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DIFFERENTIAL MORTALITY IN THE UK

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ABSTRACT

In this paper we use the two waves of the British Retirement Survey (1988/89 and 1994) to quantify the relationship between socio-economic status and health outcomes. We find that, even after conditioning on the initial health status, wealth rankings are important determinants of mortality and the evolution of the health indicator in the survey. For men aged 65 moving from the 40th percentile to the 60th percentile in the wealth distribution increases the probability of survival by between 2.4 and 3.4 percentage points depending on the measure of wealth used. A slightly smaller effect is found for women of between 1.5 and 1.9 percentage points. In the process of estimating these effects we control for non-random attrition from our sample.

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1 Introduction

The issue of how mortality, and more generally health status, is related to economic conditions has recently received renewed attention. Such a relationship is of obvious interest to economists, epidemiologists and policy makers alike. It has important implications, among other things, for the progressivity of the social security system and for the incentives to save for retirement.

While the existence of a correlation between health outcomes and socio-economic status is well established, it is not clear what are the causal links between health and wealth. In particular, it has not been established what is the direction of causation, as one can easily construct plausible stories to justify causality running in both directions.

Many epidemiologists, such as Michael Marmot and his collaborators in the Whitehall I and II studies, have stressed the importance of relationship between socio-economic status and health outcomes, often implying a causal relationship running from the former to the latter (Marmot *et al*, 1991; Marmot, 1999). In his influential book, Wilkinson (1996) stresses the relationship between wealth inequality and health status.

While some of the evidence in the epidemiological literature is quite striking, it is very easy to think of reasons why mortality might affect wealth rather than vice-versa. Two of the most obvious reasons are the possibility that poor health prevents the accumulation of wealth (or wealth is depleted to remedy poor health) and the fact that individuals with a shorter life span might spend down there wealth faster than individuals who enjoy higher longevity. For this reason, economists have been much more reluctant to give a causal interpretation to the observed correlations, stressing the possibility of reverse causation. As James Smith nicely argues in his *Journal of Economic Perspectives* piece (Smith 1999), it is possible that poor health causes low wealth by hampering productivity and jeopardizing the ability to accumulate wealth. Without a dynamic model and evidence from panel data, it is not easy to discriminate among different hypothesis.

The existing evidence of a relationship between health outcomes and socio-economic position is extensive and too large to be surveyed here. Shorrocks (1975) was among the first to present some estimate of its magnitude. He also stressed the implications that such a relationship can have for the estimates of the life cycle profile of wealth accumulation and for testing the life cycle model's hypothesis that individual decrease their wealth holdings in the last part of their life cycle.

More recently, Attanasio and Hoynes (2000) have estimated the relationship between mortality and wealth by assuming that the former is a function of the relative position an individual has within a given cohort. The main aim of Attanasio and Hoynes is that of correcting cohort age profiles for wealth (and other economic variables) for the biases induced by differential mortality. Deaton (1999) and Deaton and Paxson (1999) have analysed mortality patterns in data for different cohorts of Americans and tried to relate it to inequality. They fail to find any significant relationship.

The aims of this paper are two. First, we want to quantify the relationship between mortality, health status and wealth. Second, we try to control for reverse causation by using two waves of a longitudinal data base and conditioning on initial health status. A similar exercise has recently been performed by Hurd and McFadden (2000). They find that once one controls for the initial health status, one does not find any relationship between economic variables and health outcomes. This evidence, therefore, seems to undermine the epidemiologists' view and indicate the importance of reverse causality. The results we obtain, using a different data set and a different approach from Hurd and McFadden (2000), are quite different. Below we show that, even after controlling for the initial health status, economic variables are important determinants of future health outcomes.

To achieve these two goals, we use the British Retirement Survey data set.[1] This survey was first conducted in late 1988 and early 1989 and measured a large number of variables for individuals in the target age group and their partners. In 1994, an attempt was made to contact the same individuals to measure the same variables. An element of particular interest of the dataset is the fact that in both surveys many health status questions were asked. These questions allowed the compilation of a health status indicator. We use the value of this indicator in 1988/89 to condition on the current health status in our regressions that explain mortality and the health status in 1994.

Another element of interest is that the survey contains several measures of wealth and income. This allows us to experiment to establish what are the most appropriate indicators of the relationship between socio-economic status and health. Our prior was that variables that reflect the amount of life cycle resources available to an individual are the most likely to be important in modelling health outcomes. For this reason, we particularly value the possibility to estimate the value of pension wealth, which for many of the individuals in the sample is linked directly to lifetime earnings (either through SERPS or an occupational pension). Also for this reason, we do not think that current income is a good indicator: some of these individuals are already retired, while others are about to. In addition to economic variables, we can also control for education, region of residence and so on.

With all its advantages, our data source presents a major problem. As the first interview was originally not supposed to be followed by the second one, attrition (for reasons other than mortality) is particularly severe in our sample. As attrition is unlikely to be random, this poses a number of methodological problems that we address below. In particular, we model explicitly the process of attrition allowing for the possibility that this is correlated with mortality and the evolution of the health status. Non-parametric identification of such a selection process requires a variable that is likely to predict attrition and that does not predict health outcomes. As such a variable we use a measure of the quality of the regional statistical office responsible for a given observation.

There are a number of important issues that we do not address, but leave for future research. First, as we discuss in the conclusions, we do not take a strong stance on the precise way in which health affects wealth. In particular, we do not take a stance on whether relative rather than absolute wealth is the relevant concept. Second, we do not use directly the estimates we compute to correct for the life cycle profiles for income, consumption or wealth. The reason for this is that this exercise would have required linking our estimates to another data set that would include younger individuals, and also may not have the health measure available in the British Retirement Survey.

The rest of the paper is organised as follows. In section 2 we describe briefly the data we use and present some simple cross tabulations. In section 3 we present the model we estimate and discuss some of the econometric issues. In section 4 we present our basic estimation results. Section 5 concludes the paper.

[1] For more details on the British Retirement Survey see the symposium in *Fiscal Studies* edited by Hurd (1998).

2 The Data

We describe our data source in detail in the Appendix. In this section, however, we relate their main features. The data we use comes from the British Retirement Survey. Individuals aged between aged 55 to 69 in late 1988 / early 1989, the year in which the data were first collected, constitute the Survey's target group. Spouses of individuals in the target groups included in the sample were also interviewed, regardless of whether they were in the target age group or not. A total of 4,000 individuals were interviewed. Of these about 3,500 belong to the target group.

In 1994 a second wave of the Survey was carried out. As this second wave had not originally planned, there were considerable difficulties in re-contacting the original respondents. Of these, 61 per cent were re-interviewed. Of the remaining 39 per cent, we know that 10 percent had died before 1994. It was not possible to contact the last 28 per cent; in particular it was not possible to establish whether these individuals had died or were simply not contactable. In what follows, the only information from the second wave we use is whether individuals remain in the survey, die or attrit and the value of their health status indicator.[2]

In the first wave, individuals were asked reasonably detailed questions on their wealth holdings. In particular, they were asked separate questions on their financial wealth and their housing wealth. As both the questions on financial wealth and housing wealth are banded questions. In what follows we use the mid-point of the bands.[3] Individuals were also asked detailed questions about any occupational and SERPS pension schemes. Furthermore, we have some information on their job history.

In addition to financial and housing wealth, the survey collects information on several other variables, such as the current income and employment status of the respondents. We also use the information on their highest education attainment, as shown in table 2.1.

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[2] An obvious extension that we have left for future research is to construct an explicit model of the evolution of wealth.

[3] Those reporting that they had housing wealth over £200,000 were assumed to have wealth of £225,000 while those reporting that they had more than £30,000 of financial wealth were assumed to have £40,000 of financial wealth.

Table 2.1. Percentage with each educational attainment, by gender.

Highest qualification	Men	Women	*All*
Degree level or equivalent	11.6	8.7	*10.0*
A level or equivalent	5.0	2.8	*3.8*
O level or equivalent	31.0	23.0	*26.7*
No formal qualifications	52.5	65.6	*59.5*
Observations	*1,914*	*2,217*	*4,131*

Note: Columns may not sum to one hundred due to rounding.

Finally, for each individual in the sample we have an index of health status. This is calculated using the definition of disability used in the 1988 Office of Population Censuses and Surveys (OPCS) survey of disability and the individuals responses to several questions relating to each of 13 different areas of disability such as locomotion, personal care and behaviour. The distribution of this variable is shown in table 2.2, which shows that this index of disability tends to be higher for older individuals of both sexes. More details can be found in Appendix A with a more detailed analysis provided in Martin, J., Meltzer, H. and Elliot D. (1988).

Table 2.2. Percentage with each severity score, by gender & age group.

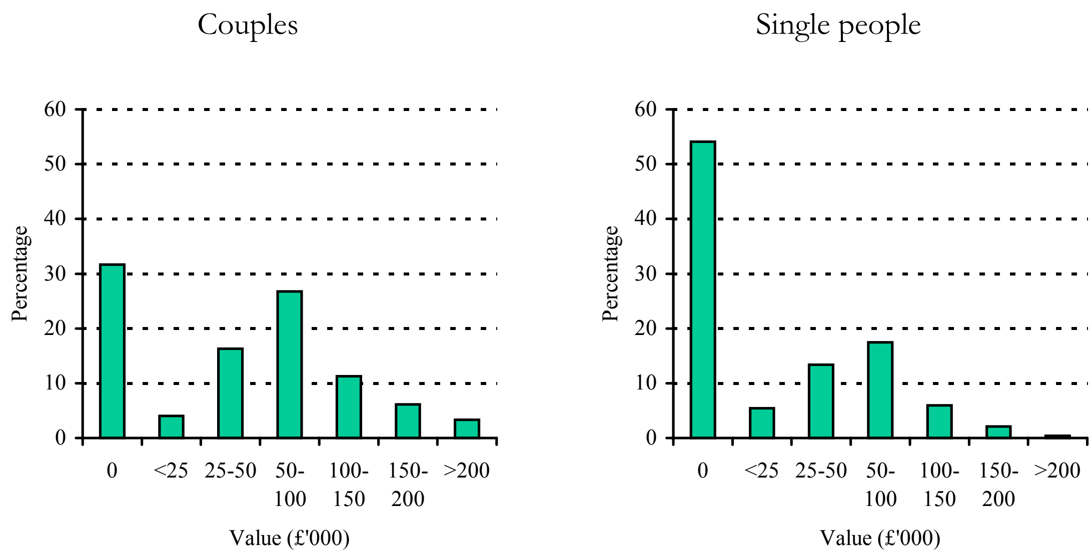
Severity	Men			Women		
score	55–59	60–64	65–69	55–59	60–64	65–69
0	71.4	64.1	60.1	72.4	67.9	60.3
1	12.2	14.9	17.7	10.8	10.9	15.2
2	3.8	8.8	5.9	4.7	5.6	6.7
3	4.0	4.2	6.1	2.9	4.2	5.7
4	2.1	2.3	2.7	2.2	2.5	4.0
5	1.4	1.6	3.0	2.5	3.0	2.9
6	2.4	2.1	1.4	2.7	2.5	2.7
7	1.4	0.9	1.1	0.5	0.8	1.1
8	1.0	1.0	1.4	0.9	1.1	0.4
9	0.3	0.4	0.7	0.3	1.3	1.1
10	0.0	0.0	0.0	0.0	0.3	0.0
Mean	*0.82*	*0.92*	*1.07*	*0.80*	*1.03*	*1.13*

Note: Columns may not sum to one hundred due to rounding, includes those aged between 55 and 69 (inclusive) only.

In Figure 2.1 we plot the distribution of housing wealth (defined here as the value of the first home), while in Figure 2.2 we plot the distribution of financial wealth. Just over 30 per cent of those in couples and 54 per cent of single people had no housing wealth. The majority of these individuals were living in council houses. Conditional on ownership, the distribution of housing wealth exhibits considerably less skewness than the distribution of financial wealth.

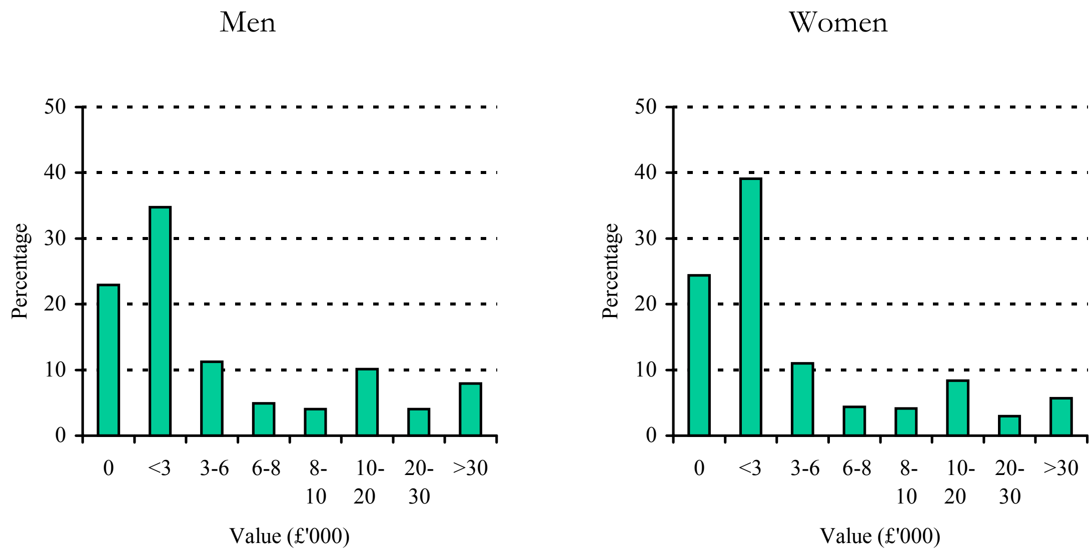
In particular, conditional on ownership, the coefficient of skewness for housing wealth in our data set is equal to 1.02, to be compared with 1.61 and 2.00 for male and female financial wealth respectively. Figure 2.2 contains two separate panels for the men and women in the sample. It is remarkable that, according to the figure, more than 60 per cent of the sample reports financial wealth of less than £3,000. [4]

Figure 2.1. Distribution of housing wealth, 1st home only.



[4] See Banks, Blundell and Smith (2001) for a recent comparison of wealth holdings in the UK and the US.

Figure 2.2. Distribution of financial wealth.



In Table 2.3 we consider what happened between 1988 and 1994 to the 4,131 individuals that constitute our basic sample. In particular, we see that 61 per cent of them were still in the sample in 1994. At the other extreme, 28 per cent have disappeared from the sample for unknown reasons. Men are much more likely to die than women (12.5 per cent vs. 8.0 per cent) but there seems to be no difference between the two sexes in terms of their likelihood to attrit from the sample for unknown reasons.

Table 2.3. What happened to the sample between 1989 and 1994?

	Men	Women	All	No obs.
Those who remain in the sample	59.3	63.3	61.5	2,539
Those who die	12.5	8.0	10.1	416
Those who attrit from the sample	28.2	28.7	28.5	1,176

Note: Column may not sum to one hundred due to rounding.

In Table 2.4 we summarise the information on mortality and attrition for all the men and women in the sample and compute the mortality rates implied by different assumptions on the nature of attrition. For instance, under the assumption that the attrition is completely random and uncorrelated to mortality, we have that the mortality rate for men in our sample is 17.4%, to be compared to 11.2% for women. Surprisingly these are slightly higher than the figure suggested by using UK lifetables to calculated the expected number of deaths, which is 15.3% among men and 7.5% among women, assuming that there is a five year gap between the two interviews.

Table 2.4. Percentage dying between the two waves under various assumptions, compared to expected deaths calculated from life tables.

	Men	Women	All
Retirement Survey, assuming:			
All those who attrit survive	12.5	8.0	10.1
Attrition is random	17.4	11.2	14.1
All those who attrit die	40.7	36.7	38.5
Expected deaths from GAD life tables			
Using 5 year expectations	12.4	6.0	9.0
Using 6 year expectations	15.3	7.5	11.1

Source: 1992–94 life tables published by the Government Actuary's Department.

Table 2.5 considers different 5 age groups: under 55, 55–59, 60–64, 65–69 and those 70 and over. Not surprisingly, mortality rates increase with age. More interestingly, attrition rates decrease with age between the first and second group, probably reflecting greater mobility of the relatively younger individuals. Attrition rates then increase again substantially among both men and women in the last age group. Table 2.5 also shows that the higher number of deaths in the retirement survey compared to life table calculations seen in table 2.4 occurs across each of the age groups.[5]

Table 2.5. Percentage who attrit and die in the Retirement Survey, compared to the percentage expected to die from life tables assuming random attrition, by age & gender.

	Retirement Survey				Life tables	
Age group	Attrit		Deceased		Expected deceased	
	Male	Female	Male	Female	Male	Female
Under 55	(36.4)	43.7	(9.5)	1.1	4.6	2.4
55–59	29.6	25.9	9.5	9.4	7.7	4.6
60–64	22.6	27.3	16.1	9.2	13.1	7.7
65–69	24.0	23.2	23.9	17.8	20.3	12.2
Over 70	42.5	32.0	28.6	22.4	32.6	20.4
Total	*28.2*	*28.7*	*17.4*	*11.2*	*15.3*	*7.5*

Note: For the life table estimates a six year gap between interviews is assumed. Figure in brackets indicates a sample size less than 50.

Source: 1992–94 life tables published by the Government Actuary's Department.

Table 2.6 constitutes our first look at the relationship between wealth and mortality. In particular, we compute mean financial and housing wealth for those who stay, those who attrit and those who die. As found by Disney, Johnson and Stears (1998) those who stay are considerably wealthier than those die. Indeed this result is significant at the 1% level for financial wealth and housing wealth and when pension wealth is included. The comparison between those who die and those who attrit is more ambiguous. Across the whole sample, and within each of the four subgroups shown in table 2.6 the difference in either measure of wealth is never significant at the 5% level.

Table 2.6. Mean wealth by mortality and attrition ('000)

	Stay	Die	Attrit	Total
Couples – men				
Financial & housing wealth	43.2	28.9	33.3	38.8
Financial, housing & pension wealth	165.6	143.4	139.8	156.2
Couples – women				
Financial & housing wealth	39.6	30.5	34.3	37.5
Financial, housing & pension wealth	161.4	137.0	142.8	154.6
Single men				
Financial & housing wealth	44.5	38.3	34.8	40.6
Financial, housing & pension wealth	104.6	105.3	88.7	99.7
Single women				
Financial & housing wealth	43.8	25.5	33.6	39.0
Financial, housing & pension wealth	133.2	108.8	116.2	126.0

Note: For more details of the measures of wealth used see Appendix A.

In Table 2.7, we consider the relationship between education and the health indicator discussed above and the second wave outcome. The individuals who die are on average less educated than those who survive – for example 54.5 per cent of those remaining in the sample have no formal qualifications compared to 68.0 per cent of those who die. There is no clear difference in the education levels of those who die and those who attrit from the sample. Looking at health status those who die are found to be on average less healthy than both those who remain in the sample and those who attrit.

[5] The only exception to this is among women aged under 55, in which category there are only two deaths in our sample compared to eight predicted by the life tables.

Table 2.7. Mean levels of education and health by whether remained in sample, deceased or attrit.

	Stay	Die	Attrit	Total
Education level				
No qualifications	54.5	68.0	67.4	59.5
O level	29.2	21.4	23.2	26.7
A level	4.5	2.2	2.8	3.8
Degree	11.8	8.4	6.6	10.0
Health level				
Mean severity score	0.80	1.66	1.10	0.97
Proportion with severity score>0	0.30	0.47	0.36	0.34
Number of observations	*2,539*	*416*	*1,176*	*4,131*

Note: For more information on the health variable see Appendix A.

The strength of the correlation between health status and wealth is demonstrated in table 2.8. This gives the results from an ordered probit on the severity variable in the first wave of the sample with a range of observable characteristics. The wealth measure used is total wealth which includes financial, housing and pension wealth. Individuals are then ranked within their (5-year) age group. In order to avoid issues of equivalisation couples and single people ranked separately. For more details of the wealth measure see Appendix A.

Those with worse levels of health are found to be more likely to be single, older, and have lower formal educational achievements. We also include a variable for the position of the individual in the wealth distribution within their age group and whether they are single or in a couple. It is found that on average those lower down the wealth distribution are more likely to have worse levels of health.

Table 2.8. Ordered probit showing correlations with severity score in wave 1.

Dependent variable – severity score	Co-efficient	Standard Error
Male	–0.176	0.106
Couple	–0.177	0.045
Age	0.329	0.103
Age ^ 2	–0.106	0.086
Age ^ 3	0.023	0.025
Interaction between male and age	0.167	0.080
Individual has o level	–0.086	0.047
Individual has a level or degree	–0.197	0.069
Relative wealth rank	–1.014	0.674
Relative wealth rank ^ 2	–0.144	1.601
Relative wealth rank ^ 3	0.329	1.072
Wealth rank missing	–0.390	0.097
Joint (F-test) on age variables	23.46	
Joint (F-test) on rank variables	126.25	
Observations	*4,131*	
Pseudo R-squared	0.0287	
Log likelihood	–5,016	

Note: Severity score is an index from 0 to 10, for more details see table 2.2 and appendix A.

3 The model and estimation issues

In this section we describe two simple statistical models we use to identify the relationship between mortality, morbidity and wealth. These models allow us to consider simultaneously the effect of the several variables that are likely to affect mortality rates, wealth, current health status age, education, while at the same taking into account non-random attrition from our sample.

Unlike Attanasio and Hoynes (2000) who consider the couple as their unit of analysis, we estimate our model on individual data. We consider males and females separately. This allows us to avoid the issue of considering the correlation between spouses in our estimation, while at the same time allowing a more flexible specification of the effects of gender on morbidity and mortality. On the other hand, dealing with individuals rather than couples will pose some problems in the definition of wealth ranks that we discuss below.

As mentioned in the introduction, another important difference between our statistical model and that used by Attanasio and Hoynes (1999) is that we condition on the current health status, as measured in the first wave of our panel. As we discussed, this is important because it constitutes an attempt to address the issue of reverse causality between wealth and health discussed in Smith (1999). A similar approach is used by Hurd and McFadden (2000).

In what follows we estimate two different models, one for mortality and one for morbidity. As mentioned in the data section, attrition is an important issue in our sample and it is probably non-random. For each individual in the first wave of our sample we have three possibilities. First, the individual appears in the second wave, in which case we observe the value of the health indicator. Second, the individual dies between the waves. Third, the individual attrits and we are not able to observe whether the individual survives.

3.1 The mortality model

When we model just mortality, we assume that death is determined by a simple probit model. That is, each individual dies when an index I^d is less than zero. Such an index I^d is given by the following equation:

(1) $$I^d = b'x + u^d$$

where x is a vector of observable variables with associated vector of coefficients b and u^d is a normally distributed random variable. In choosing an appropriate specification for our model we have considered in the vector x variables several variables, including age, marital status, education indicators, the current health status, regional variables as well as several wealth related variables.

To control for attrition, we model it explicitly with another simple model. In particular, we assume that attrition occurs when another index I^a is less than zero. This index is given by the following equation:

(2) $$I^a = d'w + u^a$$

Where w is a vector of observable variables with the associated vector of coefficients d and u^a is another normally distributed random variable, which is possibly correlated with u^d . The vector w does not necessarily coincide with the vector x in equation (1).

The outcome of equation (2) is always observed. That is we know whether a household attrits or not. However, the outcome of equation (1) is observed only when the index I^a is greater than zero. Given this structure, the parameters b and d , as well as the correlation coefficient between the two residuals can be easily estimated by Maximum Likelihood. The likelihood function for our sample is given by the following expression:

(3) $$L = \Pi_{i=attrit}\Phi(-d'w)\,\Pi_{i=stay,alive}\Theta(-d'w,'b'x,\rho)\Pi_{i=stay,die}\Psi(-d'w,-b'x,\rho)$$

where Φ, Ψ, and Θ are transformations of the univariate and bivariate normal distribution functions.

3.2 The health status model

In addition to mortality, we also model the evolution of the health status, as measured by the indicator discussed in the previous section. As mentioned above, the indicator can take 11 values (0 to 10). For the purpose of modelling its evolution, however, we aggregate these into three categories, which we choose on the basis of the empirical distribution of the indicator itself: the first two categories correspond to the first two values of our indicator, while the third corresponds to values of the indicator between 2 and 10. To these categories we add, for the second wave, a fourth category which corresponds to death. We assume that, in the absence of attrition, the evolution of our indicator is determined by a simple ordered probit model. Therefore we have a single index and three cut-off points. If the index is below the first cut-off point, the indicator takes the first value, if it is between the first and second cut-off, it takes the second value and so on.

As before, attrition is determined by a simple probit model. Conditional on not attriting, we observed the realization of the first index, otherwise we do not. Under these assumptions, it is straightforward to write down the likelihood function for our model.

3.3 Identification

Given the non-linearity of the system formed by equation (1) and (2) (where (1) is either the probit for mortality or the ordered probit for the evolution of the health status) induced by the normality assumption and by the discrete nature of the outcomes, the parameters are identified even in the absence of exclusion restrictions in the two equations. However, non-parametric identification is only achieved if we can find a variable that affects attrition that does not affect mortality. For such a purpose we use information on the quality of the interviewers in the first wave. We proxy this by the percentage of complete income responses obtained by each of the offices that carried out the survey in the first wave. It turns out that such a variable is a good prediction of attrition, while clearly being uncorrelated with mortality.

4 Results

In this section, we report the results we obtain for the conditional probit we use to model mortality and those for the conditional ordered probit we use to describe the evolution of the health status indicator. In estimating both models, we experimented with flexible specifications for the effect of wealth, health status and age. For wealth we consider as our main variable the rank that an individual has within the wealth distribution of individuals of the same age group. For age and wealth status, we tried polynomials in the two variables and their interaction. Moreover, we always include a dummy for the observations with missing wealth data. For the health status indicator we tried both the level of the index and dummy variables corresponding to the three main groups we consider (in addition to death) in the ordered probit estimates. Finally, we report the results obtained with two wealth measures: the first includes only financial wealth and housing, while the second also includes pension wealth. Rather than reporting all of our estimates, for the sake of brevity, we show only our favourite specifications. Other results, referred to in the text, are available upon request.

In addition to age, wealth and health status, we control for marital status, and education. We have also experimented with regional dummies, but failed to find any significant effect, once we control for the other variables in our model. This is despite the fact that standardised mortality rates, relative to the UK average, are 11% lower in the South-West and 16% higher in Scotland (Office for National Statistics, 2001). This finding suggests that this variation is completely explained by the observable characteristics of the resident population.

4.1 Mortality

We report the main results for our mortality model in Tables 4.1 and 4.2, for males and females respectively. These tables are divided into two parts: part a reports the estimates of the coefficients of the index that determines mortality, while part b reports the estimates of the attrition model. The estimates for the mortality model should be read as determining the probability of being alive.

Starting with the estimates for males in Table 4.1a and b, we never found non linear effects of age and, for this reason, we report estimates that contain only a linear term in age. While this result might seem surprising, it should be remembered that the effect on the surviving probability is non-linear (through the normal cdf) and that the sample is made of a relatively homogeneous group of individuals in terms of age.

As far as the health indicator in 1988 is concerned, we also found that a linear function worked better than dummies defined over three groups of values of the indicator. Such an indicator is obviously a very important determinant of mortality throughout the specifications in Table 4.1.

As far as the additional controls are concerned we do not find, perhaps surprising, strong or significant effects of either education or marital status in none of our specifications.

Turning finally to the wealth status variables, in column 1 and 2 we use housing and financial wealth, while in columns 3 and 4 we also include pension wealth. Even though the two definitions differ quite substantially, they work in a similar fashion. In the mortality equation we only find linear effects of the wealth rank. As can be seen in columns 2 and 4, quadratic and cubic terms fail to attract significant coefficients.[6] The same can be said of interactions of age and wealth ranks (the results are available upon request). The dummy for missing wealth information is not statistically significant.

As far as the attrition equation is concerned, we notice three things. First, the variable that gives us non-parametric identification, that is the quality of the statistical office that collects the data – as measure by the percentage of correct income questions in the first wave, is not strongly significant. The best p-value such a variable attracts is 0.2. Second, wealth ranks have complex effects on the probability of attrition: both quadratic and cubic terms are strongly significant. Third, unlike in the mortality equation, we find quadratic effects of age.

Turning now to the discussion of the results for females, we observe that the results have only marginal differences relative to those for males. First, once again, we only find linear effects in age, wealth rank and health status. However, we find some effect of marital status, which increases the probability of surviving. Education, however, as for males, is insignificant, once we control for the other variables.

As far as attrition is concerned, we find again significant non-linear effects of the wealth rank. The office quality variable is even less significant than in the same equation for males. Neither health status, nor marital status is an important determinant of attrition, while education is.

[6] The specifications that included polynomials in the wealth ranks in the mortality equation, had considerable problems in reaching convergence. Notice that the estimate of the correlation coefficient between the two residuals of the model changes sign when we introduce non linear effects. Moreover, the intercept of the

Table 4.1a

Conditional probit for mortality and attrition

Male mortality

	Type of wealth used			
	Financial and housing wealth		Including pension wealth	
Age	–0.501 (0.080)	–0.499 (0.083)	–0.504 (0.080)	–0.500 (0.083)
A-level or degree	0.087 (0.132)	0.111 (0.129)	0.102 (0.130)	0.126 (0.126)
Health status in 1988	–0.094 (0.021)	–0.093 (0.021)	–0.099 (0.021)	–0.097 (0.021)
Couple	0.131 (0.111)	0.141 (0.107)	0.094 (0.110)	0.091 (0.106)
Wealth rank in 1988	0.594 (0.164)	2.212 (1.713)	0.420 (0.174)	2.090 (1.494)
Wealth rank^2 in 1988	–	–3.374 (3.838)	–	–3.704 (3.555)
Wealth rank^ 3 in 1988	–	1.975 (2.460)	–	2.274 (2.379)
Missing wealth	0.087 (0.172)	0.242 (0.234)	–0.005 (0.165)	0.130 (0.152)
loglikelihood	–1685.1	–1684.6	–1685.7	–1685.1

Note: Standard errors in parentheses. Number of observations 1,914.

models change considerably, implying, especially for females, much lower surviving probabilities. We attribute these results to numerical problems.

Table 4.1b

Conditional probit for mortality and attrition

Male attrition

	Type of wealth used			
	Financial and housing wealth		Including pension wealth	
Age	0.999	0.988	0.941	0.929
	(0.224)	(0.225)	(0.225)	(0.226)
Age^2	–0.393	–0.389	–0.377	–0.373
	(0.078)	(0.078)	(0.078)	(0.078)
A-level or degree	0.309	0.309	0.249	0.249
	(0.094)	(0.094)	(0.098)	(0.098)
Health status in 1988	–0.030	–0.030	–0.030	–0.030
	(0.016)	(0.016)	(0.016)	(0.016)
Couple	0.212	0.212	0.167	0.166
	(0.080)	(0.079)	(0.081)	(0.081)
Wealth rank in 1988	2.886	3.033	2.523	2.664
	(1.318)	(1.302)	(1.129)	(1.104)
Wealth rank^2 in 1988	–5.604	–5.906	–5.872	–6.172
	(2.991)	(2.959)	(2.712)	(2.655)
Wealth rank^ 3 in 1988	3.348	3.523	4.150	4.327
	(1.929)	(1.913)	(1.817)	(1.786)
Missing wealth	0.0855	0.102	–0.000	0.014
	(0.180)	(0.178)	(0.153)	(0.152)
Quality of stat. office	0.543	0.537	0.557	0.550
	(0.435)	(0.430)	(0.436)	(0.430)
Rho	0.320	0.463	0.321	0.490
	(0.411)	(0.370)	(0.417)	(0.374)

Note: Standard errors in parentheses. Number of observations: 1,914.

Table 4.2a

Conditional probit for mortality and attrition

Female mortality

	Type of wealth used			
	Financial and housing wealth		Including pension wealth	
Age	–0.513 (0.089)	–0.280 (0.302)	–0.504 (0.092)	–0.445 (0.088)
A-level or degree	0.124 (0.191)	0.247 (0.129)	0.071 (0.181)	0.107 (0.161)
Health status in 1988	–0.090 (0.023)	–0.067 (0.040)	–0.087 (0.022)	–0.085 (0.020)
Couple	0.205 (0.094)	0.152 (0.117)	0.236 (0.096)	0.234 (0.091)
Wealth rank in 1988	0.469 (0.240)	2.884 (1.538)	0.563 (0.265)	1.167 (1.610)
Wealth rank^2 in 1988	–	–4.709 (3.971)	–	–1.623 (3.709)
Wealth rank^ 3 in 1988	–	2.591 (2.747)	–	1.242 (2.455)
Missing wealth	0.202 (0.188)	0.284 (0.231)	0.244 (0.183)	0.218 (0.239)
loglikelihood	–1808.5	–1807.3	–1805.1	–1805.0

Note: Standard errors in parentheses. Number of observations: 2,217.

Table 4.2b

Conditional probit for mortality and attrition

Female attrition

	Type of wealth used			
	Financial and housing wealth		Including pension wealth	
Age	0.374	0.375	0.371	0.377
	(0.095)	(0.096)	(0.095)	(0.094)
Age^2	–0.118	–0.117	–0.111	–0.117
	(0.049)	(0.050)	(0.049)	(0.050)
A-level or degree	0.247	0.244	0.164	0.161
	(0.097)	(0.097)	(0.101)	(0.101)
Health status in 1988	–0.003	–0.003	–0.002	–0.002
	(0.016)	(0.016)	(0.016)	(0.016)
Couple	0.016	0.013	0.026	0.025
	(0.066)	(0.066)	(0.067)	(0.066)
Wealth rank in 1988	3.272	3.289	1.330	1.315
	(1.173)	(1.177)	(1.111)	(1.173)
Wealth rank^2 in 1988	–6.933	–6.992	–3.476	–3.444
	(2.703)	(2.712)	(2.534)	(2.540)
Wealth rank^ 3 in 1988	4.408	4.452	2.848	2.827
	(1.774)	(1.773)	(1.664)	(1.668)
Missing wealth	0.121	0.111	–0.084	–0.090
	(0.161)	(0.160)	(0.161)	(0.162)
Quality of stat. office	0.401	0.201	0.450	0.384
	(0.421)	(0.462)	(0.425)	(0.414)
Rho	–0.243	0.837	–0.243	0.386
	(1.114)	(0.407)	(1.114)	(0.256)

Note: Standard errors in parentheses. Number of observations: 2,217.

The relationship between wealth and mortality for the linear specification for both genders and for both definitions of wealth is shown more clearly in figure 4.1. These give the survival probabilities separately for men and women of different ages by their wealth rank implied by our estimates.[7] These are calculated using the results from tables 4.1a and 4.2a – the probabilities shown are for married individuals who do not have an a level or higher educational attainment and who are in good health in the first wave. Notice that even for the linear specification, the relationship between survival probabilities and wealth rankings is not linear, as the index determining mortality probabilities goes through the normal distribution function.

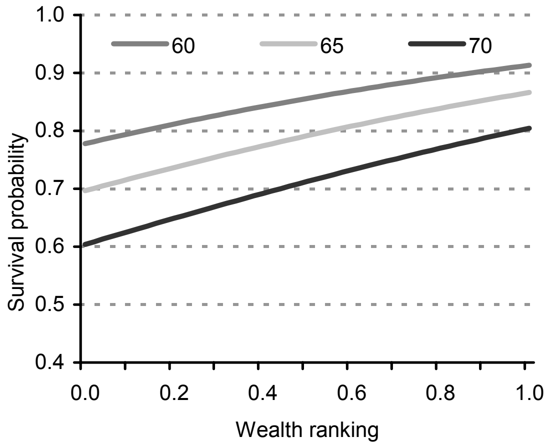
It is clear that for both genders there is a positive relationship between wealth and the probability of survival, regardless of the wealth measure used or the specification of the model. For example for men aged 65 moving from the 40th percentile to the 60th percentile in the wealth distribution using the linear models increases the probability of survival by 3.4 percentage points when using financial and housing wealth only and 2.4 percentage points when pension wealth is included. A slightly smaller effect is found for women of 1.5 or 1.9 percentage points respectively.

[7] Given the fact that the non-linear effects are not significantly different from zero, we do not report these graphs. The pictures, available upon request, show a concave profile for the survival probabilities. The effects are strongest up to the 25th percentile.

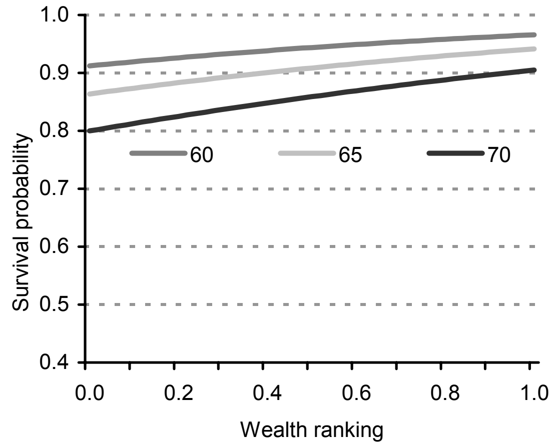
Figure 4.1. Impact of wealth and age on mortality.

Financial and housing wealth

By wealth rank & selected ages:males

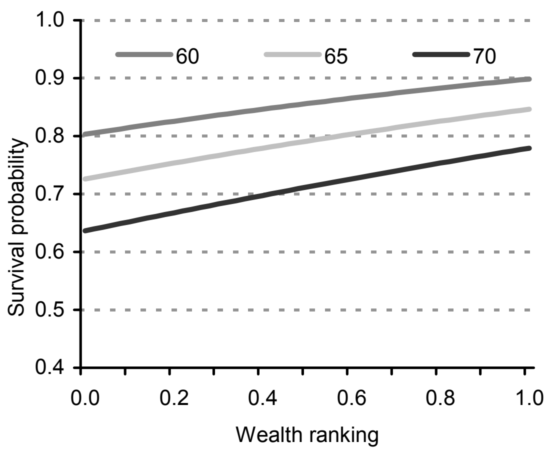


By wealth rank & selected ages:females

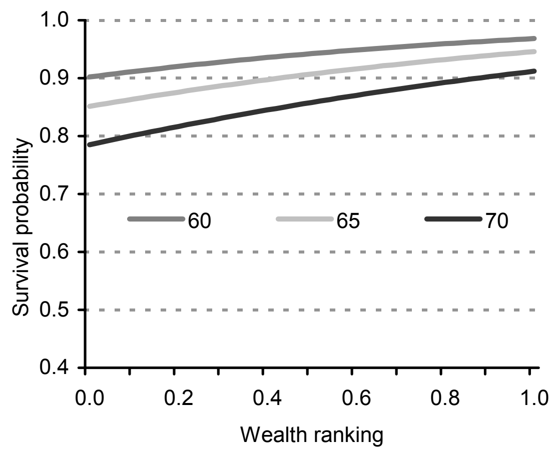


Including pension wealth

By wealth rank & selected ages: males



By wealth rank & selected ages:females



Note: The survival probabilities are calculated for a married man or women who is in good health and who does not have an a level qualification or higher.

4.2 The evolution of health status

In table 4.3 and 4.4, we present the results of the estimation of the conditional ordered probit for our health status variable. As mentioned above, we divide the 11 possible values (0 to 10) of our indicator into 3 groups (0, 1 and more than 1). To this we add death as a fourth possible value in wave 2. In panel (a) of the table we report the coefficients of the ordered probit, while in the panel (b) we report those of the attrition model. Table 4.3 is for males, while 4.4 is for females. Finally, the first two columns of each table use as a wealth variable housing and financial wealth, while the last two include pension wealth. After some experimentation, we found that the initial health status variable, unlike in the model for mortality, explains changes in health status better if entered as two dummy variables for status 2 and 3 of the initial wave health indicator. The coefficients of the ordered probit should be read as determining the probability of a worsening of the health status: therefore they have the opposite sign than in the previous table.

In columns 1 and 3 of Table 4.3, we report the results of a simple specification, where both age effects and the effect of wealth rank are linear. It is important to notice that, once again, as in the mortality model, we find significant wealth effects even after controlling for the initial health variable. It should be stressed that the result is robust to changes in the specification of the equation. Once again, the results are also robust to the wealth definition used. Notice that education is now significant, while marital status, as in the case of mortality, is not. Surprisingly, the correlation coefficient between the residuals of the health status and attrition equation is positive, albeit not significant. This contradicts the evidence from the previous tables and might be an indication of convergence to a local maximum.[8]

In columns 2 and 4, we use a slightly more complicated specification, where age enters quadratically and the wealth rank enters both linearly and interacted with age. Several aspects are worth noticing. First, both quadratic age effects and the interaction term are significant. The effect of the wealth variable is still significant and negative. However, the interaction of wealth rank and age attracts a positive and significant sign. This might indicate that older poor individuals who survive are selected into the sample for higher unobserved longevity. Second, once we add the quadratic in age and the interaction term, the effect of education disappears. Finally, the missing wealth dummy is now significantly negative. This result

[8] We were unable to find a different maximum for the likelihood function. However, the numerical algorithms we used had some problems in reaching convergence in this case.

might indicate that richer individuals are both less likely to die and less willing to answer the wealth questions.[9]

Table 4.3a.

Conditional ordered probit model for health status – males.

Dependant variable = 0 good health, 1 fair, 2 bad, 3 dies	*Wealth measure used*			
	Financial wealth and housing		Including pension wealth	
Age	0.442	0.726	0.452	0.763
	(0.061)	(0.226)	(0.062)	(0.227)
Age^2	–	–0.246	–	–0.254
		(0.072)		(0.073)
A level or degree	–0.197	–0.031	–0.182	–0.032
	(0.094)	(0.080)	(0.092)	(0.073)
Initial health fair	0.592	0.512	0.597	0.507
	(0.102)	(0.085)	(0.102)	(0.085)
Initial health bad	0.950	0.707	0.958	0.711
	(0.092)	(0.080)	(0.092)	(0.080)
Married	–0.033	0.105	0.014	0.133
	(0.084)	(0.070)	(0.082)	(0.073)
Wealth rank	–0.688	–1.095	–0.604	–0.979
	(0.128)	(0.232)	(0.138)	(0.230)
Wealth rank * age	–	0.510	–	0.499
		(0.149)		(0.145)
Missing wealth dummy	–0.182	–0.282	–0.126	–0.226
	(0.127)	(0.103)	(0.124)	(0.103)
Log likelihood	–2757.5	–2753.1	–2759.6	–2736.8

Note: Standard errors in parentheses. Number of observations 1,914.

[9] Finally, the results are numerically much more stable than in the previous column.

Table 4.3b.

conditional ordered probit model for health status – males.

Attrition

Dependant variable = 0 if attrits sample, 1 if remains or dies	*Wealth measure used* Financial wealth and housing		Including pension wealth	
Age	–0.985	–0.982	–0.948	–0.943
	(0.220)	(0.210)	(0.221)	(0.203)
Age^2	0.388	0.370	0.379	0.359
	(0.074)	(0.070)	(0.074)	(0.070)
A level or degree	–0.309	–0.297	–0.269	–0.243
	(0.094)	(0.093)	(0.097)	(0.096)
Initial health fair	–0.055	0.032	–0.050	0.040
	(0.093)	(0.091)	(0.092)	(0.091)
Initial health bad	0.131	0.201	0.122	0.199
	(0.080)	(0.080)	(0.080)	(0.080)
Married	–0.207	–0.150	–0.180	–0.101
	(0.079)	(0.076)	(0.079)	(0.078)
Wealth rank	–0.280	–2.241	–0.374	–1.955
	(0.122)	(1.085)	(0.125)	(0.905)
Wealth rank^2	–	4.329	–	4.247
		(2.545)		(2.220)
Wealth rank ^3	–	–2.614	–	–2.970
		(1.681)		(1.522)
Missing wealth dummy	0.197	–0.029	0.157	0.013
	(0.117)	(0.154)	(0.116)	(0.134)
Quality of area office	–0.593	–0.350	–0.600	–0.374
	(0.434)	(0.382)	(0.435)	(0.382)
Correlation coeff.	0.172	–0.935	0.186	–0.936
	(0.364)	(0.193)	(0.373)	(0.032)
Log likelihood	–2757.5	–2734.9	–2759.6	–2736.8

Note: Standard errors in parentheses. Number of observations 1,914.

Turning to the attrition equation, we notice that, as in the previous case, we find significant quadratic and cubic effects of the wealth status variable. The other results are more or less unaffected.

Table 4.4a.

Conditional ordered probit model for health status – females.

Dependant variable = 0 good health, 1 fair, 2 bad, 3 dies	*Wealth measure used*			
	Financial wealth and housing		Including pension wealth	
Age	0.394	0.393	0.388	0.387
	(0.047)	(0.047)	(0.047)	(0.047)
A level or degree	0.000	–0.006	0.027	0.023
	(0.094)	(0.094)	(0.096)	(0.097)
Initial health fair	0.556	0.557	0.559	0.559
	(0.083)	(0.083)	(0.083)	(0.083)
Initial health bad	0.893	0.894	0.890	0.890
	(0.075)	(0.075)	(0.074)	(0.075)
Married	–0.042	–0.041	–0.060	–0.067
	(0.058)	(0.058)	(0.058)	(0.059)
Wealth rank	–0.386	0.928	–0.383	–1.013
	(0.099)	(1.066)	(0.106)	(0.984)
Wealth rank ^2	–	–3.454	–	1.204
		(2.459)		(2.251)
Wealth rank ^3	–	2.401	–	–0.660
		(1.609)		(1.480)
Missing wealth dummy	–0.330	–0.223	–0.332	–0.330
	(0.102)	(0.149)	(0.104)	(0.102)
Log likelihood	–3005.9	–3001.9	–3002.1	–2998.6

Note: Standard errors in parentheses. Number of observations: 2,217.

Table 4.4b.

conditional ordered probit model for health status –females.

attrition

Dependant variable = 0 if attrits sample, 1 if remains or dies	*Wealth measure used*			
Age	–0.378	–0.385	–0.351	–0.353
	(0.083)	(0.085)	(0.082)	(0.082)
Age^2	0.111	0.116	0.094	0.094
	(0.041)	(0.041)	(0.040)	(0.041)
A level or degree	–0.220	–0.220	–0.182	–0.144
	(0.096)	(0.097)	(0.098)	(0.100)
Initial health fair	0.119	0.126	0.109	0.101
	(0.089)	(0.089)	(0.089)	(0.090)
Initial health bad	0.106	0.098	0.096	0.098
	(0.074)	(0.076)	(0.075)	(0.076)
Married	0.0038	–0.005	–0.008	–0.008
	(0.064)	(0.064)	(0.064)	(0.065)
Wealth rank	–0.212	–3.179	–0.315	–1.049
	(0.107)	(1.144)	(0.115)	(1.058)
Wealth rank^2	–	7.154	–	2.924
		(2.640)		(2.427)
Wealth rank ^3	–	–4.674	–	–2.468
		(1.727)		(1.600)
Missing wealth dummy	0.207	–0.063	0.153	0.145
	(0.106)	(0.157)	(0.109)	(0.156)
Quality of statistical office	–0.335	–0.354	–0.349	–0.372
	(0.366)	(0.365)	(0.361)	(0.362)
Correlation coefficient	-0.945	-0.947	-0.952	-0.950
	(0.093)	(0.036)	(0.036)	(0.108)
Log likelihood	–3005.9	–3001.9	–3002.1	–2998.6

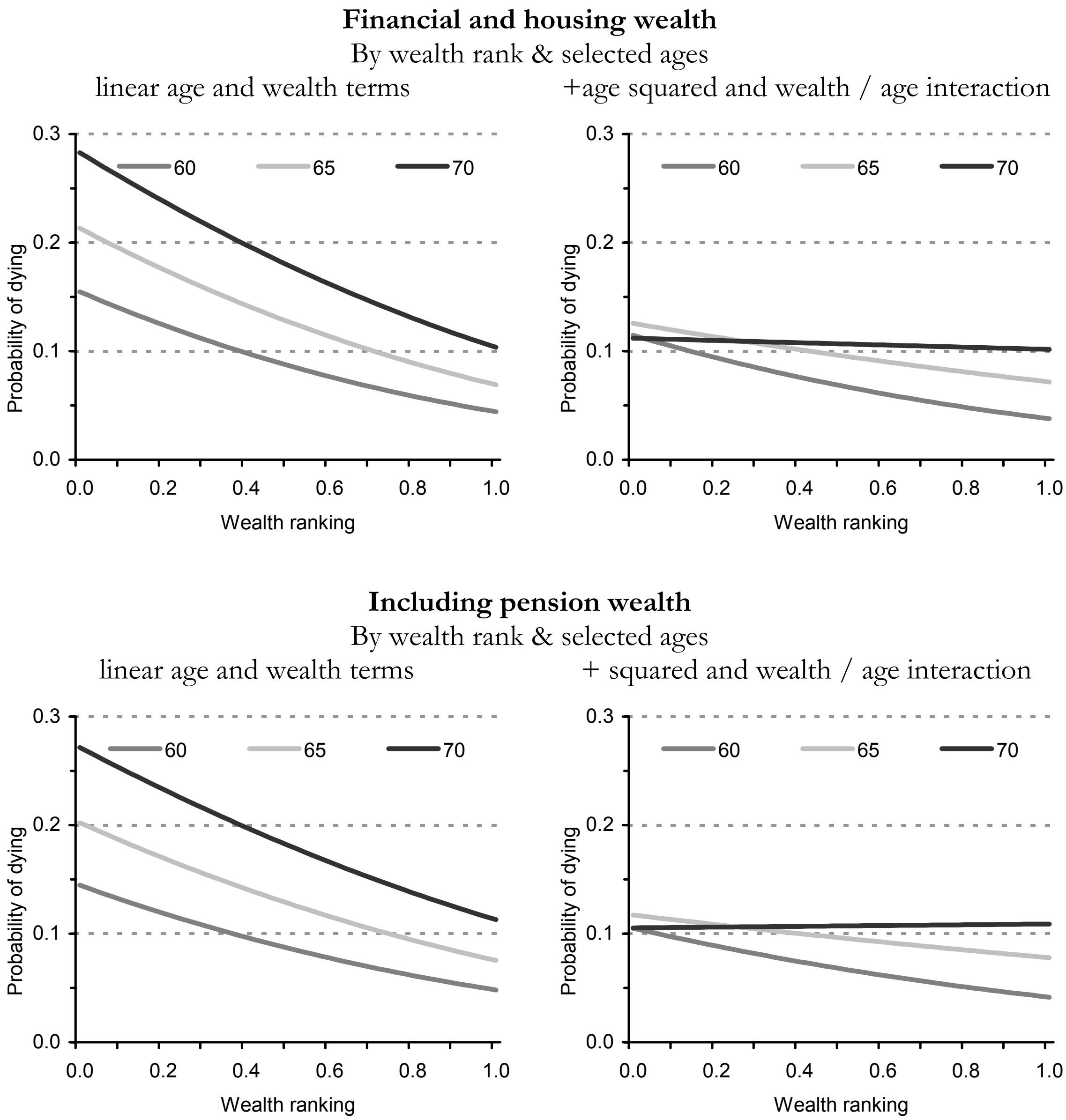
Note: Standard errors in parentheses. Number of observations: 2,217.

Turning finally to the results for females, the results in Table 4.4a indicate that non-linear effects in wealth rank are not significant. As before, education or marital status effects are not very strong. As for the conditional probit in the previous subsection, non linear wealth effects are significant in the attrition equation (see Table 4.4b).

As for the model for mortality, we find it useful to illustrate the importance of our results graphically. For this reason, in Figure 4.2 and 4.3, we plot mortality probability as a function of wealth rank for different ages. Again we shown the probabilities for married couples who have lower education attainment and are in good health in the first wave. The two figures refer to male and females, respectively. The top panel refers to the specification which includes only financial and housing wealth, while the bottom panel corresponds to the specification that includes also pension wealth. Finally, the left panels correspond to the simplest models while the right panels to the more complicated.

Overall, the magnitude of the wealth effects on the probability of dying told by the left panels of figures 4.2 and 4.3 are comparable to those illustrated in Figure 4.1. However, the significant non-linear terms (the interaction between age and mortality for males and the non linear terms for females) make for more interesting stories in the right panels. For males, the right panel indicate that by age 70 the interaction between age and wealth has completely neutralized the effect of the age rank. For females, the effect of wealth changes depending on the wealth measure. Not much should be read in this changes, however, given the low precision with which the non-linear terms are estimated in Table 4.4.

Figure 4.2. Impact of wealth and age on mortality, conditional ordered probit for health status – men.



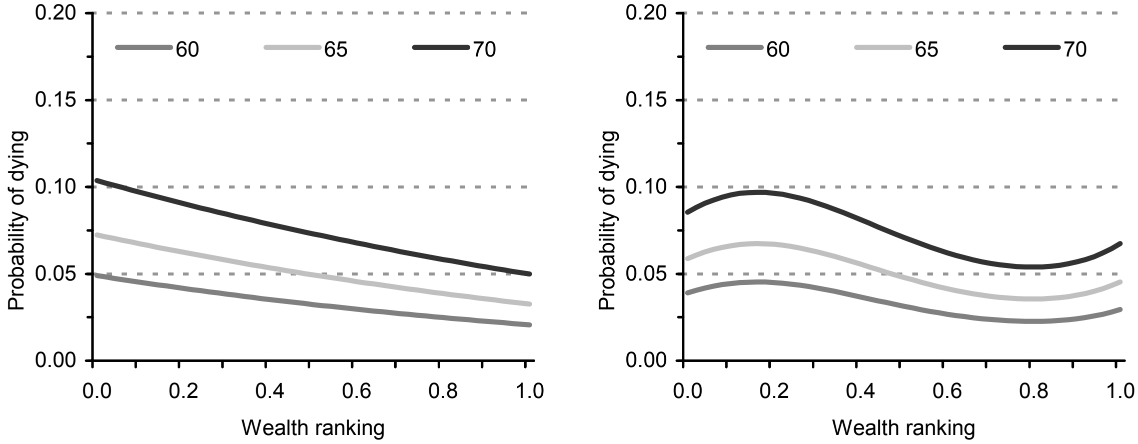
Note: The probabilities of death are calculated for a married man in good health who does not have an a level qualification or higher.

Figure 4.3. Impact of wealth and age on mortality, conditional ordered probit for health status – women.

Financial and housing wealth

By wealth rank & selected ages

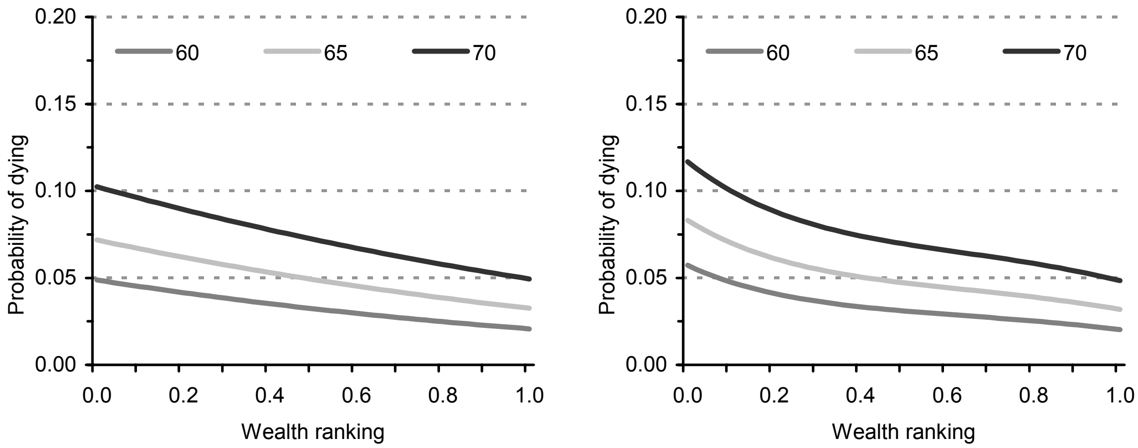
linear age and wealth terms + squared and cubed wealth terms.



Including pension wealth

By wealth rank & selected ages

linear age and wealth terms +squared and cubed wealth terms.



Note: The probabilities of death are calculated for a married woman in good health who does not have an a level qualification or higher.

5 Conclusions

In this paper we have studied the relationship between health and economic status in the British Retirement Survey. Our main contribution, in addition to the quantification of such a relationship, was to show that even after controlling for initial health status, wealth rankings are important determinants of mortality and, more generally, health outcomes. This is an important result because it goes some way towards addressing the issue of reverse causality. Obviously this does not mean that health does not cause wealth, but that probably the causal link runs also in the other direction.

This result is also remarkable when compared to that obtained by Hurd and McFadden (1999) for a US dataset. One might have expected to find a weaker relationship running from wealth to health in a country such as the UK with universal health care. For example, a recent World Health Organisation report used a measure of child mortality to rank the distribution of health in 191 countries. Of these countries the UK was ranked 2nd while the US was ranked 32nd (World Health Organisation, 2000).

We find that in most cases wealth rankings enter our specifications linearly. The only exception is the model for male mortality, where we have significant interactions of wealth ranks and age. Non-linear wealth effects enter, however, the equations for attrition. Surprisingly enough, once we control for wealth and initial health status, we find no effect of variables such as education and marital status. We also find no regional effects suggesting that the variation in standardised mortality rates seen across the regions of Britain is completely explained by the observable characteristics of the resident population.

While wealth measures seem to do a much better job at predicting health outcomes than income variables, we found it hard to distinguish among various health measures. We reported results using financial wealth and a measure that also includes pension wealth, without much difference.

The specifications we report have, as our economic variable, the wealth rank of an individual in his or her cohort. It is therefore tempting to speculate that the relevant wealth concept, in accordance with some recent epidemiological literature, is relative rather than absolute wealth. However, the specification we propose could be simply a result of a very non-linear relationship between health outcomes and the levels of wealth. Empirically it is not possible, with our data, to distinguish between these hypotheses.

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Appendix A. Data description

Wealth measures.

Financial and housing wealth. This is calculated from individuals banded responses. For each band the mid-point is taken, except for those reporting that they have over £30,000 of assets, where it is assumed that they have wealth of £40,000. This applies to just 6.1 percent of the sample. For housing wealth we also take the mid-point from the individuals banded responses. Those reporting that their house is worth more than £200,000 are assumed to have housing wealth of £225,000. This applies to just 2.6 per cent of the sample. Where appropriate we also add in the value of an individuals second home. We then simply add estimates of financial and housing wealth together.

Pension wealth. This is calculated as a combination of social security wealth and, where appropriate, occupational pension wealth. We assume that single people qualify for the full basic state pension while couples receive the basic state pension and the dependants addition. Entitlements to SERPS are estimated using information on usual earnings, number of years in work since 1978 and whether the individual was a member of SERPS or whether they had opted out into a private pension. Using life expectancy tables we then calculate how long we expect the individuals to receive these flows of income. With couples we also take account of any state pension that they would inherit from their partner. This flow of income is then discounted to the present day using a discount rate of 3 percent a year.

For occupational pension income we use the methodology used by Disney, Johnson and Stears (1998). This utilises information on those individuals who receive a private pension in 1994. This works by regressing the amount received on the number of years spent in occupational pension schemes, the number of occupational pension schemes that they have been a member of, and the individuals social class. The estimated co-efficients are then use to predict the weekly amount of pension received in 1994 for all of those who are members of an occupational pension. We are then able to construct the present discounted value of this stream of income as we were with social security wealth. We assume that surviving partners inherit half of their deceased partners pension.

Creating wealth rankings. This is constructed by ranking individuals by their wealth within 5 year age groups (under 55, 55-59, 60-64, 65-69 and 70+). Single people and couples are ranked separately in order to mitigate problems of equivalising wealth. This ranking is done separately for both wealth measures (i.e. financial and housing wealth only or all wealth including social security and occupational pension wealth). Individuals that fall into the same family type and age group who have the same wealth are given the same rank. Those with missing wealth information are given a rank of zero.

Severity scores.

Individuals asked questions relating to 13 different areas of health – locomotion; reaching and stretching; dexterity; personal care; continence; seeing; hearing; communication; behaviour; intellectual functioning; consciousness; eating, drinking and digestion; and disfigurement (scars, blemishes and deformities). Each area has a number of questions – for example there are 13 questions on locomotion, 10 on reaching and stretching and just one on both eating, drinking and digestion and disfigurement. Each question carries a severity score, and these are summed across each of the 13 areas of health. For example in the locomotion section not being able to walk at all scores 11.5 while not being able to walk 400 yards without stopping scores 0.5. The maximum severity score in each category also varies, for example it is only possible to score 0.5 in the eating, drinking and digestion category. The three highest severity scores is then taken and a variable SCORE calculated using the following formula:

$$\text{SCORE} = \text{Highest sev score} + 0.4 \times \text{2nd highest sev score} + 0.3 \times \text{3rd highest sev score}$$

This variable SCORE is then converted to a the SEVERITY variable used in our analysis using the following scale

Table A.2. Calculation of severity score

Severity category	Weighted severity score
10 (most severe)	19–21.4
9	17–18.95
8	15–16.95
7	13–14.95
6	11–12.95
5	9–10.95
4	7–8.95
3	5–6.95
2	3–4.95
1	0.5–2.95
0 (least severe)	<0.5