then equivalised by the modified-OECD scale to adjust for household size and composition. Income is then transformed to measure the mean across all waves prior to retirement, in order to reduce concerns over endogeneity, as income can be expected to decline at retirement. The logarithm of personal income is used as a proxy for pension entitlement. Other household income separate from the individual's personal income is used to capture the influence of the spouse's income. The other wealth-related variable available to us reflects home ownership and a binary dummy variable is included.

4. Other socio-demographic variables

The following socio-demographic variables are used in the analysis. Educational attainment graded using the highest grade of education achieved on the 3 level ISCED scale - completed third level secondary education; completed second stage of secondary education; completed less than second stage of secondary education - converted to binary variables; age and age-group dummy variables; the number of children living in the household; and cohabitational status as a binary variable.

The complete set of variables are summarised with names and definitions in the Appendix.

B. Stock sample

1. Creation of sample

The interest of this study is in the role of health in the decision to retire and thus we need to observe individuals, who are in employment, over a period when they are at a risk of retiring. Jenkins (1995) defines such a group as a stock sample. We thus have selected those individuals who were members of wave 1 in the ECHP, were aged 50 – 64 years in wave 1, were employed or self-employed in the first wave and had measures of health and employment activity recorded for all available waves. Once an individual retired or was missing then their data after that point was excluded.

2. Labour market transitions

The stock sample consists of all individuals in work in the first wave of the ECHP. The transitions to other employment states are summarised for each wave of the data confirming the selection of only individuals who are in work, either employed or self-employed, in wave 1 (Table 1).

Table 1

Labour market status by wave in ECHP sample

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Employed	6119	4795	3985	3169	2539	2103	1705	1398
self-employed	3512	2772	2358	1968	1664	1385	1183	1035
unemployed		190	235	250	207	163	125	102
retired		478	938	1371	1699	1939	2180	2344
other		394	421	454	457	474	447	428
attrition or death		1002	1694	2419	3065	3567	3991	4324
total	9631	9631	9631	9631	9631	9631	9631	9631
in-work	9631	7576	6343	5137	4203	3488	2888	2433

C. Health stock and health shocks

1. Creation of the health stock

It was emphasised earlier that using measures of self-reported health that are recorded prior to an indivdiual's exit from the labour market should help to mitigate problems of justification bias. However there may be antipcipation effects and measurement errors may still occur. To address this possibility the method of estimating a model of SAH as a function of more objective measures of health is used to define a latent 'health stock'. This follows the approach of Bound (1991) as implemented in Bound et al. (1999) and more recently used by Disney et al. (2006) and Roberts et al. (2006). There are differences in how the later two studies have created their latent health variable. Disney et al (2006) use personal characteristics as well as health indicators while Roberts et al. (2006) only include the health indicators when constructing the health stock. In this study both forms of the latent health variable are used. The idea of constructing this health stock variable is analogous to using the health indicators as instruments for the measurement error in the SAH variable.

To construct this individual's latent health stock we consider the aspect of health that influences an individual's decision to retire, h^R_{it}, to be a function of the health indicators, Z_{it}, such that:

(1) $$h^R_{it} = Z'_{it}\beta + \varepsilon_{it}, \qquad i = 1,2,\ldots\ldots, n; \quad t = 1,2,\ldots\ldots,T_i$$

where ε_{it} is a time varying error term uncorrelated with Z_{it} . h^R_{it} can not be directly observed but instead we have a measure of self assessed health (SAH), h^S_{it} and we can specify the latent counterpart of this as h^*_{it} such that:

(2) $$h^*_{it} = h^R_{it} + \eta_{it}$$

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

(3) $$h^*_{it} = Z'_{it}\beta + \varepsilon_{it} + \eta_{it} = Z'_{it}\beta + \nu_{it}$$

The presence of η_{it} in (3) is a source of bias if h^*_{it} is used directly when estimating the impact of health on retirement. This can either be distributed randomly or be a function of the labour market status of the individual. If it were distributed randomly it would represent classical measurement error and could attenuate the effect of health on retirement. Alternatively, if it is a function of the labour market status i.e., individuals rationalise early labour market exit by reporting ill-health, then this would overestimate the effect of health on retirement. To avoid this bias a predicted health stock $\hat{h}^*_{it}$ is used as this is purged of measurement error.

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

(4) $$h_{it} = j \text{ if } \mu_{j-1} < h^*_{it} \leq \mu_j \text{ , } j = 1,\ldots,m$$

where $\mu_0 = -\infty$, $\mu_j \leq \mu_{j+1}$, $\mu_m = \infty$. Assuming ν_{it} is normally distributed model (3) can be estimated as an ordered probit using maximum likelihood. The predicted values for the health stock can then be used in our retirement model. Disney et al. (2006) used other personal characteristics of their sample to reduce the bias, due to individual-specific unobserved factors, in the SAH measure.

2. Computing the health stock

The main decisions in computing the health stock variable are in the choice of health indicators and whether to include demographic variables in the model. The ECHP does not have the same extensive range of objective health variables as the BHPS, as used by Disney et al. (2006) and Roberts et al. (2006), but does have a small set of measures relating to limitation in daily activities, recent illness or mental problem and a history of in-patient stay in hospital.

Two latent health stock measures were created; one using only the objective health data and one using demographic variables in addition. The first model regressed the measure of self-reported self-assessed health (SAH) on the objective health variables.[3] The coefficients from the ordered probit models were used to obtain the latent health stock variable for each country. In all countries the estimated coefficients displayed the expected negative sign demonstrating that indicators of health problems were associated with lower reporting of self-assessed health. We refer to this measure as the non-normalised latent health stock.

The same approach was taken in estimating the health stock variable using the method of Disney, Emmerson and Wakefield (2006). They estimated the individual's health stock for each wave of the data using the wave specific values of the objective health variables but also included some demographic variables. These estimated values are then normalised as a deviation of the individual's health index from the cohort mean for each year. This predicted individual 'health stock' thus creates a health stock for each individual in relation to the year on year average for the sample. The normalised variable has a mean of 0 and a

[3] The UK data has some limitation recorded only in wave 6. In the other waves it is collapsed into severe limitation. The UK data also does not contain the mental problem data. The other countries in the ECHP have all variables available in each wave except France which codes illness and mental problem in waves 1, 3, 4 only. The ordered probit models were adjusted accordingly.

standard deviation of 1 for each wave of the sample and we refer to this measure as the normalised latent health stock.

3. Defining health shocks

Both health stock variables can be used to demonstrate gradual deterioration in an individual's health. However the decision to retire may be more related to a 'health shock', i.e. a more acute deterioration. To identify a health shock we have conditioned on the initial health stock and used the lagged value of the health stock variable. This is because the decision to retire may take time as the permanence of any health deterioration, and its effects on ability to perform one's work tasks are not necessarily immediately obvious. Conditioning on initial health stock allows the estimated coefficients on lagged health to represent the deviation from the underlying health stock and has the advantage of helping to control for individual-specific unobserved health-related heterogeneity.

In addition to this approach we have used a more direct measure of a health shock based on the differences between consecutive waves in an individual's normalised health stock value. This is similar to the concept of an acute health shock described by Riphahn (1999), although she uses reported health rather than a purged measure. Three exclusive binary dummy variables were created for a 'small' acute health shock representing a decrement of $\geq 0.5 - < 1.0$ standard deviations; a 'medium' acute health shock representing a decrement of $\geq 1.0 - < 2.0$ standard deviations and a 'large' acute health shock representing a decrement of ≥ 2.0 standard deviations. These three binary dummy variables thus represent a graduated acute health shock and are used in a model that also conditions on the initial normalised health stock value.

To ensure that these measures are indeed picking up acute health shocks they are compared to changes in the objective health variables. A clear gradient of increasing severity of health challenge is apparent, with increasing severity of health shock associated with both an increase in the number and in the severity of adverse health events. This is illustrated for wave 2 of the data in Table 2. This is the first wave where an acute health shock can be measured. What this can mean at an individual level is shown by the two examples of the reported experiences of two individual respondents shown in Table 3.

Table 2

Correlation of health shocks with objective health measures

	no shock	Small shock	Medium shock	Large shock
N	5963	320	335	307
Illness (%)	3.2	37	39	50
Inpatient (%)	3.4	37	32	38
Some or severe limitation (%)	6.3	34	68	99
Number of health problems[1] (%)				
0	89	15	1	0
1	7	56	57	27
2	2	19	28	34
3	1	6	9	22
4-5	0.2	4	6	16

[1] sum of binary dummy variables illness, mental problem, inpatient, some limitation and 2* severe limitation; range 0 – 5

Table 3

Health shocks - individual examples

	SAH	health stock	health shock	objective health measures	outcome
52 year old male - employed					
W1	v gd	.525		no problems, no limitations	
W2	v gd	.540	-	no problems, no limitations	
W3	fair	-3.6	large	illness, mental problem, severe limitation	retires
W4	fair	-3.4	-	illness, severe limitation	retired
W5	fair	-3.5	-	illness, mental problem, severe limitation	retired
53 year old female, unpaid work in family enterprise					
W1	fair	.452		no problems, no limitation	
W2	fair	-1.7	large	illness, mental prob, in-patient, no limitation	
W3	fair	-2.9	medium	in-patient, some limitation	house work
W4	fair	-2.9	-	illness, in-patient, some limitation	other - inactive
W5	bad	-4.1	medium	illness, mental prob, in-patient, sev. limitation	other – inactive

III. Analytical methods and results

A. Discrete-time hazard analysis

The econometric approach used in this study estimates hazard functions for the transition to retirement. This is done using the stock-sampling approach of Jenkins (1995) which represents the transition to retirement as a discrete-time hazard specification, based on the Prentice-Gloekler (1978) model. For this analysis the data are organised so that the unit of analysis is the time at risk of the event i.e., retirement. This organisation of the data and conditioning on stock sampling – such that time periods prior to selection can be ignored – means that the estimation of a discrete-time hazard model is simplified to the extent that any method suitable for the estimation of a binary responses may be used.

The theoretical construct of these models is summarised as follows, using notation similar to Jenkins (1995). The time at risk has a range from $t = \tau$ (wave 1) to $t = \tau + s_i$ where $\tau + s_i$ is the year when retirement occurs (complete duration data, $\delta_i = 1$) or when the observation period for that individual ends (censored duration data, $\delta_i = 0$). Thus each individual contributes s_i years of employment epoch data. The probability of retiring at each t gives information on the duration distribution and the discrete-time hazard rate is defined as:

(5) $$h_{it} = P[T_i = t \mid T_i \geq t; X_{it}]$$

where X_{it} is a vector of covariates which may vary with time and T_i is a discrete random variable representing the time at which the end of the epoch occurs.

The conditional probability of observing a retirement (event history) of someone with an incomplete employment epoch at a particular time period is:

(6) $$prob(T_i > t \mid T_i > \tau - 1) = \prod_{i=t}^{\tau+si} (1 - h_{it})$$

and the conditional probability of observing a retirement (event history) of someone completing an employment epoch at a particular time period is:

(7) $$prob(T_i = t \mid T_i > \tau - 1) = h_{i\tau+si} \prod_{i=t}^{\tau+si} (1 - h_{it}) = (h_{i\tau+si} / (1 - h_{i\tau+si})) \prod_{i=t}^{\tau+si} (1 - h_{it})$$

the corresponding log-likelihood of observing the retirement history data for the whole sample is:

(8) $$\log \boldsymbol{L} = \sum_{i=1}^{n} \delta_i \log (h_{i\tau+si} / (1 - h_{i\tau+si})) + \sum_{i=1}^{n} \sum_{i=t}^{\tau+si} \log (1 - h_{it})$$

Jenkins simplifies this log-likelihood by defining $y_{it} = 1$ if $t = \tau + s_i$ and $\delta_i = 1$, $y_{it} = 0$ otherwise. Thus for those still working $y_{it} = 0$ for all periods, while for those who retire, y_{it}

= 0, for all periods except the period in which they retire, when $y_{it} = 1$. The likelihood can then be expressed as:

$$\text{(9)} \qquad \log \boldsymbol{L} = \sum_{i=1}^{n} \sum_{i=t}^{\tau+si} y_{it} \log (h_{i\tau+si} / (1- h_{i\tau+si})) + \sum_{i=1}^{n} \sum_{i=t}^{\tau+si} \log (1 - h_{it})$$

The specification is completed by specifying a complementary log-log hazard rate for h_{it}:

$$\textit{(10)} \qquad h_{it} = 1 - \exp(-\exp(X_{it}\,\beta + \theta(t)))$$

where $\theta_{(t)}$ is the baseline hazard and is modelled as a step function by using dummy variables to represent each period at risk. This non-parametric form for the baseline hazard leads to a semi-parametric specification of the discrete-time duration model. Analyses are carried out using Jenkins's (1997) discrete-time hazard model Stata program 'pgmhaz8'. This program automatically incorporates frailty (unobserved heterogeneity) by assuming a gamma distributed unobserved heterogeneity (Meyer, 1990) and reports the model with and without frailty.

This model is estimated using the following measures of health; estimated latent health stock variables; an objective measure of health relating to absence of limitiations; the subjective measure of health SAH and the calculated graduated health shock variables, with each model containing the same demographic and financial variables. All models were run using the two alternative definitions of retirement; self-reported retirement and an expanded definition based on the shift to inactivity in the labour market.

B. Stock sample

The nine countries selected for study have a total of 105,613 participants in the ECHP. Of these 22,456 met the age selection criteria for the stock sample with 9,631 (43% of age group) meeting the employment and complete data requirements for the stock sample. Those analysed regarding retirement totalled 8,629 (38% of age group). This varied by country with a high of 61% in Denmark of the eligible age group being in the stock sample and 56% being in the analysis compared to the low in Spain of 37% and 30% respectively (Table 4). The proportion of those analysed who retired during the eight year time period varied by country and by definition of retirement with a high of 47% in the UK self-reporting retirement compared with a low of 21% in Ireland. Just over one third of the sample (37%) reported retiring during the study period. However many more became inactive in the labour market with almost half (46%) doing so during the study period.

Countries fall into two groups based on the percentage increase in the retirement rate between the two definitions of retirement. Greece, Ireland, Portugal, Spain and the UK had approximately a 30% increase in retirements using the expanded definition of inactivity in the labour market. Belgium, Denmark, France and Italy showed only a 9 – 13% increase. Overall in the EU there was a 22% increase from 3,222 to 3,946 individuals retiring depending on the definition.

Table 4

Stock sample recruitment by country

Country	ECHP total	50–64 yrs inc	selected Wave 1	%[1]	present Wave 8	number analysed	%[1]	Retirements (%[2]) sr[3]	exp[4]
UK	9,028	1,668	854	51	655	779	47	312 (40)	410 (53)
Spain	17,893	3,884	1,447	37	674	1,165	30	375 (32)	521 (45)
Portugal	11,621	2,737	1,411	52	988	1,256	46	416 (33)	531 (42)
Italy	17,729	3,917	1,607	41	910	1,466	37	684 (47)	771 (53)
Ireland	9,904	2,026	920	45	321	754	37	159 (21)	212 (28)
Greece	12,492	2,920	1,313	45	840	1,203	41	456 (38)	598 (50)
France	14,333	2,872	1,095	38	591	924	32	411 (44)	453 (49)
Denmark	5,903	1,172	718	61	380	651	56	220 (34)	239 (37)
Belgium	6,710	1,260	487	39	231	431	34	189 (44)	211 (49)
EU total	105,613	22,456	9,631	43	5,590	8,629	38	3222 (37)	3946 (46)

[1] as percent of eligible age group; [2] as percent of those analysed; [3] self-report retirement; [4] inactive in labour market

The mean age of individuals in each country's stock sample is similar though there are differences in the distribution across the age groups as shown in Table 5. There are differences in employment status and in the proportion of males between countries in the sample. There are also differences in the reported self-assessed health status and the proportion having some degree of limitation because of health problems (Table 5) similar to that reported by Hernandez-Quevedo et al. (2006).

Table 5

Comparisons of characteristics of individuals in wave 1 of stock samples by country

Country	UK	Sp	Port	It	Ire	Gr	Fr	Dk	Be
n	799	1180	1354	1504	755	1226	965	651	440
self employed (%)	20	35	45	38	44	68	20	20	25
mean age (yrs)	55	56	56	55	56	56	54	55	55
age 50 – 54 (%)	53	46	40	51	45	42	58	51	55
age 55 – 59 (%)	33	33	34	35	33	34	35	33	30
age 60 – 64 (%)	15	21	27	14	22	24	7	16	15
males (%)	55	74	63	73	78	70	59	56	66
SAH									
very good (%)	25	12	3	10	39	32	14	48	20
good (%)	53	46	42	41	43	38	46	34	54
fair (%)	17	30	37	39	16	23	35	14	23
bad (%)	5	11	16	9	1	6	3	3	2
very bad (%)	1	2	2	2	0	1	2	0	0
severe limitation (%)	8[1]	4	6	5	1	4	8	1	3
some limitation (%)	--	12	21	19	13	13	10	11	18
no limitation (%)	92	84	73	76	86	83	82	87	79

For all countries there was a general decline in the health status of the stock sample as individuals aged during the study period. This deterioration in health was accompanied by the occurrence of acute health shocks though these did not increase in prevalence across the waves occurring in 13.9% of individual's in wave 2 and 13.8% in wave 8 (Table 6). The large acute health shocks are the least frequent and in the individual country data involve only small numbers of individuals.

Table 6

Occurrence of acute health shocks by wave

Health shock	Wave 2	Wave3	Wave4	Wave5	Wave6	Wave7	Wave8
None	7355	6865	6164	5599	5192	4864	4541
Small	411(4.8)	327(4.2)	360(5.0)	287(4.4)	305(5.1)	198(3.5)	265(5.0)
Medium	421(4.9)	401(5.1)	356(5.0)	414(6.4)	362(6.0)	365(6.5)	338(6.4)
Large	357(4.2)	268(3.4)	260(3.6)	214(3.3)	156(2.6)	162(2.9)	127(2.4)
Total	8544	7861	7140	6514	6015	5589	5271

(% of total in each wave)

C. Hazard models

1. Pooled analysis

The first set of results pool all of the data across countries. In the hazard models the latent health measures, the subjective SAH and the objective absence of limitation are entered as both a lagged and an initial value. In the models with acute health shocks the shocks are not lagged but are also conditioned on the initial value of the normalised latent health stock. The complete regression results are available from the authors on request, for brevity we summarize the key results in terms of hazard ratios. The hazard ratio measures the proportional effect on the underlying (instantaneous) hazard of retiring of a one unit change in the value of the variable in question.

For example, in the pooled models with acute health shocks the hazard ratios for the three health shock variables are 1 or greater indicating that, once conditioned on initial latent health, the occurrence of an acute health shock is associated with an increase in the probability of retiring during that time period. Hence, for the pooled data, the occurrence of a medium acute health shock would (ceteris paribus) increase the probability of retiring (as measured by self-report) by approximately 44% and for a large acute health shock this increases slightly to 47%. These effects are consistently greater across all three acute health shocks in the expanded retirement definition model and the gradient between the three graduated acute shocks is more pronounced demonstrating a clear 'dose-response' relationship in the gradient of the effects.

All measures of a change in health are associated with a change in the hazard of retirement. This is detailed for each measure and both definitions of retirement in Table 7 with the change in the hazard of retiring for a one unit change in each health measure shown as an absolute value. The results are consistent in direction within and across the definitions of retirement. Higher values of the latent health stock measures and SAH, and the absence of limitations due to health, are all associated with a decrease in the likelihood of retiring whereas the medium and large acute health shocks are associated with a significant increase in the likelihood of retiring. All measures consistently show a greater strength of effect in the expanded retirement models and this is most marked with the largest of the acute health shocks. There is evidence of a gradient in the response to the acute health shocks and this is clearer in the expanded retirement models. The effect size in absolute terms was also greater for the acute health shocks suggesting that acute changes have more impact than gradual changes as represented by the lagged latent health stock variables. The absolute effect size for the subjective lagged SAH – which was increasing in good health –

was closer to the effect size of the normalised rather than the non-normalised latent health stock.

Table 7

Hazard ratios for health measures by retirement definition - combined country data

Health measure	Self-report retirement	Expanded retirement
Subjective - (lagged)		
SAH	0.85*** (15)[1]	0.82*** (18)
Objective - (lagged)		
no limitation due to health	0.75*** (25)	0.70*** (30)
Latent health variables - (lagged)		
non-normalised	0.82*** (18)	0.77*** (23)
normalised	0.87*** (13)	0.83*** (17)
Acute health shocks		
small	1.00 (0)	1.14 (14)
medium	1.44*** (44)	1.50*** (50)
large	1.47*** (47)	2.06*** (106)

*** significant at 0.1% level; [1] absolute effect size of change in probability of retirement for a one unit change in variable

The effects of the other covariates are very stable across the different models, within each definition of retirement, though there are notable differences across the two definitions of retirement (Table 8). Increases in age shows the expected increase in probability of retirement and the results are similar for both measures of retirement. The initial level of health is significant in all models, with higher levels being associated with a reduced hazard of retirement for both definitions of retirement. Increasing personal income is associated with a consistent 20% increase in the likelihood of self-reported retirement but a consistent 14% decrease in the probability using the expanded definition of becoming inactive in the labour market. Other household income had no effect in the self-report models but is associated with a small though significant increase in the probability of retiring with the expanded definition. The last measure of wealth used in the analyses, house ownership has a small though insignificant effect on increasing the probability of retirement and this is greater under the expanded definition (3% to 6%).

Men report retirement at the same rate as females but are significantly less likely to demonstrate a transition to inactivity in the labour market. In contrast having completed the third level of secondary education is associated with a decrease in the hazard of self-reported retirement of approximately 19% in comparison to having only completed the second stage of secondary education, but a smaller and insignificant decrease of 7% in the expanded definition models. The remaining covariates were all insignificant but were consistent within and across the two classes of retirement models. Running these models on a sub-sample of individuals who appeared in all waves gave similar parameter estimates.

Within the pooled model there is significant variation in the country effects. This is demonstrated in Table 9 using the United Kingdom as the base country. One group of countries, comprising Belgium, France and Italy have an increased probability of retiring, ceteris paribus, compared to the UK and this is consistent in direction across retirement definitions and predominantly consistent in size of effect within each of the retirement definitions. A second group of Ireland, Portugal and Spain, have a reduced probability of retiring relative to the UK and again this is consistent in direction across definitions of retirement and similar in size of effect within models. Denmark and Greece are different, in showing no difference in comparison to the UK in the latent health stock models for self-reported retirement while the remaining models suggest a reduced probability of retiring compared to the UK.

Table 8:

Comparison of hazard ratios for covariates in retirement models by health shock measure – combined country data model

	Latent health stock		Acute health shocks	Other health measures	
	Non-normalised	Normalised		Objective - limitations	Subjective - SAH
Self-report retirement					
Initial[1]	0.89**	0.91***	0.86***	0.82**	0.92*
Age					
Age 50 – 54	0.03***	0.03***	0.03***	0.03***	0.03***
Age 55 – 59	0.08***	0.08***	0.08***	0.08***	0.08***
Age 60 – 64	0.27***	0.27***	0.26***	0.27***	0.27***
Financial					
Other household income	1.01	1.01	1.01	1.01	1.01
Personal income	1.19***	1.21***	1.20***	1.19***	1.20***
House owner	1.01	1.04	1.04	1.01	1.03
Other demographic					
Male	0.97	1.02	1.00	0.98	0.99
Cohabiting	1.02	1.02	1.02	1.03	1.02
Children at home	0.94	0.94	0.95	0.94	0.94
3rd level education	0.80**	0.83*	0.82*	0.80**	0.82*
1st level education	1.06	1.02	1.04	1.06	1.06
Expanded retirement					
Initial	0.90	0.92	0.84***	0.83	0.90
Age					
Age 50 – 54	0.07***	0.08***	0.08***	0.07***	0.07***
Age 55 – 59	0.13***	0.13***	0.13***	0.13***	0.13***
Age 60 – 64	0.34***	0.34***	0.34***	0.34***	0.34***
Financial					
Other household income	1.04*	1.05*	1.04*	1.04*	1.04*
Personal income	0.86***	0.86***	0.87***	0.86***	0.86***
House owner	1.05	1.08	1.08	1.04	1.05
Other demographic					
Male	0.70***	0.73***	0.71***	0.70***	0.70***
Cohabiting	1.01	1.01	1.01	1.01	1.01
Children at home	0.93	0.93	0.93	0.93	0.93
3rd level education	0.92	0.95	0.95	0.91	0.92
1st level education	1.04	0.99	1.01	1.04	1.04

* significant at 5% level; ** significant at 1% level; *** significant at 0.1% level; [1] refers to relevant measure i.e., initial normalised latent health stock for models using normalised measures, non-normalised value for non-normalised latent health stock model; initial objective health for objective health measures model; initial SAH for subjective health measures model.

Table 9

Hazard ratios for country effects relative to UK by health model and retirement definition – pooled model

	Self-reported retirement		**Inactive in labour market**	
	Acute health shock	Normalised latent health stock	Acute health shock	Normalised latent health stock
Belgium	0.95	2.01***	1.43**	1.43**
Denmark	0.68***	1.11	0.78*	0.78*
France	1.38**	2.12***	1.42***	1.41***
Greece	0.35***	1.04	0.83*	0.82*
Ireland	0.52***	0.51***	0.56***	0.55***
Italy	1.56***	1.78***	1.24**	1.21*
Portugal	0.24***	0.64***	0.48***	0.48***
Spain	0.35***	0.92	0.96	0.95

* significant at 5% level; ** significant at 1% level; *** significant at 0.1% level

There are major differences between these countries in the incentives in their social security and tax systems in relation to retirement, in the age at which early retirement is permitted and in the manner in how benefits are accrued (Gruber & Wise, 1997). Not surprisingly then, the results reveal major differences between countries in the probability of retiring when compared to the UK. The group of countries (Belgium, France, Italy) where the probability of retirement is significantly greater than in the UK are those who have a very high "tax force"[4] to retire in comparison to the UK (Gruber & Wise, 1997). Those countries with a decreased probability of retiring in comparison to the UK presumably have a lower "tax force" driving retirement. These findings are robust across the different health measures as well as across the two definitions of retirement.

[4] The "tax force" is a crude measure to compare countries as regards incentives for early retirement and is the sum of implied tax rates on continued work beginning from a country's early retirement age through to age 69 years

2. Separate analyses by country

Differences between countries can be explored further by running the two classes of retirement models separately for each country. This allows the impact of healths shocks to differ across countries. The hazard ratios for the medium acute health shock and the normalised latent health stock variables are summarised in Table 10 These show some heterogeneity between the countries though for most countries the latent health stock hazard ratios are consistent in indicating a reduced hazard of retiring with higher values of the latent health stock. This is relatively consistent in size of effect across the two definitions of retirement with the exception of Spain were there is a difference of 21% between the two sets of models. There is more heterogeneity between countries in relation to the magnitude of effect from acute shocks though in general, in most countries, the acute shock measures have a greater effect size on the hazard of retiring than more gradual changes in the latent health stock (Table 10). The majority of countries show a gradient, with an increasing effect size with increasing size of acute health shock though there is some variability in this response.

The major difference in the behavior of the financial variables is confirmed in the analyses of individual country data. Higher mean personal income is associated with an increased hazard of self-reported retirement but a decreased probability of having a transition from activity in the labour market to inactivity. The two exceptions are Belgium and Greece where there is no decrease in likelihood of retiring with increasing mean personal income in the expanded retirement model and this exception is consistent across the other health measures.

Table 10

Individual country hazard ratios for 'medium' acute health shock and normalised latent health stock

Country	Self-report retirement		Inactivity in labour market	
	'Medium' acute shock	**Latent health**	**'Medium' acute shock**	**Latent health**
Belgium	1.39 (39%)	0.87 (13%)	1.27 (27%)	0.83 (17%)
Denmark	1.59 (59%)	0.70 (30%)	1.42 42%)	0.75 (25%)
France	1.50 (50%)	0.90 (10%)	1.31 (31%)	0.87 (13%)
Greece	1.77 (77%)	0.98 (2%)	1.79 (21%)	0.97 (3%)
Ireland	2.58 (158%)	0.86 (14%)	3.22 (222%)	0.85 (15%)
Italy	1.17 (17%)	0.91 (9%)	1.17 (17%)	0.90 (10%)
Portugal	1.48 (48%)	0.75 (25%)	1.47 (47%)	0.73 (27%)
Spain	1.38 (38%)	0.87 (13%)	1.73 (73%)	0.66 (34%)
UK	0.94 (6%)	0.78 (22%)	1.24 (24%)	0.83 (17%)

The pattern of response for the age and income measures is summarised, using the results from the acute health shock models, in Table 11. These findings are consistent across all health measures. The effects of the age group variables confirm the findings in the analysis of the pooled data with an increasing probability of retirement with age in all countries. This is most noticeable in Belgium, Denmark and France. Again there are small differences between the two retirement definitions.

Table 11

Hazard ratios for age and financial variables for individual countries by retirement definition - acute health shock models, individual country data models

	Self-reported retirement					**Inactive in labour market**				
	Age groups (yrs)			Income		Age groups (yrs)			Income	
	50-54	55-59	60-64	other	personal	50-54	55-59	60-64	other	personal
Belgium	0.04***	0.14***	0.67	1.14	1.32*	0.05***	0.16***	0.68	1.14	0.99
Denmark	0.02***	0.03***	0.58*	0.99	1.11	0.04***	0.05***	0.61*	0.99	0.81*
France	0.01***	0.11***	0.69	1.05	1.15	0.05***	0.17***	0.80	1.06	0.82*
Greece	0.05***	0.13***	0.24***	0.97	1.18*	0.09***	0.20***	0.36***	1.00	0.99
Ireland	0.03***	0.09***	0.18***	1.10	1.30	0.10***	0.16***	0.30***	0.99	0.66***
Italy	0.09***	0.17***	0.36***	1.04	1.13	0.11***	0.17***	0.32***	1.09	0.91
Portugal	0.09***	0.14***	0.26***	1.02	1.17*	0.16***	0.23***	0.35***	1.04	0.89*
Spain	0.01***	0.01***	0.08***	1.00	1.35**	0.03***	0.03***	0.08***	1.12*	0.91
UK	0.01***	0.03***	0.13***	1.05	.94	0.04***	0.05***	0.17***	1.01	0.79
EU	0.03***	0.08***	0.26***	1.01	1.20***	0.08***	0.13***	0.34***	1.04*	0.87***

IV. Discussion

Our results provide, for the first time, comparisons of the effects of health and health shocks across a range of European countries based on internationally comparable panel data. They provide further evidence of the relationship of health to retirement and additionally shows that acute changes in health are of particular importance. The use of a set of graduated health shocks shows a gradient in the effect. The results demonstrate that the effects of other covariates, especially financial factors, is robust across models despite the use of different health measures. They also show the importance of the specific definition of retirement used as the outcome measure.

The measures of health used in past studies have ranged from subjective self-assessed health to detailed batteries of more objective questions about limitations, impairments or diseases. All are used as some approximation of the 'true' health state of the individual. Not surprisingly, given the range of measures used, the findings have shown great variability in magnitude of effect though have been more consistent in showing that deterioration in health state is associated with an increased probability of retirement. The more recent literature has attempted to overcome the potential problems of endogeneity and measurement error in the subjective self-assessed measures by 'purging' this measure by regression on a set of objective factors, though these themselves are usually self-reported, and using the predicted values from these regressions as a measure of a latent health stock (Bound et al., 1999, Au et al., 2005; Disney et al., 2006). Additionally lagging this measure attempts to remove any justification bias in relation to the retirement decision (Bazzoli, 1985) and when conditioned on either initial or contemporaneous values gives some measure of a health shock. This is the approach taken in our work. The ECHP has a limited range of objective data on health but the available set was used, on its own and in association with demographic variables, to instrument the self-assessed health measure recorded in the ECHP and to construct a latent health stock. The second of these measures was then normalised in the manner of Disney et al. (2006). These latent health stock variables, with higher values corresponding to better health, were then used as both lagged and initial values to assess the effects of initial and declining health stock on the retirement decision. The results show a consistency of effect with only small variation in magnitude both for these latent health stock variables as well as the subjective SAH measures. This was consistent across countries. This is compatible with previous findings that declining health is associated with an increased probability of retirement (see Currie & Madrian, 1999; Deschryvere, 2004)

Additionally a three-level graduated acute health shock variable was created by adapting the method of Riphahn (1999) and using the normalised latent health stock variable. The effects of an acute ≥ 0.5 - < 1.0 standard deviation, ≥1.0 < 2.0 standard deviation or a ≥ 2.0 standard deviation decrement showed good evidence of a gradient, with increasing probability of retiring with increasing magnitude of the acute health shock. These acute shocks were associated with a greater magnitude of effect on the probability of retiring than the more gradual declining latent health stock measure. The large magnitude of effect seen with the largest of these acute health shocks is similar to that reported by Riphahn (1999) in her study. Again there is a consistency in these results across countries though more variability is seen due to small numbers of individuals experiencing such shocks in some countries.

Many different definitions of retirement have been used in previous research work. We use two definitions, one restricted to when the individual reported themselves as being retired and a more expanded definition to include those on disability benefits and other forms of being economically inactive but excluding those who reported themselves as unemployed.

The effects of health shocks would be expected to be different with these two definitions as the disability benefit programs vary between countries and, in some, offer an alternative route to early retirement (Gruber & Wise, 1997). Our results reveal a much greater magnitude of effect from health shocks, especially acute shocks, when the expanded definition of retirement is used. This finding is consistent across countries for the two larger of the health shocks. This is consistent with the work of Kerkhofs et al. (1999) and Bound et al. (1999) who, using models with alternative exit routes from the labour market as outcome, also reported a greater impact of health shocks on individuals seeking exit from the work force through disability insurance programs.

The effect, both in direction and magnitude, of other socioeconomic factors is robust and consistent across the different health measures and definitions of retirement definition. This is compatible with the work of Kerkhofs et al. (1999) but contrary to that of Au et al. (2005). It implies that the specific health measure used is unimportant when the focus is on the influence of the other factors. However there are major differences between models based on the definition of retirement. This is most noticeable in relation to financial factors and is consistent in the pooled models and the models for specific countries. A higher mean personal income up to the time of retirement is associated (ceteris paribus) with an increased hazard of self-reporting retirement but a decreased hazard of being inactive in the labour market, including being on disability benefits. This is compatible with individuals with higher personal incomes choosing at an earlier age to retire officially rather than utilise a non-retirement or disability route. This could relate to better pension entitlement as well as the negative tax effects in many countries of continuing to work (Gruber & Wise, 1997). Higher personal incomes will also more commonly be associated with sedentary occupations where an acute health shock may have less impact on the ability of the individual to perform their work tasks. This will permit the individual to focus on the single decision of permanent retirement.

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APPENDIX: VARIABLE LABELS AND DEFINITIONS

Variable	description
retired	binary dependent variable = 1 if individual reports being retired, 0 otherwise
rtire	binary dependent variable = 1 if individual not active in labour market or unemployed, 0 otherwise
active	self-defined main activity status; 1: if working with an employer in paid employment (15+ hrs/week); 2: if working with an employer in paid apprenticeship (15+ hrs/week); 3: if working with an employer in training under special schemes (15+ hrs/week); 4: if self-employed (15+ hrs/week); 5: if unpaid work in family enterprise (15+ hrs/week); 6: if in education or training; 7: if retired; 8: if doing housework; 9: if looking after children or other persons; 10: if in community or military service; 11: if other economically inactive; 12: if working less than 15hrs/week
hampnot	self-assessed health limitation: 1 if none limits daily activities, 0 otherwise
sah	self-assessed health; 1: very bad, 2: bad; 3: fair; 4: good; 5: very good
sahvgood	self-assessed health: 1 if very good, 0 otherwise
sahgood	self-assessed health: 1 if good, 0 otherwise
sahfair	self-assessed health: 1 if fair, 0 otherwise
sahbad	self-assessed health: 1 if bad, 0 otherwise
sahvbad	self-assessed health: 1 if very bad, 0 otherwise
sahlat	predicted latent health stock from oprobit model, non- normalised
sahlatdn	predicted latent health stock from wave specific oprobit models, normalised
hs1	small acute health shock, binary dummy variable = 1 if individual has $\geq$ 0.5 - < 1.0 sd decrement in sahlatdn values between waves, 0 otherwise
hs2	medium acute health shock, binary dummy variable = 1 if individual has $\geq$ 1.0 - < 2.0 sd decrement in sahlatdn values between waves, 0 otherwise
hs3	large acute health shock, binary dummy variable = 1 if individual has $\geq$ 2.0 sd decrement in sahlatdn values between waves, 0 otherwise
mlnhinc	individual-specific mean of log equivalised total household income
mlnpinc	individual-specific mean of log equivalised individual income
mlotinc	individual specific mean of log of equivalised other household income separate from personal
hseown	house ownership: 1 if own house with/without mortgage, 0 if not
cohab	cohabitational status: 1 if with partner, 0 if not
isced7	1 if completed third level of secondary education, 0 otherwise
isced3	1 if completed second stage of secondary education, 0 otherwise
isced2	1 if less than second stage of secondary education, 0 otherwise
male	1 if male, 0 otherwise
age5054	1 if aged 50 to 54 years (inclusive), 0 otherwise
age5559	1 if aged 55 to 59 years (inclusive), 0 otherwise
age6064	1 if aged 60 to 64 years inclusive, 0 otherwise
age6569	1 if aged 65 to 69 years inclusive, 0 otherwise

uk	1 if resident of United Kingdom, 0 otherwise
sp	1 if resident of Spain, 0 otherwise
po	1 if resident of Portugal, 0 otherwise
ne	1 if resident of the Netherlands, 0 otherwise
it	1 if resident of Italy, 0 otherwise
ir	1 if resident of Ireland, 0 otherwise
gr	1 if resident of Greece, 0 otherwise
fr	1 if resident of France, 0 otherwise
dk	1 if resident of Denmark, 0 otherwise
be	1 if resident of Belgium, 0 otherwise

APPENDIX (NOT FOR PUBLICATION): Full results for hazard models for self-reported retirement and expanded retirement status in EU using acute health shocks (hs1, hs2, hs3) as health shock variables – pooled data

Self-reported retirement

```
PGM hazard model with gamma frailty             Number of obs   =      33822
                                                LR chi2()       =          .
Log likelihood = -8149.7515                     Prob > chi2     =          .
------------------------------------------------------------------------------
          _d |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
hazard       |                                                                    HR
         hs1 |  -.0050752    .096426    -0.05   0.958    -.1940667    .1839162    1.00
         hs2 |   .3616999   .0764815     4.73   0.000     .2117989     .511601    1.44
         hs3 |   .3833708    .099885     3.84   0.000     .1875998    .5791419    1.47
   sahlatdn0 |  -.1550371   .0243071    -6.38   0.000    -.2026782    -.107396    0.86
     age5054 |  -3.475488   .1259296   -27.60   0.000    -3.722306   -3.228671    0.03
     age5559 |  -2.562605   .0980812   -26.13   0.000    -2.754841    -2.37037    0.08
     age6064 |  -1.330438   .0759253   -17.52   0.000    -1.479249   -1.181627    0.26
     nch_inh |  -.0569197   .0471401    -1.21   0.227    -.1493127    .0354732    0.95
        male |  -.0044162     .05672    -0.08   0.938    -.1155853     .106753    1.00
    mlnotinc |   .0108315   .0231127     0.47   0.639    -.0344685    .0561315    1.01
     mlnpinc |   .1863021    .032548     5.72   0.000     .1225091    .2500951    1.20
     lhseown |   .0403862   .0677354     0.60   0.551    -.0923727    .1731452    1.04
       cohab |   .0213052   .0788431     0.27   0.787    -.1332245    .1758349    1.02
     isced7 |   -.197038     .08155    -2.42   0.016    -.3568729    -.037203    0.82
     isced2 |   .0405373   .0648257     0.63   0.532    -.0865187    .1675932    1.04
          dk |  -.3795948   .1451832    -2.61   0.009    -.6641487   -.0950409    0.68
          be |   -.054992   .1795921    -0.31   0.759    -.4069861     .297002    0.95
          fr |   .3243561   .1263844     2.57   0.010     .0766473    .5720649    1.38
          ir |  -.6588481   .1260103    -5.23   0.000    -.9058237   -.4118726    0.52
          it |   .4474841   .0951243     4.70   0.000     .2610439    .6339243    1.56
          gr |  -1.050553   .1896475    -5.54   0.000    -1.422255   -.6788505    0.35
          sp |  -1.056227   .1900433    -5.56   0.000    -1.428705   -.6837489    0.35
          po |  -1.445769   .1786891    -8.09   0.000    -1.795993   -1.095545    0.24
          t2 |   .2228012   .0727318     3.06   0.002     .0802495     .365353
          t3 |   .4395746   .0751284     5.85   0.000     .2923256    .5868236
          t4 |     .44192   .0809543     5.46   0.000     .2832525    .6005875
          t5 |   .3332054   .0886494     3.76   0.000     .1594557     .506955
          t6 |   .3720055   .0945562     3.93   0.000     .1866786    .5573323
          t7 |   .3765503    .101561     3.71   0.000     .1774945    .5756062
       _cons |  -2.592899   .3743349    -6.93   0.000    -3.326582   -1.859216
-------------+----------------------------------------------------------------
ln_varg      |
       _cons |  -.6193382   .2016062    -3.07   0.002    -1.014479   -.2241973
-------------+----------------------------------------------------------------
  Gamma var. |   .5383006   .1085247     4.96   0.000     .3625913    .7991574
------------------------------------------------------------------------------
LR test of Gamma var. = 0: chibar2(01) =   36.7269  Prob.>=chibar2 =  6.8e-10
```

Expanded retirement – inactive in labour market

PGM hazard model with gamma frailty — Number of obs = 31205

LR chi2() = .

Log likelihood = -9345.9543 — Prob > chi2 = .

_d	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]	**HR**
hazard							
hs1	.1347871	.0842367	1.60	0.110	-.0303139	.2998881	**1.14**
hs2	.4036872	.0694481	5.81	0.000	.2675714	.539803	**1.50**
hs3	.7221727	.0792735	9.11	0.000	.5667995	.8775459	**2.06**
sahlatdn0	-.1762133	.0224641	-7.84	0.000	-.2202422	-.1321844	**0.84**
age5054	-2.595515	.1022874	-25.37	0.000	-2.795995	-2.395036	**0.08**
age5559	-2.025151	.0911965	-22.21	0.000	-2.203893	-1.846409	**0.13**
age6064	-1.093569	.0736701	-14.84	0.000	-1.237959	-.9491778	**0.34**
nch_inh	-.0705892	.0391894	-1.80	0.072	-.147399	.0062206	**0.93**
male	-.3375377	.0513123	-6.58	0.000	-.4381079	-.2369674	**0.71**
mlnotinc	.042565	.020955	2.03	0.042	.001494	.0836361	**1.04**
mlnpinc	-.1405571	.0256839	-5.47	0.000	-.1908966	-.0902175	**0.87**
lhseown	.0759111	.0598591	1.27	0.205	-.0414105	.1932328	**1.08**
cohab	.0071113	.0690843	0.10	0.918	-.1282914	.1425141	**1.01**
isced7	-.0505889	.0728518	-0.69	0.487	-.1933758	.0921979	**0.95**
isced2	.0099055	.0579459	0.17	0.864	-.1036663	.1234773	**1.01**
dk	-.2437073	.1029292	-2.37	0.018	-.4454447	-.0419698	**0.78**
be	.3546135	.1106239	3.21	0.001	.1377947	.5714323	**1.43**
fr	.3491285	.0870466	4.01	0.000	.1785203	.5197366	**1.42**
ir	-.578312	.1063284	-5.44	0.000	-.7867119	-.3699121	**0.56**
it	.2158536	.0813911	2.65	0.008	.0563299	.3753773	**1.24**
gr	-.1914403	.0907104	-2.11	0.035	-.3692295	-.0136511	**0.83**
sp	-.0423067	.0869233	-0.49	0.626	-.2126731	.1280598	**0.96**
po	-.7409845	.0919249	-8.06	0.000	-.9211541	-.5608149	**0.48**
t2	-.0312719	.0604006	-0.52	0.605	-.1496548	.0871111	
t3	.1289589	.0651025	1.98	0.048	.0013603	.2565574	
t4	.1400398	.0734004	1.91	0.056	-.0038223	.2839019	
t5	.0774122	.0829209	0.93	0.351	-.0851098	.2399342	
t6	.070961	.0912901	0.78	0.437	-.1079644	.2498864	
t7	.0573683	.1004994	0.57	0.568	-.1396069	.2543436	
_cons	.4467492	.3335699	1.34	0.180	-.2070359	1.100534	
ln_varg							
_cons	-.9940429	.2668119	-3.73	0.000	-1.516985	-.4711012	
Gamma var.	.3700775	.0987411	3.75	0.000	.2193724	.6243144	

LR test of Gamma var. = 0: chibar2(01) = 19.253 Prob.>=chibar2 = 5.7e-06