

# Economic Resources, Mortality and Inequality

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## Abstract

Using full-population register data from Denmark, this study shows that estimates of the economic gradient in mortality depends on the specific measure of economic resources used, where we investigate permanent income, annual income or financial and housing wealth. Our favorite measure is what we call 'Permanent income', that is the average level of income over a long interval. We find that when using annual income or current wealth, the gradient is overestimated, unless one controls for a number of additional variables, such as education, civil status and initial health. In the last part of the paper, we compare the results from Denmark to results from the UK. Although the countries are very different in terms of inequality, the estimates of the gradient we find are very similar, suggesting that differential levels of resources (including information), rather than inequality itself, determine the gradient in survival and mortality.

Keywords: Mortality, Permanent Income, Economic resources and Inequality.

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# 1 Introduction

A large body of literature within economics and epidemiology has used micro data to estimate the link between economic resources (e.g. income or wealth) and mortality—the economic gradient in mortality. The magnitude of such a gradient is relevant for scholars and policy makers for many reasons: a large negative gradient reduces life-time progressivity of social security and can even make it regressive; a negative relation between longevity and wealth gives the poor fewer incentives to save for retirement and the composition of saving is likely to be affected by differential mortality. The literature has found, perhaps not surprisingly, a negative relationship between economic resources and mortality both across countries and within countries: rich people live longer, sometimes much longer even within the same country or the same city. However, the extent to which longevity and wealth relate differs across studies and countries. Furthermore, the causal relation between economic inequality itself and mortality is much debated, most recently in Angus Deaton’s book “The Great Escape - Health, Wealth and the Origins of Inequality”. No consensus exists on the origin and mechanisms behind such a relationship. One obvious link is between the different material resources available to rich and poor and mortality. Another hypothesis links differential mortality to different information or life styles of rich and poor individuals. Some epidemiologists have also hypothesised that inequality per se could increase mortality for those at the bottom of the resource distribution.<sup>1</sup>

Our starting point is that different results across studies are partially caused by the use of different measures of economic welfare. The choice of the relevant variable used in the analysis is often dictated by data availability. However, some choices could be problematic. If, for instance, lifetime resources are what determine health and mortality, using current income to proxy them could give a very imprecise proxy of the relevant concept and introduce a substantial attenuation bias.

The purpose of the current study is twofold: First, using a rich data set from Denmark, where different measures of economic resources are available, we investigate the empirical importance of different measures of economic resources (permanent income, wealth or annual income) as

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See, for instance, Wilkinson (1996)

well as the impact of including covariates when estimating the relationship between economic resources and mortality. Second, using some of the results from the first analysis and some available evidence, we compare the gradients in Denmark and UK, two societies that have similar average income levels but differ in the degree of inequality. Such a comparison can be informative on the issue of whether inequality per se is a determinant of mortality: if the inequality hypothesis holds, we should see a difference in the gradients in Denmark and UK. However, using comparable measures of permanent income to represent the level of economic resources available to individuals, we find more similarities than differences in the mortality patterns in the two countries.

In the first part of the current study, we construct measures of 'permanent income' as better proxies for lifetime resources and use them in the estimation of the mortality gradient. The main virtue of such measures is that they might be better at capturing the underlying heterogeneity in the population that determines economic choices, such as optimal consumption, savings and health investments—quintessential for evaluating individual long-run health and welfare.<sup>2</sup>

In the analysis of consumption, Friedman's PIH suggests that *permanent income*—rather than current income—determines consumption and, ultimately, welfare. In parallel, and by taking insights from the Grossman (1972) framework, we suggest that permanent income, rather than annual income or wealth, is a better proxy of the economic resources relevant for determining *mortality*. This approach is in principal not new; but because accessible data with long time-series of individual income levels, needed to construct a permanent income measure, used to be rare, an empirical baseline analysis of how permanent income performs when predicting mortality is lacking. By exploiting income data back from 1980, we are able to construct the relevant measure, which is novel in the literature.

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A few studies have used wealth as an alternative proxy lifetime resources (e.g. Hurd et al. (1999); Attanasio and Emmerson (2003)), which is probably an improvement over using current income. Differences in wealth across individuals, especially when controlling for age, probably better reflect differences in the overall control of resources over the life cycle. However, different shapes of the life cycle profile of income may induce different (optimal) wealth profiles with these differences being unrelated, even at a given age, to differences in lifetime resources. Moreover, people who expect to live longer are likely to save more. And finally, wealth can be affected substantially by negative health shocks that can be obviously related to mortality. In the latter case, the relationship between wealth and mortality would be over-estimated (see Attanasio and Hoynes (2000)), although some studies argue that such a bias is potentially eliminated if the analysis conditions on individual initial health characteristics.

Obviously, the use of permanent income or long run averages of income is not exempt from conceptual problems. Early health shocks may affect the ability of an individual to earn over the life cycle and be, also, related to mortality. As with wealth, such a situation would imply that the associations we document could not be given a causal interpretation. However, these events are likely to be less common and, as with wealth, we can control for initial health conditions to reinforce a causal interpretation.

In the second part of the paper, we will be comparing the UK and Denmark. Such a comparison is of interest for several reasons. As mentioned above, several recent studies have focused on whether what matters for mortality is absolute or relative income.<sup>3</sup> Interestingly, Snyder and Evans (2006) finds that the US “Social Security Notch” within Old Age and Survivors Insurance (OASI) reducing benefits for cohorts born just after January 1st 1917, reduced mortality for the affected cohorts, i.e., the study finds that less income *increased* survival. The authors explain this surprising result by an increase in part time labor for the affected (younger) cohorts. However, the notch did not change pre-retirement permanent income (earnings) that were in fact determining the levels of benefits received within OASI. Hence, the finding is consistent with the hypothesis that life-time resources determined earlier in life cycle is the underlying determinant of mortality.

One controversial finding by Eibner and Evans (2005) backs up the hypothesis stated by Wilkinson (1996) that income inequality and relative deprivation itself rather than resources determines mortality. If this is interpreted as a causal statement, policy makers, who intend to decrease mortality rates, could focus on decreasing inequality rather than increasing absolute levels of economic resources. Critics, on the other hand, have pointed out that if the relationship between mortality and resources is non-linear, it may be very difficult to identify the effect of ‘relative’ resources or inequality. As the level of inequality (and the redistribution implemented by the state) is very different between the UK and Denmark, comparing the relationship between mortality and wealth in the two countries can be quite informative in this respect.

The subjects in the current analysis are approximately 1,000,000 Danish residents aged 53 to 68. Using Danish administrative data from 1980-2003 on individual income for the subjects of

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<sup>3</sup> See Wagstaff and van Doorslaer (2000) for a review and Gerdtham and Johannesson (2004); Eibner and Evans (2005); Schultz Hansen et al. (2007); Brønnum-Hansen and Baadsgaard (2007); Hoffmann (2011) for later analyses.

interest and their spouses, we construct a measure of permanent income at the household level averaging household income over the period *when the subjects are aged 45-53*. Having estimated each individual ‘permanent income’, information from the Danish death registers allows us to predict five-year individual survival probabilities from 2003 through 2008.

As alternative measures of economic resources relevant for mortality, and to mimic what has been done in the literature, we use income and wealth. For the latter, we add financial wealth deposits in banks and financial intermediaries measured on the 31st of December 2003, as well as the value of houses owned by the subjects and their spouses.

To control for important covariates when estimating the economic gradient in mortality, we add individual education levels from the education registers and hospital records from the Danish National Patient Register that covers all public and private hospital admissions, durations and diagnoses in Denmark. These data allow us to estimate the economic gradient in mortality robustly using three different measures of economic resources: permanent income, financial and housing wealth and annual income—all at the household level. Furthermore, we are able to control for education, civil status and initial health. Our results show that permanent income seems to fit the data best and approximate the relationship between the level of economic resources and mortality even when we do not control for other observable variables, such as education and initial health status. This is probably because the level of permanent income already captures the effect of many of these covariates.

We use the Danish data to estimate the mortality model set up in Attanasio and Emmerson (2003) and compare the survival probabilities of economic resources in Denmark and the UK directly. We find striking similarities in the gradients in the two countries, suggesting that the level of permanent income rather than inequality itself is determining mortality.

The remainder of the study is organized as follows: Section 2 provides background information about the mortality gradient debate and synthesizes the permanent income hypothesis in mortality, section 3 shows the features of the Danish data, section 4 presents the model and estimation strategy, section 5 reports the estimation results and compares them with state-of-the-art results from the UK and section 6 concludes.

## 2 Framework

### 2.1 The permanent income hypothesis in mortality

The economic gradient in mortality has received much attention, because it reveals striking differences in a fundamental measure of welfare within a society. The explanation of such a gradient is of course not easy and could be directly related to economic resources (maybe through access to better care) or to different life styles associated with high resources, or differential information (possibly driving different demand for health care), or many other factors. Before delving into the causes, however, it is crucial to establish well the nature of the relationship and the 'size' of the gradient. If the relevant economic resources are mis-measured or are related to variables that covary with mortality, the gradient is inconsistently estimated. For example, health and education are likely to be determinants of both income and mortality through different channels. Moreover, unemployment and other shocks that affect income and wealth transitorily have been shown to be determinants of mortality (Browning and Heinesen (2012)). The same is true for short run access to liquidity: Evans and Moore (2012) show that over a calendar month mortality incidence correlates with the timing of earnings and social insurance payments. If, however, the relevant measure for mortality is permanent income, as measured as the amount of resources available to an individual over the life course, then estimating the gradient from current income potentially leads to biased estimations of the relevant relationship between economic resources and mortality.

The tight connection between the life-cycle model and Grossman (1972)'s human capital model—in which human capital (health and education<sup>4</sup>) determines earnings capacities and mortality—synthesizes the relationship between permanent income and mortality. In Grossman's framework health depreciates as time goes by, and from a certain point in the life cycle the depreciation rate increases. Once the health stock reaches a certain threshold the individual dies. To maintain the health stock, the individual demands the commodity "good health". Therefore, the length of life is affected by the investment decisions that, in turn, depend on the resources available to an individual and the cost of health investments.<sup>5</sup> Education is likely to be related to

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<sup>4</sup> While education determines the individuals productivity, health determines the total hours a person can spend producing earnings and commodities.

<sup>5</sup> The costs are not only expenditures to medical care, but also the opportunity costs of labor income, working hours

health investments both because higher human capital command higher resources and because, and as shown by (Cutler et al. (2006)), more educated people are more likely to adopt health improving technologies. Thus, the same underlying economic mechanisms are expressed in both permanent income levels and mortality rates. Permanent income (rather than transitory elements in the income process) determines, to a large extent, consumption. By the same token, investigating the inequalities in permanent income and mortality is essential for welfare analysis.

While Deaton and Paxson (1998) stress the importance of the relation of life-cycle patterns in economic resources and health, the majority of the literature has focused on investigating the relationship either between health and mortality or income and mortality (see e.g., Idler and Benyamini (1997), Marmot (2002), Wagstaff and van Doorslaer (2000) for reviews and discussions). If we want to focus on life time resources, the immediate concern about how we best measure such a concept arise. With the ideal data, one would be able to construct the life-time income through a given age for many individuals and compare their survival probabilities.<sup>6</sup> Such datasets, however, are extremely rare. The issue, then, is whether a meaningful analysis could be performed with available data and, in some specific cases, with measures of ‘permanent income’ available when subjects are at older ages.

In recent years, an increasing literature suggests that very early life conditions determines health outcomes in adult life. The hypothesis is backed up by numerous empirical studies (see e.g., Almond and Currie (2011)). Hence, long run health is determined by early characteristics. These early life traits are not only determinants of health, but as it turns out also labor market outcomes seems to be related with early life time characteristics (e.g., Black et al. (2007)). This insight suggests that long-run health is a function of characteristics and events that do not change when people have reached mature ages. This is the essential motivation for using the measure average household income at, say, ages 45 to 53 as our measure for permanent income.<sup>7</sup>

The virtues of such a measure is that we not only capture the relevant concept of economic

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and consumption.

<sup>6</sup> Such approach has already been attempted: Using a sample of 3,969 subjects in the National Longitudinal Survey from 1966-1983, Menchik (1993) shows that racial differences in mortality are reduced dramatically once one uses a permanent income measure. While the purpose of Menchik (1993) is somewhat different from ours, that study shows how annual income tends to overestimate the gradient compared to permanent income.

<sup>7</sup> We do not go beyond 53 because early retirement was possible down to age 55 in some years of our income data window, 1980-2006.

resources that determines long run economic variables such as consumption, savings and health investments, but as more and more longitudinal datasets are becoming available for researcher (be it administrative data, longitudinal survey datasets or combinations of such data sources, e.g., HRS for the US and SHARE in some European countries) it is in fact possible to calculate permanent income measure in many environments. Because our administrative income and mortality data is measured with no or only minor error, the current analysis can be seen as a baseline analysis for the importance of permanent income in predicting mortality.

Still, as we mention above, a big issue in this literature is that of the simultaneity of economic resources and the occurrence of health shocks: the causal link might be running in both directions with economic resources causing health (and mortality) and health causing economic resources. While early life traits may determine both permanent income and long-run health, the occurrence of adverse health shocks may in particular affect both transitory income and an immediate depreciations of the health stock. A few papers have tried to circumvent the potential reverse causation between economic resources and mortality by controlling for education and initial health. For example, once they controlled for such measures, Hurd et al. (1999) find no significant gradient in mortality in the US: people are able to correctly assess their own survival probabilities, and once they control for this, the economic gradient vanish. For the UK, instead, Attanasio and Emmerson (2003) find that even after controlling for initial health and education, the gradient in wealth—a better proxy for permanent income than current income—persists. These studies emphasize the importance of the applied measures for economic resources and controls included. However, none of these studies reveal the effects of permanent income.

## **2.2 The Danish Environment**

We turn to Denmark, because data availability allows us to construct permanent income measures with no (or only little) measurement error, as well as comprehensive initial health variables from hospitalization records. The case of Denmark has been studied previously in the literature: the crude pattern is that while other OECD countries experienced declining mortality rates in 1970s through the mid-1990 the Danish rates remained at the same level. Although the mortality rates did decline after the mid-1990s they did not improve as much as in other developed countries—neither for men nor women, Jacobsen et al. (2002). By investigating the patterns at different ages Juel et al. (2000) argue that the difference between life expectancy in



Denmark and seven other European countries<sup>8</sup> is found in the mortality of the 35-75 age groups.<sup>9</sup> The excess mortality of the Danes is driven by ischaemic heart diseases and cancer, i.e., life style diseases related to smoking (Jacobsen et al. (2004), Jacobsen et al. (2006)).

A few Danish studies have analyzed the socio-economic gradient in health and mortality, broadly interpreted as differences in socio-economic status and combinations of annual income, wealth, education, skill level of salaried work, home-ownership or sector of occupation, e.g., Osler et al. (2002) and Osler and Anne-Marie Nybo Andersen (2005). However, none of these studies addresses the problem of reverse causality; none of these studies uses permanent income or even just controls for initial health conditions. Most recently, Hoffmann (2011) shows that the Danish economic gradient in mortality is even larger than those in the US estimated using the HRS. It is, however, unclear how these estimated gradients are confounded by the lack of initial health controls. Munch and Svarer (2005) use multiple variables (among these wealth and annual income) to estimate a competing risk proportional hazard model looking at how socio-economic differences affect mortality in different diseases (cancer, circulatory diseases, ill-defined conditions and other causes). Using Danish register data from 1992-1997, they find an inverse correlation between socio-economic status and mortality for men. For men annual income is negatively correlated with mortality. But the inverse relation between socio-economic and life expectancy is to a large degree absent among women, when looking at variables such as being married and income.

### **3 Data**

In this section, we present the available Danish register data and provide some initial descriptive evidence on the relationship between permanent income and mortality. We start by describing the nature of the data we use.

All Danish residents are assigned a unique personal identification number (CPR), which is

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<sup>8</sup> Norway, the former Federal Republic of Germany, the Netherlands, the UK, France, Italy and the former Czechoslovakia

<sup>9</sup> Bagger (2004) presents a negative relation between the national tax burden and “disability adjusted life expectancy” at birth in western European countries with more than 4 million inhabitants. By noticing that the Danish excess mortality is present particularly for the 35-74 year age groups, and by claiming that this age group probably is the one most heavily affected by high taxes, Bagger (2004) argues that this group needs to work more to get a reasonable income. Therefore, despite the relatively high gross income level in Denmark, mortality can be high due to the high tax burden.

used by all government institutions to administer information specific to Danish citizens. A large number of registers are stored at Statistics Denmark and can be linked via the CPR. Under strict security precaution, the register data is available for researchers affiliated to authorized Danish research institutions. For the years 1980-2006, we have access to the Danish tax, transfers, patient and education registers for all Danish residents older than 44. In addition, the data contains financial wealth information from banks and financial intermediates on December 2003. Furthermore, we have access to the Danish death registers from 1980 through 2008. These registers include the death date of all deceased individuals in the population. When we combine all these registers, we end up with 1,016,635 individuals residing in Denmark aged 45-53 and alive on 31 December 2003. These are all individuals born between 1935 and 1950 and still alive at the end of 2003. The data include similar information for their spouses (regardless of their age or birth-cohort).

To construct permanent and annual income measures, we use the information, available in the registers, on disposable income, which includes all taxable and non-taxable income (earnings and transfers), net of taxes, alimony and pension contributions. Our wealth measure includes the quoted value of financial and housing wealth on 31 December 2003 and is measured after taxes are paid. Financial wealth includes holdings in savings accounts, stocks, bonds, mutual funds and deeds. Housing wealth captures the public valuation of all houses owned by the household. We deflate all income and wealth variables by the Danish consumer price index and measure the variables in 2000-prices.

We define our measure of *permanent income* as the average household income, obtained as the sum of subject's and spouse's disposable incomes), over the nine years when the subjects were between 45 and 53 years old. When taking this average, we equalise income to compare single and married (or cohabitating) individuals. Because we want to compare the Danish gradient with that estimated in Attanasio and Emmerson (2003) for the UK, we use the same household equalizing scale used in that study. In particular, we divide singles' income by 0.61. Formally, permanent income,  $PI_i$  is therefore calculated as follows:

$$PI_i = \frac{\sum_{t=45}^{53} [(I_{it} + I_{spouse,it}) (couple_{it}) + (\frac{I_{it}}{0.61}) (1 - couple_{it})]}{9} \quad (1)$$

Table 1: Equivalized household income and wealth distributions

|                 | Men:              |                              |                    | Women:            |                              |                    |
|-----------------|-------------------|------------------------------|--------------------|-------------------|------------------------------|--------------------|
|                 | Permanent Income  | Financial and Housing wealth | Annual Income      | Permanent Income  | Financial and Housing wealth | Annual Income      |
| Mean            | 261687<br>(81976) | 1399907<br>(1333817)         | 298840<br>(120130) | 253808<br>(78364) | 1333335<br>(1284939)         | 281292<br>(110979) |
| 1st percentile  | 73554             | 6                            | 46183              | 81032             | 155                          | 79783              |
| 1st quintile    | 196038            | 206431                       | 198334             | 190365            | 115239                       | 187925             |
| 2nd quintile    | 235704            | 911218                       | 252336             | 227583            | 850002                       | 233285             |
| 3rd quintile    | 270369            | 1384804                      | 307840             | 261487            | 1346185                      | 287442             |
| 4th quintile    | 319224            | 2153012                      | 381408             | 309652            | 2114695                      | 360935             |
| 99th percentile | 629993            | 9198800                      | 916558             | 605192            | 8494965                      | 834926             |
| N               | 504923            | 504923                       | 504923             | 511712            | 511712                       | 511712             |

Standard Errors in parenthesis. Measured after tax in Danish 2000-prices (1£ app. 11 DKK).

The variable  $couple_{it}$  is a dummy variable that equals 1 if individual  $i$  is married (or cohabiting) in a given calendar year,  $t$ , and zero otherwise.  $I_{it}$  measures individual  $i$ 's annual disposable income.  $I_{spouse,it}$  measures the annual disposable income of individual  $i$ 's spouse in year  $t$ . If individual  $i$  is cohabiting a spouse household income is simply the sum of  $I_{it}$  and  $I_{spouse,it}$ . In years the individual  $i$  is single, the income is divided by the equivalizing factor, 0.61. We only measure  $PI_t$  individual  $i$ 's if disposable income is observed in all years from age 45 through 53. Consequently, we exclude individuals who pass away or migrate between age 45 and 53.

Table 1 shows some statistics of the distributions of permanent income, wealth and annual income for males and females. The mean permanent income level is approx. 260,000 DKr for men and 254,000 DKK for women. For men (women), mean wealth is 5.34 (5.25) times larger and annual income is 1.14 (1.10) times larger than mean permanent income level (note that wealth and annual income are measured in 2003 when individuals are between age 53 and 67). The difference between the 90th and 10th percentile for men (women) is 556,439=629,993-73,554 (524,160=605,192-81,032). Permanent income has, for both genders, the least dispersed distribution of the three measures. The 90th-10th percentile difference is 16.5 (16.2) times larger for men's (women's) wealth and 1.56 (1.44) times larger for annual income. Thus, financial and housing wealth is much more dispersed than both permanent and annual income. Permanent income has the least dispersed distribution.

For both males and females, Table 2 explores the correlation between permanent income and five-year survival probabilities. The number of individuals in our sample declines with age

Table 2: 5-year survival probabilities by permanent income quintiles, age and gender

| Age          | Permanent Income quintiles: |                  |                  |                  |                  |                  |
|--------------|-----------------------------|------------------|------------------|------------------|------------------|------------------|
|              | All                         | 1st              | 2nd              | 3rd              | 4th              | 5th              |
| <b>Men</b>   |                             |                  |                  |                  |                  |                  |
| 53-56        | 0.959<br>(0.001)            | 0.911<br>(0.002) | 0.956<br>(0.001) | 0.971<br>(0.001) | 0.976<br>(0.001) | 0.981<br>(0.001) |
| N            | 148976                      |                  |                  |                  |                  |                  |
| 57-60        | 0.941<br>(0.001)            | 0.899<br>(0.002) | 0.931<br>(0.001) | 0.950<br>(0.001) | 0.958<br>(0.001) | 0.967<br>(0.001) |
| N            | 152261                      |                  |                  |                  |                  |                  |
| 61-64        | 0.918<br>(0.001)            | 0.886<br>(0.002) | 0.903<br>(0.002) | 0.918<br>(0.002) | 0.933<br>(0.002) | 0.949<br>(0.001) |
| N            | 112116                      |                  |                  |                  |                  |                  |
| 65-68        | 0.882<br>(0.001)            | 0.856<br>(0.003) | 0.864<br>(0.003) | 0.877<br>(0.002) | 0.896<br>(0.002) | 0.915<br>(0.002) |
| N            | 91570                       |                  |                  |                  |                  |                  |
| <b>Women</b> |                             |                  |                  |                  |                  |                  |
| 53-56        | 0.973<br>(0.000)            | 0.950<br>(0.001) | 0.971<br>(0.001) | 0.977<br>(0.001) | 0.983<br>(0.001) | 0.984<br>(0.001) |
| N            | 148343                      |                  |                  |                  |                  |                  |
| 57-60        | 0.961<br>(0.000)            | 0.940<br>(0.001) | 0.956<br>(0.001) | 0.964<br>(0.001) | 0.970<br>(0.001) | 0.975<br>(0.001) |
| N            | 150877                      |                  |                  |                  |                  |                  |
| 61-64        | 0.947<br>(0.001)            | 0.929<br>(0.002) | 0.935<br>(0.002) | 0.949<br>(0.001) | 0.955<br>(0.001) | 0.965<br>(0.001) |
| N            | 114299                      |                  |                  |                  |                  |                  |
| 65-68        | 0.919<br>(0.001)            | 0.904<br>(0.002) | 0.906<br>(0.002) | 0.919<br>(0.002) | 0.925<br>(0.002) | 0.942<br>(0.002) |
| N            | 98193                       |                  |                  |                  |                  |                  |

Binary Standard Errors in parenthesis.

so that we have a larger number of individuals in the younger cohorts.<sup>10</sup> Permanent income quintiles are assigned within each cohort, and the survival probabilities are calculated for four age groups. The table shows a positive relation between permanent income and survival. Not surprisingly, survival probabilities decrease with age and are generally lower for men than for women. The difference in surviving probabilities by permanent income quintiles (the gradient) is most pronounced for men.

Our initial health control captures a three-year-history of hospital records from the National Patient Register. For both public and private hospitals, the National Patient Register contains

<sup>10</sup> People aged 57-60 consists of the large cohorts born in 1943-1946.

Table 3: Initial health distributions deduced from the National Patient Register

|                      | Men:             |                  |                  | Women:           |                  |                  |
|----------------------|------------------|------------------|------------------|------------------|------------------|------------------|
|                      | 2003             | 2002             | 2001             | 2003             | 2002             | 2001             |
| Hospitalnights       | 2.228<br>(9.609) | 2.020<br>(9.639) | 1.801<br>(8.106) | 2.025<br>(8.346) | 1.892<br>(8.122) | 1.724<br>(7.176) |
| 1st percentile       | 0                | 0                | 0                | 0                | 0                | 0                |
| Median               | 0                | 0                | 0                | 0                | 0                | 0                |
| 75th percentile      | 1                | 1                | 1                | 1                | 1                | 1                |
| 99th percentile      | 39               | 34               | 31               | 35               | 31               | 30               |
| Max                  | 365              | 365              | 365              | 365              | 365              | 365              |
| Number of diagnoses  | 0.557<br>(1.084) | 0.517<br>(1.018) | 0.476<br>(0.957) | 0.550<br>(1.047) | 0.524<br>(0.998) | 0.483<br>(0.941) |
| 1st percentile       | 0                | 0                | 0                | 0                | 0                | 0                |
| Median               | 0                | 0                | 0                | 0                | 0                | 0                |
| 75th percentile      | 1                | 1                | 1                | 1                | 1                | 1                |
| 99th percentile      | 5                | 4                | 4                | 5                | 4                | 4                |
| Max                  | 12               | 11               | 12               | 12               | 13               | 12               |
| Lung disease<br>(sd) | 0.025<br>(0.000) | 0.021<br>(0.000) | 0.019<br>(0.000) | 0.024<br>(0.000) | 0.021<br>(0.000) | 0.019<br>(0.000) |
| Nerves<br>(sd)       | 0.022<br>(0.000) | 0.021<br>(0.000) | 0.019<br>(0.000) | 0.017<br>(0.000) | 0.016<br>(0.000) | 0.015<br>(0.000) |
| Metabolic<br>(sd)    | 0.030<br>(0.000) | 0.026<br>(0.000) | 0.023<br>(0.000) | 0.028<br>(0.000) | 0.025<br>(0.000) | 0.021<br>(0.000) |
| N                    | 504923           | 504923           | 504923           | 511712           | 511712           | 511712           |

Standard deviations in parenthesis for hospital nights and number of diagnoses. Binary standard errors for diagnosis groups.

admission dates and durations of all hospitalizations (hospital, emergency, in-patients and psychiatric hospital admissions), as well as ICD10-diagnoses for the full population. We include variables that measure the time distance to the most recently experienced hospitalization, the count of hospital days and diagnoses as well as dummies for diagnoses covering three main diagnosis groups related to life-style diseases (lung, nerve and metabolic diseases) three years back in time.

Table 3 shows the distributions of number of hospital nights and diagnoses within a classification of 23 diagnoses-groups.<sup>11</sup> The table also reports the share of the population diagnosed

<sup>11</sup> The Danish National Board (the government institution under the Danish Ministry of Health responsible for compiling the National Patient Register) grouped ICD10-codes into 23 categories: 1) infection, 2) lung disease, 3) nerves, 4) circulation, 5) lymph, 6) veins, 7) blood, 8) digestive system, 9) urinary, 10) musculoskeletal, 11) gynecology, 12) pregnancy, 13), skin, 14) eyes, 15) ear nose throat, 16) metabolic, 17) mental illnesses, 18) breast, 19) sterilization, 20) concussion, 21) poisoning, 22) live born child and 23) other illnesses. We added a 24th group: diagnoses that the National board of health did not classify within any of the group 23 diagnoses. Appendix A shows the exact ICD-10 categories that make up each group 23-category.

with the three diagnosis groups in 2001-2003. In this time period approx. 50% of the population had at least one hospitalization record (regardless of gender). The table shows that men (women) on average spend 2.2 (2.0) nights in hospitals in 2003. The standard deviations are large and reflect two features of the distributions: 1) the measures inferred from hospital records are truncated at zero (the median had no records in none of the years from 2001-2003; the third quartile had one) and 2) the distribution is skewed to the right.

From the education registers we know, for each individual, the highest educational degree achieved. We grouped these education levels into 6 categories: 1) Basic school (up to nine years schooling) 2) high school (up to twelve years) including short educations such as office clerks, 3) vocational educations (e.g., skilled craftsmen such as carpenters, painters and hairdressers) 4) Intermediate educations (e.g., journalists and nurses) 5) long educations (academic educations) and 6) unknown educations (i.e., information on education is missing, which is particularly relevant for immigrants).

The first six rows of Table 4 report the share of the population in each of the six education categories. These rows reveal that men are generally more educated than women in these age groups. The next two rows report the shares of the population who is single in 2003 and at least once in the period from age 45-53 (the time period in which we calculate permanent income).

Although we have income data for both self-employed and wage earners, the data might not capture available economic resources for both occupation groups, e.g., self-employed could potentially reallocate revenues from the business between business equity and personal income to minimize tax-payments. To circumvent this problem in the mortality analysis, we include a dummy for self-employment status of the household in the years we measure income. The ninth row of Table 4 shows the share of households in which either the subject or their spouse is self-employed in 2003. The tenth row reports the share of subjects for whom either the subject or the spouse was self-employed at least once in the period the subject was 45-53 years old.

Table 4: Covariates

|                                   | Men              | Women            |
|-----------------------------------|------------------|------------------|
| <u>Education level:</u>           |                  |                  |
| Basic School                      | 0.313<br>(0.001) | 0.419<br>(0.001) |
| High School                       | 0.065<br>(0.000) | 0.048<br>(0.000) |
| Vocational                        | 0.423<br>(0.001) | 0.351<br>(0.001) |
| Intermediate                      | 0.112<br>(0.000) | 0.137<br>(0.000) |
| Long                              | 0.065<br>(0.000) | 0.027<br>(0.000) |
| Unknown                           | 0.022<br>(0.000) | 0.018<br>(0.000) |
| Single in 2003                    | 0.233<br>(0.001) | 0.293<br>(0.001) |
| Ever single from age 45-53        | 0.309<br>(0.001) | 0.315<br>(0.001) |
| Selfemployed in 2003              | 0.113<br>(0.000) | 0.093<br>(0.000) |
| Ever Self-employed from age 45-53 | 0.245<br>(0.001) | 0.237<br>(0.001) |
| N                                 | 504923           | 511712           |

Binary standard Errors in parenthesis.

## 4 Empirical specification

As mentioned above, in this paper, we investigate the extent to which our definition of permanent income, wealth or annual income determines the estimated gradient in mortality and whether the gradients in mortality in Denmark and the UK are similar. To pursue these goals we use the model set up by Attanasio and Emmerson (2003), who have studied the UK gradient. In particular, using Danish data on mortality and a variety of income and wealth measures, we estimate:

$$s_i^* = \alpha + f(y_i) + \delta h_i + \eta e_i + \theta c_i + \gamma_1 a_i + \gamma_2 a_i^2 + \varepsilon_i \quad (2)$$

where  $s_i^*$  a latent variable determining five-year survival for individual  $i$ .<sup>12</sup> The model assumes that survival probability is a function of economic resources,  $y_i$ ; initial health,  $h_i$ ; education,  $e_i$ ; civil status,  $c_i$ ; age,  $a_i$ ; age squared,  $a_i^2$ , and a random variable,  $\varepsilon_i$ . In what follows we assume that  $\varepsilon_i$  is normally distributed so that we estimate equation (2) as a probit.

Notice that the explanatory variables refer to a period prior to that over which survival is measured: in the UK study, the covariates are measured at the first round of the BRS while survival or mortality is measured between the two waves; in the Danish data, the variables are constructed using register data from 1980-2003 as described in section 3 while survival is observed between 2003 and 2008.

In equation (2), the relationship between mortality and economic resources is captured by the function  $f(y_i)$ . We want to be flexible on the nature of this relationship and, therefore, we experiment with three different functional assumptions for  $f(\cdot)$ : we report estimates obtained assuming that  $f(\cdot)$  is a third order polynomial in  $y_i$ ; or a third order polynomial in  $\log(y_i)$  or that is linear in the rank of individual  $i$  relative to  $y_i$  within a birth cohort and gender. The rank specification, besides being a different non-linear transformation of the variable of interest, deals

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<sup>12</sup> In the UK-study the survival spell runs between two interview rounds of the British Retirement Survey (BRS) the 1988/89 and 1994 waves; in the current study the spell runs from 31 December 2003 through 2008. Thus, the survival window is open for a slightly longer period in the UK-study than in the current study. Therefore, we expect the predicted survival probabilities to be slightly higher in Denmark than in the UK.



with the problem of comparing levels of wealth across age groups. For instance, if wealth peaks just prior to retirement, as a simple life-cycle theory would predict, then wealth levels differ mechanically across age groups. However, if the rank of wealth within cohorts is constant over time, then the estimation of the gradient is not flawed by in-comparability across age groups (Attanasio and Hoynes (2000)).

As mentioned above, we also investigate different proxies for economic resources. In our baseline specification, we assume that  $y_i$  is best represented by permanent income, as we defined it above. We then compare how the estimates of the parameters of the various specifications of  $f(y_i)$  change when we use different definitions of  $y_i$ . In particular, we consider wealth (including financial wealth and housing) and current annual income. Finally, we also investigate how the relationship between mortality and economic resources change when we include covariates, and in particular when controlling for education (which can represent permanent income or proxy for information about health) and health conditions. Therefore we estimate equation (2) with and without  $h_i$ ,  $e_i$ , and,  $c_i$ . This analysis is suggestive of what are the best proxies for economic resources and on the relevance of the different types of biases we discussed above.

Attanasio and Emmerson (2003), to control for initial health when estimating the mortality gradient for the UK to which we compare our Danish results, used calculated severity scores from BRS. In the case of the Danish data, instead, we can use objective health measures deduced from the National Patient Register. In particular, we proxy initial health by second order polynomials in the time passed from the most recent hospitalization (measured in days from 31 December 2003) and the number of hospital days in 2003, 2002 and 2001, the number of different diagnosis-groups in each of the three years, and dummies for having lung, nerve or metabolic diagnoses in each of the three years.

For the UK study, Attanasio and Emmerson (2003) controlled for education by including a dummy for having an A-level. For the Danish specification, we include five dummies for high school, vocational education, intermediate, long or unknown education (the reference is basic schooling). In the UK data, age is measured at the first round of the BRS. In the Danish data, we measure age on 31 December 2003. The outcome of interest is five-year survival.

## 5 Results

In this section, we report the results from estimating the probit survival models described above for men and women separately. For ease of exposition, we do not report the parameter estimates on the initial health variables and education here. The full set of parameter estimates can be found in the appendix. The appendix also contains parameter estimates of the models estimated without education, civil status in 2003 and initial health covariates. In the remainder of the section, we first compare the estimation of the gradient using permanent income, wealth and annual income and plot survival probabilities given the estimations. Next we compare directly the predicted survival probabilities to those in the UK and in particular the nature of the gradient.

To obtain the results we report, we trimmed the data so to exclude the top and bottom 1% percent of the variables measuring economic resources (permanent income, financial and housing wealth and annual income).

### 5.1 Permanent Income, wealth or annual income

In this subsection, we compare the estimated mortality gradient using the three different measures of economic resources, different functional forms and different sets of controls. Table 5 reports the parameter estimates we obtain using permanent income as the measure of economic resources.<sup>13</sup> The first three columns report estimates for men: Column (1) contains the estimates for the specification where mortality depends on a third order polynomial in permanent income, where the latter is measured in 100,000 Danish 2000-prices (1£~10DKK: 1\$~6DKK); Column (2) contains the results obtained assuming that mortality is a function of a polynomial in log permanent income and Column (3) the results for the rank transformation. Columns (4)-(6) report similar estimates for women. The bottom row of the table reports the likelihood ratio of jointly excluding the permanent income variables. The large LR values (around 1000 for men and 500 for women) for the first two specifications reveal that permanent income is a very important determinant of mortality. We should stress that the relationship between mortality and economic resources seem indeed non-linear across the permanent income distribution.

As a baseline specification, we started including both age and age-squared as determinants of mortality. As for men the squared term turns out to be insignificant, we have excluded it from

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<sup>13</sup> In appendix B table 9 reports the full set of parameter estimates. Furthermore, table 10 reports the parameter estimates of the model estimated without controlling for initial health, education and single status in 2003.

the statistical model we report. To control for civil status in the period permanent income was earned, we include a dummy indicating if the subject was single at least once between age 45 and 53. Similarly, we include a dummy indicating if either the subject or the spouse was self-employed when permanent income is measured. Both of these variables are significant for both genders indicating that married or cohabitating individuals are more likely to survive.

Table 5: The five-year survival probability (Probit)

|                          | Men:                    |                         |                         | Women:                   |                         |                         |
|--------------------------|-------------------------|-------------------------|-------------------------|--------------------------|-------------------------|-------------------------|
|                          | Levels                  | Natural<br>Logs         | Rank<br>(percentile)    | Levels                   | Natural<br>Logs         | Rank                    |
|                          | (1)                     | (2)                     | (3)                     | (4)                      | (5)                     |                         |
| Permanent Income         | -.0175<br>(.05345)      | -214.3***<br>(15.01)    | .3791***<br>(.01192)    | .08665<br>(.06774)       | -190.8***<br>(19.92)    | .2822***<br>(.01351)    |
| Permanent Income Squared | .08234***<br>(.0183)    | 17.36***<br>(1.221)     |                         | .03901<br>(.0237)        | 15.52***<br>(1.618)     |                         |
| Permanent Income Cubed   | -.0117***<br>(.001918)  | -.4674***<br>(.03308)   |                         | -.007812***<br>(.002547) | -.4201***<br>(.04378)   |                         |
| Single age 45-53         | -.08388***<br>(.008022) | -.08155***<br>(.008029) | -.08395***<br>(.008021) | -.05604***<br>(.008897)  | -.05347***<br>(.008906) | -.05437***<br>(.008898) |
| Selfemployed age 45-53   | .1232***<br>(.007414)   | .1231***<br>(.007399)   | .1228***<br>(.007203)   | .09108***<br>(.0085)     | .08988***<br>(.008487)  | .08824***<br>(.008289)  |
| Age                      | -.3784***<br>(.006773)  | -.378***<br>(.006767)   | -.4436***<br>(.006666)  | .5923***<br>(.2164)      | .5911***<br>(.2164)     | .4887*<br>(.2161)       |
| - squared                |                         |                         |                         | -.0754***<br>(.0178)     | -.07525***<br>(.0178)   | -.07131***<br>(.01777)  |
| Single in 2003           | -.3271***<br>(.008292)  | -.3241***<br>(.008301)  | -.3285***<br>(.008288)  | -.1578***<br>(.008772)   | -.1565***<br>(.008778)  | -.1588***<br>(.008773)  |
| constant                 | 3.499***<br>(.07148)    | 883.7***<br>(61.49)     | 3.996***<br>(.05135)    | .5736<br>(.6564)         | 781.1***<br>(81.7)      | 1.236<br>(.6551)        |
| Initial Health           | Yes                     | Yes                     | Yes                     | Yes                      | Yes                     | Yes                     |
| Education                | Yes                     | Yes                     | Yes                     | Yes                      | Yes                     | Yes                     |
| Pseudo R-squared         | 0.126                   | 0.126                   | 0.126                   | 0.129                    | 0.129                   | 0.129                   |
| LR                       | 1036.8***               | 1165.7***               | 1022.7***               | 456.7***                 | 500.9***                | 439.3***                |
| N                        | 494825                  | 494825                  | 494825                  | 501478                   | 501478                  | 501478                  |

Permanent income measures equalized average household income from age 45-53 (100k Danish 2000-prices )

Significance levels: \*\*\*<0.001, \*\*<0.01, \*<0.05.

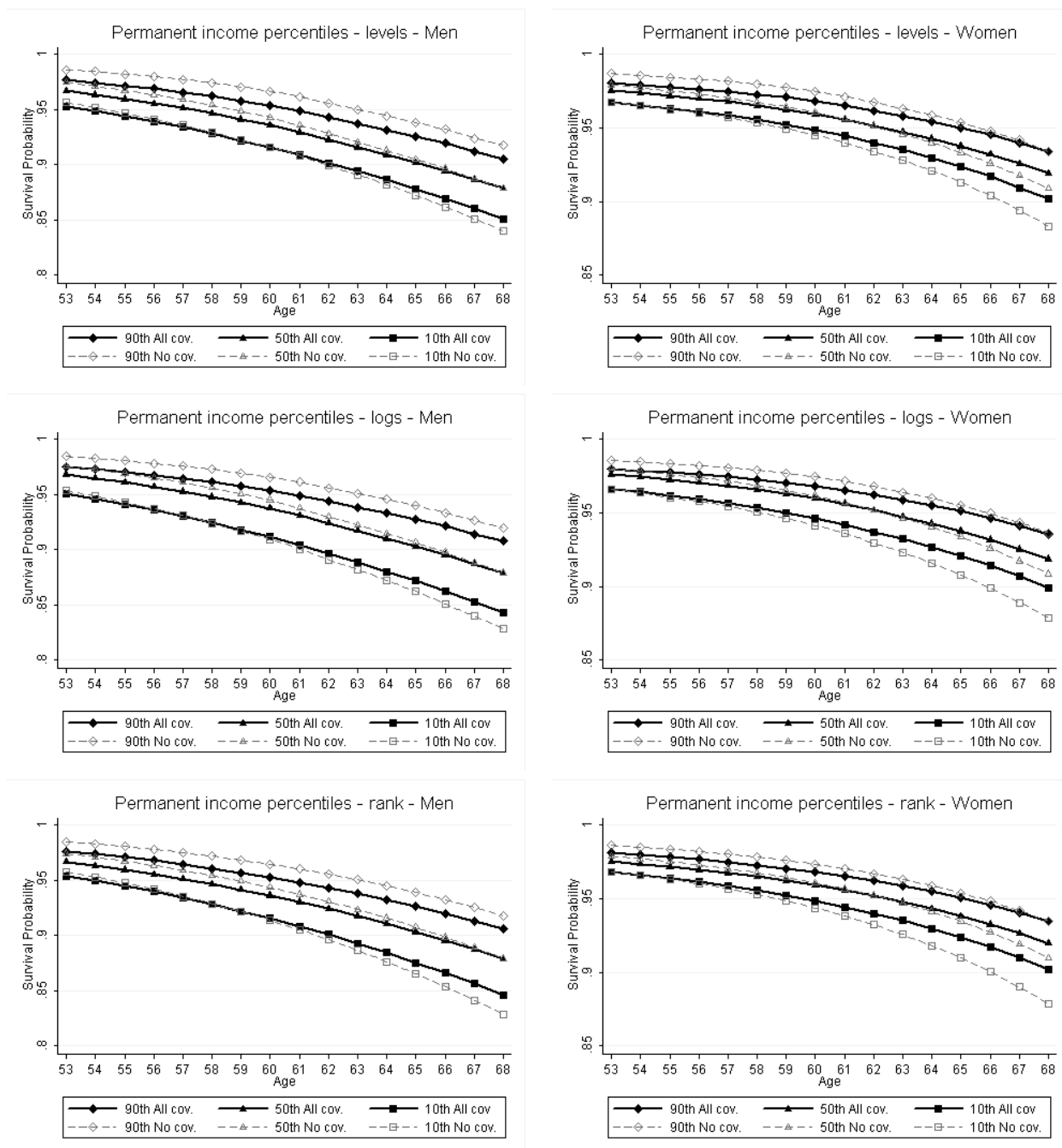
The table shows the parameter estimates of probit models regressing a dummy indicating whether people are alive on December 31st 2008 on permanent income (household equalized average disposable income from age 45-53) and the set of covariates used in Attanasio and Emmerson (2003). The squared age term did not come out significant for the men. Therefore we excluded it from the regression. Only people alive on December 31st 2003 are included in the estimation sample. Columns 1-3 report the estimations results for men, and Columns 4-6 report the results for women.

We trimmed the top and bottom 1% of the permanent income distribution.

The full set of parameter estimates, i.e. a table including the estimates of education and initial health is found in table 9 in the appendix. Estimation results including the permanent income and age-variables only are found in Table 10 in the appendix.

Since we estimate survival probabilities in a probit framework, we cannot interpret magnitudes of the parameter estimates as marginal effects. Given the nonlinearities of our specification,

Figure 1: Impact of Permanent Income and age on Survival



Note: The pictures show the predictions of five-year survival for non-single men (left) and women (right) with basic education and in good health given their position in the permanent income distribution. Lines marked with a diamond are predictions for people on the 90th percentile in the age and gender specific permanent income distribution. Triangles are those on the median and squares are people on the lowest decile. The upper row graphs the predictions using the levels-specification of permanent income; the middle-row the log-transformation; and the bottom-row the rank-transformation. The bold lines are predictions from the models that include all covariates. The dashed lines include no covariates other than age (and age-squared for the women).

we find that the best way to interpret our results is by plotting estimated survival probabilities against age at different points of the permanent income distribution for a representative individual who is married or cohabiting and is currently in good health and with basic education, as we do in Figure 1. The graphs plot the age-survival profiles (the probability of surviving five years given a specific age) at the 90th (marked with diamonds), 50th (triangles) and 10th percentile (squares) of the permanent income distribution. By plotting survival against age at different percentiles (instead of plotting survival against income levels for instance), we are able to compare directly how the estimation of inequality varies for different specifications of the model, such as levels-, logs- and rank-transformations of permanent income. The left (right) column of pictures plots the results for men (women). Each row of pictures presents the predictions for each of the transformations of the permanent income variable: levels (top), logs (middle) and rank (bottom). In each graph, the bold lines represent estimated survival probabilities that control for several other regressors (such as education and initial health) while the dashed lines refer to specifications that include no covariates other than age (and age-squared for women).

The gap between the various percentiles in the permanent income distributions reflects inequality in mortality. Not surprisingly, survival probabilities are higher at younger ages. Moreover, as expected, wealthier individuals have higher survival probabilities. This inequality, moreover, increases with age. Note that permanent income captures average income over the most recent nine years for the youngest, but more than 15 years before we evaluate survival probabilities for the oldest. Still, the gradient persists and is even more pronounced among the old. For example, when we include all covariates the prediction of the five-year survival probability men aged 53 in the 90th percentile of the (levels specification) permanent income distribution is 98%, while men in the 10th percentile have a 95% survival probability. This gap in survival probabilities widens at older ages: at age 68 there is a 6 percentage-point difference between the top and bottom percentiles in the permanent income distribution. Whilst non-linearities are obviously important, this general pattern is robust across the three non-linear functional forms we use (levels, logs or rank). Whilst survival levels are obviously higher for women, more interesting is the fact that inequality in mortality seems less pronounced for them. Although richer women do tend to live longer, at age 68 the difference between the top and bottom percentile of the permanent income distribution is only about 3.5 percentage-points.

Figure 1 also reveals how the inclusion of covariates changes the age profiles at different levels of permanent income. For both men and women, the gradient tend to change when covariates are included, but the shape of the age-profiles are remarkable similar whether or not the covariates are included. For example, looking at the rank specification for men at age 53, we do see that the survival probabilities are slightly higher when the covariates are not included, but survival-inequalities between the richest and the poorest remain the same at about 3 percentage-point. At age 68 the 90/10 differential in survival is 6 percentage-points when the covariates are included but 9 percent when they are not. The results are similar for women, but again for them the effect of inequality is less pronounced. The shapes of the age-profiles are similar across percentiles of the permanent income distribution. It should be stressed that, when we include controls, we are comparing the profiles for a given group (in particular, low educated and good health individuals). These variables will obviously be correlated with permanent income: not many individuals with low education will be in the top 10% of the permanent income distribution. In this sense, results that do not include control might be more interesting.

We now turn to compare the estimates we obtain with the measures of economic resources that have been used in the literature to date: wealth and annual income. We first estimate the probit equation above using these measures instead of permanent income, and then compare graphically the estimated gradients with and without covariates. Table 6 reports the parameter estimates using wealth and annual income instead of permanent income.<sup>14</sup> The upper part of the table reports the parameter estimates using financial and housing wealth (measured in millions, Danish 2000-prices). In all specifications the measures of economic resources we use are statistically significant, as indicated by the LR and most t-values.<sup>15</sup>

The lower part of the table reports the estimated values using annual household income in 2003 as the measure of economic resources. All parameter estimates (except for the squared term for both men and women levels-transformation) are significant. To control for differential income effects for self-employed we included a dummy indicating if the subject, or the spouse,

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<sup>14</sup> The full set of estimates are found in tables 11 and 13 in appendix B. Furthermore, tables 12 and 14 report the parameter estimates of the models estimated without controlling for initial health, education and single status in 2003.

<sup>15</sup> In the specification for women's mortality that includes log wealth the coefficients of the third order polynomial are not individually significant but they are clearly jointly significant.

is self-employed in 2003. This variable is significant in all specifications.

Table 6: The five-year survival probability (Probit) - Other measures of household resources

|   | Men:                     |                           |                      | Women:                   |                       |                       |
|---|--------------------------|---------------------------|----------------------|--------------------------|-----------------------|-----------------------|
|   | Levels                   | Natural<br>Logs           | Rank<br>(percentile) | Levels                   | Natural<br>Logs       | Rank<br>(percentile)  |
| Wealth: Equivalized Financial and Housing wealth (1000k Danish 2000-prices ) at the household level |                          |                           |                      |                          |                       |                       |
| Wealth  | .2895***<br>(.009842)    | .0481*<br>(.0201)         | .5075***<br>(.01105) | .2272***<br>(.01195)     | -.00877<br>(.06207)   | .3695***<br>(.01273)  |
| Wealth Squared  | -.06259***<br>(.004085)  | -.009966***<br>(.002731)  |                      | -.05561***<br>(.005306)  | .000701<br>(.006985)  |                       |
| Wealth Cubed  | .004324***<br>(.0004103) | .0007514***<br>(.0001161) |                      | .004244***<br>(.0005759) | .0001702<br>(.000256) |                       |
| Covariates  | Yes                      | Yes                       | Yes                  | Yes                      | Yes                   | Yes                   |
| Pseudo R-squared  | 0.128                    | 0.128                     | 0.128                | 0.129                    | 0.129                 | 0.129                 |
| LR  | 2199.3***                | 2241.9***                 | 2155.9***            | 852.4***                 | 887.7***              | 854.8***              |
| N   | 494841                   | 494841                    | 494825               | 501485                   | 501470                | 501478                |
| Equivalized Annual Income in 2003 (100k Danish 2000-prices ) at the household level                 |                          |                           |                      |                          |                       |                       |
| Annual Income   | .1585***<br>(.02838)     | -.143***<br>(7.883)       | .4727***<br>(.01189) | .09506*<br>(.04074)      | -150.8***<br>(14.78)  | .3092***<br>(.01321)  |
| Annual Income Squared   | .006257<br>(.00758)      | 11.46***<br>(.6349)       |                      | .01302<br>(.01136)       | 12.08***<br>(1.183)   |                       |
| Annual Income Cubed   | -.00205***<br>(.0005917) | -.3053***<br>(.01703)     |                      | -.002561**<br>(.0009417) | -.3216***<br>(.03155) |                       |
| Selfemployed in 2003  | .1575***<br>(.01089)     | .1445***<br>(.01089)      | .1538***<br>(.01073) | .09298***<br>(.01371)    | .08633***<br>(.01372) | .09031***<br>(.01359) |
| Covariates  | Yes                      | Yes                       | Yes                  | Yes                      | Yes                   | Yes                   |
| Pseudo R-squared  | 0.128                    | 0.129                     | 0.128                | 0.129                    | 0.129                 | 0.129                 |
| LR  | 1477.6***                | 1728.8***                 | 1598.7***            | 514.2***                 | 572.8***              | 551.0***              |
| N   | 494825                   | 494825                    | 494825               | 501478                   | 501478                | 501478                |

Significance levels: \*\*\*<0.001, \*\*<0.01, \*<0.05.

The table shows the parameter estimates of probit models regressing a dummy indicating whether people are alive on December 31st 2008 on household equivalized financial and housing wealth in 2003 (upper panel) and household equivalized annual disposable income in 2003 (lower panel) as well as the set of covariates used in Attanasio and Emmerson (2003). The squared age term did not come out significant for the men. Therefore we excluded it from the regression. Only people alive on December 31st 2003 are included in the estimation sample. Columns 1-3 report the estimations results for men, and Columns 4-6 report the results for women.

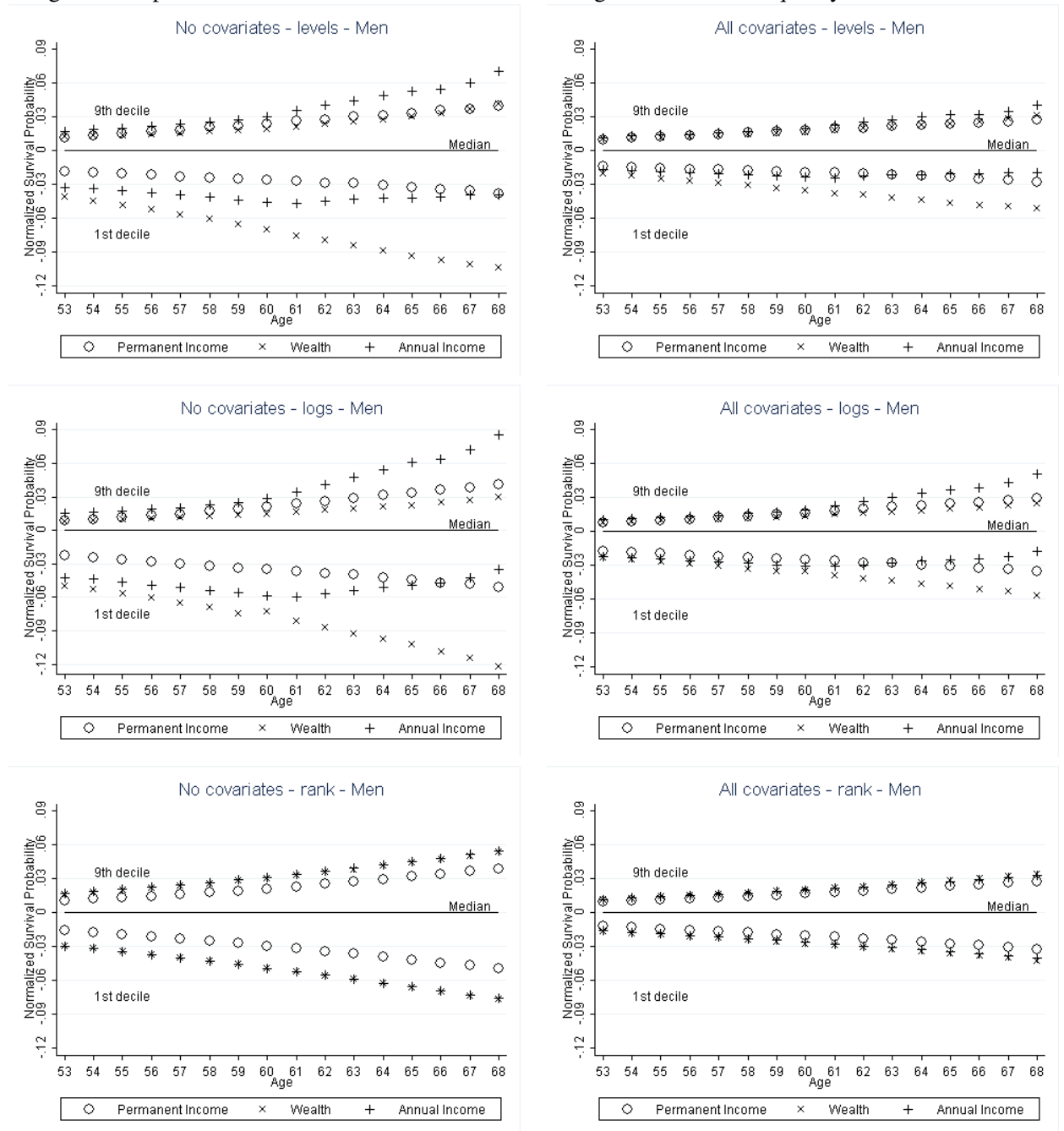
We trimmed the top and bottom 1% of the permanent income distribution.

Covariates include age, civil status in 2003, education levels and initial health. The full set of parameter estimates are found in Tables 11 and 13 in the appendix. Estimation results including the wealth/annual income and age-variables only is found in Tables 12 and 14 in the appendix.

We are interested in how the different measures determine inequalities in survival probabilities. To make this comparison as clear as possible, Figures 2 (men) and 3 (women) plot the difference in the estimated survival probabilities of the first and the ninth decile relative to that of the median for each of the three measures of economic resources we have considered.<sup>16</sup> The

<sup>16</sup>Note that the graphs for permanent income do not contain additional information than in Figure 1, which in fact also contains information of the survival levels. Figures 2 and 3 plot the differential survival probabilities to ease the exposition when comparing inequality features of many variables.

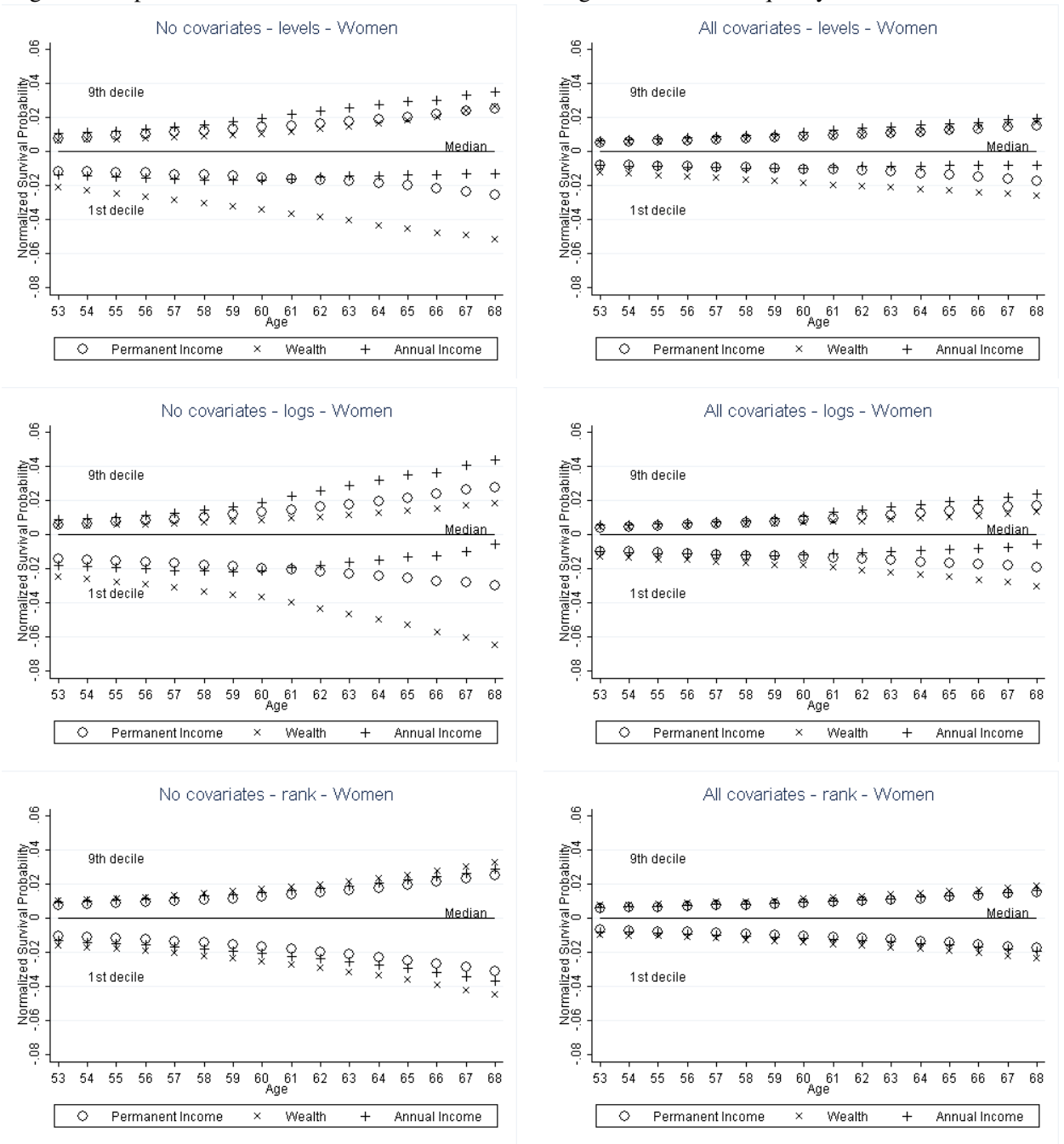
Figure 2: Impact of Different Economic Resources and Age on Survival Inequality - Men



Note: For married (and cohabiting) men with basic education and in good health, the pictures show at different ages the five-year survival probabilities normalized around the median in a given distribution of resources. Hence, the normalized median survival probability is the horizontal line at zero. The scatters above the median line are the difference between the ninth decile and median; and the scatters below the median line are the difference between the first decile and median. The circles (“o”) represent permanent income; the crosses (“x”) financial and housing wealth; and the pluses (“+”) annual income. All variables are measured at the household level. The upper row graphs the predictions using the levels-specification of economic resources; the middle-row the log-transformation; and the bottom-row the rank-transformation. Pictures on the left are predictions from the models that include no other covariates than age. Pictures on the right control for age, civil status, education and initial health.



Figure 3: Impact of Different Economic Resources and Age on Survival Inequality- Women



Note: For married (and cohabiting) women with basic education and in good health, the pictures show at different ages the five-year survival probabilities normalized around the median in a given distribution of resources. Hence, the normalized median survival probability is the horizontal line at zero. The scatters above the median line are the difference between the ninth decile and median; and the scatters below the median line are the difference between the first decile and median. The circles (“o”) represent permanent income; the crosses (“x”) financial and housing wealth; and the pluses (“+”) annual income. All variables are measured at the household level. The upper row graphs the predictions using the levels-specification of economic resources; the middle-row the log-transformation; and the bottom-row the rank-transformation. Pictures on the left are predictions from the models that include no other covariates than age. Pictures on the right control for age, civil status, education and initial health.

points above the x-axis reflect the pattern of 'excess survival' of individuals at the 90th percentiles of resources relative to the median, while the points below the x-axis show how much lower the survival probabilities of individuals in the first decile are relative to those of individuals with median resources. Circles ("o") represent permanent income; crosses ("x") are housing and financial wealth; and plusses ("+") annual income. The upper panel of pictures are the levels-, the middle panel is the logs-, and the bottom panel is the rank-transformation. Pictures on the left include no other controls than age, and pictures on the right include all covariates.

When no covariates are included, we see that the normalized age-profiles are extremely sensitive to which measure of economic resources we use; the transformation (levels, logs or rank) and whether we look at the richer (ninth decile) or the poorer (first decile) people. For example, by looking at the levels-transformation permanent income and wealth line up almost perfectly for the top of the distributions, while estimates based on annual income tends to overestimate the 90-50 survival gradient for individuals over sixty—the most common early retirement age in Denmark. Hence, at this age income sources are likely to change from labor to retirement income. This pattern is more pronounced in the logs-specification.

These patterns are *not* mirrored in the bottom of the wealth and annual income distributions, which shows the non-linearity of the gradient in mortality. A marginal increase in economic resources affects the rich and poor differentially. The levels- and the log-transformations of wealth tend to overestimate the excess mortality of the poor. Interestingly, the shape of the profiles for annual income is very different in the bottom. While inequality increases monotonically with age in the top of the distribution, the poorest decile has a u-shaped profile—with a turning point exactly at age 60 for both genders. This pattern is found in both the levels and the logs-transformation, but is more pronounced in the latter.

This pattern completely disappears when we look at the rank-specifications: no-longer do we see any breaks at age 60—in fact annual income and wealth line up almost perfectly. This is consistent with the feature of the rank-transformation that we mentioned earlier: if people over time keep their position in the given resource distribution (within their cohort), the rank specification is insensitive to level changes in these measures. Consequently, we can better compare the gradient across ages. For annual income, for instance, the changes in the age profiles at age 60 could stem from people changing income sources at retirement and a change in the level of income upon

retirement. Given that people plan for retirement, this income drop may be compensated by the release labor resources for home production, i.e., although income is falling the overall welfare (consumption) of the household is not. That a changing shape at age 60 does not materialize in the rank specification is consistent with people maintaining their rank in the income distribution even though their levels of income change. Hence, the levels- and log transformations of annual income are subject to an attenuation bias when people crosses into retirement.

Also for wealth we observe a break in the survival pattern on the first decile at age 60. This break is most pronounced in the logs-transformation. At age 60 capital pensions (lump-sum pension withdrawals) become eligible for withdrawal. Our wealth measure captures financial and housing wealth—pension balances are unobserved. When capital pensions are withdrawn they are likely to be transferred to liquid financial balances, which we do observe in our data. This mechanic generates noise in our estimations. If capital pensions make up a relatively large share of wealth in the household portfolio—which is likely the case in the bottom of the wealth distribution—then the log-transformation, that captures relative changes in wealth, accentuates the break at 60. Again, the break at 60 vanishes in the rank transformation.

The permanent income specification has no peculiar breaks at age 60, because the measure in all cases is measured at ages 45-53—well before the normal retirement age. In fact, the shape of the profiles is robust to the use of either the levels, logs, or rank-transformations.

Nevertheless, permanent income shows a lower mortality inequality than the other measures. However, these differences among different measures of wealth disappear once we control for a number of observable variables. This is clear when we compare the pictures on the left with those on the right. We find that covariates reduce the attenuation bias around retirement age, and the shape of age-profiles to become more similar across the three resource measures. Furthermore, when we use the rank specification, the normalized survival probabilities line up across all three measures—even among the old and the poor.

In summary, the permanent income gradient in survival is larger for men and than for women, and compared to wealth and annual income, robustly estimated. Once covariates are included in the estimations, both wealth and annual income are predicting survival inequalities in the same ranges as permanent income. Among the various functional forms considered, those based on the rank, seem particularly useful. The results raise a note of caution for studies that rely solely on

annual income or wealth—such studies should be careful to not only include the relevant covariates (education, civil status and initial health), but also make relevant non-linear transformations (such as a rank transformation) of the economics resource measure.

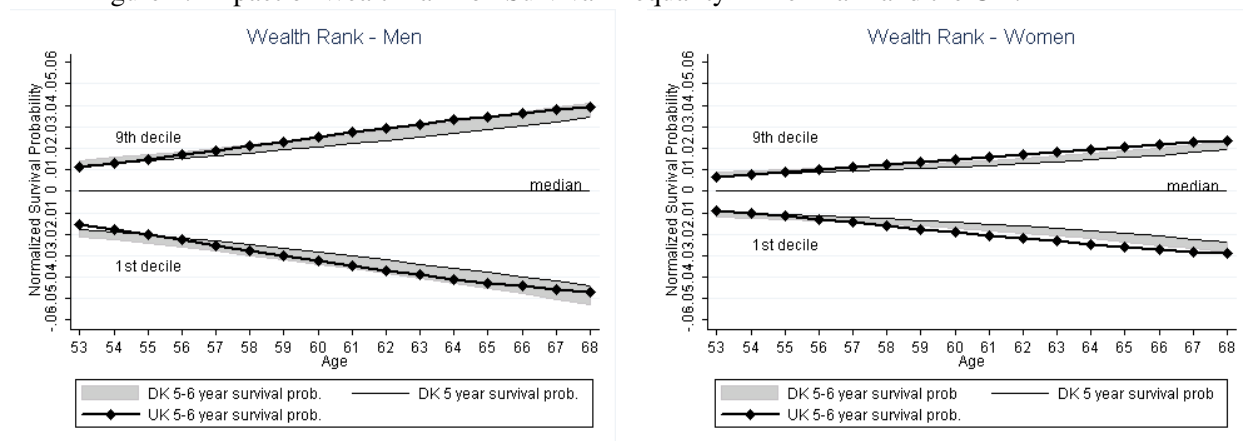
## 5.2 Inequality in Mortality

The previous subsection showed a positive and significant relationship between permanent income and survival in Denmark. Furthermore, once the estimations control for education, civil status and initial health, predicted survival probabilities estimated from wealth or annual income fit the range of the predicted survival probabilities estimated from permanent income—most robustly in the rank specification. However, the subsection did not consider whether the magnitude of the gradient is small, compared to an economically more unequal country, which would be the prediction of the inequality hypothesis in mortality. To answer this question an ideal experiment would randomly allocate individuals with similar characteristics into societies with differential economic inequality. Since we obviously lack this opportunity, we compare the economic gradient in Denmark and the UK. Both countries have for decades been among the richest in the world, and both have universal health care. According to Penn World Tables average GDP/capita from 1980-2003 was 20,250 ppp in Denmark and 18,705 ppp in the UK. According to OECD figures the median after tax Gini coefficient within the OECD countries was around 0.29-0.30 from the mid-1980's through the mid-2000's. The corresponding Gini-figures varied between 0.33-0.37 for the UK and 0.21-0.23 for Denmark.

This subsection directly compares the estimates of financial and housing wealth in UK and Denmark, which is available in the current study and for the UK (Attanasio and Emmerson, 2003). We use the probit parameter estimates from the ranks specifications, which as we mentioned above, fit the data well. We can compare this specification, (which implies a fit very similar to the other functional forms we considered) directly with that in Attanasio and Emmerson, 2003. Figure 4 plots the 90-50 and 50-10 survival probability differentials against age for both countries. For Denmark, the picture corresponds to the lower right pictures in Figures 2 and 3.

For the UK the bold and marked lines plot the predicted differences in median and the 1st

Figure 4: Impact of Wealth rank on Survival Inequality in Denmark and the UK.



Note: The pictures plot the normalized survival probabilities for the 1st and 9th decile in the financial and housing wealth distribution for married and cohabiting men (left) and women (right) with basic education and in good health (see notes for Figure 5.2 and 5.3 for detailed description). For Denmark the models predict the five-year survival probabilities from 31st December 2003 to December 2008. For the UK the graphs are predictions of 5-6 years survival from 1988/1989 to 1994. This is because survival in the UK is captured by an indicator of whether respondents are alive in both the first and the second wave of the British Retirement Survey. The time between the interviews varies from 5 to 6 years. In both countries the models of the rank-transformation of financial and housing wealth (WE) are used. The graphs for the UK are constructed using the estimates from Table 9A and 9B in Attanasio and Emmerson (2003). The thick (and marked) lines represent the inequality in 5-6 years survival in the UK. The thin lines are the inequality in five-year survival in Denmark. To make the predictions in the two countries directly comparable—in terms of the period we measure survival probabilities within—the shaded areas plot the lower (five-year survival) and upper bound (six-year survival) inequality in Denmark. Under the assumption that the gradient in five- and six-year survival is the same on average, the upper bound is calculated by multiplying the five-year survival inequality by  $(6/5)$ .

(9th) decile wealth in 5-6 years survival the thin line plots the difference in five-year survival in Denmark. The UK-study measures survival between two waves of the British Retirement Survey, which are 5-6 years apart, whereas the Danish study plots the estimated probability of survival over an exact period of five years. This complicates the comparison. To circumvent this problem, we also approximate a six-year survival probability for Denmark, simply by multiplying the difference in five year survival by  $(6/5)$ . This approximation would be valid under the assumption that the difference (inequality) across the resource distribution we predicted for the first 5 years in Denmark, persists from the 5th to the 6th year, too. Given that inequality mortality increase in age for the groups of interest—which the widening inequality gap by age suggests—there is no reason to believe that the inequality in mortality rates would decrease from the fifth to the sixth year. In that sense, our approximation is in fact a lower bound for the six-year survival probability in Denmark. The shaded area in 4 plots the bounds for the 5-6 years-survival in Denmark. We see that the predictions of the inequality in the UK-men's survival probability are within the range of the Danish men's. But we do, however, see a slightly larger inequality among the UK-women. However, what is most striking about the Figure is the similarity of the pattern of inequality in mortality between the two countries. Although the two countries have very different levels of inequality, with the UK being considerably more unequal, the distribution of mortality rates across the distribution of economic resources is substantially the same in the two countries.

All together we find a significant survival gradient in Denmark with striking similarities to the survival gradient in the UK. This finding suggests that inequality itself is not determining differential mortality. Consequently, studies relying on macro data (e.g. regressions of national longevity on GDP per capita) potentially miss the heterogeneity within populations, which our analysis showed to be important controls when estimating the gradient.

## **6 Conclusion**

In this study, we have explored the relationship between three different measures of economic resources (permanent income, annual income and wealth) and mortality. Using administrative records for Denmark covering all residents aged 53-68 in 2003, we show that permanent income is robustly estimating the gradient in survival. However, both annual income and wealth provide

unbiased estimates of the gradient, once we control for education, civil status and initial health. Moreover, we find a non-linear relationship between mortality and economic resources, which is approximated best with a rank transformation of the economic resource data. Of the variables we have considered, permanent income seems to be fitting the data best and approximate the relationship between the level of economic resources and mortality even when we do not control for other observable variables. This is probably because the level of permanent income, at least in the way we approximate it, seems to capture already the effect of many of these variables, such as education and initial health status.

The current study is furthermore pointing to similarities in the economic inequality in mortality in Denmark and the UK. Because both countries are highly developed, yet Denmark is more equal, this seems to contradict the inequality hypothesis claiming that inequality itself is a main determinant mortality. Instead, we suggest that differential permanent income determine mortality.

## **Appendix A. Grouping ICD-10 codes**



Table 7: Grouping of ICD-10 diagnoses, a

|  | Infections   | Lung disease   | Nerves   | Circulation                 | Lymphs   | Veins        | Blood   | Digestive system   | Urinary  | Musculoskeletal  | Gynecology   | Pregnancy |
|--|--|--|--|-----------------------------|--|--------------|---|--|--|--|--|-----------|
|  | DA000-DA099  | DA150-DA169  | DA170-DA179  | DT820-DT829<br>DT862-DT863B | DI700-DI809B<br>DI820-DI829B<br>DI870-DI899<br>DL040-DL049<br>DQ270-DQ279<br>DR590-DR599 | DI830-DI839B | DC463<br>DC754<br>DC770-DC779B<br>DC810-DC969<br>DD360<br>DD459-DD479<br>DD500-DD729<br>DD740-DD849<br>DD861<br>DD890-DD899<br>DO990-DO991A<br>DT860-DT860A<br>DZ832A | DA183-DA183E<br>DB150-DB199<br>DB942<br>DC150-DC269<br>DC451<br>DC480-DC488<br>DC494-DC495A<br>DC762-DC763<br>DC784-DC788<br>DD001-DD019<br>DD120-DD139<br>DD175<br>DD191<br>DD194-DD195<br>DD200-DD201<br>DD214-DD215<br>DD371-D0379<br>DD483-DD484<br>DD730-DD739<br>D819<br>DI840-DI859<br>DI864-DI864A<br>DK209-DK938<br>DO984-DO984C<br>DO996<br>DQ390-DQ459<br>DQ790-DQ794A<br>DQ890-DQ890C<br>DR100-DR108B<br>DR129<br>DR149-DR162B<br>DR190-DR198H<br>DS360-DS369<br>DT180-DT189<br>DT281-DT282<br>DT286-DT287<br>DT855-DT855C<br>DT864-DT864B<br>DT915-DT915B | DA181-DA181F<br>DB374-DB374A<br>DB901<br>DC600-DC689<br>DC790-DC791X<br>DD074-DD091<br>DD176<br>DD290-DD309<br>DD400-DD419<br>DI861<br>DN000-DN518C<br>DN990-DN991B<br>DN995-DN999 | DA180-DA180G<br>DB453<br>DB902-DB902B<br>DC400-DC419B<br>DC461<br>DC491-DC492B<br>DC764-DC765<br>DC795-DC795B<br>DD160-DD169B<br>DD172-DD172B<br>DD192-DD192D<br>DD211-DD212B<br>DD480<br>DG560-DG563<br>DG570<br>DG572-DG576A<br>DL030-DL031I<br>DM000-DM099<br>DQ650-DQ749<br>DQ760-DQ789<br>DQ798-DQ799<br>DS000-DS019<br>DS091-DS091B<br>DS097-DS109<br>DS118-DS119<br>DS169-DS169B<br>DS200-DS233A<br>DS234-DS235A<br>DS290-DS301<br>DS307-DS311<br>DS317-DS328C<br>DS334-DS335<br>DS336-DS337B<br>DS390-DT019<br>DT021-DT039<br>DT041-DT059<br>DT063-DT149<br>DT840-DT849<br>DT870-DT876F<br>DT920-DT939 | DA349<br>D0000-D0979<br>DO994<br>DO998-DP969<br>DR090<br>DZ370-DZ379 |           |
|  | DA000-DA099<br>DA182<br>DA188-DA188H<br>DA209-DA339<br>DA359-DA499A<br>DA659-DA709B<br>DA740-DA799<br>DA909-DA999<br>DB007-DB019<br>DB027-DB069<br>DB084-DB084A<br>DB088-DB099<br>DB200-DB279<br>DB330-DB349A<br>DB377-DB379<br>DB399<br>DB447-DB449<br>DB457-DB459<br>DB509-DB839<br>DB908<br>DB929<br>DB948-DB999<br>DI100-DI118C<br>DI0980-DO980C<br>DO985-DO988<br>DT899 | DA190-DA199<br>DB371<br>DB440-DB441<br>DB450<br>DB909<br>DC339-DC379<br>DC381-DC399<br>DC450<br>DC761<br>DC780-DC783<br>DD021-DD024<br>DD142-DD150<br>DD152-DD159<br>DD174<br>DD190<br>DD193<br>DD213<br>DD381-DD389<br>DD860<br>DD862<br>DI120-DI229<br>DI409-DI998E<br>DO995<br>DQ320-DQ341<br>DR040-DR068E<br>DR091<br>DS270-DS281<br>DT174-DT179A<br>DT275-DT275B<br>DT914 | DA170-DA179<br>DA800-DA899<br>DB003-DB004A<br>DB020-DB022B<br>DB375<br>DB451-DB451A<br>DB900<br>DB919<br>DB941<br>DC470-DC479B<br>DC700-DC729<br>DC751-DC753<br>DC793-DC794<br>DD320-DD339<br>DD353-DD354<br>DD361-DD361B<br>DD420-DD439<br>DD482-DD482E<br>DG000-DG558<br>DG564-DG569<br>DG571-DG571A<br>DG578-DG998<br>DI600-DI698<br>DQ000-DQ079<br>DQ280-DQ283E<br>DQ750-DQ753<br>DQ850-DQ859<br>DR250-DR261<br>DR270-DR278A<br>DS020-DS021I<br>DS027-DS029<br>DS040-DS049<br>DS061-DS080A<br>DS120-DS146<br>DS189<br>DS233B<br>DS240-DS246<br>DS330-DS333B<br>DS335A<br>DS340-DS348C<br>DT020<br>DT040<br>DT060-DT062<br>DT850-DT851A<br>DT902-DT903<br>DT905<br>DT911<br>DT913 | DT820-DT829<br>DT862-DT863B | DI700-DI809B<br>DI820-DI829B<br>DI870-DI899<br>DL040-DL049<br>DQ270-DQ279<br>DR590-DR599 | DI830-DI839B | DC463<br>DC754<br>DC770-DC779B<br>DC810-DC969<br>DD360<br>DD459-DD479<br>DD500-DD729<br>DD740-DD849<br>DD861<br>DD890-DD899<br>DO990-DO991A<br>DT860-DT860A<br>DZ832A | DA183-DA183E<br>DB150-DB199<br>DB942<br>DC150-DC269<br>DC451<br>DC480-DC488<br>DC494-DC495A<br>DC762-DC763<br>DC784-DC788<br>DD001-DD019<br>DD120-DD139<br>DD175<br>DD191<br>DD194-DD195<br>DD200-DD201<br>DD214-DD215<br>DD371-D0379<br>DD483-DD484<br>DD730-DD739<br>D819<br>DI840-DI859<br>DI864-DI864A<br>DK209-DK938<br>DO984-DO984C<br>DO996<br>DQ390-DQ459<br>DQ790-DQ794A<br>DQ890-DQ890C<br>DR100-DR108B<br>DR129<br>DR149-DR162B<br>DR190-DR198H<br>DS360-DS369<br>DT180-DT189<br>DT281-DT282<br>DT286-DT287<br>DT855-DT855C<br>DT864-DT864B<br>DT915-DT915B | DA181-DA181F<br>DB374-DB374A<br>DB901<br>DC600-DC689<br>DC790-DC791X<br>DD074-DD091<br>DD176<br>DD290-DD309<br>DD400-DD419<br>DI861<br>DN000-DN518C<br>DN990-DN991B<br>DN995-DN999 | DA180-DA180G<br>DB453<br>DB902-DB902B<br>DC400-DC419B<br>DC461<br>DC491-DC492B<br>DC764-DC765<br>DC795-DC795B<br>DD160-DD169B<br>DD172-DD172B<br>DD192-DD192D<br>DD211-DD212B<br>DD480<br>DG560-DG563<br>DG570<br>DG572-DG576A<br>DL030-DL031I<br>DM000-DM099<br>DQ650-DQ749<br>DQ760-DQ789<br>DQ798-DQ799<br>DS000-DS019<br>DS091-DS091B<br>DS097-DS109<br>DS118-DS119<br>DS169-DS169B<br>DS200-DS233A<br>DS234-DS235A<br>DS290-DS301<br>DS307-DS311<br>DS317-DS328C<br>DS334-DS335<br>DS336-DS337B<br>DS390-DT019<br>DT021-DT039<br>DT041-DT059<br>DT063-DT149<br>DT840-DT849<br>DT870-DT876F<br>DT920-DT939 | DA349<br>D0000-D0979<br>DO994<br>DO998-DP969<br>DR090<br>DZ370-DZ379 |           |

Table 8: Grouping of ICD-10 diagnoses, b

| Skin          | Eyes         | Ears/nose/Throat | Metabolic    | Mental Illnesses | Breast       | Sterilization | Concussion | Poisoning   | Live Born Child | Other Illnesses |
|---------------|--------------|------------------|--------------|------------------|--------------|---------------|------------|-------------|-----------------|-----------------|
| DA184-DA184I  | DA185-DA185D | DA186            | DA187-DA187A | DF000-DF999      | DC500-DC509  | DZ402         | DS060      | DT360-DT659 | DZ380-DZ388P    | DC437-DC459     |
| DA500-DA649   | DA719        | DB002-DB002B     | DC739-DC750  | DO993-DO993B     | DD6050-DD059 |               |            | DT969-DT979 |                 | DC467-DC469     |
| DR000-DR001B  | DB005-DB005G | DB085            | DC759        | DR410-DR418A     | DD249-DD249W |               |            |             |                 | DC490-DC490C    |
| DB079-DB083   | DB023-DB023G | DB370-DB370A     | DC797        | DR440-DR458      | DD486        |               |            |             |                 | DC758           |
| DB350-DB369   | DB300-DB309  | DB442            | DD093-DD093B | DR620-DR629      | DJ972        |               |            |             |                 | DC767-DC768     |
| DB372-DB372C  | DB940        | DC000-DC148      | DD349-DD352A |                  | DN600-DN649  |               |            |             |                 | DC798-DC809     |
| DB388         | DC690-DC699  | DC300-DC329      | DD357        |                  | DQ830-DQ839  |               |            |             |                 | DC979           |
| DB409-DB439A  | DD0092       | DC462            | DD359        |                  | DTR854       |               |            |             |                 | DD097-DD099     |
| DB452         | DD221-DD221B | DD000-DD000C     | DD440-DD449  |                  |              |               |            |             |                 | DD173-DD173B    |
| DB469-DB499A  | DD231-DD231B | DD020            | DE000-DE009  |                  |              |               |            |             |                 | DD177-DD179     |
| DB850-DB899A  | DD310-DD319  | DD100-DD119      | DO992-DO992A |                  |              |               |            |             |                 | DD196-DD199     |
| DC430-DC449   | DH000-DH599  | DD140-DD141      | DQ891-DQ892I |                  |              |               |            |             |                 | DD216-DD219     |
| DC460         | DQ100-DQ159  | DD220            | DQ900-DQ999  |                  |              |               |            |             |                 | DD358           |
| DC493-DC493C  | DS050-DS059  | DD222-DD222B     |              |                  |              |               |            |             |                 | DD367-DD369     |
| DC496-DC499   | DTI50-DTI59  | DD230            |              |                  |              |               |            |             |                 | DD481           |
| DC760-DC760C  | DT260-DT269  | DD370-DD370C     |              |                  |              |               |            |             |                 | DD487-DD489     |
| DD030-DD049   | DT852-DT853C | DD380            |              |                  |              |               |            |             |                 | DD868-DD869     |
| DD170-DD171B  |              | DH600-DH959      |              |                  |              |               |            |             |                 | DR868-DR868A    |
| DD180-DD181B  |              | DI860            |              |                  |              |               |            |             |                 | DI950-DI959     |
| DD210-DD210C  |              | DI009-DI069      |              |                  |              |               |            |             |                 | DI978-DI979     |
| DD223-DD229   |              | DI300-DI399      |              |                  |              |               |            |             |                 | DI980-DI999     |
| DD233-DD239   |              | DK000-DK149      |              |                  |              |               |            |             |                 | DN994           |
| DD485         |              | DQ160-DQ189      |              |                  |              |               |            |             |                 | DO989           |
| DD863-DD863A  |              | DQ300-DQ319      |              |                  |              |               |            |             |                 | DQ288-DQ289     |
| DI979A-DI979E |              | DQ380-DQ388C     |              |                  |              |               |            |             |                 | DQ348-DQ349     |
| DI009-DI029C  |              | DQ754-DQ755      |              |                  |              |               |            |             |                 | DQ560-DQ564     |
| DI032-DI039A  |              | DR139            |              |                  |              |               |            |             |                 | DQ758-DQ759     |
| DI050-DI998B  |              | DR430-DR438C     |              |                  |              |               |            |             |                 | DQ795-DQ796     |
| DO981-DO983   |              | DR470-DR498B     |              |                  |              |               |            |             |                 | DO860-DO878I    |
| DO997         |              | DS022-DS026E     |              |                  |              |               |            |             |                 | DO894-DQ899     |
| DQ350-DQ379   |              | DS081            |              |                  |              |               |            |             |                 | DR010-DR031     |
| DQ800-DQ829   |              | DS092            |              |                  |              |               |            |             |                 | DR070-DR079     |
| DQ840-DQ849   |              | DS110-DS117      |              |                  |              |               |            |             |                 | DR092-DR098G    |
| DR200-DR238B  |              | DS170-DS179      |              |                  |              |               |            |             |                 | DR119-DR119C    |
| DT200-DT257B  |              | DTI69-DTI73      |              |                  |              |               |            |             |                 | DR179-DR189     |
| DT290-DT339   |              | DT270-DT274B     |              |                  |              |               |            |             |                 | DR262-DR268F    |
| DT950-DT959   |              | DT280-DT280B     |              |                  |              |               |            |             |                 | DR290-DR298A    |
|               |              | DT285-DT285B     |              |                  |              |               |            |             |                 | DR400-DR402     |
|               |              |                  |              |                  |              |               |            |             |                 | DR429           |
|               |              |                  |              |                  |              |               |            |             |                 | DR460-DR468     |
|               |              |                  |              |                  |              |               |            |             |                 | DR500-DR589     |
|               |              |                  |              |                  |              |               |            |             |                 | DR600-DR619A    |
|               |              |                  |              |                  |              |               |            |             |                 | DR630-DR699     |
|               |              |                  |              |                  |              |               |            |             |                 | DS088-DS089     |
|               |              |                  |              |                  |              |               |            |             |                 | DS197-DS199     |
|               |              |                  |              |                  |              |               |            |             |                 | DS315           |
|               |              |                  |              |                  |              |               |            |             |                 | DS377-DS383C    |
|               |              |                  |              |                  |              |               |            |             |                 | DT276-DT277     |
|               |              |                  |              |                  |              |               |            |             |                 | DT284           |
|               |              |                  |              |                  |              |               |            |             |                 | DT289           |
|               |              |                  |              |                  |              |               |            |             |                 | DT340-DT357     |
|               |              |                  |              |                  |              |               |            |             |                 | DT669-DT819     |
|               |              |                  |              |                  |              |               |            |             |                 | DT856-DT859     |
|               |              |                  |              |                  |              |               |            |             |                 | DT868-DT869     |
|               |              |                  |              |                  |              |               |            |             |                 | DT880-DT889     |
|               |              |                  |              |                  |              |               |            |             |                 | DT900-DT901     |
|               |              |                  |              |                  |              |               |            |             |                 | DT904-DT904B    |
|               |              |                  |              |                  |              |               |            |             |                 | DT908-DT910D    |
|               |              |                  |              |                  |              |               |            |             |                 | DT912-DT912B    |
|               |              |                  |              |                  |              |               |            |             |                 | DT918-DT919     |
|               |              |                  |              |                  |              |               |            |             |                 | DT940-DT941     |
|               |              |                  |              |                  |              |               |            |             |                 | DT980-DZ301     |
|               |              |                  |              |                  |              |               |            |             |                 | DZ303-DZ369     |
|               |              |                  |              |                  |              |               |            |             |                 | DZ390-DZ832     |
|               |              |                  |              |                  |              |               |            |             |                 | DZ833-DZ999     |

## **Appendix B. Full sets of estimates**

Table 9: The survival/permanent income gradient

|   | Men:                       |                            |                            | Women:                     |                            |                            |
|---|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
|   | Levels                     | Natural<br>Logs            | Rank<br>(percentile)       | Levels                     | Natural<br>Logs            | Rank                       |
| Average household income from age 45-53 (100k Danish 2000-prices) |                            |                            |                            |                            |                            |                            |
| Permanent Income  | -.0175<br>(.05345)         | -214.3***<br>(15.01)       | .3791***<br>(.01192)       | .08665<br>(.06774)         | -190.8***<br>(19.92)       | .2822***<br>(.01351)       |
| Permanent Income Squared  | .08234***<br>(.0183)       | 17.36***<br>(1.221)        |                            | .03901<br>(.0237)          | 15.52***<br>(1.618)        |                            |
| Permanent Income Cubed  | -.0117***<br>(.001918)     | -.4674***<br>(.03308)      |                            | -.007812**<br>(.002547)    | -.4201***<br>(.04378)      |                            |
| Single age 45-53  | -.08388***<br>(.008022)    | -.08155***<br>(.008029)    | -.08395***<br>(.008021)    | -.05604***<br>(.008897)    | -.05347***<br>(.008906)    | -.05437***<br>(.008898)    |
| Selfemployed age 45-53  | .1232***<br>(.007414)      | .1231***<br>(.007399)      | .1228***<br>(.007203)      | .09108***<br>(.0085)       | .08988***<br>(.008487)     | .08824***<br>(.008289)     |
| Age   | -.3784***<br>(.006773)     | -.378***<br>(.006767)      | -.4436***<br>(.006666)     | .5923**<br>(.2164)         | .5911**<br>(.2164)         | .4887*<br>(.2161)          |
| - squared   |                            |                            |                            | -.0754***<br>(.0178)       | -.07525***<br>(.0178)      | -.07131***<br>(.01777)     |
| Single in 2003  | -.3271***<br>(.008292)     | -.3241***<br>(.008301)     | -.3285***<br>(.008288)     | -.1578***<br>(.008772)     | -.1565***<br>(.008778)     | -.1588***<br>(.008773)     |
| High School   | .1158***<br>(.01353)       | .1127***<br>(.01353)       | .1136***<br>(.01354)       | .1686***<br>(.0182)        | .166***<br>(.0182)         | .1663***<br>(.01822)       |
| Vocational  | .04411***<br>(.006684)     | .04133***<br>(.006692)     | .0423***<br>(.006685)      | .09333***<br>(.007694)     | .09061***<br>(.007706)     | .0942***<br>(.007709)      |
| Intermediate  | .1135***<br>(.01133)       | .1095***<br>(.0113)        | .1119***<br>(.01133)       | .1803***<br>(.012)         | .1762***<br>(.01199)       | .1799***<br>(.012)         |
| Long  | .1589***<br>(.01603)       | .1628***<br>(.016)         | .1648***<br>(.01575)       | .1335***<br>(.02552)       | .1355***<br>(.0255)        | .1148***<br>(.02502)       |
| Unknown   | .1701***<br>(.02005)       | .1676***<br>(.02006)       | .1689***<br>(.0201)        | .1729***<br>(.02623)       | .1714***<br>(.02624)       | .1686***<br>(.02628)       |
| Hospital record 2001-2003   | -.08833***<br>(.02012)     | -.08854***<br>(.02013)     | -.08842***<br>(.02012)     | -.1493***<br>(.0225)       | -.1492***<br>(.0225)       | -.1503***<br>(.0225)       |
| Days to next hospital record                                      | -.0007781***<br>(.0000588) | -.0007781***<br>(.0000588) | -.0007792***<br>(.0000588) | -.0008261***<br>(.0000654) | -.0008263***<br>(.0000654) | -.0008229***<br>(.0000654) |
| - Squared   | -5.13e-07***<br>(5.16e-08) | -5.14e-07***<br>(5.16e-08) | -5.15e-07***<br>(5.16e-08) | -5.92e-07***<br>(5.73e-08) | -5.92e-07***<br>(5.73e-08) | -5.91e-07***<br>(5.73e-08) |
| Hospital record in 2003   | .1738***<br>(.01737)       | .1736***<br>(.01738)       | .1729***<br>(.01737)       | .1812***<br>(.01936)       | .1814***<br>(.01937)       | .181***<br>(.01937)        |
| Hospitalnights in 2003  | -.01903***<br>(.0004346)   | -.01902***<br>(.0004347)   | -.019***<br>(.0004345)     | -.02391***<br>(.0004925)   | -.02392***<br>(.0004925)   | -.02401***<br>(.0004924)   |
| - Squared   | .0000598***<br>(2.24e-06)  | .0000598***<br>(2.24e-06)  | .0000597***<br>(2.24e-06)  | .0000798***<br>(2.77e-06)  | .0000798***<br>(2.77e-06)  | .0000798***<br>(2.77e-06)  |
| No of diagnoses in 2003   | -.03329***<br>(.004329)    | -.03314***<br>(.00433)     | -.03313***<br>(.004329)    | -.02044***<br>(.004718)    | -.02029***<br>(.004718)    | -.02057***<br>(.004717)    |
| Lung disease in 2003  | -.2947***<br>(.01543)      | -.2942***<br>(.01544)      | -.294***<br>(.01544)       | -.3665***<br>(.01644)      | -.3662***<br>(.01644)      | -.3674***<br>(.01644)      |
| Nerves in 2003  | -.06624***<br>(.01707)     | -.06619***<br>(.01707)     | -.06774***<br>(.01705)     | -.04613*<br>(.02066)       | -.04629*<br>(.02067)       | -.04711*<br>(.02067)       |
| Metabolic in 2003   | .05258**<br>(.01624)       | .05299**<br>(.01625)       | .05093**<br>(.01624)       | .04592*<br>(.01822)        | .04642*<br>(.01823)        | .04487*<br>(.01821)        |
| Hospital record in 2002   | .03618**<br>(.01138)       | .03579**<br>(.01138)       | .03627**<br>(.01137)       | .024<br>(.01253)           | .02385<br>(.01254)         | .02343<br>(.01254)         |
| Hospitalnights in 2002  | -.01062***<br>(.0004596)   | -.01064***<br>(.0004597)   | -.01063***<br>(.0004596)   | -.01583***<br>(.0005107)   | -.01582***<br>(.0005107)   | -.01572***<br>(.0005112)   |
| - Squared   | .0000314***<br>(1.90e-06)  | .0000315***<br>(1.90e-06)  | .0000314***<br>(1.90e-06)  | .0000472***<br>(2.41e-06)  | .0000473***<br>(2.41e-06)  | .0000468***<br>(2.41e-06)  |
| No of diagnoses in 2002   | -.02046***<br>(.004629)    | -.02005***<br>(.004631)    | -.02047***<br>(.00463)     | .002437<br>(.005038)       | .002522<br>(.005039)       | .002697<br>(.005042)       |
| Lung disease in 2002  | -.1887***<br>(.01729)      | -.1885***<br>(.0173)       | -.1895***<br>(.01729)      | -.2167***<br>(.01862)      | -.2166***<br>(.01862)      | -.2182***<br>(.01863)      |
| Nerves in 2002  | -.0547**<br>(.0186)        | -.05422**<br>(.01861)      | -.05398**<br>(.01861)      | -.08035***<br>(.02238)     | -.0808***<br>(.02238)      | -.08214***<br>(.02238)     |
| Metabolic in 2002   | -.03984*<br>(.01768)       | -.04031*<br>(.01769)       | -.03846*<br>(.01769)       | .008102<br>(.01963)        | .008689<br>(.01963)        | .006068<br>(.01962)        |
| Hospital record in 2001   | .06404***<br>(.01111)      | .06392***<br>(.01111)      | .06354***<br>(.01111)      | .07418***<br>(.01227)      | .07441***<br>(.01227)      | .07481***<br>(.01228)      |
| Hospitalnights in 2001  | -.007472***<br>(.00052)    | -.007475***<br>(.0005201)  | -.007389***<br>(.0005186)  | -.01196***<br>(.0006095)   | -.01195***<br>(.0006095)   | -.01192***<br>(.0006096)   |
| - Squared   | .0000233***<br>(2.72e-06)  | .0000234***<br>(2.73e-06)  | .0000228***<br>(2.69e-06)  | .00004***<br>(3.97e-06)    | .00004***<br>(3.97e-06)    | .0000399***<br>(3.97e-06)  |
| No of diagnoses in 2001   | -.04247***<br>(.004861)    | -.04204***<br>(.004863)    | -.04292***<br>(.004859)    | -.02491***<br>(.005305)    | -.02489***<br>(.005305)    | -.02463***<br>(.005311)    |
| Lung disease in 2001  | -.1417***<br>(.01835)      | -.1421***<br>(.01835)      | -.1447***<br>(.01833)      | -.1445***<br>(.01983)      | -.1439***<br>(.01984)      | -.1471***<br>(.01984)      |
| Nerves in 2001  | -.1112***<br>(.01905)      | -.1116***<br>(.01906)      | -.1089***<br>(.01906)      | -.08199***<br>(.0234)      | -.08222***<br>(.0234)      | -.08457***<br>(.0234)      |
| Metabolic in 2001   | -.04625*<br>(.01844)       | -.04611*<br>(.01845)       | -.04287*<br>(.01846)       | -.0481*<br>(.02065)        | -.04762*<br>(.02065)       | -.04796*<br>(.02065)       |
| constant  | 3.499***<br>(.07148)       | 883.7***<br>(61.49)        | 3.996***<br>(.05135)       | .5736<br>(.6564)           | 781.1***<br>(81.7)         | 1.236<br>(.6551)           |
| Pseudo R-squared  | 0.126                      | 0.126                      | 0.126                      | 0.129                      | 0.129                      | 0.129                      |
| N   | 494825                     | 494825                     | 494825                     | 501478                     | 501478                     | 501478                     |

Table 10: The survival/permanent income gradient estimated without covariates

|  | Men:                    |                        |                        | Women:                  |                        |                        |
|--|-------------------------|------------------------|------------------------|-------------------------|------------------------|------------------------|
|  | Levels                  | Natural<br>Logs        | Rank<br>(percentile)   | Levels                  | Natural<br>Logs        | Rank                   |
| Average household income from age 45-53 (100k Danish 2000-prices ) |                         |                        |                        |                         |                        |                        |
| Permanent Income   | -.1642**<br>(.05044)    | -295.1***<br>(14.47)   | .5637***<br>(.01048)   | -.09757<br>(.06337)     | -287.2***<br>(18.9)    | .4405***<br>(.01173)   |
| Permanent Income Squared   | .1638***<br>(.01719)    | 23.84***<br>(1.176)    |                        | .1337***<br>(.02206)    | 23.27***<br>(1.535)    |                        |
| Permanent Income Cubed   | -.02099***<br>(.001798) | -.6403***<br>(.03187)  |                        | -.01881***<br>(.002361) | -.6273***<br>(.04151)  |                        |
| Single age 45-53   | -.2963***<br>(.005951)  | -.2908***<br>(.005965) | -.2954***<br>(.005927) | -.1599***<br>(.006685)  | -.1557***<br>(.006701) | -.1586***<br>(.006695) |
| Selfemployed age 45-53   | .1545***<br>(.007109)   | .1545***<br>(.007093)  | .1598***<br>(.006896)  | .1252***<br>(.008058)   | .1234***<br>(.008041)  | .1279***<br>(.007856)  |
| Age  | -.4216***<br>(.006484)  | -.4212***<br>(.006482) | -.5184***<br>(.006343) | .8577***<br>(.2053)     | .8469***<br>(.2053)    | .6601**<br>(.2049)     |
| - squared  |                         |                        |                        | -.1018***<br>(.01688)   | -.1008***<br>(.01689)  | -.09259***<br>(.01685) |
| constant   | 3.816***<br>(.06147)    | 1219***<br>(59.29)     | 4.413***<br>(.03894)   | -.007723<br>(.6217)     | 1179***<br>(77.54)     | .913<br>(.6203)        |
| Pseudo R-squared   | 0.052                   | 0.053                  | 0.053                  | 0.037                   | 0.037                  | 0.037                  |
| N  | 494825                  | 494825                 | 494825                 | 501478                  | 501478                 | 501478                 |

Table 11: The survival/Wealth gradient

|  | Men:                       |                            |                            | Women:                     |                            |                            |
|--|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
|  | Levels                     | Natural<br>Logs            | Rank<br>(percentile)       | Levels                     | Natural<br>Logs            | Rank                       |
| Financial and housing wealth (1000k Danish 2000-prices ) |                            |                            |                            |                            |                            |                            |
| Wealth   | .2895***<br>(.009842)      | .0481*<br>(.0201)          | .5075***<br>(.01105)       | .2272***<br>(.01195)       | -.00877<br>(.06207)        | .3695***<br>(.01273)       |
| Wealth Squared   | -.06259***<br>(.004085)    | -.009966***<br>(.002731)   |                            | -.05561***<br>(.005306)    | .000701<br>(.006985)       |                            |
| Wealth Cubed   | .004324***<br>(.0004103)   | .0007514***<br>(.0001161)  |                            | .004244***<br>(.0005759)   | .0001702<br>(.000256)      |                            |
| Age  | -.4307***<br>(.006611)     | -.4332***<br>(.006619)     | -.4286***<br>(.006624)     | .2041<br>(.217)            | .1887<br>(.2171)           | .472*<br>(.2169)           |
| - squared  |                            |                            |                            | -.04616**<br>(.01784)      | -.04517*<br>(.01785)       | -.06922***<br>(.01783)     |
| Single in 2003   | -.3532***<br>(.006663)     | -.3451***<br>(.00671)      | -.3649***<br>(.006484)     | -.1559***<br>(.007387)     | -.1499***<br>(.007427)     | -.1661***<br>(.0072)       |
| High School  | .1118***<br>(.01352)       | .1146***<br>(.01352)       | .1099***<br>(.01353)       | .1623***<br>(.01811)       | .1631***<br>(.0181)        | .1557***<br>(.01809)       |
| Vocational   | .05114***<br>(.006669)     | .05232***<br>(.006662)     | .05191***<br>(.006661)     | .09734***<br>(.007608)     | .0979***<br>(.007605)      | .09561***<br>(.007613)     |
| Intermediate   | .1235***<br>(.01104)       | .128***<br>(.01102)        | .1212***<br>(.01104)       | .184***<br>(.01162)        | .1844***<br>(.01161)       | .1816***<br>(.01163)       |
| Long   | .19***<br>(.01521)         | .1932***<br>(.01515)       | .1802***<br>(.01516)       | .1361***<br>(.02445)       | .1345***<br>(.0244)        | .1231***<br>(.02435)       |
| Unknown  | .1873***<br>(.02042)       | .1921***<br>(.02045)       | .1864***<br>(.02044)       | .1913***<br>(.02696)       | .1993***<br>(.02701)       | .1896***<br>(.02696)       |
| Hospital record 2001-2003                                | -.08399***<br>(.02024)     | -.08506***<br>(.02024)     | -.0877***<br>(.02023)      | -.1403***<br>(.02266)      | -.1415***<br>(.02266)      | -.1414***<br>(.02266)      |
| Days to next hospital record                             | -.000721***<br>(.0000591)  | -.0007233***<br>(.0000591) | -.0007239***<br>(.0000591) | -.0007967***<br>(.0000657) | -.0007962***<br>(.0000657) | -.000796***<br>(.0000657)  |
| - Squared  | -4.81e-07***<br>(5.19e-08) | -4.83e-07***<br>(5.19e-08) | -4.86e-07***<br>(5.19e-08) | -5.65e-07***<br>(5.77e-08) | -5.66e-07***<br>(5.77e-08) | -5.65e-07***<br>(5.77e-08) |
| Hospital record in 2003                                  | .1576***<br>(.01747)       | .158***<br>(.01747)        | .157***<br>(.01748)        | .1817***<br>(.01945)       | .1812***<br>(.01945)       | .1819***<br>(.01945)       |
| Hospitalnights in 2003                                   | -.0189***<br>(.0004353)    | -.0189***<br>(.0004354)    | -.01895***<br>(.0004356)   | -.0239***<br>(.0004944)    | -.02393***<br>(.0004946)   | -.02389***<br>(.0004945)   |
| - Squared  | .0000587***<br>(2.22e-06)  | .0000587***<br>(2.22e-06)  | .0000588***<br>(2.22e-06)  | .0000796***<br>(2.78e-06)  | .0000797***<br>(2.78e-06)  | .0000796***<br>(2.78e-06)  |
| No of diagnoses in 2003                                  | -.03231***<br>(.004365)    | -.03204***<br>(.004366)    | -.03245***<br>(.004365)    | -.02038***<br>(.004747)    | -.02013***<br>(.004748)    | -.02039***<br>(.004748)    |
| Lung disease in 2003                                     | -.2906***<br>(.01555)      | -.2897***<br>(.01555)      | -.2911***<br>(.01556)      | -.3561***<br>(.01656)      | -.3549***<br>(.01656)      | -.3559***<br>(.01657)      |
| Nerves in 2003   | -.06272***<br>(.01718)     | -.06362***<br>(.01718)     | -.06253***<br>(.01718)     | -.04726*<br>(.02076)       | -.04839*<br>(.02076)       | -.04604*<br>(.02077)       |
| Metabolic in 2003  | .06211***<br>(.01635)      | .06178***<br>(.01635)      | .06135***<br>(.01635)      | .04589*<br>(.01831)        | .04654*<br>(.01831)        | .04718*<br>(.01832)        |
| Hospital record in 2002                                  | .03673**<br>(.01145)       | .03706**<br>(.01145)       | .03673**<br>(.01145)       | .0296*<br>(.0126)          | .02976*<br>(.0126)         | .02893*<br>(.0126)         |
| Hospitalnights in 2002                                   | -.01086***<br>(.0004627)   | -.0109***<br>(.0004627)    | -.01085***<br>(.0004632)   | -.01605***<br>(.0005129)   | -.01607***<br>(.0005129)   | -.01602***<br>(.0005133)   |
| - Squared  | .0000323***<br>(1.91e-06)  | .0000324***<br>(1.91e-06)  | .0000324***<br>(1.92e-06)  | .0000478***<br>(2.43e-06)  | .0000478***<br>(2.43e-06)  | .0000477***<br>(2.43e-06)  |
| No of diagnoses in 2002                                  | -.017***<br>(.004668)      | -.01672***<br>(.004669)    | -.01732***<br>(.004668)    | .003473<br>(.005072)       | .003657<br>(.005073)       | .003129<br>(.005071)       |
| Lung disease in 2002                                     | -.1829***<br>(.01744)      | -.1824***<br>(.01744)      | -.187***<br>(.01742)       | -.219***<br>(.01871)       | -.2184***<br>(.01872)      | -.2184***<br>(.01872)      |
| Nerves in 2002   | -.05353**<br>(.01873)      | -.05451**<br>(.01873)      | -.05538**<br>(.01873)      | -.06911**<br>(.02259)      | -.07033**<br>(.02259)      | -.06902**<br>(.0226)       |
| Metabolic in 2002  | -.03325<br>(.0178)         | -.03351<br>(.0178)         | -.03291<br>(.0178)         | .009137<br>(.01975)        | .009676<br>(.01975)        | .009283<br>(.01975)        |
| Hospital record in 2001                                  | .0696***<br>(.0112)        | .06989***<br>(.0112)       | .07057***<br>(.0112)       | .08065***<br>(.01235)      | .08117***<br>(.01235)      | .0809***<br>(.01235)       |
| Hospitalnights in 2001                                   | -.007448***<br>(.0005245)  | -.00746***<br>(.0005245)   | -.007499***<br>(.0005263)  | -.01233***<br>(.0006229)   | -.01238***<br>(.0006229)   | -.01233***<br>(.0006231)   |
| - Squared  | .0000231***<br>(2.75e-06)  | .000023***<br>(2.75e-06)   | .0000237***<br>(2.78e-06)  | .0000428***<br>(4.18e-06)  | .000043***<br>(4.18e-06)   | .0000428***<br>(4.18e-06)  |
| No of diagnoses in 2001                                  | -.04156***<br>(.004908)    | -.04107***<br>(.004909)    | -.042***<br>(.004907)      | -.02262***<br>(.005344)    | -.02197***<br>(.005345)    | -.02308***<br>(.00534)     |
| Lung disease in 2001                                     | -.1385***<br>(.01846)      | -.1378***<br>(.01846)      | -.1399***<br>(.01846)      | -.1473***<br>(.01998)      | -.1465***<br>(.01998)      | -.1463***<br>(.01998)      |
| Nerves in 2001   | -.1037***<br>(.0192)       | -.1045***<br>(.0192)       | -.1036***<br>(.01919)      | -.08577***<br>(.02349)     | -.08648***<br>(.02349)     | -.08515***<br>(.02349)     |
| Metabolic in 2001  | -.04602*<br>(.01857)       | -.04584*<br>(.01858)       | -.04665*<br>(.01856)       | -.05143*<br>(.02076)       | -.05066*<br>(.02076)       | -.05041*<br>(.02076)       |
| constant   | 3.896***<br>(.05136)       | 3.774***<br>(.06987)       | 3.873***<br>(.05133)       | 2.003**<br>(.6582)         | 1.993**<br>(.6816)         | 1.218<br>(.6577)           |
| Pseudo R-squared   | 0.128                      | 0.128                      | 0.128                      | 0.129                      | 0.129                      | 0.129                      |
| N  | 494841                     | 494841                     | 494825                     | 501485                     | 501470                     | 501478                     |

Table 12: The survival/Wealth gradient estimated without covariates

|  | Men:                    |                        |                        | Women:                   |                         |                        |
|--|-------------------------|------------------------|------------------------|--------------------------|-------------------------|------------------------|
|  | Levels                  | Natural<br>Logs        | Rank<br>(percentile)   | Levels                   | Natural<br>Logs         | Rank                   |
| Financial and housing wealth (1000k Danish 2000-prices ) |                         |                        |                        |                          |                         |                        |
| Wealth   | .546***<br>(.008966)    | -.06002**<br>(.01967)  | .811***<br>(.0101)     | .4076***<br>(.0107)      | -.2522***<br>(.05983)   | .6098***<br>(.01125)   |
| Wealth Squared   | -.1375***<br>(.003856)  | .006758*<br>(.002649)  |                        | -.1081***<br>(.004934)   | .02815***<br>(.006702)  |                        |
| Wealth Cubed   | .01021***<br>(.0004003) | .0001753<br>(.0001121) |                        | .008615***<br>(.0005496) | -.000701**<br>(.000245) |                        |
| Age  | -.4828***<br>(.006282)  | -.4901***<br>(.006296) | -.4791***<br>(.006295) | .213<br>(.2061)          | .1803<br>(.2063)        | .6635**<br>(.2059)     |
| - squared  |                         |                        |                        | -.05268**<br>(.01695)    | -.05036**<br>(.01696)   | -.09156***<br>(.01693) |
| constant   | 4.033***<br>(.03831)    | 4.043***<br>(.06075)   | 4.006***<br>(.03836)   | 2.076***<br>(.624)       | 2.756***<br>(.6478)     | .7574<br>(.6233)       |
| Pseudo R-squared   | 0.053                   | 0.054                  | 0.050                  | 0.039                    | 0.040                   | 0.038                  |
| N  | 494841                  | 494841                 | 494825                 | 501485                   | 501470                  | 501478                 |

Table 13: The survival/annual income gradient

|  | Men:                       |                            |                            | Women:                     |                            |                            |
|--|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
|  | Levels                     | Natural Logs               | Rank (percentile)          | Levels                     | Natural Logs               | Rank                       |
| Annual Income in 2003 (100k Danish 2000-prices ) |                            |                            |                            |                            |                            |                            |
| Annual Income                                    | .1585***<br>(.02838)       | -.143***<br>(7.883)        | .4727***<br>(.01189)       | .09506*<br>(.04074)        | -150.8***<br>(14.78)       | .3092***<br>(.01321)       |
| Annual Income Squared                            | .006257<br>(.00758)        | 11.46***<br>(.6349)        |                            | .01302<br>(.01136)         | 12.08***<br>(1.183)        |                            |
| Annual Income Cubed                              | -.00205***<br>(.0005917)   | -.3053***<br>(.01703)      |                            | -.002561**<br>(.0009417)   | -.3216***<br>(.03155)      |                            |
| Selfemployed in 2003                             | .1575***<br>(.01089)       | .1445***<br>(.01089)       | .1538***<br>(.01073)       | .09298***<br>(.01371)      | .08633***<br>(.01372)      | .09031***<br>(.01359)      |
| Age  | -.3412***<br>(.006772)     | -.3307***<br>(.006808)     | -.4295***<br>(.006601)     | .2109<br>(.2161)           | .2256<br>(.2162)           | .4307*<br>(.2157)          |
| - squared  |                            |                            |                            | -.04139*<br>(.01778)       | -.04217*<br>(.01779)       | -.06577***<br>(.01773)     |
| Single in 2003                                   | -.3611***<br>(.006594)     | -.3547***<br>(.006609)     | -.3555***<br>(.006575)     | -.1926***<br>(.007057)     | -.1897***<br>(.007068)     | -.1929***<br>(.007047)     |
| High School                                      | .113***<br>(.01354)        | .1052***<br>(.01355)       | .1053***<br>(.01353)       | .1594***<br>(.01821)       | .1541***<br>(.01822)       | .1549***<br>(.01815)       |
| Vocational                                       | .05251***<br>(.006629)     | .04829***<br>(.00664)      | .04943***<br>(.00664)      | .09259***<br>(.00767)      | .08924***<br>(.007683)     | .08974***<br>(.007683)     |
| Intermediate                                     | .1009***<br>(.0113)        | .08965***<br>(.0113)       | .09307***<br>(.0113)       | .1611***<br>(.01204)       | .1536***<br>(.01207)       | .1595***<br>(.01204)       |
| Long   | .1366***<br>(.01596)       | .1326***<br>(.0159)        | .1368***<br>(.0156)        | .09635***<br>(.02531)      | .09481***<br>(.02529)      | .1009***<br>(.02493)       |
| Unknown  | .1662***<br>(.02065)       | .141***<br>(.02072)        | .1521***<br>(.0206)        | .1647***<br>(.02715)       | .1484***<br>(.02721)       | .1603***<br>(.02724)       |
| Hospital record 2001-2003                        | -.08838***<br>(.02008)     | -.08839***<br>(.02009)     | -.08804***<br>(.0201)      | -.1458***<br>(.02248)      | -.1459***<br>(.02249)      | -.1452***<br>(.0225)       |
| Days to next hospital record                     | -.0007422***<br>(.0000587) | -.0007434***<br>(.0000587) | -.0007435***<br>(.0000587) | -.0008129***<br>(.0000652) | -.0008136***<br>(.0000653) | -.0008131***<br>(.0000653) |
| - Squared  | -4.92e-07***<br>(5.15e-08) | -4.94e-07***<br>(5.15e-08) | -4.92e-07***<br>(5.15e-08) | -5.79e-07***<br>(5.72e-08) | -5.80e-07***<br>(5.72e-08) | -5.79e-07***<br>(5.73e-08) |
| Hospital record in 2003                          | .1635***<br>(.01734)       | .163***<br>(.01735)        | .1645***<br>(.01735)       | .179***<br>(.01931)        | .1794***<br>(.01932)       | .1796***<br>(.01932)       |
| Hospitalnights in 2003                           | -.01892***<br>(.0004331)   | -.01892***<br>(.0004332)   | -.01894***<br>(.0004334)   | -.02388***<br>(.0004925)   | -.02388***<br>(.0004926)   | -.02385***<br>(.0004927)   |
| - Squared  | .0000592***<br>(2.21e-06)  | .0000592***<br>(2.21e-06)  | .0000593***<br>(2.21e-06)  | .00008***<br>(2.79e-06)    | .00008***<br>(2.79e-06)    | .0000799***<br>(2.79e-06)  |
| No of diagnoses in 2003                          | -.03224***<br>(.004322)    | -.03169***<br>(.004324)    | -.03238***<br>(.004324)    | -.02062***<br>(.004707)    | -.0205***<br>(.004708)     | -.02086***<br>(.00471)     |
| Lung disease in 2003                             | -.2969***<br>(.01541)      | -.296***<br>(.01542)       | -.2963***<br>(.01542)      | -.3672***<br>(.0164)       | -.3669***<br>(.0164)       | -.3682***<br>(.0164)       |
| Nerves in 2003                                   | -.06797***<br>(.017)       | -.06821***<br>(.01701)     | -.06735***<br>(.01701)     | -.04901*<br>(.0206)        | -.0493*<br>(.0206)         | -.04991*<br>(.0206)        |
| Metabolic in 2003                                | .05644***<br>(.01622)      | .05632***<br>(.01622)      | .05937***<br>(.01623)      | .04659*<br>(.01816)        | .04693**<br>(.01816)       | .04678*<br>(.01816)        |
| Hospital record in 2002                          | .03812***<br>(.01135)      | .03791***<br>(.01136)      | .03844***<br>(.01136)      | .02607*<br>(.0125)         | .02635*<br>(.01251)        | .02639*<br>(.01251)        |
| Hospitalnights in 2002                           | -.01061***<br>(.0004589)   | -.01059***<br>(.000459)    | -.01062***<br>(.000459)    | -.0157***<br>(.0005114)    | -.0157***<br>(.0005114)    | -.01564***<br>(.0005117)   |
| - Squared  | .0000314***<br>(1.90e-06)  | .0000314***<br>(1.90e-06)  | .0000314***<br>(1.90e-06)  | .0000463***<br>(2.42e-06)  | .0000463***<br>(2.42e-06)  | .0000461***<br>(2.43e-06)  |
| No of diagnoses in 2002                          | -.02016***<br>(.00462)     | -.01989***<br>(.004622)    | -.02017***<br>(.004621)    | .001487<br>(.005024)       | .001521<br>(.005024)       | .001175<br>(.005026)       |
| Lung disease in 2002                             | -.1877***<br>(.01727)      | -.1867***<br>(.01728)      | -.1878***<br>(.01727)      | -.2156***<br>(.01859)      | -.2153***<br>(.01859)      | -.2158***<br>(.0186)       |
| Nerves in 2002                                   | -.05342***<br>(.01855)     | -.05341**<br>(.01855)      | -.05423**<br>(.01855)      | -.08453***<br>(.02234)     | -.08491***<br>(.02234)     | -.08645***<br>(.02234)     |
| Metabolic in 2002                                | -.03714*<br>(.01766)       | -.0357*<br>(.01766)        | -.03576*<br>(.01766)       | .005956<br>(.01955)        | .006325<br>(.01956)        | .006172<br>(.01956)        |
| Hospital record in 2001                          | .06644***<br>(.01109)      | .06635***<br>(.01109)      | .06736***<br>(.01109)      | .07649***<br>(.01224)      | .07672***<br>(.01225)      | .07769***<br>(.01225)      |
| Hospitalnights in 2001                           | -.007347***<br>(.000517)   | -.007328***<br>(.0005172)  | -.007318***<br>(.0005175)  | -.01195***<br>(.0006091)   | -.01195***<br>(.0006091)   | -.01194***<br>(.0006091)   |
| - Squared  | .0000221***<br>(2.68e-06)  | .000022***<br>(2.68e-06)   | .000022***<br>(2.68e-06)   | .0000398***<br>(3.97e-06)  | .0000398***<br>(3.97e-06)  | .0000398***<br>(3.96e-06)  |
| No of diagnoses in 2001                          | -.04342***<br>(.004843)    | -.04298***<br>(.004845)    | -.04374***<br>(.004845)    | -.02477***<br>(.005291)    | -.02462***<br>(.005292)    | -.02533***<br>(.005292)    |
| Lung disease in 2001                             | -.1413***<br>(.01829)      | -.1417***<br>(.0183)       | -.1422***<br>(.0183)       | -.1505***<br>(.01977)      | -.1502***<br>(.01977)      | -.1515***<br>(.01978)      |
| Nerves in 2001                                   | -.1095***<br>(.01899)      | -.11***<br>(.019)          | -.1086***<br>(.01899)      | -.08522***<br>(.02332)     | -.08557***<br>(.02332)     | -.08547***<br>(.02332)     |
| Metabolic in 2001                                | -.04048*<br>(.01841)       | -.03965*<br>(.01841)       | -.03938*<br>(.01841)       | -.051*<br>(.02055)         | -.05079*<br>(.02055)       | -.05095*<br>(.02055)       |
| constant   | 3.127***<br>(.06333)       | 595.9***<br>(32.6)         | 3.871***<br>(.05108)       | 1.668*<br>(.6533)          | 628***<br>(61.49)          | 1.374*<br>(.6541)          |
| Pseudo R-squared                                 | 0.128                      | 0.129                      | 0.128                      | 0.129                      | 0.129                      | 0.129                      |
| N  | 494825                     | 494825                     | 494825                     | 501478                     | 501478                     | 501478                     |



Table 14: The survival/annual income gradient estimated without covariates

|  | Men:                      |                       |                        | Women:                    |                        |                       |
|--|---------------------------|-----------------------|------------------------|---------------------------|------------------------|-----------------------|
|  | Levels                    | Natural<br>Logs       | Rank<br>(percentile)   | Levels                    | Natural<br>Logs        | Rank                  |
| Annual Income in 2003 (100k Danish 2000-prices ) |                           |                       |                        |                           |                        |                       |
| Annual Income                                    | .3041***<br>(.0262)       | -234.6***<br>(7.805)  | .7829***<br>(.01015)   | .05459<br>(.03792)        | -257.9***<br>(14.08)   | .4948***<br>(.01121)  |
| Annual Income Squared                            | .002442<br>(.007002)      | 18.85***<br>(.6275)   |                        | .04847***<br>(.01056)     | 20.6***<br>(1.126)     |                       |
| Annual Income Cubed                              | -.003059***<br>(.0005453) | -.503***<br>(.01681)  |                        | -.006244***<br>(.0008708) | -.5473***<br>(.03002)  |                       |
| Selfemployed in 2003                             | .2638***<br>(.01046)      | .2427***<br>(.01046)  | .2504***<br>(.01032)   | .1824***<br>(.01293)      | .1689***<br>(.01293)   | .1825***<br>(.01282)  |
| Age  | -.3286***<br>(.006401)    | -.313***<br>(.006439) | -.4765***<br>(.006262) | .3399<br>(.2045)          | .3706<br>(.2047)       | .6388**<br>(.2042)    |
| - squared  |                           |                       |                        | -.05437**<br>(.01683)     | -.05608***<br>(.01684) | -.08901***<br>(.0168) |
| constant   | 2.67***<br>(.05065)       | 973.2***<br>(32.33)   | 3.969***<br>(.03818)   | 1.251*<br>(.6172)         | 1075***<br>(58.62)     | .841<br>(.6183)       |
| Pseudo R-squared                                 | 0.049                     | 0.051                 | 0.050                  | 0.034                     | 0.035                  | 0.034                 |
| N  | 494825                    | 494825                | 494825                 | 501478                    | 501478                 | 501478                |

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