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SOCIO-ECONOMIC DIFFERENCES IN MORTALITY
Implications for pensions policy

Edward R. Whitehouse and Asghar Zaidi

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The report has benefited from discussion at the meeting of the OECD Working Party on Social Policy in December 2007. In particular, Josef Bauernberger (Austria), Olivier Bontout (European Commission) and Agnieszka Chlon-Dominczak (Poland) provided very helpful observations. Participants at an OECD seminar – particularly Anna D'Addio, Martine Durand and Mark Pearson – also provided valuable input. Nevertheless, the report represents the personal views of the principal authors.

Many of the results rely on the OECD pension models, which use the APEX (Analysis of Pension Entitlements across Countries) infrastructure originally developed by Axia Economics, with the help of funding from the OECD and the World Bank.

SUMMARY

The analyses included in the report show that there are big socio-economic differences in mortality, especially for men, and they appear to have become bigger over time. The report discusses implications of mortality differentials for five major areas of pension policy: the progressivity of the pension system, the pension eligibility age, the retirement incentives, future pension expenditures and private pensions. The empirical work shows that the mortality differentials reduce progressivity in pension systems. Moreover, there is empirical evidence that raising retirement age is not more unfair to socio-economic groups with lower life expectancy.

RESUME

Les analyses présentées ici montrent qu'il existe de fortes différences socioéconomiques en termes de mortalité, surtout chez les hommes, et qu'elles se sont apparemment accentuées au fil du temps. Ce document examine les conséquences des écarts de mortalité pour cinq grands aspects de la politique de retraite : la progressivité du système de retraite, l'âge d'ouverture des droits à pension, les incitations à la retraite, les dépenses de retraite futures et les pensions privées. Les travaux empiriques font apparaître que les écarts de mortalité réduisent la progressivité des régimes de retraite. De plus, des données d'observation montrent que le relèvement de l'âge de la retraite n'est pas plus pénalisant pour les catégories socioéconomiques ayant une espérance de vie plus courte.

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SOCIO-ECONOMIC DIFFERENCES IN MORTALITY: IMPLICATIONS FOR PENSIONS POLICY

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PART I. POLICY ISSUES

1. Differences in health, mortality and life expectancy between socio-economic groups have been found in numerous countries and over time.[1] These differentials are, of course, important in their own right as an indicator of social equity. But they also have important implications for the analysis of pension systems and for the design of pension policies.

2. A "pension" is usually a periodic payment until death, typically from the time of retirement. Mortality rates are therefore an important factor in analysing pensions. They can underlie the variables or parameters that determine pension benefits (in defined-contribution and notional-accounts schemes, for example).[2] They also have an impact on the likely duration that the pension is paid, and so on the lifetime value of the flow of pension benefits, which in OECD analyses (OECD, 2005, 2007) is called "pension wealth".

3. This report explores the implications of systematic mortality differentials across socio-economic groups for five specific areas of a pension policy.

4. The first relates to the progressivity of the pension system: equity and redistribution between individuals. How does differential mortality affect the degree of progressivity of the pension system? Should pension benefit formulae be designed to offset the inequities caused by differential mortality?

5. The second policy issue is the choice of pension eligibility age. How are different groups affected by an increase in the pension age? Are there reasons to suggest that different occupational groups should have (or continue to have) an earlier pension eligibility age on the grounds of shorter life expectancy?

6. The third area of concern is the impact of socio-economic differences in mortality on retirement incentives. How greater are incentives for early retirement for disadvantaged socio-economic groups when faced with the same set of rules as others?

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1. René Villermé provides probably the first scientific study, comparing death rates and poverty across the *arrondissements* of Paris in the 1820s (Deaton, 2002; Porter, 1997; Krieger, 2001).

2. This also applies to countries that have introduced links to life-expectancy in other kinds of pension plans: see Whitehouse (2007).

7. Fourthly, future pension expenditures will be affected by the evolution of differentials in future mortality rates and life expectancy across socio-economic groups, an impact that might not be captured by current forecasting methods. Finally, systematic mortality differentials have implications for the operation of voluntary, private pension schemes.

I.1 Pension-system progressivity

8. Pension systems differ substantially in the degree to which retirement benefits are linked to earnings when working or, put the other way around, in the degree of progressivity in pension benefits. A progressive system is defined as one in which the replacement rate – pension entitlements relative to individual earnings – declines with earnings. If low earners have systematically shorter life expectancy compared with higher-income groups, the progressivity of the system might compensates for the shorter expected duration of pension receipt. Conversely, in proportional (or non-progressive) pension systems, socio-economic differences in mortality exacerbate inequities in pension wealth.

9. In public pension systems, there is a number of ways in which pension benefit formulae might offset inequities caused by differential mortality. This can be achieved either through a progressive formula in earnings-related schemes or by providing separate, redistributive, retirement-income programmes. The report makes use of the OECD's "progressivity index" to summarise the relationship between pre-retirement earnings and pension entitlements in a single number (see Whitehouse, 2006 and OECD, 2007). The empirical results reported in this report show the extent to which differences in mortality reduce the progressivity of the pension system.

I.2 Pension eligibility age

10. One of the most common reforms to the pension systems of OECD countries since 1990 has been to reverse the previous trend to earlier pension eligibility ages (see Whiteford and Whitehouse, 2006 and OECD, 2007, Part II.1). Germany and the United Kingdom have recently legislated phased increases in the normal pension age: to 67 and 68, respectively. Prominent in the arguments of politicians and trade unionists opposed to increasing pension age in both countries was the concept that the rise in pension eligibility age would hit the poorest hardest, precisely because they die younger than the rich. For example, Brendan Barber, General Secretary of the Trades Union Congress in the United Kingdom, said: "We remain opposed to helping pay for more generous state pensions by increasing the state pension age. This means that the poor and those with stressful jobs will end up paying for better pensions for the better off with longer life expectancies."

11. Pension wealth – the lifetime value of pension – is the ideal measure for assessing the impact of reforms that change the pension age, because such changes alter the duration over which pensions are paid. The empirical work reported in the report explores the effect at different income levels of increasing the pension age from 65 to 67. These exploratory analyses confirm that a pension promise, *ceteris paribus*, is worth more *ex ante* to a rich person than a poor person because of socio-economic differences in mortality. However, it is critical to note that changes in pension age make little difference either way to this redistribution from poor to rich. Fairness in the pension system can only be addressed by a redistributive benefit formula: changes in pension age are broadly neutral in their distributional consequences.

I.3 Retirement incentives

12. In 17 OECD countries, it is possible to retire earlier than the normal pension age, drawing at least one part of the retirement-income package. In this case, the benefit is generally reduced to reflect the longer period for which the pension is paid. Similarly, it is possible to defer the pension claim after normal pension age in 19 countries. In this case, there is a benefit increment to reflect the shorter likely duration of

retirement. In nearly every case, these adjustments take the form of a percentage change in the pension entitlement for each year of early or late retirement. The average reduction in benefits for early retirement is 5.1% a year, while the average increase for late retirement is 6.2% (Queisser and Whitehouse, 2006).

13. Adjustments of this nature are naturally worth more *ex ante* to people who expect to live longer. Thus, incentives to retire earlier are greater for disadvantaged socio-economic groups who are faced with the same set of rules. It is difficult to implement higher benefit reductions for early retirement for groups with shorter life expectancy, either politically or practically. However, it is rather easier to take account of mortality differentials in adjusting benefits for late retirement. For example, in Australia and the United Kingdom, the benefits from deferring the public pension can be taken as a lump-sum payment, whose *ex ante* value does not vary with mortality.

I.4 Long-term financial forecasts of pension-system finances

14. Pension expenditures will also be affected by the evolution of differentials in future mortality rates and life expectancy across socio-economic groups. Pension policy involves uniquely long time horizons: pensions promised to 20 years old today will still be in payment in 60 years' time. Long-term projections of the finances of different retirement-income schemes are therefore essential for effective pension policymaking: in particular, assessing whether pension promises made to today's workers will be affordable. The OECD and the European Union have both produced cross-country analysis of these long-term financial projections.[3] An important driver of future pension expenditures is, of course, the way in which mortality rates and life expectancy are projected to evolve.

15. Like most pension-policy analysis, long-term financial forecasts are based on population mortality rates and they do not allow for socio-economic differences in mortality. However, systematic differentials in mortality could potentially have an effect. Take a country with a retirement income system that has a strong link between pension and earnings. If there are socio-economic differences in mortality, then one would expect that people with higher pensions will tend to live longer than those with lower pensions. This means that projections of future pension expenditures will be biased downwards. However, this effect will not occur in countries that pay flat-rate pensions: there can be no correlation between the value of the pension and mortality rates. As a result, only population mortality matters for forecasting future expenditures under these schemes.

16. On the other hand, it is also possible that the socio-economic differentials in mortality will be reduced in the future, *i.e.*, greater life expectancy gains will be observed for those groups, who currently have shorter life expectancy. In such a case, the differentials in life-expectancy gains will reduce inequities arising due to mortality differentials, and the projections based on population average will have less of a systematic downward bias.

I.5 Private pensions

17. The discussion of pension-policy issues arising from socio-economic differences has so far focused mainly on public pension schemes. However, private pensions play an important and growing role in providing retirement incomes in most OECD countries (see OECD, 2007, Part II). This is particular because the private, defined-contribution pensions have become increasingly important (see also Antolín and Whitehouse, 2008). With defined-contribution pensions, the accumulated contributions and investment returns are converted on retirement into a pension or annuity. The terms of this conversion are typically

3. Dang, Antolín and Oxley (2001) and European Union (2005, 2006).

expressed as an annuity rate, which can be thought of as the "price" in the annuity market.[4] Annuity markets generally differentiate this price only by sex and age. This means that, if sex and age do not account for all key differences in mortality, socio-economic groups with shorter life expectancy cross-subsidise groups that systematically live longer.

18. There is one market in which annuities with prices differentiated by risk are widely available: the United Kingdom. Specialist providers have offered higher annuity rates to certain people with shorter life expectancies since the mid 1990s. The first, launched in 1995, used public data on mortality rates for people with specific medical conditions to offer them better pensions. Actuaries describe these as "impaired-life" annuities. Calculating the mortality risks is obviously a complex business, and patterns vary between medical conditions: cancer, for example, increases mortality rates for five years or so and then these revert to the same as the population. Diabetes, in contrast, increases mortality risk at any point in time (Richards and Jones, 2004). This very specific approach is also subject to uncertainty: advances in treating cardio-vascular disease, for example, have rapidly improved mortality rates.

19. A second product is known as an "enhanced" annuity. This is based on rather less detailed, and so less expensive, analysis. In 1996, one firm began to offer smokers better annuity rates. Others have since entered the market and broadened the range of people that are eligible for higher annuity rates by classifying them according to bodyweight or previous occupation, for example. The market for these annuities has grown rapidly. The first survey showed around £200 million sold in one year (Ainslie, 2000). By the first quarter of 2003, sales had reached £800 million on an annualised basis, according to a survey by Watson Wyatt. The withdrawal of a key provider shrank the market for a period, but by the end of 2006, it had grown further to over £1 billion. Overall, some 10% of annuities sold in the United Kingdom are "enhanced". In conclusion, the private sector has set a precedent in introducing adjustment in pension payments based on mortality differentials, and this is an area in which public pension schemes might also consider innovating.

20. Actuaries have also explored the potential for enhanced annuities in other countries. For example, Brown and McDaid (2002) concluded an article in the *North American Actuarial Journal*: "We are truly excited about the possibility of a new annuity-pricing paradigm being created. We see much room for more creativity in the annuity pricing and pension valuation world, for a more broadly based risk classification model."

21. Recent developments in the United Kingdom serve to illustrate the salient policy issues. In 2007, Legal & General, one of the largest providers of private pensions, entered the enhanced annuity market, proposing to offer annuities differentiated on where people live (while in retirement). Life expectancy at birth in the Scottish city of Glasgow, for example, is 69.7 years for men and 76.7 for women. In the London borough of Kensington and Chelsea, in contrast, the figures are 80.8 for men and 85.8 for women. The press response was interesting. The *Daily Mail* reported under the headline: "Postcode boost for poor in retirement", while the *Daily Telegraph* took the opposite perspective: "Middle-class pensions slashed as pay out becomes a postcode lottery". The policy quandary is precisely that higher pensions for people living in poorer areas mean lower pensions for those in richer regions: what is actuarially fair may not be perceived as being fair in the usual sense of the term.

I.6 Structure of the report

22. The next part of the report provides a review of findings in socio-economic differences in mortality and life expectancy using previous studies on the topic. The results of these studies are then

4. For example, an annuity rate of 7% would mean that a lump sum of €100 000 would buy a pension of €7 000 a year.

further analysed so as to show implications of their findings on pensions. Part III presents new evidence on links between income and mortality using panel datasets for Germany, the United Kingdom and the United States. The report then explores the implications of income-based differences in mortality on pensions (Part IV).

PART II. MEASURING SOCIO-ECONOMIC DIFFERENCES IN MORTALITY: PREVIOUS FINDINGS

II.1 Mortality differentials

23. More than 50 studies of socio-economic differences in mortality were surveyed for this report. These studies, which cover various countries, various time periods and various measures of socio-economic status, are unanimous in finding significant differences in life expectancy between different socio-economic groups. This part of the report presents the findings of these studies exploring the systematic differences in mortality rates with respect to three socio-economic attributes: education, occupation and income.

II.1.1 Education and mortality

24. Numerous studies have provided clear evidence that higher levels of education reduce mortality and increase life expectancy. For example, Sorlie *et al.* (1995) show that working-age men in the United States with 16 or more years of education are around 60% less likely to die in a particular period than men with 12 years of education, while men with 5-8 years of education are 35% more likely to die than the baseline. The effects for women are smaller but still significant. Elo and Preston (1996) report that an extra year's education reduces mortality by 8% on average.

25. Huisman *et al.* (2004) report that people with low education are 40% more likely on average to die each year than people with middle or high education in 6 European countries. However, using data for the United Kingdom, Attanasio and Emmerson (2001) find that education significantly affects morbidity (*i.e.* health status), but not mortality. Deaton and Paxson (2001) show that education reduces mortality in the United Kingdom but it is a much weaker effect than that observed in the United States.

26. Other studies have explored the relationship between education and mortality more deeply. Using data for the United States, Pappas *et al.* (1993) report death rates that fall consistently with education. Adjusting for other socio-economic variables reduces the effect of education, but it is still significant. Similarly, Rogers *et al.* (2000) and Kallan (1997) find a continuous inverse relationship between education and mortality that is robust to controls for age, sex, race, marital status, income, *etc*. Deaton and Paxson (1999) also show that income and education are separately protective. Preston and Elo (1995) find a greater improvement in life expectancy from education than from occupation and income. In contrast, Lantz *et al.* (1998) and Rogers *et al.* (2000) argue that education is related to mortality mainly because it increases income. Similarly, Duleep (1986) and Menchik (1993) find that income and wealth better predict mortality risk than education.

27. As noted above, Sorlie *et al.* (1995) found a much weaker effect of education on life expectancy for women than for men in the United States. This result is confirmed by Brown (2000). However, Lantz *et al.* (1998) find the opposite effect: a stronger relationship between education and mortality for women than for men. Deaton and Paxson (1999) show that education affects life expectancy differently: for men, education and mortality are linked only through income, while for women, education has an independent influence on death rates.

28. Huisman *et al.* (2004) show a weaker link between education and mortality rates for women than for men in Austria, Belgium, Switzerland and the United Kingdom. However, in Finland and Norway the impact is similar between the sexes.

29. Brown (2000), Deaton and Paxson (1999) and Sorlie *et al.* (1995) all report stronger, positive relationships between education and life expectancy in the United States among younger groups — those of working age — than for older groups — those of retirement age. Huisman *et al.* (2004) find a similar pattern for men in the six European countries in their study. However, for women, there is a decline in the life-expectancy effect of education with age only in Norway and the United Kingdom. In Austria, Belgium, Finland, Switzerland, the impact of education is broadly constant with age for men and women. However, it is important to note that this study only looks at 50-90 year olds, while the papers using data from the United States cover younger people of working age.

30. Educational differentials in life expectancy appear to have increased in recent years, in the United States, at least (Feldman *et al.*, 1989). Pappas *et al.* (1993) report absolute declines in mortality rates for all educational groups, but the reduction is greater for those with more education than for those with less. Preston and Elo (1995) find that educational inequalities in death rates have widened for men but contracted for working-age women. Also, inequality has worsened more among people of retirement age than for people of working age.

II.1.2 Occupation and mortality

31. Occupation is a core socio-economic variable that reflects educational attainment, individual income and economic development (Lee, 1995) and so is likely to be correlated with life expectancy. Moreover, some occupations expose individuals directly to greater hazards and more physical demands.[5] And occupational patterns differ between men and women (Valinn, 1995). The evidence reported below gives a strong evidence of a link between mortality and occupations.

32. Sorlie *et al.* (1995) and Rogers *et al.* (2000) both show that higher occupations have much lower death rates than lower ones in the United States. For the United Kingdom, the Office of National Statistics reports that professional men can expect to live 4 years longer than the average population for men, while unskilled men live more than 4 years less than the average. For women, occupational life-expectancy differentials are about half of those for men. Cambois (2004) finds similar results for French men.

33. Blane and Drever (1998) show that mortality differentials measured in years of potential life lost fell more rapidly for men in professional and managerial occupations than they did for manual workers between 1970 and 1993, with only a very small improvement for unskilled manual workers.

II.1.3 Income and mortality

34. Numerous studies have shown that death rates decline with income. In addition to those cited below in the rest of this section, these include Attanasio and Emmerson (2001) and Gardner and Oswald (2004), Kallan (1997), Statistical Bulletin (1975) and Williams and Collins (1996).

35. In terms of correlation with other socio-economic characteristics and health, Rogers *et al.* (2000) report an inverse relationship between household income and mortality that holds regardless of sex, age, race, or marital status. Moreover, the relation is robust to controls for other variables, including education and occupation.

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5. For a description of jobs that are categorised as hazardous or arduous, see Whitehouse and Zaidi (2009).

36. A number of studies have been concerned with whether other characteristics — notably health — affect both income and mortality (Adams *et al.* 2003, Adda *et al.*, 2003; Lee, 1982; Luft, 1975; Smith, 1999). However, Deaton and Paxson (1999) show that only some of the effect of income is removed when allowing for reverse causality. Wolfson *et al.* (1990, 1993) report similar findings on Canadian data.

37. Note here that most studies use current household income to assess mortality differentials. This is a comprehensive measure, because it allows for the impact of taxes and transfers and capital incomes on living standards, as well as allowing for the sharing of resources within families and households. However, current income may not be a good measure because this magnifies the simultaneous determination of income and mortality probabilities by health status. Moreover, there are often substantial income changes as people move from work into retirement (Rogers, 1995; Banks, Blundell and Tanner, 1998).

38. Some studies have explored this issue by comparing the impact on mortality of permanent versus transitory income. Deaton and Paxson (1999) and Wolfson *et al.* (1990, 1993) on Canadian data find that permanent income has a stronger effect than current income. Deaton and Paxson (1999) investigate the dynamic effects of income on death rates. The upshot of these studies is that differences in incomes in middle age may have effects on mortality that persist into retirement.

39. Some studies have looked at the effect of individual earnings rather than incomes on mortality rates. For example, Knox and Tomlin (1997) compare mortality rates with pre-retirement earnings in Australia, finding strong income-related differentials in death rates for men. Wolfson *et al.* (1990, 1993) find that mortality during retirement in Canada is linked to earnings in middle age.

40. As for age differences, Wolfson *et al.* (1990, 1993) find that mortality in Canada is linked to income at nearly all age ranges, but the effect diminishes after age 65. Knox and Tomlin (1997) find similar results for Australia, while Deaton and Paxson (1999), Williams and Collins (1996), Sorlie *et al.* (1995), and Rogers *et al.* (2000) have similar findings.

41. Amongst the time series studies, Pappas *et al.* (1993) find a consistent relationship between higher income and lower mortality and that the disparity increased between 1960 and 1986. Similarly, Miller Schalick *et al*. (2000) show death rates for people with high incomes fell 2-3 times more rapidly than for low and mid-income groups between 1967 and 1986.

II.1.4 Summary

42. Broadly speaking, this review of previous evidence suggests:

- Socio-economic status – income, occupation or education – strongly affects mortality;
- The effects are generally larger for men than for women; and
- The size of mortality differences by socio-economic status has increased over time.

43. To examine what these mortality differentials imply for pension entitlements is not straightforward. Most studies report mortality differentials in the form of life expectancies, which is not sufficient to model pension entitlements. Therefore, the next section calculates estimates of the annuity factor using life-expectancy differentials reported in these studies to illustrate the scale of the effect and its implications for pensions.

II.2 Implications for pensions

44. To compare the "value" of pensions due to the differences in life expectancy, it is necessary to multiply the annual pension payment by a value that reflects the expected duration of payment. This value is called the "annuity factor". The annuity factor depends on both the age at which the pension is drawn and life expectancy.[6] If the annuity factor were 15, then a one euro payment each year from pension age would be worth 15 euros, measured at the time of retirement. Comparing annuity factors between different income groups shows how *ex ante* systematic differences in life expectancy affect the expected lifetime value of the pension.

II.2.1 United States — race and education — Brown (2000)

45. The analysis in Brown (2000) uses the National Longitudinal Mortality Study. The results are presented as life expectancy at age 22 and age 67 for different groups. These are divided by sex, race (black, white and Hispanic) and by education separately for blacks and whites (college level or greater, high school or less than high school).

Pre-retirement differentials in mortality

46. The mortality rates by sex and single year of age taken from the UN/World Bank population database were calibrated to deliver the same life expectancy at age 22 as reported by Brown (2000). These adjusted mortality rates were then used to calculate the probability of a 22 year old surviving to age 67 (in Table II.1). This pre-retirement survival probability varies from 60% for less-educated black men to 94% for higher-educated white women.

Table II.1. Life expectancy at age 22 and calculated probability of survival from 22 to 67 by sex, race and education

	Life expectancy at 22		*Probability of survival to 67*	
	Men	*Women*	*Men*	*Women*
All	77.4	83.4	81.5	92.3
White	78.3	84.0	82.9	92.8
Black	71.8	80.0	70.3	88.5
Hispanic	77.4	85.2	81.5	93.8
White				
College +	80.5	85.1	85.6	93.7
HS+	77.8	83.9	82.1	92.7
<HS	75.3	82.1	77.8	91.0
Black				
College +	75.7	81.9	78.6	90.8
HS+	71.6	80.0	69.9	89.5
<HS	68.1	77.5	60.5	84.7
2040 UN/WB	*80.1*	*85.6*	*85.5*	*94.1*

Note: HS = high school.

Source: OECD calculations based on Brown (2000) and UN/World Bank population data.

6. The annuity factor also depends on the discount rate and on the procedure for adjusting pensions in payment ("indexation") policy. See Queisser and Whitehouse (2006) for a detailed, technical description of calculating and using annuity factors.

Post-retirement differentials in mortality

47. The mortality rates by sex and single year of age taken from the UN/World Bank population database were calibrated to deliver the same life expectancy at age 67 as reported by Brown (2000). These were then used to calculate annuity factors at age 67 for different groups, using standard actuarial techniques. The discount rate assumed is the standard one of 2% and it is assumed that pensions in payment are indexed to prices. The final two columns of Table II.2 and Figure II.1 show these annuity factors relative to those for the population as a whole. The differentials by both race and education are larger for men than they are for women. For example, black men's higher post-retirement mortality implies that a given pension is worth 14% less than for the population as whole, compared with 8% less for white men. The pension worth for black men with less than higher secondary education is worst (20% lower than the overall average), whereas Hispanic women fare better than everyone else (13% higher).

Table II.2. Life expectancy at age 67 and calculated annuity factors by sex, race and education: United States

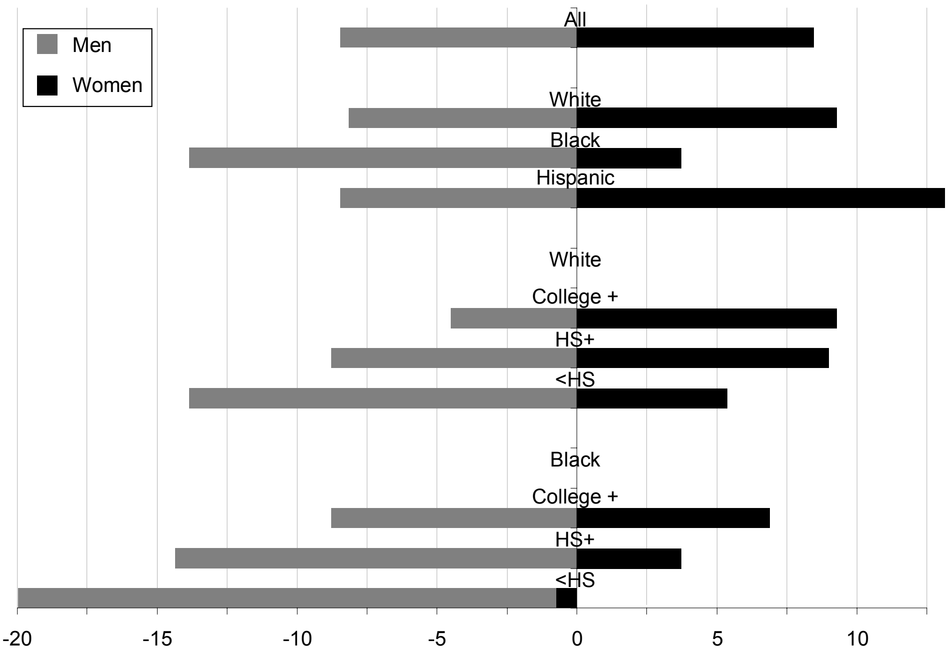
	Life expectancy at 67		*Annuity factor*		*Relative to all (%)*	
	Men	*Women*	*Men*	*Women*	*Men*	*Women*
All	83.5	87.2	13.89	16.45	*-8.5*	*8.5*
White	83.6	87.4	13.93	16.58	*-8.1*	*9.3*
Black	82.3	86.1	13.07	15.73	*-13.9*	*3.7*
Hispanic	83.5	88.3	13.89	17.16	*-8.5*	*13.1*
White						
College +	84.4	87.8	14.48	16.58	*-4.5*	*9.3*
HS+	83.4	87.3	13.84	16.53	*-8.8*	*9.0*
<HS	82.3	86.5	13.07	15.98	*-13.9*	*5.4*
Black						
College +	83.4	86.8	13.84	16.21	*-8.8*	*6.9*
HS+	82.2	86.1	12.99	15.73	*-14.4*	*3.7*
<HS	81.0	85.1	12.14	15.06	*-20.0*	*-0.7*
2040						
UN/WB	*84.0*	*87.4*	*14.23*	*16.58*		

Note: HS = high school.

Source: OECD calculations based on Brown (2000) and UN/World Bank population data.

Figure II.1. Calculated annuity factors at age 67 by sex, race and education: United States

(percentage difference from whole population)



Note: HS = high school.

Source: OECD calculations based on Brown (2000) and UN/World Bank population data.

II.2.2 Eleven European countries/cities — education — Huisman et al. (2004)[7]

48. The study uses data from mortality registries linked with population census data of 11 countries and cities of Europe from the beginning of the 1990s. The analysis of this study uses only cases with complete data from age 50 to 90 (data for Denmark and France are only available for a limited age range) and for those based on national populations (thereby excluding Turin, Barcelona and Madrid). Results are only reported for age 50 and above, and so the extended analysis looks only at mortality during retirement.

Post-retirement differentials in mortality

49. The populations were grouped into three categories by education. However, the reported results compare the low education group with the other two. The calculations show relative mortality rates by sex and in 10-year age bands, which are reproduced in Table II.3. These were used to calibrate the single-year mortality rates by sex and age from the UN/World Bank population database. Annuity factors were calculated for the two education groups, assuming a discount rate of 2%. The calculations use national pension eligibility ages and national indexation policies. The largest differential in annuity factors by education is for men in Austria. The pension for a low-educated man is worth less than 90% of that for a man with higher education levels. Differentials are larger for men than they are for women, with the ratio of annuity factors averaging 91.5% for men and 94.1% for women. Results for all countries exhibit pension duration differences across men and women, but also across low- and high-educated groups within each sex.

7. See also Kunst, Groenhof and Mackenbach (1998) and Kunst and Mackenbach (1994).

Table II.3. Relative mortality rates by sex and age group and annuity factors by sex and education: Austria, Belgium, Finland, Norway, Switzerland and United Kingdom

	Men						*Women*					
	Mortality rates: ratio of low to high education				*Annuity factors*		*Mortality rates: ratio of low to high education*				*Annuity factors*	
	50-59	*60-69*	*70-79*	*80-89*	*Low*	*High*	*50-59*	*60-69*	*70-79*	*80-89*	*Low*	*High*
Austria	1.86	1.56	1.39	1.27	13.6	15.2	1.21	1.30	1.30	1.39	16.4	17.7
Belgium	1.44	1.38	1.29	1.24	14.0	15.3	1.24	1.34	1.35	1.26	16.6	17.7
Finland	1.49	1.41	1.25	1.17	14.5	15.7	1.42	1.28	1.24	1.17	17.8	18.6
Norway	1.60	1.41	1.38	1.05	13.4	14.5	1.67	1.36	1.64	1.12	15.5	16.7
Switzerland	1.62	1.39	1.30	1.17	16.0	17.4	1.29	1.30	1.28	1.33	18.8	20.2
United Kingdom	1.36	1.61	1.17	1.28	13.7	14.9	1.44	1.53	1.19	1.07	16.5	17.1

Note: Based on national indexation procedures: 50%/50% prices/earnings for Switzerland, 80%/20% prices/earnings for Finland and prices for all other cases. Based on national pension eligibility ages, which are 65 except for Norway (67) and women in Switzerland (64). Data for United Kingdom are based on England and Wales only.

Source: OECD calculations based on Huisman et al. (2004) and UN/World Bank population data.

II.2.3 Australia — pre-retirement earnings — Knox and Tomlin (1997)

50. The data, provided by the Australian Government Actuary, comprise individual final salaries and their subsequent mortality experience by age and sex. The sample is individuals who retired in the four years 1991-94 inclusive from the Commonwealth Superannuation Scheme (for employees of the federal government).

Post-retirement differentials in mortality

51. Table II.4 shows the relative mortality rates by pre-retirement earnings for men.[8] For example, low-earnings men aged 65-69 are 1.26 times more likely to die than the average, while the highest earners have mortality rates of only 68% of the average. The annuity factors, calculated by applying the mortality differences found by Knox and Tomlin to the mortality rates in the UN/World Bank population database, show quite small differences. Pensions are worth 92% of the average to low earners and 106% for the highest earners. The relatively small differences in this study probably arise because of the sample of government employees rather than the population as a whole.

Table II.4. Relative mortality rates by age and pre-retirement earnings and annuity factors by pre-retirement earnings in Australia, men

Earnings	*Relative mortality rates by age*						*Annuity factor*	
(AUD)	*55-59*	*60-64*	*65-69*	*70-74*	*75-79*	*80-84*	*Average Value*	*Relative to average*
20-30	1.31	1.48	1.26	1.42	1.30	1.16	14.2	0.92
30-40	0.93	1.14	1.11	1.10	1.03	0.90	15.4	1.00
40-50	1.14	0.94	1.03	0.76	1.08	0.98	15.6	1.01
50-60	1.00	0.80	0.83	0.74	0.60	1.23	15.8	1.02
60+	0.50	0.46	0.68	0.89	0.81	0.88	16.3	1.06
Total	1.00	1.00	1.00	1.00	1.00	1.00	15.4	1.00

Note: final salaries shown in real 2004 AUD.

Source: OECD calculations based on Knox and Tomlin (1997) and UN/World Bank population data.

8. The sample for women is much smaller than that for men and so further analysis for women is not possible.

II.2.4 United Kingdom — social class — Office of National Statistics data

52. The Office of National Statistics (ONS) carries out a longitudinal study of mortality on the basis of a 1% sample from the census (see Donkin, Goldblatt and Lynch, 2002 and Hattersley, 1999 for a description of the data). The results are divided by social class, which is based on occupation.

Pre-retirement differentials in mortality

53. Table II.5 shows summary results for life expectancy at birth by social class. Professional men can expect to live four years longer than the population average for men, while unskilled men live more than four years less than average. For women, the differences in life expectancy by social class are about half of those for men.

Table II.5. Life expectancy at birth and calculated probability of surviving age 20-65 by sex and social class: United Kingdom

	Life expectancy			*Survival probability*	
	Men	*Women*		*Men*	*Women*
I (Professional)	79.4	82.2	}	90.1%	94.6%
II (Managerial/technical)	77.8	81.7			
IIIN (Skilled non-manual)	76.8	81.3		87.8%	94.2%
IIIM (Skilled manual)	74.6	79.3		85.2%	93.2%
IV (semi-skilled)	73.3	78.6	}	82.8%	92.2%
V (unskilled)	71.0	77.6			
All	75.4	80.1		86.5%	93.7%

Source: OECD calculations based on ONS (2006) and UN/World Bank population data.

54. The right-hand columns of Table II.5 show the calculated probability of surviving labour-market entry at age 20 to pension eligibility age of 65. These probabilities were calculated from the UN/World Bank population data on single-year mortality rates by sex adjusted by relative mortality rates by social class in five-year age bands. Small sample sizes mean that it is necessary to group classes I and II and IV and V together. Around 87% of men of age 20 would be expected to survive until age 65, with this survival probability over three percentage points higher for the top social classes and nearly four points lower for the lowest classes. Again, the differentials for women are smaller: a 1 percentage point higher survival for high classes, and 1.5 point lower for the lower classes.

Post-retirement differentials in mortality

55. Data for life expectancy at age 65 by social class are reproduced in the left-hand columns of Table II.6 below. The average retirement duration for a man is 15.7 years (from 65 to 80.7). But professional men who reach age 65 can expect to live 2.5 years longer than this average while the unskilled live around 2.5 years less than average. As at working age, post-retirement mortality differences for women by class are smaller than they are for men.

Table II.6. Life expectancy at age 65 and calculated annuity factor by sex and social class: United Kingdom

	Life expectancy		Annuity factor	
	Men	*Women*	*Men*	*Women*
I (Professional)	83.3	85.6	15.9	17.9
II (Managerial/technical)	82.1	85.1		
IIIN (Skilled non-manual)	81.7	84.7	15.4	17.6
IIIM (Skilled manual)	80.2	83.2	14.5	16.7
IV (semi-skilled)	79.2	82.8	13.6	16.3
V (unskilled)	78.3	81.9		
All	80.7	83.8	14.9	17.1

Source: OECD calculations based on ONS (2006) and UN/World Bank population data.

56. The UN/World Bank population data are adjusted to reflect the differences in mortality rates by five-year age band in the ONS data. Annuity factors are calculated assuming a 2% discount rate and price indexation of pensions in payment. Occupational differentials in mortality at older ages mean that pensions for professional men are worth 6% more than for men on average while for low-skilled men they are worth 9% less. For women, the longer retirement associated with higher occupation increases likely pension receipt by 4%, while a low occupation reduces this by 5%.

II.3 Conclusions

57. The literature review presented above has covered various countries, different time periods and a range of measures of socio-economic status to show that there are significant differences in the mortality rate across socio-economic groups. The socio-economic attributes of particular importance are education, occupation and income. The mortality differentials observed are generally higher for men than for women, and the size of the differences made by the socio-economic status has appeared to become larger over time.

58. These mortality differentials imply that the pension worth, as measured by the annuity factor calculations, differ significantly across socio-economic groups. For example, in the United States, black men with less than higher secondary education have pensions worth 20% less than the average, whereas Hispanic women fare 13% better than the average. The annuity factor differences alone account for the fact that the pension for a low educated man in Austria is worth less than 90% of that for a man with higher education.

59. To examine further the effects of mortality differences on the policy issues raised in Part I, we require more detailed results. Hence, the next part reports new estimates of mortality by income level, using longitudinal data from Germany, the United Kingdom and the United States.

PART III. MEASURING SOCIO-ECONOMIC DIFFERENCES IN MORTALITY: NEW EVIDENCE ON LINK BETWEEN INCOME AND LIFE EXPECTANCY

III.1 Measurement issues

III.1.1 Paucity of relevant data

60. Fortunately, death is now a rare event in developed countries until quite advanced ages. At age 40, for example, just below the middle of the working age period, the annual probability of a man dying in OECD countries is 0.13% and for women, just 0.06%.[9] Unfortunately, this makes measuring mortality for different socio-economic groups quite difficult. The rarity of the event means that large samples are needed for precise estimates. This, in turn, limits the number of groups into which populations can be divided to show differences in mortality by socio-economic status. For example, it might be necessary to use very broad age bands (say 20 years) or only 2-3 education or occupation groupings. It also has implications for the sources of data that can be used.

61. Most studies of the socio-economic differences in mortality use special longitudinal datasets that follow a subset of the census population over the following year(s), recording any deaths. This approach has the advantage of delivering a large sample, and therefore the possibility of dividing the sample into a number of different groups for the analysis of differential mortality. However, census data typically have little or no information on economic variables, such as income or earnings.

62. An alternative data source is household panel studies. Since these are also longitudinal studies (following individuals over time), the death of members of the sample is generally recorded. Furthermore, many of these surveys, unlike the census, have detailed information on economic variables such as income and wealth. However, sample sizes are rather smaller for these surveys than they are for census follow-up studies. The estimates of mortality differentials can therefore only be made on larger groupings by socio-economic status and/or with less precision. Also, there is the problem of sample attrition: people leave the survey for reasons other than death. While there are econometric techniques that can control for this problem, it undoubtedly also has a cost in terms of precision of estimated effects.

63. The final data source comes from administrative databases: from a pension scheme's records, for example. These records show the value of pensions and, usually, individuals' lifetime earnings history (at least when were covered by the relevant scheme). The pension scheme should also know when people die. Such administrative data, however, only includes earnings and not other socio-economic characteristics, such as education, occupation and income from other sources.

III.1.2 Methodological challenges

64. Studies of mortality require longitudinal data that includes observations both of characteristics when alive and of the time of death. This causes a number of methodological difficulties. Socio-economic status varies for individual across the lifecycle. For example, people may change occupations and their incomes fluctuate. Only the level of education can possibly be thought of as fixed once people enter the labour market and even then, the promotion of "lifelong learning" is likely to undermine this observation. Secondly, characteristics such as "occupation" are only observed for people when in work so can be hard to determine for older people, for example. In contrast, education is observed for people outside the labour force.

9. Source: UN/World Bank population database.

65. A related problem of interpretation arises because of changes between cohorts. For example, younger cohorts have higher levels of education on average than earlier generations. Also, over time, there has been a shift in the occupational structure of the population with a decline in the proportion of manual workers. However, one generally observes period or cross-section data, that is, the mortality experience of a particular cohort over only a small proportion of its life. It is impossible to say whether the mortality of today's younger clerical workers will be the same at older ages as for today's older clerical workers, particularly when other characteristics will differ between the generations.

66. There is a strong correlation between different socio-economic characteristics: education, occupation and income are closely linked (see Statistical Bulletin, 1975, for a discussion of the issues). Some studies therefore take a multivariate approach, attempting to identify separately the impact of the different factors. These studies might show, for example, whether education improves life expectancy because it is a pathway to a higher income or it offers an independent protective effect even controlling for the higher income. The correlation between different characteristics is important for the analyses of differences in life expectancy *per se*, and so the sources of such differentials and therefore policies that might improve equity. Nevertheless, it is not relevant for exploring the implications of life-expectancy differentials for pensions, since it is sufficient for that purpose to observe that the differences occur.

67. Similarly, the question of direction of causation underlying these correlations is important for students of mortality differentials. For example poor health might lead both to a higher mortality risk and reduce income-earnings opportunities at the same time. But, again, the fact that the correlation between socio-economic status and mortality exists is still significant in itself for the analysis of pension systems.

III.1.3. Data and methodology used in this report

68. As noted above, a longitudinal element in the dataset is an essential prerequisite of data suitable for analysing socio-economic differences in mortality. The most common method is to follow a sample drawn from the census. An alternative is to use household panel surveys, which is the approach adopted here.

69. The analysis uses data from three sources: namely the British Household Panel Survey (BHPS), the Panel Study on Income Dynamics for the United States (PSID) and the German Socio-economic Panel (GSOEP). The focus is on income differences in mortality rates. This is because these are easiest to combine with the OECD pension models to explore the implications of mortality differentials for pension policy.

70. The BHPS has been collected annually since 1991 by the ESRC UK Longitudinal Studies Centre with the Institute for Social and Economic Research (ISER) at the University of Essex. The initial sample of around 10 300 individuals in about 5 500 households has since been expanded by a total of nearly 2 500 further households.

71. The PSID, which began in 1968, is a longitudinal study of a representative sample of households in the United States. The sample size has grown from 4 800 families in 1968 to more than 7 000 in 2001: the PSID has so far collected information about more than 65 000 individuals spanning up to 35 years of their lives. The study is conducted at the Survey Research Center at the University of Michigan.

72. The Socio-economic Panel, established in 1984, has been produced by the DIW (Deutsches Institut für Wirtschaftsforschung, German Institute for Economic Research) since 1990. In 1984, it contained around 15 300 individuals belonging to 5 600 households in West Germany. Following reunification, around 2 200 East German households were added and further increases in the sample have happened since.

III.1.4 Evaluating mortality data from panel surveys

73. To evaluate the quality of the mortality data from the panel survey, The Annex Figure compares administrative data on mortality with the mortality rates derived from the household panel data for each country. The data from official statistics and the panel datasets are very similar, at least until the age of 75 or more. It is not surprising that mortality at very old ages is not entirely reflected in the panel datasets. This is because people dying at these ages often die in institutions, where it is difficult to follow panel members and also to retrieve the information that the respective person died. However, it is relatively simple to adjust the data to take account of this affect. The analysis is based in the first instance on administrative mortality rates. These are then adjusted for different income groups by the *relative* mortality rates for a particular group (compared with the average).

74. While household panel data has the advantage over census follow-up data in providing relatively reliable information on household incomes, the datasets are relatively small. This limits the extent to which the datasets can be divided into different groups. Individuals are therefore grouped by the tertile (or third) of equivalised household net income into which their household falls. This gives three income groups: the lowest third, middle third and highest third.

75. Both mortality rates and incomes vary with age. Again, sample size problems are a constraint. Having experimented with finer age bands, the results that follow are based on a 10-year moving average (55-64 year olds, 56-65 year olds *etc.*). Individuals are allocated to an income tertile by age.

III.2 New evidence on link between income and life expectancy

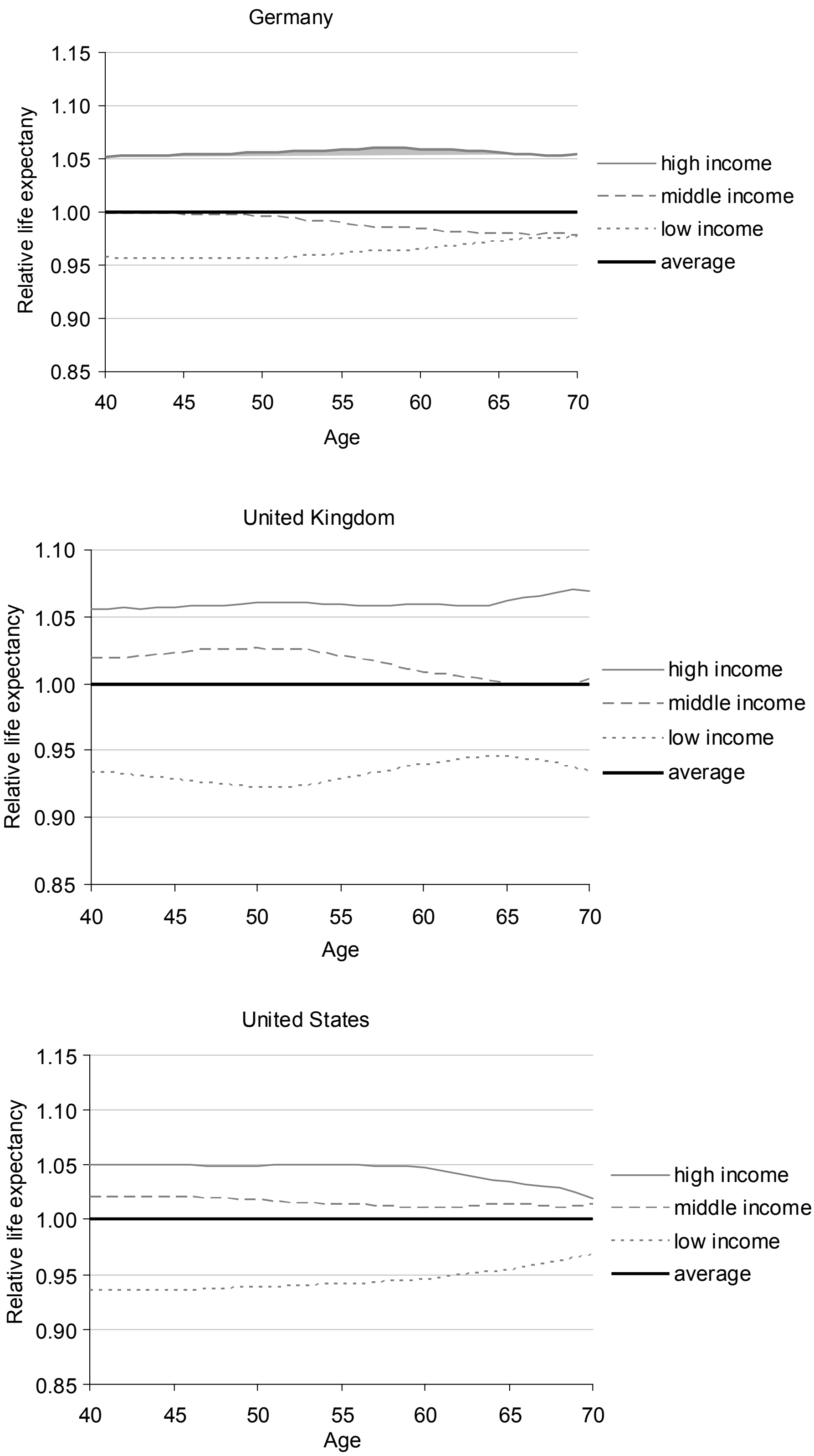
76. The core results, showing how life expectancy varies by sex, age and household income, are presented in Figures III.1 and III.2. In each case, the results are normalised to the average life expectancy for the population as a whole at a particular age.

77. Taking the United Kingdom as an example, total life expectancy for a 40-year-old man is 76.6 years on average. For poor people (in the lowest third of household incomes) it is just 73.9 years, while for the richest third it is 78.9 years. That gives an income gap in life expectancy of five years.

78. Average total life expectancy for a 40-year-old German man is similar to the result for the United Kingdom: 76.2 years. However, the life-expectancy gap between the average and low-income men is smaller than in the United Kingdom: life expectancy for the lowest tertile is 74.7 years. For richer men, life expectancy at age 40 is 78.4 years, giving a rich-poor differential at age 40 of 3.7 years.

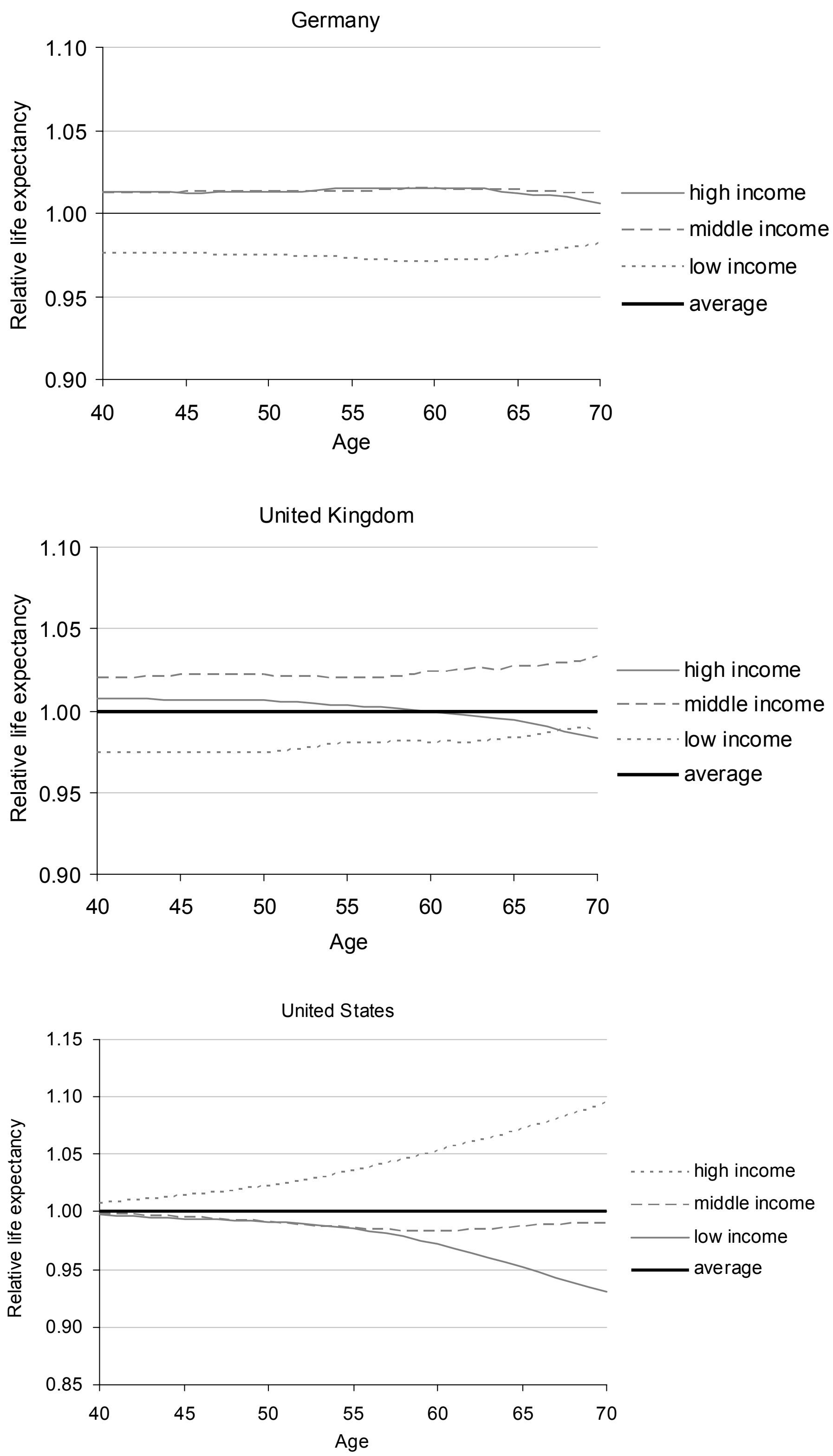
79. The patterns in life-expectancy differentials vary with age. In Germany, high-income men retain their life expectancy advantage up to age 70. However, mortality of low-income men converges from age 55. In the United Kingdom, there is convergence between age 50 and 65, but then some divergence up to age 70. In the United States, there is clear convergence from age 60 to 70, with relative life expectancy of richer men falling and that for poorer men rising towards the average.

Figure III.1. Income differences in life expectancy: men



Source: OECD calculations using UN/World Bank population database; BHPS, GSOEP and PSID panel data.

Figure III.2. Income differences in life expectancy: women



Source: OECD calculations using UN/World Bank population database; BHPS, GSOEP and PSID panel data.

80. It is well known that women live longer than men on average: total life expectancy at age 40 is 81.7 for German women, compared with 76.2 for men. Socio-economic differences in mortality between women are generally much smaller than for men. The life-expectancy gap for 40-year-olds in Germany is 3.7 years for men and 1.5 years for women. For the United Kingdom, the data show that middle-income women have the lowest mortality risk: the gap between low- and high-income women is very small (1.5 years).

81. In both Germany and the United Kingdom, the differentials for women are fairly constant with age. In contrast, the United States shows marked divergence in life expectancy with age for women. This is also the opposite effect of that for American men, for whom life expectancy converges with age.

III.3 Income, life expectancy and the lifetime value of pensions

82. The implication of socio-economic differences in mortality can be measured in a number of ways. This report makes use of annuity factor as well as the progressivity of pension benefits and pension wealth to quantify impact of differential mortality on pensions.

83. Table III.1 reports the annuity factor for men and women across income tertiles, calculated on the basis of results for Germany, the United Kingdom and the United States (as reported in the Annex). For British men aged 65, the annuity factor for a man with a low income is 11.9 compared with 13.2 for a man with household income in the top third. Against the baseline, pensions are worth around 5% less than the average for poorer men and 5% more for richer than for people with average life expectancy. The differentials are similar albeit slightly smaller for men in Germany and the United States.

84. For women, the differences are much less pronounced than they are for men in Germany and the United Kingdom. There are two main reasons. First, mortality differences are smaller for women than they are for men. Secondly, women live longer than men on average so a particular difference in life expectancy is proportionally less important. In Germany, the difference in annuity factors between the rich and poor thirds is 8 percentage points for men and just 3.5 for women. In the United Kingdom, there is an inverted U-shape of annuity factors with household income: low and high-income women have near to the population average expected pension wealth, but middle-income women live longest. Their pensions are worth 2.3% more than the average. The largest difference in annuity factors is for American women, with richer women living sufficiently longer than the average to mean that pensions are worth 9% more than the average.

85. These results confirm that a pension promise, *ceteris paribus*, is worth more on a lifetime basis *ex ante* to a rich person that a poor person because of differences in mortality related to income.[10]

10. This effect is also summarised by measures other than the annuity factor in Part IV.

Table III.1. Annuity factors at age 65 by sex and tertile of household income: United Kingdom, Germany and United States

	Low	*Middle*	*High*	*Average*
Germany – men				
Annuity factor (65)	14.40	14.68	15.60	14.87
Relative to baseline (%)	*-3.16*	*-1.28*	*4.91*	
United Kingdom – men				
Annuity factor (65)	11.91	12.51	13.19	12.51
Relative to baseline (%)	*-4.80*	*0.00*	*5.44*	
United States – men				
Annuity factor (65)	12.03	12.72	12.97	12.57
Relative to baseline (%)	*-4.30*	*1.19*	*3.18*	
Germany – women				
Annuity factor (65)	14.45	15.00	14.97	14.80
Relative to baseline (%)	*-2.36*	*1.35*	*1.15*	
United Kingdom – women				
Annuity factor (65)	15.10	15.06	14.71	14.76
Relative to baseline (%)	*2.30*	*2.03*	*-0.34*	
United States – women				
Annuity factor (65)	14.73	15.15	16.75	15.32
Relative to baseline (%)	*-3.85*	*-1.11*	*9.33*	

Source: OECD pension models; BHPS, GSOEP and PSID panel data; UN/World Bank population data.

PART IV. SOCIO-ECONOMIC DIFFERENCES IN MORTALITY: POLICY IMPLICATIONS

86. Mortality differentials across socio-economic groups have important implications for many areas of pension policy, as set out in Part I. This Part of the report uses the results on income differences in mortality to explore two of them. The first is the progressivity of the pension system, and the degree of equity and redistribution between individuals. The second is the question of pension age. In particular, would an increase in pension age be regressive?

IV.1 The pension-earnings link and progressivity of pension benefits

87. Pension systems differ substantially in the degree to which retirement benefits are linked to earnings when working or, put the other way around, in the degree of progressivity in pension benefits. The analysis that follows uses the OECD pension models (see OECD, 2005, 2007 for a description). Differences in mortality by income are mapped on to the earnings used to model pension benefits. The modelling assumes that people in a particular tertile of the income distribution are in the same tertile of the earnings distribution. The earnings distribution in the three countries under consideration (Germany, the United Kingdom and the United States) is, of course, broadest in the United States and narrowest in Germany. The lower tertile of the earnings distribution is 77% of the mean in Germany, 69% in the United Kingdom and 63% in the United States. The upper-tertile thresholds are 106% of mean earnings in the United Kingdom and United States and 107% in Germany.

88. Table III.1 at the end of the previous part of the report showed how mortality differences affect the annuity factors for different groups. The annuity factor is used to calculate pension wealth: the lifetime value of the flow of pension payments during retirement. Assume a pension worth 50% of average earnings and an annuity factor of 15. This means that pension wealth is 50% x 15 = 7.5, where pension wealth is measured as a multiple of annual economy-wide average earnings.

89. The three countries in question differ in their emphasis on the two key roles of pension systems: first, “redistribution”, ensuring that all people’s income in old age reaches some absolute level; and, second, “insurance”, giving people a retirement income designed to maintain individual, relative standard of living in retirement.

90. This can be illustrated by showing how the replacement rates vary with individual earnings (Table IV.1). In Germany, the replacement rate is 40% for workers on 50% of average earnings right up to the ceiling of the public pension, which is just over 150% of average earnings (on the OECD measure). The United Kingdom places much greater emphasis on redistribution in its pension system than Germany does. The replacement rate for a low earner (50% of average earnings) of 53% in the United Kingdom is significantly higher than in Germany. But for an average earner, replacement rates are lower in the United Kingdom – 31% – than in Germany. For high earners – with 200% of average earnings – the differences are still more marked: replacement rates of 17% and 30% respectively.

91. The United States lies between the other two countries, in placing a greater emphasis on redistribution in its public pension system than Germany but having a closer link between pension and earnings than in the United Kingdom.

Table IV.1. Gross replacement rates for full-career workers

	Median Earner	Individual earnings, multiple of mean				
		0.5	0.75	1	1.5	2
Germany	39.9	39.9	39.9	39.9	39.9	30.0
United Kingdom	33.8	53.4	37.8	30.8	22.6	17.0
United States	43.3	55.2	45.8	41.2	36.5	32.1
OECD	60.5	73.0	62.7	58.7	53.7	49.2

Source: OECD pension models.

92. Previous OECD work has used a measure of the progressivity of pension benefit formulae, which summarises the relationship between pre-retirement earnings and pension entitlements in a single number (see Whitehouse, 2006 and OECD, 2007). The progressivity index is designed so that a pure flat-rate or basic scheme would score 100% and a pure insurance scheme, zero. The calculation is based on the Gini coefficient. The higher the Gini coefficient, the more unequal is a distribution. Formally, the index of progressivity is calculated as 100 minus the ratio of the Gini coefficient of pension entitlements divided by the Gini coefficient of earnings (expressed as percentages). In each case, the Gini coefficients are calculated using the earnings distribution as the weight.

93. Table IV.2 goes through the calculations step-by-step. The first row shows the Gini coefficients for earnings, based on OECD earnings-distribution data. The earnings distribution is less dispersed in Germany than in the United Kingdom, but is the most unequal in the United States.

94. The second line of Table IV.2 shows the Gini coefficient for pension entitlements, as measured by pension wealth. At just under 8, the Gini coefficient for pensions is the lowest in the United Kingdom by a long way. It is higher in Germany (nearly 21) than in the United States (18.5).

95. Combining the Gini coefficient for pensions and the Gini coefficient for earnings gives the index of progressivity of pension benefit formulae. As expected from the data on replacement rates for people on different levels of earnings, the United Kingdom records the highest index: 73%. Germany, with 22% has the lowest, with the United States, on 44%, between the other two countries. However, none of the three conforms to the two model systems at the end of the spectrum of a pure flat-rate scheme or one with a constant replacement rate.

96. These results are based on population mortality rates. The next line of Table IV.2 shows the impact of the income differences in mortality identified using the panel data for three countries in Part III. Mortality differentials increase the Gini coefficient on pensions by about 2 points in Germany and the United Kingdom and 1 point in the United States. As expected, differences in mortality related to income reduce the progressivity of the pension system, with falls of around 7 points in the index for Germany and the United Kingdom and 4 points for the United States.

97. These results are based on gross earnings and gross pensions. However, taxes and contributions paid when working and taxes (and, in Germany, contributions) paid on pensions during retirement have an important distributional effect. The bottom half of Table IV.2 therefore repeats the analysis in net terms. Because tax systems are progressive, the Gini coefficient on net earnings is lower than that on gross earnings for all three countries: by 5.5 points in Germany, 3.5 in the United Kingdom and 3.0 in the United States.

98. However, taxes have much less of an equalising effect on pensions than they do on earnings. Table IV.2 shows that the Gini coefficient for pensions is only about 1-1.5 points lower on a net rather than on a gross basis. The index of progressivity is therefore a little higher in the United Kingdom when taxes

and contributions are taken into account and a little lower in the United States. In Germany, the index is significantly lower on a net than a gross basis.

99. The last line of Table IV.2 shows how differential mortality affects these net measures. The most striking result is that for Germany: differences in life expectancy due to differences in income entirely offset the progressivity of the pension system when measured on a net basis. For the United Kingdom and the United States, the gross and net differentials are similar.

Table IV.2. Gini coefficients and index of progressivity before and after adjusting for income differences in mortality

	United Kingdom		*Germany*		*United States*	
	Gini	*Index*	*Gini*	*Index*	*Gini*	*Index*
Gross earnings	28.85		26.70		33.19	
Gross pension wealth						
– unadjusted	7.95	72.5	20.94	21.6	18.55	44.1
– adjusted	9.87	65.8	22.93	14.1	19.68	40.7
Net earnings	25.39		21.25		29.80	
Net pension wealth						
– unadjusted	6.51	74.4	19.25	9.4	17.43	41.5
– adjusted	8.55	66.3	21.24	0.1	18.56	37.7

Source: OECD pension models.

100. The three countries under study have rather more progressive pension systems than in the OECD as a whole. For example, only the pure basic pensions in Ireland and New Zealand and Canada's mix of basic and means-tested pensions produce a higher progressivity index than in the United Kingdom. Thirteen OECD countries have a tighter link between pension and earnings than in Germany as measured by the progressivity index and the United States lies between Germany and the United Kingdom on this measure.

101. It is therefore useful to examine how mortality differentials across income groups will affect the progressivity of other OECD countries' pension systems. As data on mortality differences by income are hard to find, we have used the results for men in the United Kingdom to generate stylised measures for a broad selection of countries. Differentials are smaller for women and are smaller in Germany and the United States than they are in the United Kingdom. The results can therefore be thought of as an upper bound on the effect.

102. Table IV.3 again shows the Gini coefficients for earnings and pensions that underlie the calculations. These then generate the progressivity index, shown in the fourth and fifth columns of the Table. Countries are ranked by the progressivity index: as discussed previously, the flat-rate systems of Ireland and New Zealand have an index of 100. At the other end of the scale, the index is negative in the Netherlands and Sweden. This is because replacement rates *increase* with earnings over a significant income range (while in other countries they tend to fall). In Finland, Hungary and Poland, the index is close to zero because replacement rates are constant with earnings.[11]

103. Applying the mortality difference for men in the United Kingdom to other countries' mortality rates increases the Gini coefficient for pensions. The difference is around 2.4 points on average. It is

11. Note that the analysis uses 2006 parameters and rules. Sweden recorded a progressivity index of 10.2 on 2004 rules (OECD, 20007). However, a recent change to the occupational scheme, shifting it to defined contribution, includes a marginal contribution rate of 31% of pay. Under OECD assumptions, this means that the total replacement rate increases for individuals with upwards of 110% of average earnings.

particularly large in countries where benefits in retirement increase in line with earnings: Ireland, Luxembourg, the Netherlands, New Zealand and Norway. In these countries, the average increase in the Gini coefficient of pensions with differential mortality is 2.8 points, compared with just 2.2 points for the 10 countries with price indexation of pensions in payment. This is because the longer-lived reap greater advantage from the real increase in benefits during retirement.

104. Likewise, there is a decline in the progressivity index for all countries when income differences in mortality are taken into account. The fall averages just over 10 points. The strongest effect of income related mortality differentials is observed for Norway: a fall of almost 15 points. Hungary and Spain, on the other extreme, have the lowest decline in system progressivity. This is because these two countries have the most unequal distribution of earnings, as evidenced by the Gini coefficient. This means that the disadvantaged group has lower earnings than in other countries and the longer-lived group is relatively richer.

105. The socio-economic differences in mortality explored in this report are systematic, that is *ex ante* differences. Even if a pension scheme is actuarially fair for the population as a whole, it will be actuarially unfair to groups with systematic shorter life expectancy. Socio-economic differences in mortality therefore suggest that lower-income workers should receive higher pension replacement rates than high earners to avoid the poor cross-subsidising the rich.

Table IV.3. Gini coefficients and index of progressivity before and after adjusting for income differences in mortality, selected OECD countries, men (applying mortality differentials observed in the United Kingdom)

	Gini coefficient			*Progressivity index*		
	Gross earnings	*Gross pension wealth*				
		Unadjusted	*Adjusted*	*Unadjusted*	*Adjusted*	*Difference*
New Zealand	24.8	0.0	2.8	100.0	88.7	*-11.3*
Ireland	25.7	0.0	2.9	100.0	88.8	*-11.2*
Canada	24.6	2.8	5.1	88.6	79.4	*-9.2*
Czech Republic	23.5	6.6	9.1	71.9	61.2	*-10.7*
Korea	25.5	10.6	13.0	58.4	48.9	*-9.5*
Belgium	19.7	9.4	11.7	52.4	40.9	*-11.5*
Japan	24.0	13.1	15.3	45.5	36.6	*-8.9*
Norway	19.8	12.8	15.8	35.3	20.6	*-14.7*
Mexico	24.7	19.7	22.3	20.1	9.6	*-10.6*
Spain	26.5	21.9	23.9	17.4	9.9	*-7.6*
France	24.6	20.7	22.7	16.2	7.8	*-8.4*
Luxembourg	24.6	20.9	23.6	15.4	4.3	*-11.0*
Poland	26.0	25.3	27.5	2.8	-5.9	*-8.7*
Finland	22.0	21.6	24.0	2.0	-9.1	*-11.1*
Hungary	27.9	27.9	29.9	0.0	-7.4	*-7.4*
Netherlands	23.2	23.6	26.4	-1.8	-13.8	*-12.0*
Sweden	21.2	24.3	26.6	-14.7	-25.8	*-11.0*

Note: Based on preliminary models for 2006 parameters and rules.

Source: OECD pension models.

IV.2 Implications of changing the pension eligibility age

106. Pension wealth – the lifetime value of pension – is again the appropriate measure to assess the impact of reforms which will increase the pension eligibility age, since they change the duration over which pensions are paid. Table IV.4 explores the effect at different income levels of increasing the pension age from 65 to 67. Germany has legislated such an increase in pension age. The United Kingdom will increase its age to 68 by the middle of the century. The increase in the United States is underway and pension age will soon also be 67.

107. The Table begins with the annuity factors at age 65. The second row of each panel of Table IV.4 shows the annuity factor at age 67. It is obviously lower because of the shorter life expectancy at that age and the shorter expected duration of benefit payment than at age 65.

108. However, both of these annuity factors – at 65 and 67 – are conditional on having survived until that age. To assess the complete effects of a change in pension age from 65 to 67, it is necessary to allow for the probability of dying between 65 and 67. The third line of each section of Table IV.4 shows annuity factor that gives the value measured at age 65 of a pension starting at age 67, thus allowing for the additional pre-retirement mortality risk with the higher pension age. Take a man with average mortality rates in the United Kingdom (right-hand column of the Table). The annuity factor at age 65 is 12.5 and at age 67, it is 11.5, around 8% lower than at age 65. However, taking account of the probability of dying between 65 and 67, the annuity factor for a pension from age 67 but measured at age 65 is just 10.5, or nearly 16% lower. Thus, an increase in pension age from 65 to 67 cuts the lifetime value of the pension by 16%, based on average mortality rates.

109. Looking at the pattern for different income tertiles, the impact of differential mortality on the lifetime value of pensions is, of course, apparent in all three of the annuity factors shown for each case. The differences in annuity factors with the change in pension age are not, however, all that large. For men in the United Kingdom, the increase in pension age cuts low earners lifetime benefits by 16.4% compared with 15.1% for high earners and 16% for mid earners.

110. In Germany, there is very little difference in the losses for men between the different income groups. In contrast, the pattern of mortality rates in the United States means that lower earning men lose slightly less than average (and higher earners slightly more) from a change in pension age.

111. For women, the differences in the reduction in pension wealth are again very similar across the income range in Germany. In the United Kingdom, as for men in the United States, low-income women lose proportionally less than higher-income women from the change. In the United States, the relative losses are greater for low-income women.

112. These results confirm that a pension promise, *ceteris paribus*, is worth more *ex ante* to a rich person that a poor person because of socio-economic differences in mortality. However, changes in pension age make little difference either way to this redistribution from poor to rich. Fairness in the pension system can only be addressed by a redistributive benefit formula: changes in pension age are broadly neutral in their distributional consequences.

Table IV.4. Annuity factors by tertile, sex and retirement age: Germany, United Kingdom and United States

	Low	*Middle*	*High*	*Average*
Germany – Men				
Annuity factor (65)	14.40	14.68	15.60	14.87
Annuity factor (67)	11.96	12.04	12.83	12.26
Annuity factor (67 at 65)	10.05	10.08	10.74	10.28
Differential (65 to 67) per cent	*-15.91*	*-16.28*	*-16.25*	*-16.15*
UK – Men				
Annuity factor (65)	11.91	12.51	13.19	12.51
Annuity factor (67)	10.89	11.46	12.15	11.48
Annuity factor (67 at 65)	9.96	10.51	11.20	10.53
Differential (65 to 67) per cent	*-16.39*	*-15.99*	*-15.08*	*-15.82*
United States – Men				
Annuity factor (65)	12.03	12.72	12.97	12.57
Annuity factor (67)	11.09	11.65	11.87	11.53
Annuity factor (67 at 65)	10.22	10.67	10.87	10.58
Differential (65 to 67) per cent	*-15.08*	*-16.14*	*-16.24*	*-15.81*
Germany – Women				
Annuity factor (65)	14.45	15.00	14.97	14.80
Annuity factor (67)	13.36	13.82	13.80	13.66
Annuity factor (67 at 65)	12.35	12.73	12.72	12.60
Differential (65 to 67) per cent	*-14.52*	*-15.15*	*-14.99*	*-14.89*
UK – Women				
Annuity factor (65)	15.10	15.06	14.71	14.76
Annuity factor (67)	14.02	13.92	13.54	13.64
Annuity factor (67 at 65)	13.02	12.87	12.46	12.60
Differential (65 to 67) per cent	*-13.75*	*-14.49*	*-15.26*	*-14.62*
United States – Women				
Annuity factor (65)	14.73	15.15	16.75	15.32
Annuity factor (67)	13.50	14.04	15.67	14.17
Annuity factor (67 at 65)	12.37	13.02	14.66	13.12
Differential (65 to 67) per cent	*-16.02*	*-14.03*	*-12.49*	*-14.35*

Source: OECD pension models.

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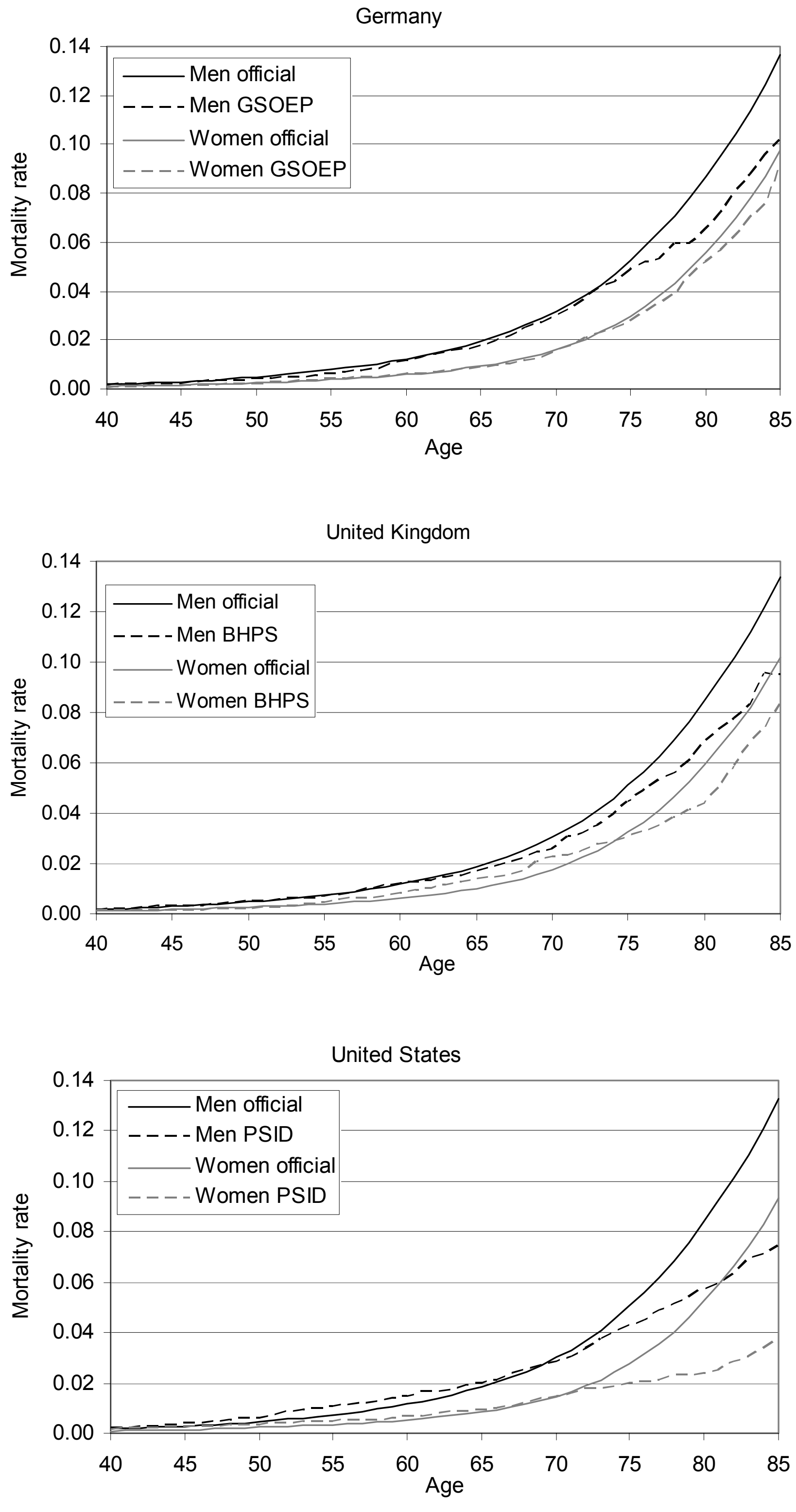
ANNEX FIGURE: MORTALITY RATES FROM ADMINISTRATIVE AND HOUSEHOLD-PANEL DATA



Source: UN/World Bank population database; BHPS, GSOEP and PSID panel data.

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