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HEALTH AND WORK AT OLDER AGES: USING MORTALITY TO ASSESS EMPLOYMENT CAPACITY ACROSS COUNTRIES

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ABSTRACT

Health and longevity have increased substantially over the last 50 years, yet the labor force participation of older men has declined in most developed countries. We use mortality as a measure of health to assess the capacity to work at older ages in 12 OECD countries. For a given level of mortality, the employment rates of older workers vary substantially across countries and over time within countries. At each mortality rate in 2007, if American men between the ages of 55 and 69 had worked as much as American men in 1977 they would have worked an additional 3.7 years between ages 55 and 69. That is, men in this age range in 2007 would have had to work 46.8 percent more to work as much as men with the same mortality worked thirty years earlier in 1977. Comparing across countries, at each mortality rate in 2007, to match the work of American men, French men for example would have to work 4.6 years more between the ages 55 to 69 than they actually did work. We also find that there is little relationship across countries between mortality improvements and the change in employment at older ages.

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Countries around the world are facing two conflicting long-run phenomena. Health and longevity have improved substantially over the past several decades. At the same time, the labor force participation of men at older ages has declined substantially. Assuming that improved health increases the productive capacity of older persons, the improvement in the capacity to work has not been allocated to increasing employment. With many countries facing financial stress on social security and/or health care programs the capacity to prolong working lives may be an important option in paying for the higher costs that increased longevity places on these programs. In this paper, we use mortality as a measure of health and the capacity to work at older ages. We think of mortality as one important indicator of health. We fully understand that mortality is only one of many potential measures of health. For our purposes, however, mortality has the advantage that it is comparable within countries over time and comparable across countries at a point in time and thus allows the comparisons that we make in this paper. We aim to shed light on the dispersion across countries in work at older ages given health as measured by mortality.

We compare results across the twelve OECD countries that are participating in the International Social Security Project for which long time-series of labor force and mortality data are available.[1] Our analysis is based on data for the fifty year time period 1957 to 2007. We focus primarily on data for ages 60 to 64, since in many countries the greatest transition between work and non-work occurs in this age range. We use data

[1] Our twelve countries are Belgium, Canada, Denmark, France, Germany, Italy, Japan, the Netherlands, Spain, Sweden, the United Kingdom, and the United States. These countries correspond to the twelve countries used in the International Social Security project studying both elderly employment (Gruber and Wise 2004) and mortality and health at older ages (Wise 2011) and the summary to the latter volume (Milligan and Wise 2011).

for men only, since long-run analysis of the employment of women is complicated by the cross-cohort growth of the female work-force in the second half of the twentieth century.

The improvement in mortality in developed countries is well-known and many papers discuss the trend. A summary of the trends in developed countries in life expectancy at age 50 is provided in Glei, Meslé, and Vallin (2010). They find that, in both the 1950 to 1980 and the 1980 to 2004 periods, lower mortality from heart disease and other circulatory diseases provide the biggest source of improvements across countries for men. Crimmins, Garcia, and Kim (2010) find a weak association between health differences and life expectancy across countries, although Japan has the best health indicators and longest life expectancy and the United States among the lowest on both. The determinants of mortality are discussed in Cutler, Deaton, and Lleras-Muney (2006). Differences within countries across socio-economic groups are documented in Pappas et al. (1993) and Rogers et al. (2000).

Employment at older ages has dropped in developed countries in the last half century although with an increase beginning in the mid-1990s in our set of twelve countries. This decline in employment motivated research to understand the causes of the drop in employment. A series of cross-country studies (Gruber and Wise 1999, 2004, 2007) investigated the impact of social security provisions on retirement, finding that inducements to retire inherent in social security policy provisions are very strongly related to work at older ages and in many countries induce early retirement. Blöndal and Scarpetta (1999) reproduce the Gruber and Wise (1999) analysis for more OECD countries. Lumsdaine and Mitchell (1999) provide a summary of the retirement and

incentives literature. More recently, von Wachter (2012) provides a meta-analysis of the impact of financial incentives on the labor supply of older workers.

Our paper is set out in several sections. In section 1 we show the relationship between mortality and other measures of health. In section 2 we discuss improvements in mortality over time. In section 3 we consider the relationship between employment and mortality across countries. In section 4, we compare employment by mortality in 1977 and 30 years later in 2007. In section 5, we develop what we believe is a novel way to measure the capacity to work and to compare the capacity to work across countries. In section 6 we use our prior results to consider capacity to work and labor force participation across countries. The results reinforce the prior evidence that differences across countries in employment, including differences in employment at given levels of mortality, are determined for the most part by differences in the policy inducement to retire inherent in social security plan provisions across countries. Differences in employment seem unrelated to health differences as captured by mortality. Moreover, if the policies that induce retirement were the same across countries employment at given mortality levels would be very similar across countries. It is unlikely that differences in work capacity at given mortality levels generate observed differences in employment across countries. Section 7 is a summary and discussion.

We believe we make the case that mortality is an important measure of health that facilitates the comparison of health and the capacity to work across countries. The mortality and employment comparisons provide new evidence on the dispersion across countries of both health and employment trends. The measure of capacity to work based on employment by mortality is novel and shows substantial and informative

variation over time both within countries and across countries. An important caveat to our results is that all of the mortality rates we use are averages across all groups in the population and do not distinguish the large differences by socioeconomic and race-ethnic group and especially by education.

1. Mortality and other measures of health

We aim to better understand the relationship between health and work at older ages and how it differs across countries. Two problems confound the study of this relationship. First, rich data on health is available only for more recent years in most countries. Surveys such as the Health and Retirement Study in the United States provide extensive data over the last twenty years, but do not provide data for study over a longer time period. The second problem is international comparability. It is well known that subjective health measures are subject to substantial country-specific response effects resulting from linguistic and cultural differences in the interpretation of survey questions.[2] More objective administrative data on health is available in some countries, but international differences in definitions and health measures limit the use of these data for cross-country comparisons.

We use mortality to overcome these problems. Comparable data on mortality are available for very long time series—stretching back to the 18th century in some countries—and allow the construction of data series that are comparable across countries.

[2] Kapteyn et al. (2007) and King et al. (2004) provide discussion of the problem of cross-cultural comparability.

To establish the relationship between mortality and other measures of health, we consider different views of the data, in particular with respect to self-assessed health (SAH). First we demonstrate the relationship between mortality and SAH across countries, including SAH country-specific response effects. Second, we show the relationship between the percent change in SAH versus the percent change in mortality across countries, in effect differencing out the country specific SAH response effects. Third we calculate mortality and SAH "equivalent ages" in the United States. Fourth, we point out the strong relationship between mortality and a more general measure of health—the Poterba, Venti, and Wise health index. We draw on two key data sources--the Human Mortality Database and the National Health Interview Survey, from which we form a series of SAH by age and year. More information on these data sources is provided in the Appendix.

Mortality and SAH across Countries: Figure 1-1 shows the relationship between mortality and SAH for men age 60-64 in the United States between 1972 and 2006. Death rates are shown on the right-hand axis and the proportion responding that self-assessed health is fair or poor is shown on the left-hand axis. Overall there is a rather close correspondence between the two series although self-assessed health has been volatile since 2002. Figure 1-2 shows comparable relationships for Sweden. There is one key difference between the data for the two countries however. The difference between mortality and SAH is much lower in Sweden than in the United States. For example, in 1987 mortality minus SAH in Sweden was about -0.08; in the United States in 1987 mortlity minus SAH was -0.22. The difference reflects the country specific response effects in SAH.

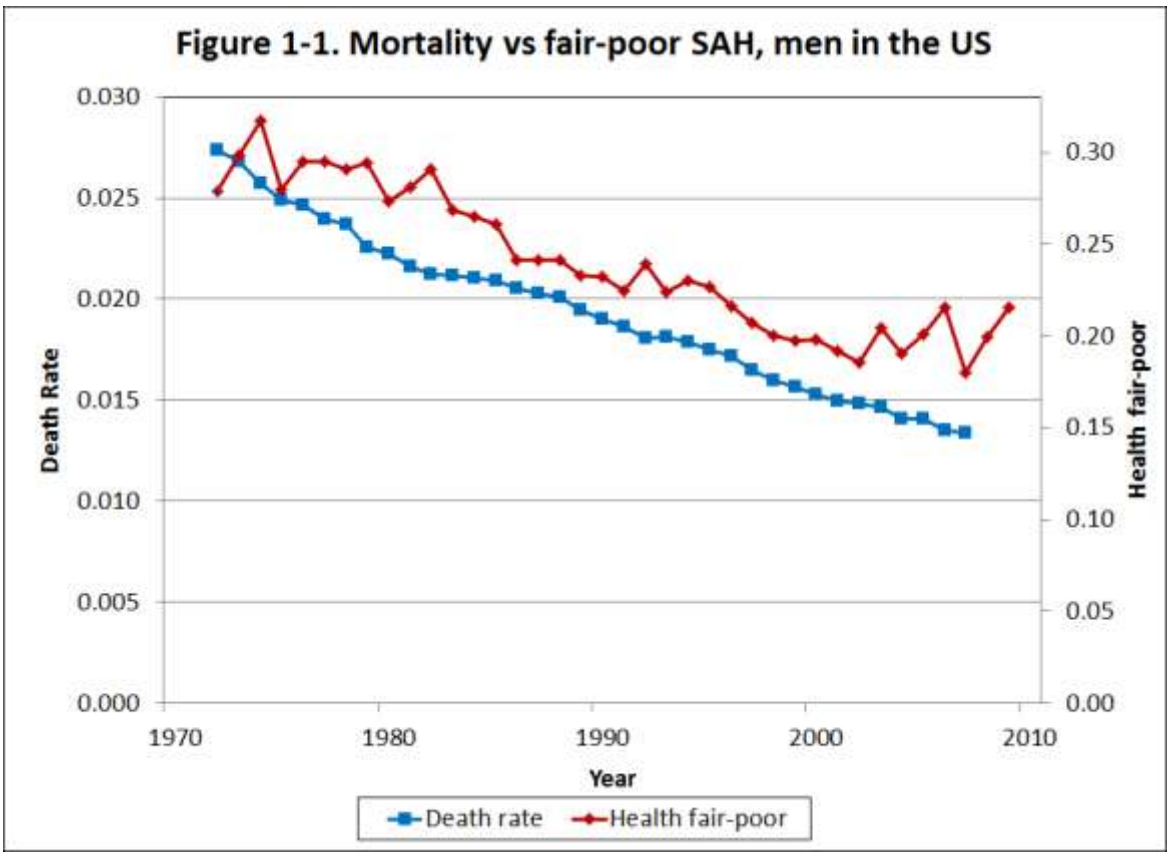


Figure 1-1. Mortality vs fair-poor SAH, men in the US
0.030
0.025
0.020
0.015
0.010
0.005
0.000
Death Rate
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Health fair-poor
1970
1980
1990
2000
2010
Year
Death rate
Health fair-poor

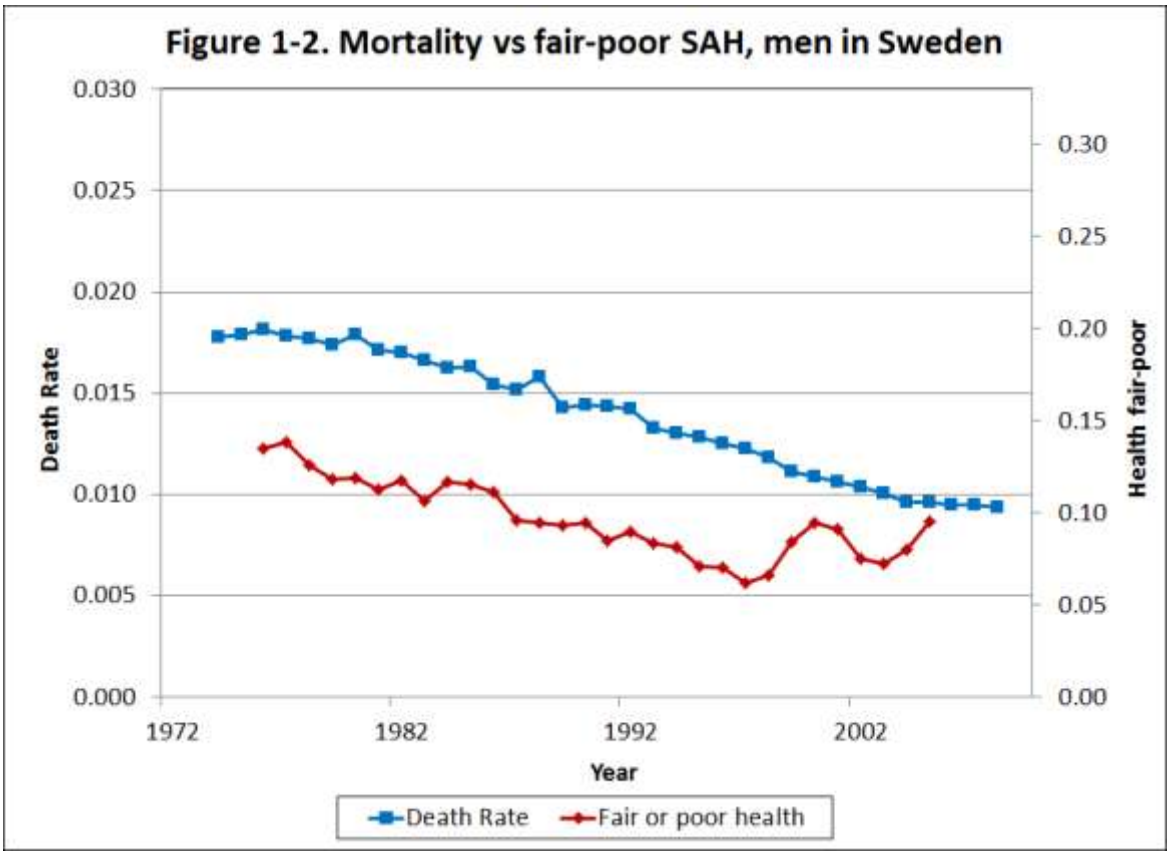
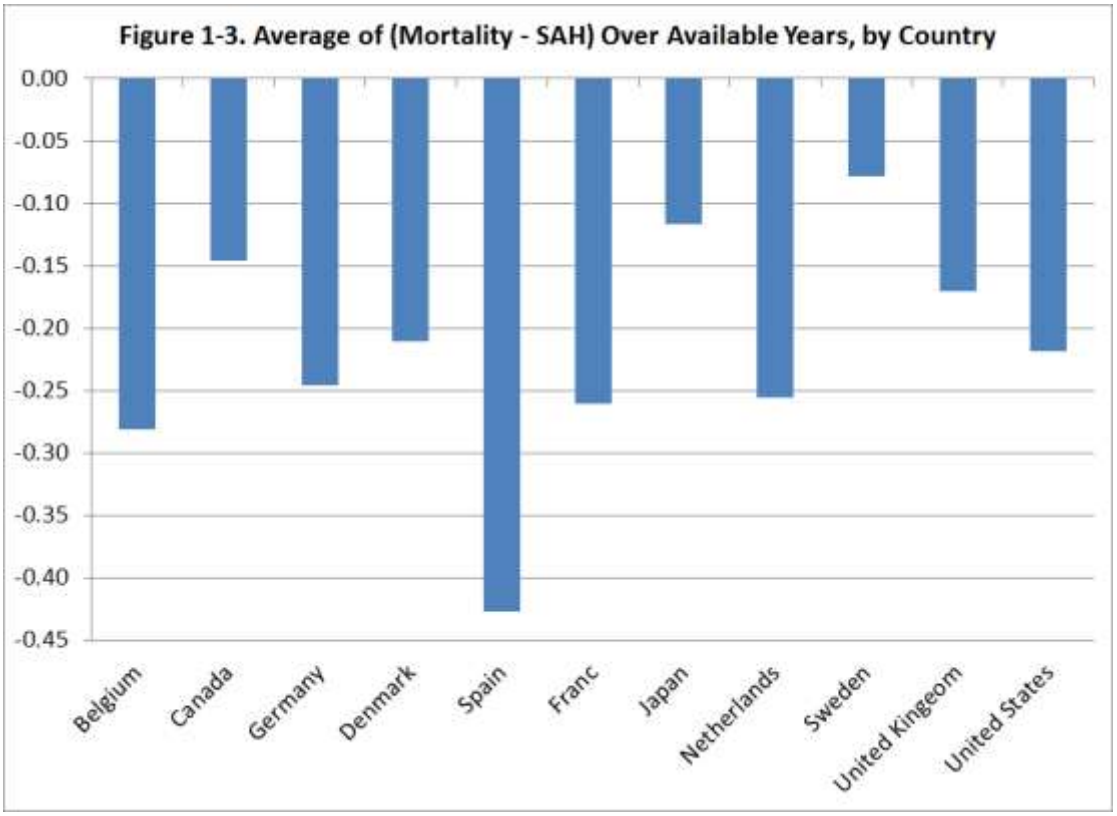


Figure 1-2. Mortality vs fair-poor SAH, men in Sweden
0.030
0.025
0.020
0.015
0.010
0.005
0.000
Death Rate
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Health fair-poor
1972
1982
1992
2002
Year
Death Rate
Fair or poor health

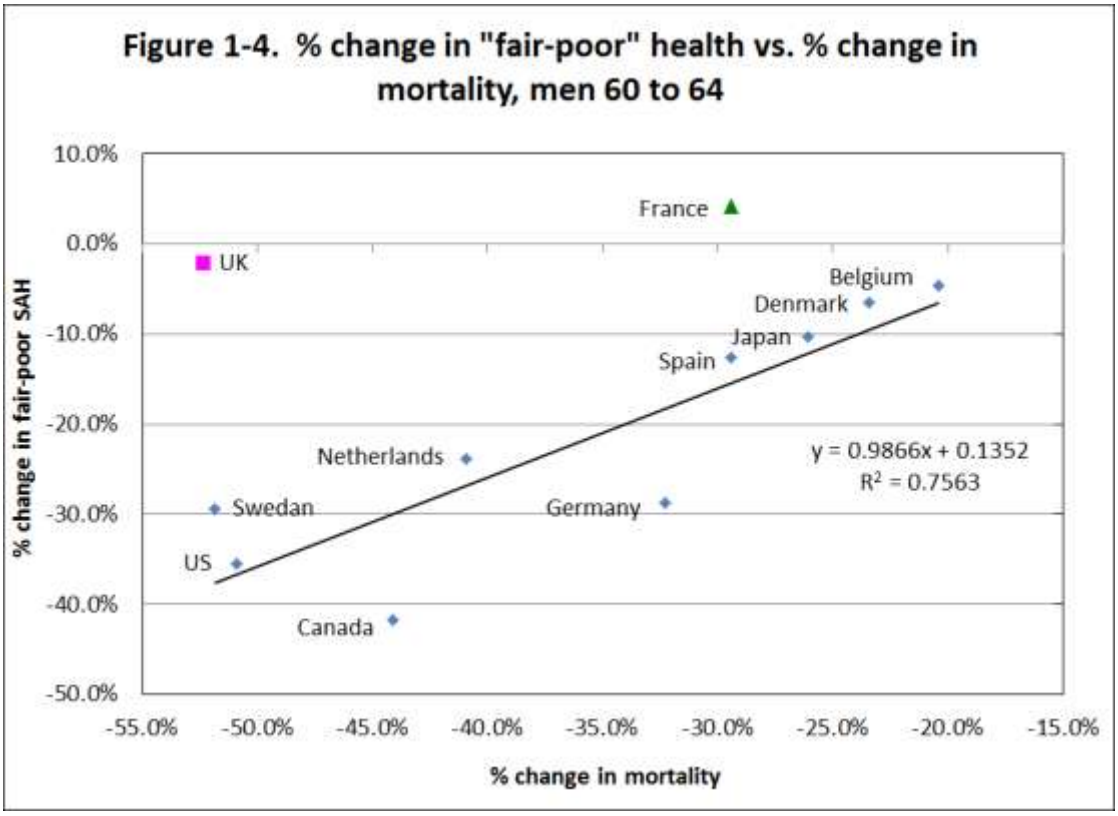
The average of mortality minus SAH over the years for which the two are available in each country—and the number of years varies across countries—which we interpret here as a simple measure of SAH country response effects with respect to mortality are shown in Figure 1-3. Thus to compare health across countries based on SAH it is necessary to make adjustment for country response effects which is explored in detail by Kapteyn, Smith, and Van Soest (2007).



Cross-Country Comparison between the Percent Change in Mortality and the Percent Change in SAH: One way to attempt to control for country-specific SAH response effects is to consider the relationship between the relationship between the percent change in SAH and the percent change in mortality across countries—that is in

effect differencing out the SAH country response effects. Following this approach, Milligan and Wise (2012) find a very strong relationship between the percent change in mortality over time and the percent change in self-assessed health over time.

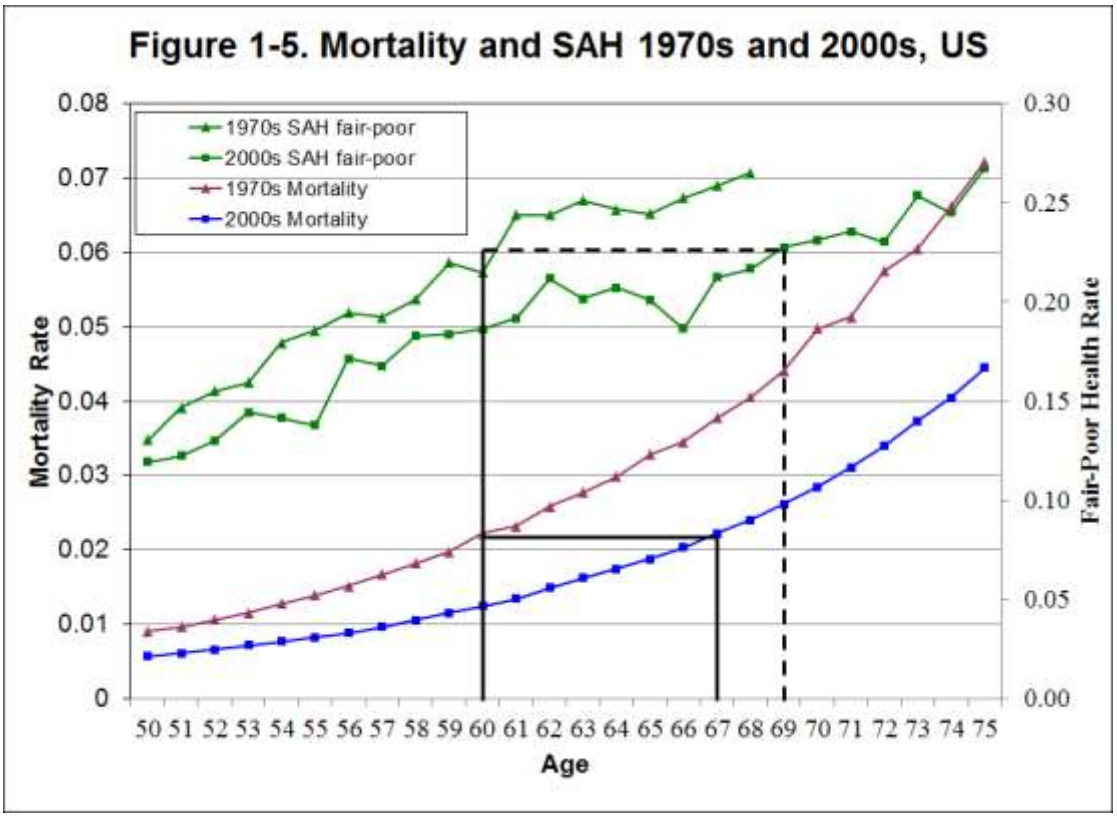
Their figure is reproduced as Figure 1-4 here. The data are for men in the age range 60-64. For 9 countries, there is a sufficiently long time series for both SAH and mortality and comparability of SAH measures to be included in the analysis.[3] For each country the percentage change in both mortality and SAH is calculated over the same time period but the time period differs across countries. The figure suggests a tight cross-country relationship between improvements in mortality and in SAH.



[33] There is no SAH data for Italy. France and the UK are included in Figure 1-4, but France is not included in the plot because the definition of SAH differs from the other countries and the UK in excluded from the plot because the SAH time seems not comparable to the series in remaining 9 countries.

Mortality Equivalent Ages versus SAH Equivalent Ages in the US:

Another way to show the relationship between mortality and SAH is to consider changes in both over time within one country. Milligan and Wise (2012) do this by examining the evolution through time of the age gradient of both mortality and SAH in two different time periods. Their results for the United States are reproduced here as Figure 1-5. First, the figure shows mortality by age in 1977 and in 2007. The figure shows that a person age 67 in 2007 had about the same mortality rate as a person age 60 in 1977, a difference of about 7 years. Second, the figure shows the proportion of people who reported they were in fair or poor health, by age, in the 1970s and in 2000s. Comparing these two trends, men who were 69 in the 2000s had about the same SAH as men who were over 9 years younger, age 60, in the 1970s.



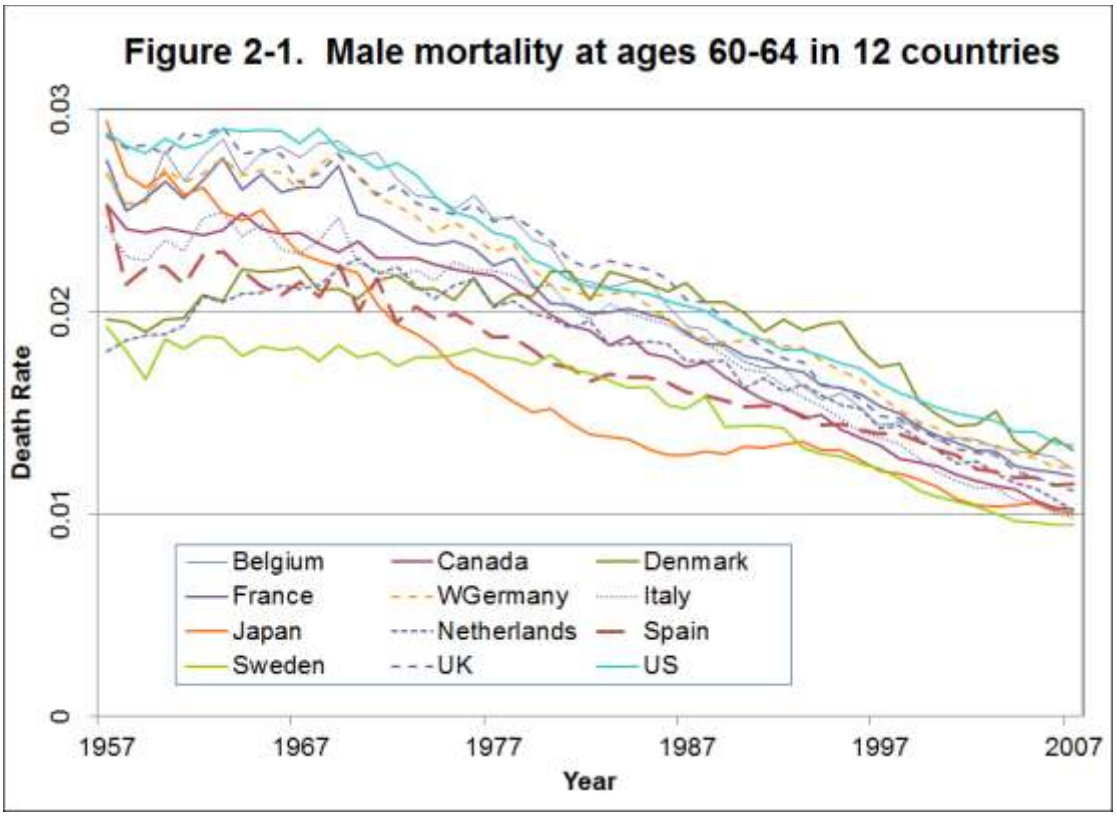
Mortality and The Poterba, Venti, Wise Health Index: The PVW index is the first principal component of the responses to 27 health questions asked in the Health and Retirement Study (HRS). It is explained in more detail and its properties are described in Poterba, Venti, and Wise (forthcoming). The index is strongly related to mortality--for example the relationship between the health index in 1992 and mortality in 2008 for members of the HRS cohort. Among those in the poorest health in 1992, approximately 46 percent are deceased by 2008. Among persons in the best health only about 10 percent are deceased by 2008. The index is strongly predictive of future health events such as stroke and the onset of diabetes. The index has been used in several contexts and is now being used to compare health in the countries participating in the International Social Security Project.

In short, we conclude that there is a rather close relationship between mortality and other measures of health, in particular SAH when scaled to "difference out" the country-specific response effects, and the PVW health index.

2. Mortality Improvement

Mortality has improved tremendously over the last fifty years in most developed countries. The extent of the improvements for the age interval 60-64 for men is shown in Figure 2-1, which graphs the death rates through time for our twelve countries. On average, mortality across these countries dropped by more than half over the fifty years from 1957 to 2007. Mortality in Denmark dropped the least, from 0.020 to 0.013; mortality in Japan dropped the most from 0.029 to 0.010. Although identifying individual countries in the figure is a bit difficult we include all countries in the same figure

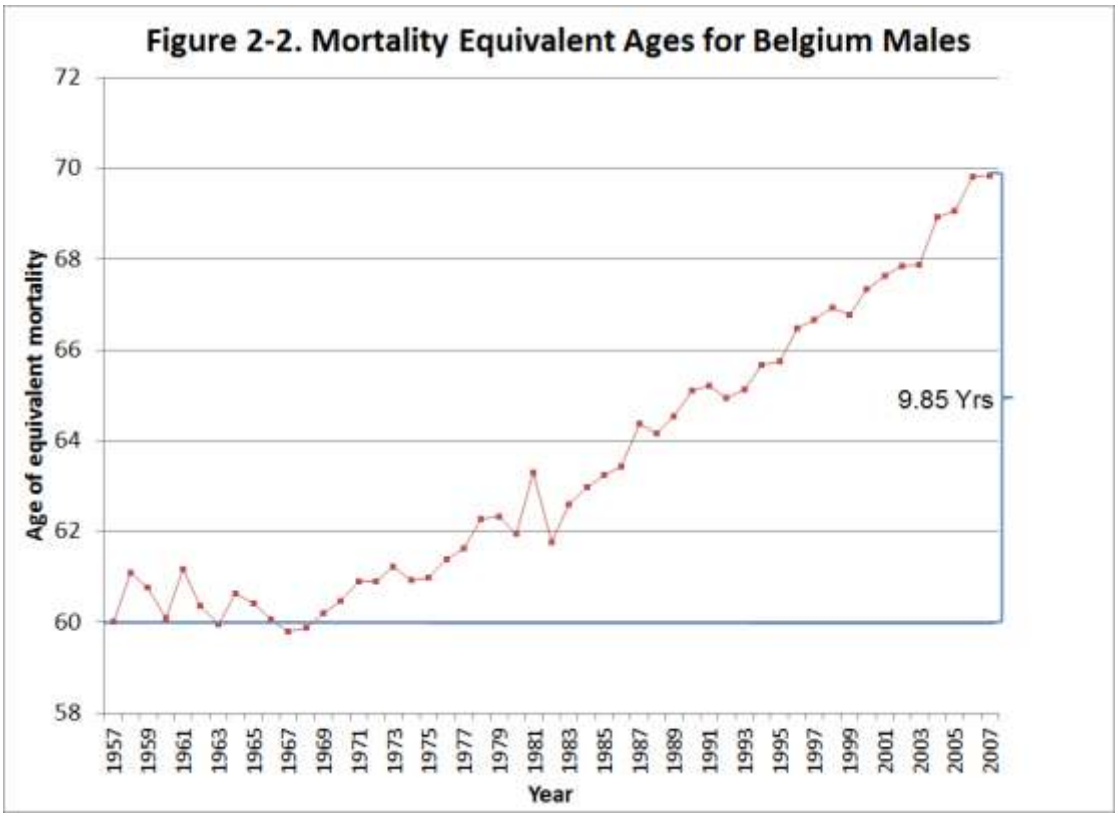
because we want to show the dispersion across countries. In 1957, the standard deviation for the death rate across the twelve countries was 0.0039, but by 2007 this had fallen by two-thirds to 0.0013. Moreover, the gains show a degree of convergence across countries. For example, Denmark, the Netherlands and Sweden that had the lowest death rates in 1957 exhibiting the smallest gains between 1957 and 2007.[4]



A concise way to summarize these gains in mortality is to calculate mortality equivalent ages over time. We begin with mortality at age 60 in 1957. Then we calculate the age at which the age 60 mortality occurred in subsequent years between 1957 and 2007. Figure 2-2 shows the graph of this relationship for Belgium. The age 60 death rate for men in Belgium in 1957 was 0.0236. This level of mortality in 2007

[4] Milligan and Wise (2012) explore this convergence more by showing that the rate of change is negatively related to the initial level of mortality.

was not attained until age 69.85, a mortality-equivalent age difference of 9.85 years.[5] Measured by mortality a Belgian man in 2007 at age 69.85 "feels like" a man age 60 in 1957.



Notes: Data from the Human Mortality Database. The graph shows for each year the age at which mortality is equivalent to mortality at age 60 in 1957.

Calculations like the one for Belgium were made for each country and the results are presented in Table 2-1. The mortality at age 60 in 1957 and at age 60 in 2007 and the percentage change in mortality are shown in the first three columns respectively. The age in 2007 at which the age 60 mortality as attained is shown in the next column and then the age gain and the percentage age gain. The gains are substantial, ranging from 11.96 years in Japan to 4.59 years in Denmark. For the United States, the 9.59

[5] Between ages, we interpolate linearly. That is, mortality in Belgium in 2007 was 0.0217 at age 69 and 0.0240 at age 70. Applying a linear interpolation means that the 0.0236 rate was reached at age 69.85.

year gain corresponds to a 16 percent increase in age 60 equivalent mortality. The gains are concentrated in the second half of the 50 year period in most countries, with Japan being a notable exception.

Table 2-1. Change in mortality at age 60 between 1957 and 2007 and mortality-equivalent age--the age in 2007 at which mortality was the same as age 60 mortality in 1957

Country	Mortality at age 60 in 1957	Mortality at age 60 in 2007	Percentage change in mortality at age 60 between 1957 and 2007	Age in 2007 that age 60 mortality occurred in 1957	Age gain (years)	Percent age gain
Belgium	0.0236	0.0105	55.4%	69.85	9.85	16.42%
Canada	0.0214	0.0093	56.8%	69.65	9.65	16.09%
Denmark	0.0166	0.0105	36.9%	64.59	4.59	7.66%
France	0.0239	0.0107	55.4%	71.25	11.25	18.75%
Italy	0.0206	0.0084	59.5%	70.02	10.02	16.70%
Japan	0.0242	0.0091	62.5%	71.96	11.96	19.93%
Netherlands	0.0153	0.0083	45.6%	65.84	5.84	9.73%
Spain	0.0219	0.0096	55.9%	69.41	9.41	15.68%
Sweden	0.0152	0.0071	53.4%	66.73	6.73	11.21%
UK	0.0233	0.0091	60.8%	70.06	10.06	16.76%
US	0.0246	0.0118	52.2%	69.59	9.59	15.98%
WGermany	0.0234	0.0107	54.3%	69.81	9.81	16.35%

Notice also that the percentage decline in mortality at age 60 ranges from about 37 percent in Denmark to 63 percent in Japan. If mortality is taken as an indicator of the capacity to work, these age-equivalent mortality data suggest that the capacity to work has increased substantially over the 1957 to 2007 period in all countries.

This conclusion is supported by alternative calculations reported below in section 4. The conclusion is also consistent with other approaches to measuring the capacity to work. Cutler, Meara and Richards-Shubik (2011) find that the capacity to work of men age 65 to 69 in the United States is 51% greater than the observed labor force rate for

those with a high school degree or less; and 58% greater for those with a college degree or more. They first estimate the relationship between labor force participation on the one hand and demographic and health characteristics on the other for persons age 62 to 64. Then they use these estimates to simulate the labor force participation for older persons 65 to 69, which they call capacity for work. These simulated participation rates do not account for Medicare or Social Security provisions. The actual "observed" labor force participation—that is affected by Medicare eligibility and Social Security provisions—is compared with the simulated participation which does not account for Medicare or for Social Security provisions. For both education groups the simulated labor force participation is substantially higher than the observed rate—53 versus 35 percent for the high school or less group and 60 versus 38 percent for the any college group. The simulated proportion on disability is also higher than the observed proportion, but the difference is very small relative to the difference in labor force participation.

In the following sections we explore how these improvements in mortality are reflected in changes to the labor market participation of men across countries.

3. Mortality and employment

The decline in labor market attachment of older workers over the last 50 years is well-documented. Time series data compiled by participants in the International Social Security Project extended back to the early 1960s for most of the countries.[6] These data show that in the early 1960s the employment rate of men 60 to 64 was between 70

[6] See Gruber and Wise (2007)

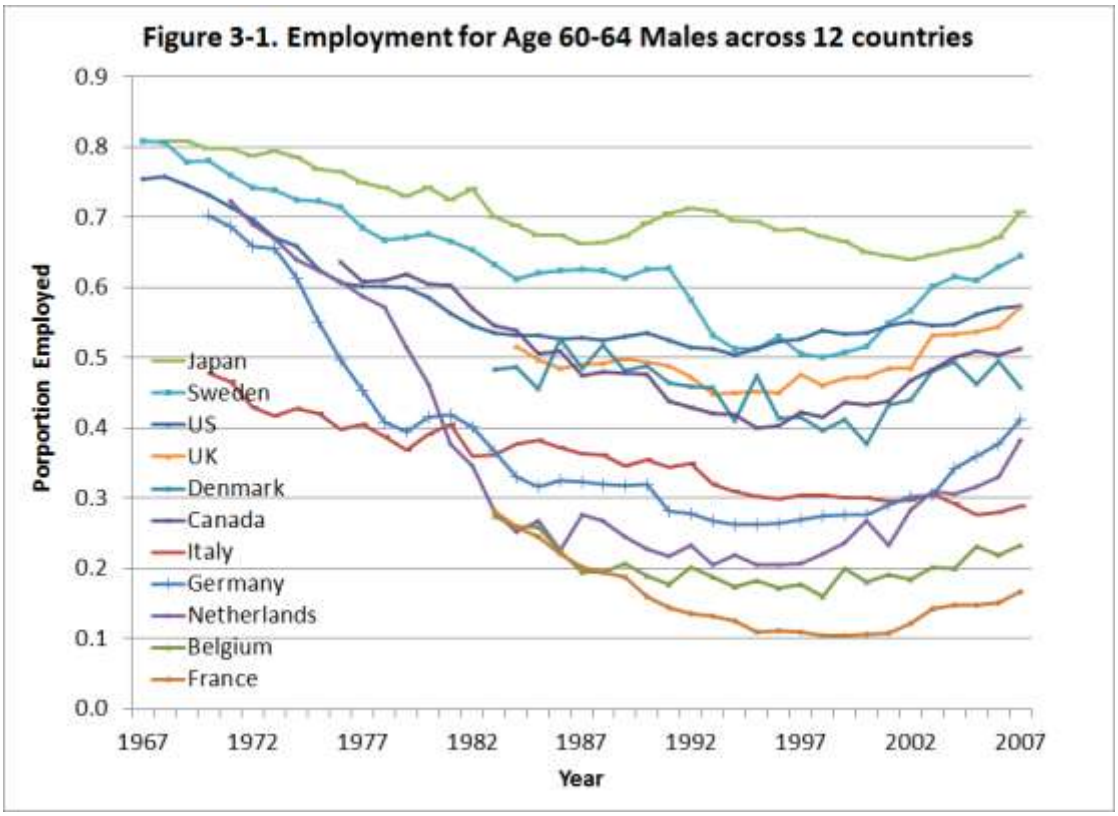
and just over 85 percent in all of the countries with the exception of Italy, where the employment rate in 1960 was about 58 percent. Thereafter the employment rate declined in all countries until the early or mid-1990s. In many of the countries the reversal in the decline in the mid-1990s can be attributed to social security program reforms (Gruber and Wise 2007). In other countries the reason for the reversal is less clear and may be due to changes in general labor market conditions.[7]

Figure 3-1, shows employment rates of 60-64 year old men in our 12 countries based on OECD data. The starting year for each country differs, but data are shown through 2007 for all countries. In 1970, the average across the five countries for which we have data is 69.8 percent. The average dropped to 36.8 percent in 1998, before rising to 45.0 percent by 2007. The variation across countries is enormous. At the trough, the employment rate ranged from a low of 16.6 percent in France and 23.3 percent in Belgium to 64.4 percent of Sweden and 70.8 percent in Japan. The employment rates for the same age group reported in Gruber and Wise (1977) are based on country data put together by the International Social Security Project participants and show data over a longer time period for some countries and show somewhat different rates for some countries, in particular lower rates for at least one country in the mid 1990's.

We emphasize one important feature of these data. In the late 1960s and early 1970s, the difference across in employment rates across countries was modest, between 70 and 80 percent in all countries for which data are available, with the exception of Italy. Large differences arose as social security programs were introduced

[7] Schirle (2008) shows that for several countries, a desire for joint retirement lead to later male retirement when female employment increased.

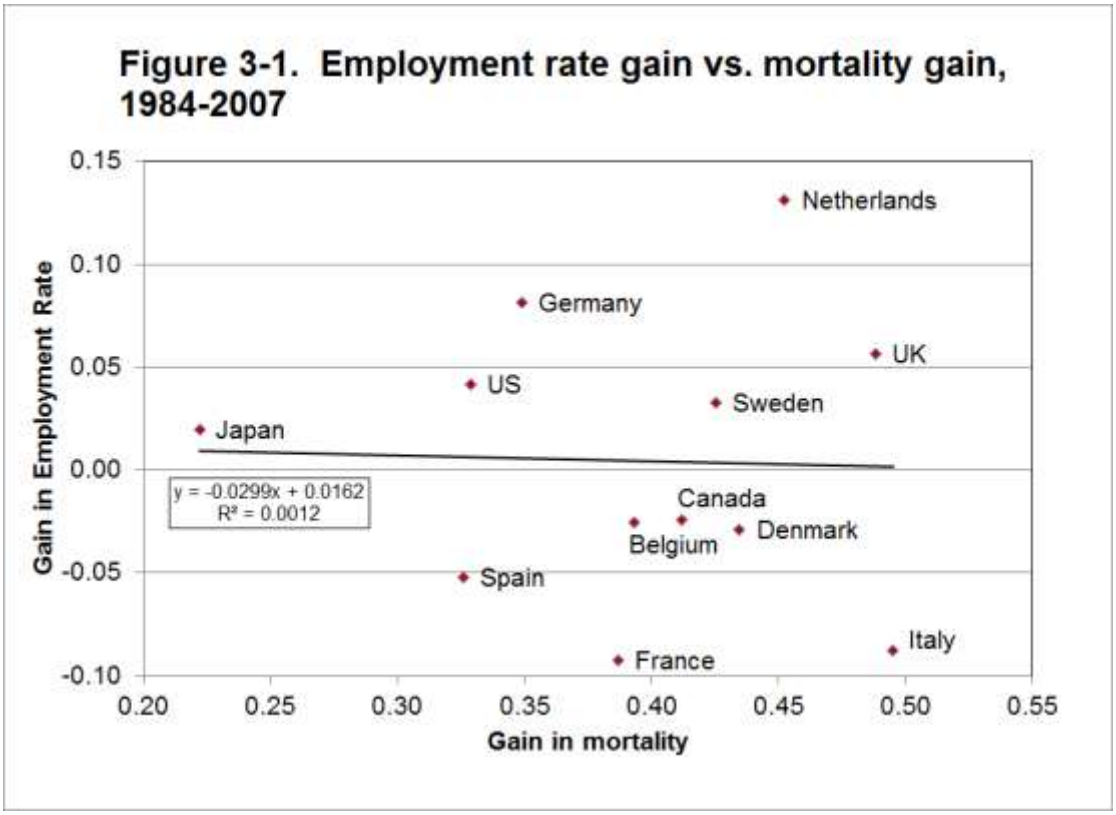
with very different provisions that provided strong inducement to retire early in some countries. We return below to further consideration of differences in employment rates across countries. We find no evidence that the growing dispersion of employment was related to dispersion over time in the capacity to work.



Notes: Data from OECD. See Appendix for details.

Change in Mortality versus Change in Employment: Have gains in "work capacity" been matched by gains in employment? We first consider the relationship across countries between the change in employment and the change in mortality. Figure 3-2 plots the change in the employment rate against the change in the death rate between 1984 and 2007 for men age 60-64. This 24 year time span is the longest span for which the data are available for each of the twelve countries. The line in the graph is an OLS regression of employment change against the reduction in mortality. There is substantial variation across countries in the change in death rates, with Italy and the UK

showing reductions twice as large as Japan. However, these large differences in the mortality gains are not reflected in employment gains. The regression line is essentially flat. The OLS slope coefficient is -0.03 and not statistically significant from zero. The results look very similar if the employment gains are graphed against the gain in mortality-equivalent age, using similar calculations as those in Table 2-1. It appears that there is no relationship across countries in the change in the capacity to work as measured by mortality and the change in employment.



Employment by Mortality versus Employment by Age: An alternative way to understand the employment-mortality relationship is to compare the employment by mortality rate with employment by age. Figures 3-3 and 3-4 show these two views of the data. Figure 3-3 shows the employment rate by mortality. To understand this figure, consider a given mortality rate and the employment rate at the age corresponding to that

mortality rate. If we do this for each mortality rate we map out an employment-mortality curve that displays the employment rate at each level of mortality.

Figure 3-3 displays this relationship for eight countries, using employment data at each age drawn from Milligan and Wise (2012). The relationship is plotted for slightly different years depending on the data available in each country. Note first that for the ages at which the mortality rate is low in each country—say between 0.002 and 0.004—there is little difference across countries in the employment rate. However, there is increasing dispersion across countries as the death rate increases—as age increases and which we return to just below. For example, at a death rate of 0.015 in each country, the employment rates varied widely from about 4.5 percent in France to about 49 percent in the United States. This substantial variation suggests that countries with the same level of health (as measured by mortality) have widely different employment levels at the same capacity to work.

Now consider the companion Figure 3-4 that shows the commonly studied relationship between employment and age. The vertical lines in the two figures mark approximately corresponding age and mortality levels. A death rate of .003 occurs between about age 43 and age 52 depending on the country, and a death rate of .015 occurs between about age 62 and age 67 depending on the country.

Note that between ages 50 and 52—corresponding approximately to death rates between 0.002 and 0.004—there is little variation in employment rates across countries—from about 0.83 to 0.90. But with increases in age the variation in employment rates increases dramatically. At age 64, for example, the employment rate varies from about 0.11 in France to about 0.48 in the US and 0.59 in Japan.

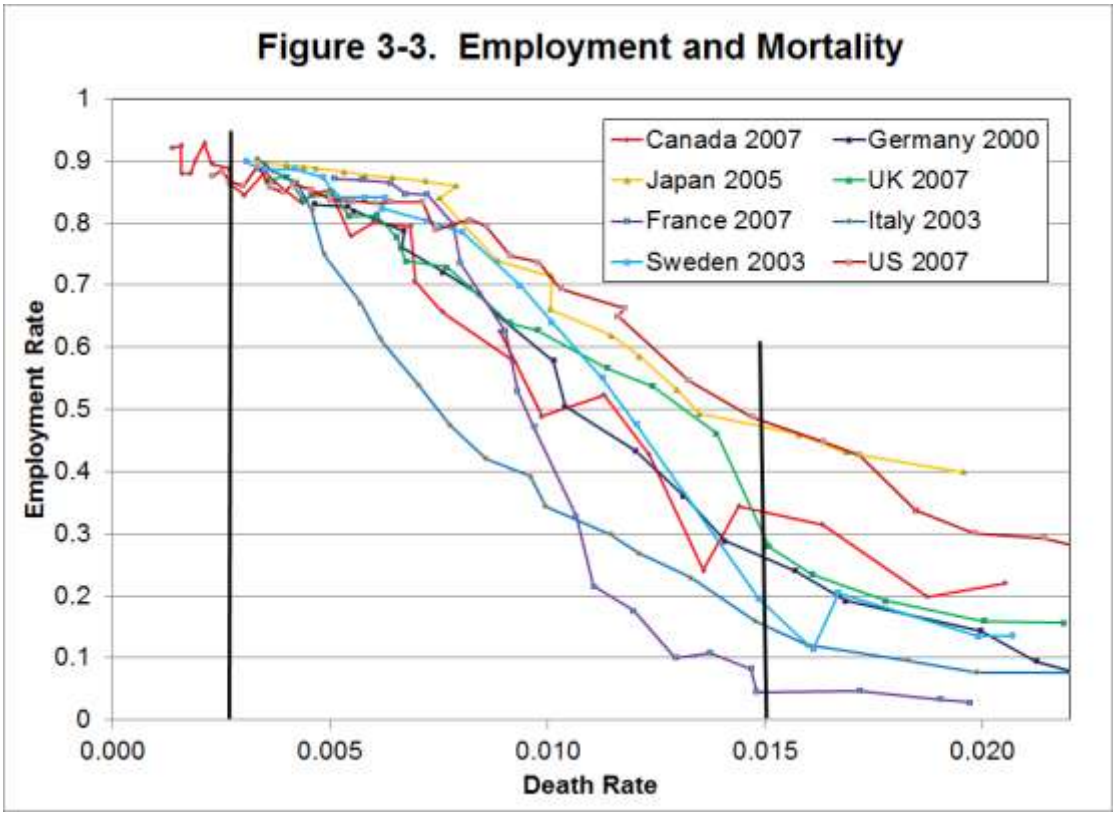


Figure 3-3. Employment and Mortality
Canada 2007
Germany 2000
Japan 2005
UK 2007
France 2007
Italy 2003
Sweden 2003
US 2007
Employment Rate
Death Rate
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.000
0.005
0.010
0.015
0.020

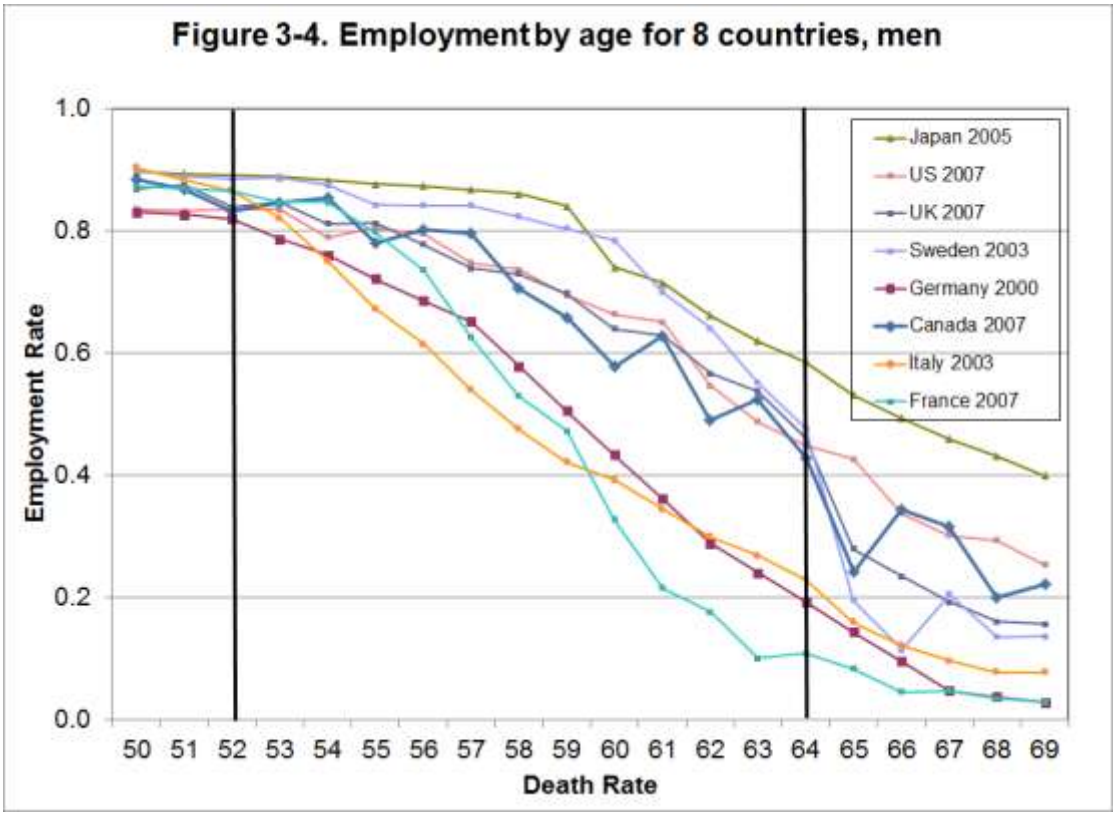


Figure 3-4. Employment by age for 8 countries, men
Japan 2005
US 2007
UK 2007
Sweden 2003
Germany 2000
Canada 2007
Italy 2003
France 2007
Employment Rate
Death Rate
0.0
0.2
0.4
0.6
0.8
1.0
50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69

4. Employment by Mortality in 1977 and 2007

We have seen that employment by mortality differs greatly across countries at a given time. We now consider how employment by mortality has changed over time. This is a precursor to developing a mortality-based measure of the capacity to work within a country and across countries. Figure 4-1 shows the differences in employment by mortality in 1977 and 2007 in the United States. The ages at which death rates are observed range from 43 to 67 in 1977 and between 45 and 69 in 2007. At younger ages—say below 46 in 1977 and below 53 in 2007—with low death rates, employment rates are between 0.85 and 0.90 in for both years. However, as the death rate approaches 0.01 the employment rates at the given mortality rate begin to diverge and the divergence becomes very large at higher mortality rates. Employment stays high until age 60 in 1977, when the death rate is 0.0207. But in 2007 when the death rate was 0.0207, the employment rate was only 0.293—between ages 67 and 68. This is a gap of almost 50 percentage points in the employment rate for that same level of mortality. At a death rate of just below 0.015, the employment rate in 2007 was about 39 percent lower in 2007 than in 1977.

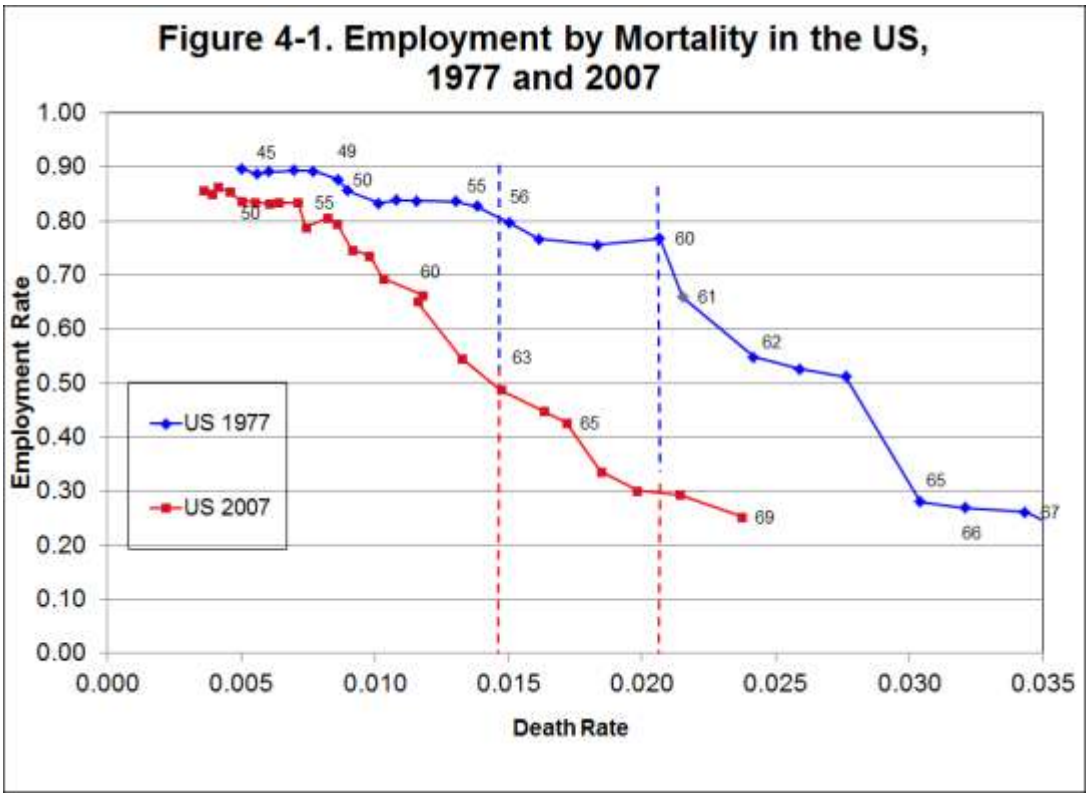


Figure 4-1. Employment by Mortality in the US, 1977 and 2007
Employment Rate
Death Rate
US 1977
US 2007
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.000
0.005
0.010
0.015
0.020
0.025
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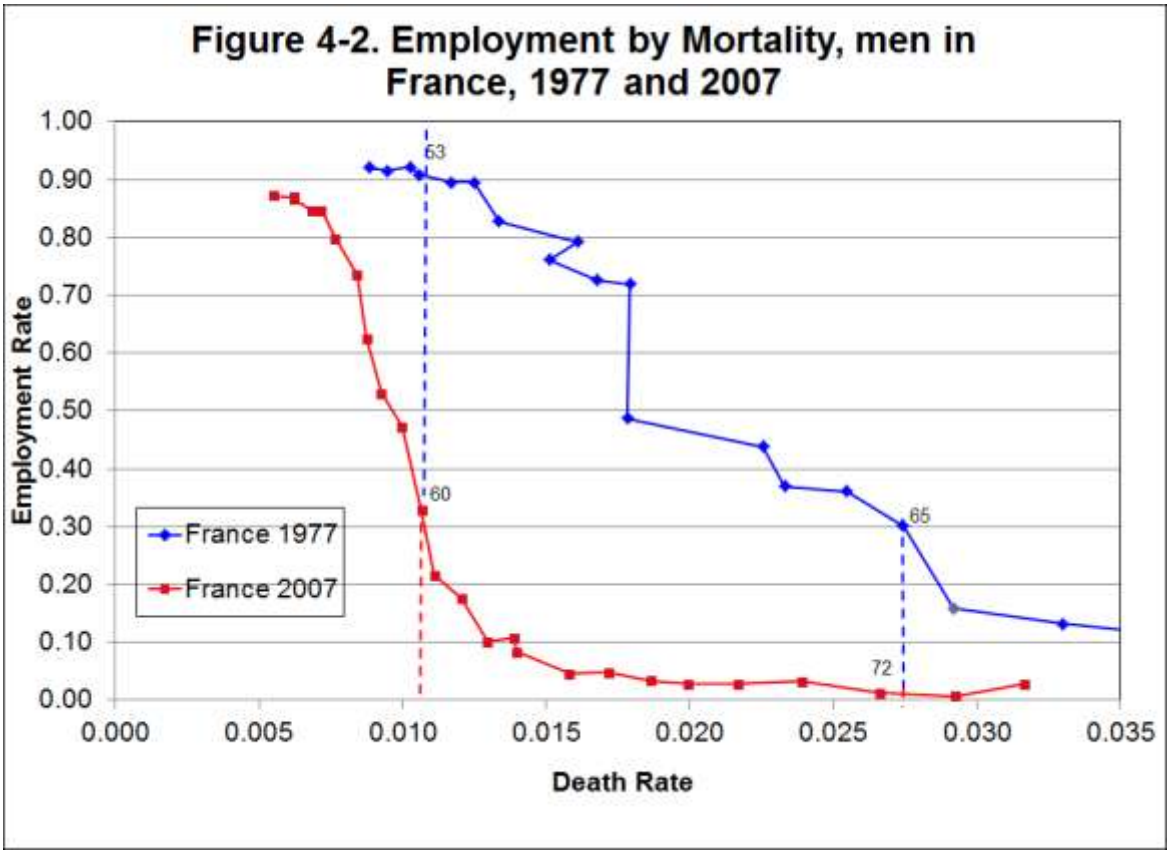
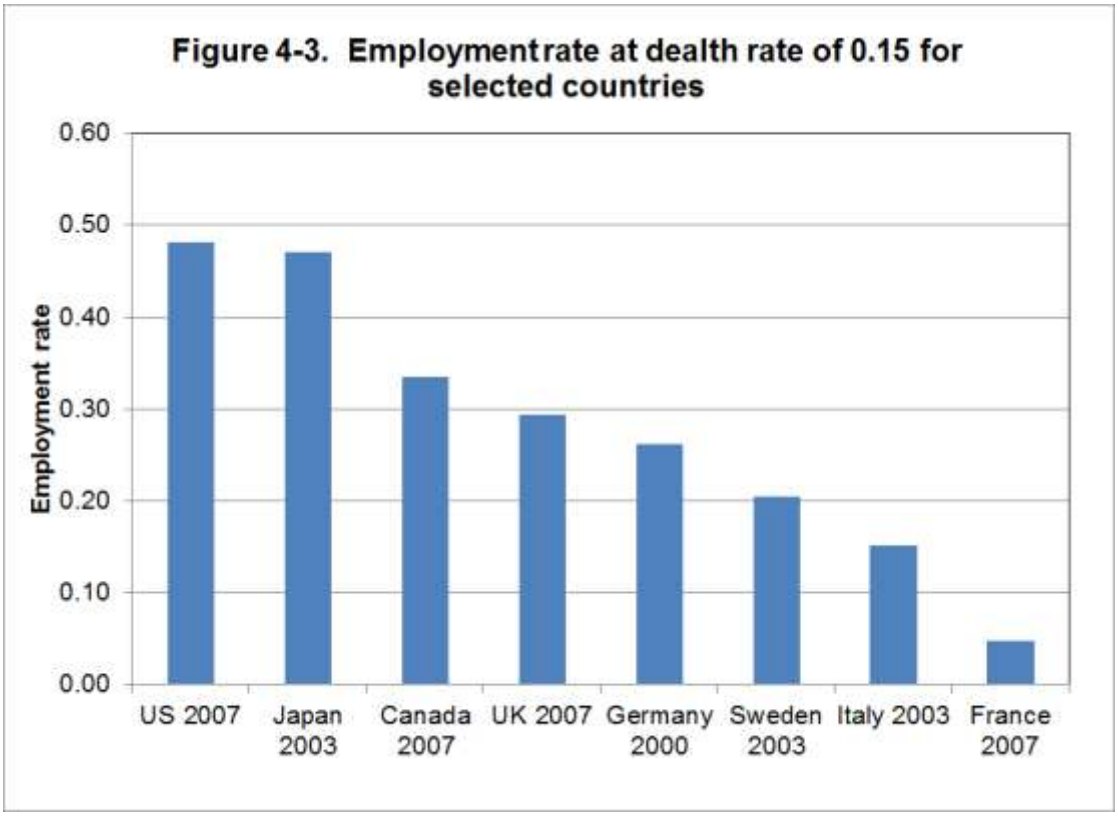


Figure 4-2. Employment by Mortality, men in France, 1977 and 2007
Employment Rate
Death Rate
France 1977
France 2007
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0.035
53
60
65
72

Figure 4-2 shows employment by mortality in France for 1977 and 2007. The reduction in employment given mortality is substantially more extreme in France than in the United State. For example, at a mortality rate of 1.1 percent, employment fell from about 90 percent in 2077 to about 30 percent in 2007, a decline of about 67 percent. Employment at a mortality rate of 2.7 percent fell from about 30 percent to close to zero.

To give a broader picture of the divergence in employment by mortality, Figure 4-3 shows the employment rates for selected country-year combinations, at a given death rate of 0.015. In 2007, the employment rate was 0.481 in the United States at the 0.015 death rate. In contrast, for France in 2007, the employment rate was only 0.135 at that same level of mortality. The employment rate at the 0.015 death rate for other countries lies between the US and France.



In short, the employment-mortality figure reveals two important features of the data. First, within countries, the employment-mortality relationship has undergone a tremendous evolution over the past 30 years. Second, there is substantial variation across countries in employment for a given level of health as measured by mortality.

5. Measuring the Capacity to Work

We present a new and perhaps novel calculation to characterize the magnitude of differences in the mortality-employment relationship within countries over time and between countries in the same time period. The evidence presented above suggests that expansions in the work capacity of older people measured by mortality reduction have not been matched by more work. In addition, for a given level of mortality, there is wide dispersion in employment rates across countries. Putting these two findings

together, a counterfactual calculation can make the magnitude of the observed changes clear.

We consider data like those in the US employment-mortality plot in Figure 4-1. Using those data, we ask what the gain in employment would be if at each level of mortality, if the employment rate was the same in 2007 as it was in 1977. That is, we calculate the distance between the two curves in Figure 4-1 at each age. The sum of these distances across all ages yields the gain in years of employment if people worked as much at each level of mortality in 2007--the comparison year--as they did in 1977--here thought of as the base year.

The calculation is performed by first choosing a base year and a comparison year. For each age of the comparison year, we observe the level of mortality and the employment rate. We then find the employment rate that corresponds to that level of mortality for the base year. We do this for each age in the comparison year. We sum across ages to determine the change in the mortality capacity to work relative to the base year.

Table 5-1. Comparison of the mortality capacity to work in the US in 1977 and 2007 and comparions between France anf the United States in 2007

	United States 2007 vs. United States 1977				France 2007 vs. United States 2007			
Age	Death Rate	Employment Rate	Emp. Rate Difference	Cumulative Gain	Death Rate	Employment Rate	Emp. Rate Difference	Cumulative Gain
55	0.008	0.805	0.078	0.078	0.008	0.798	0.000	0.000
56	0.009	0.795	0.082	0.160	0.008	0.735	0.066	0.066
57	0.009	0.747	0.106	0.266	0.009	0.626	0.132	0.198
58	0.010	0.737	0.104	0.370	0.009	0.530	0.215	0.413
59	0.010	0.694	0.140	0.511	0.010	0.473	0.266	0.679
60	0.012	0.663	0.175	0.685	0.011	0.328	0.359	1.038
61	0.012	0.651	0.187	0.872	0.011	0.215	0.463	1.501
62	0.013	0.547	0.287	1.160	0.012	0.176	0.451	1.952
63	0.015	0.487	0.318	1.478	0.013	0.100	0.465	2.417
64	0.016	0.448	0.318	1.796	0.014	0.108	0.419	2.835
65	0.017	0.427	0.335	2.131	0.015	0.083	0.406	3.241
66	0.018	0.337	0.420	2.551	0.015	0.045	0.440	3.682
67	0.020	0.301	0.463	3.013	0.017	0.047	0.379	4.060
68	0.021	0.293	0.381	3.395	0.019	0.034	0.288	4.349
69	0.024	0.253	0.314	3.709	0.020	0.028	0.276	4.625

Notes: Authors' calculation using data from Human Mortality Database and International Social Security Project. Displayed is the death rate and employment rate from the comparison year. In the right-hand panel, United States 2007 is the comparison year. In the left-hand panel, France 2007 is the comparison year. The difference in employment rate is shown relative to the base year in each case. The cumulative gain sums the employment rate difference up to the given age.

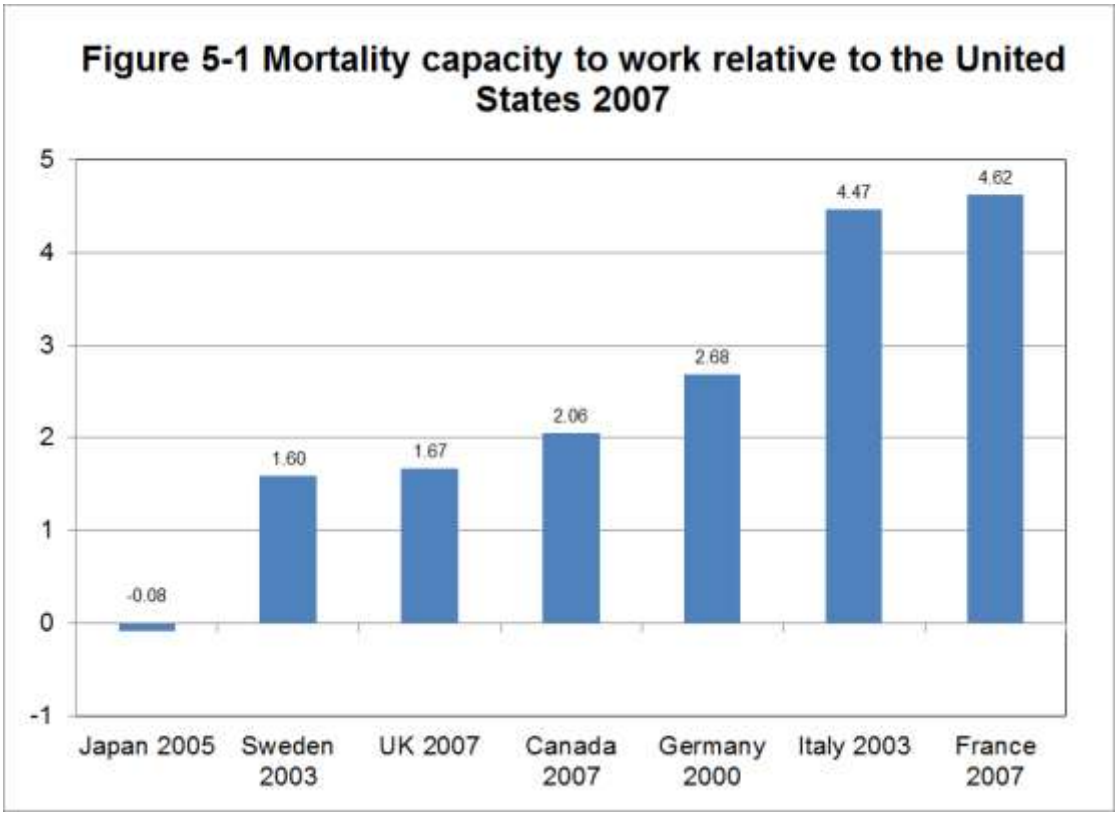
We present the results of two sets of calculations in Table 5-1. The left-hand panel of Table 5-1 takes 1977 in the United States as the base year and compares it to 2007 in the United States data. Looking back at Figure 4-1, at age 63 in 2007 the mortality rate was 0.147, and the corresponding rate of employment was 0.487. In 1977 the probability of employment at the mortality rate of 0.147 was approximately 0.805—interpolating between ages 55 and 56. Thus on average, there was a change of 0.318 in the rate of employment between 2007 and 1977. Or equivalently, when the mortality rate was 0.147 men worked 0.318 fewer years in 2007 than in 1977, on average. In 2007, at age 55 when the death rate was 0.008 the employment rate was 0.805. In

1977, when the death rate was 0.008 the employment rate was 0.877—interpolating between the rate of 0.892 at age 49 and 0.877 at age 50. Thus when the death rate was 0.008 men in 1977 worked an average of 0.078 fewer years in 2007 than in 1977. This same calculation is repeated for each age. The total gain in the mortality capacity to work, if those in 2007 worked as much as those with the same death rates in 1977, is 3.709 years of work. This represents 46.8 percent more years than the 7.932 actual years worked on average between ages 55 and 69 in 2007. The number of years worked over that age range in 1977 was 11.641. In other words, if men 55-69 in the United States in 2007 had worked as much as men in this age interval worked in 1977 at each mortality rate they would have worked 47 percent more than they worked in 2007.

The right-hand panel of Table 5-1 repeats the exercise comparing the United States and France in 2007. Taking the United States as the base, the total difference in mortality capacity and work between France and the United States in 2007 is 4.625 years. That is, if French men in 2007 worked as much as American men at each level of mortality, then they would work 4.625 more years over the age range from 55 to 69. Or, if French men worked as much as American men at each death rate, French men would work 4.625 years more than they do. That is, if French men between 55 and 69 in 2007 worked as much as American men in this age range at each mortality rate in 2007, French men in the 55-69 age interval would work 71 percent more than they do.

Figure 5-1 shows the results of calculations like those reported in Table 5-1 for France relative to the United States in 2007, but for all of the countries included in Figure 4-3, again relative to the United States in 2007. Japan is the closest to the United

States. Japanese men work somewhat more, given mortality, than American men, although the difference is small, 0.08 years. The largest differences are for Italy in 2003 and France in 2007, at 4.47 years and 4.62 years respectively. In percentage terms men in Japan in the 55-69 age range work almost one percent more than men in the US, who work 8.3 years on average over the 55 to 69 age range; men in Sweden 19.3 percent less, in the UK 20.2 percent less, in Canada 24.9 percent less, in Germany 32.4 percent less, in Italy 54.1 percent less, and in France 55.9 percent less.



Notes: Authors calculations based on data from the International Social Security Project and Human Mortality Database.

These differences in the "capacity to work" relative to the United States at older ages are large. We emphasize, however, that these differences in relative "capacity to

work" should not be taken as indicators of how much should be worked in any particular country, which will depend on individual preferences and associated retirement policies.

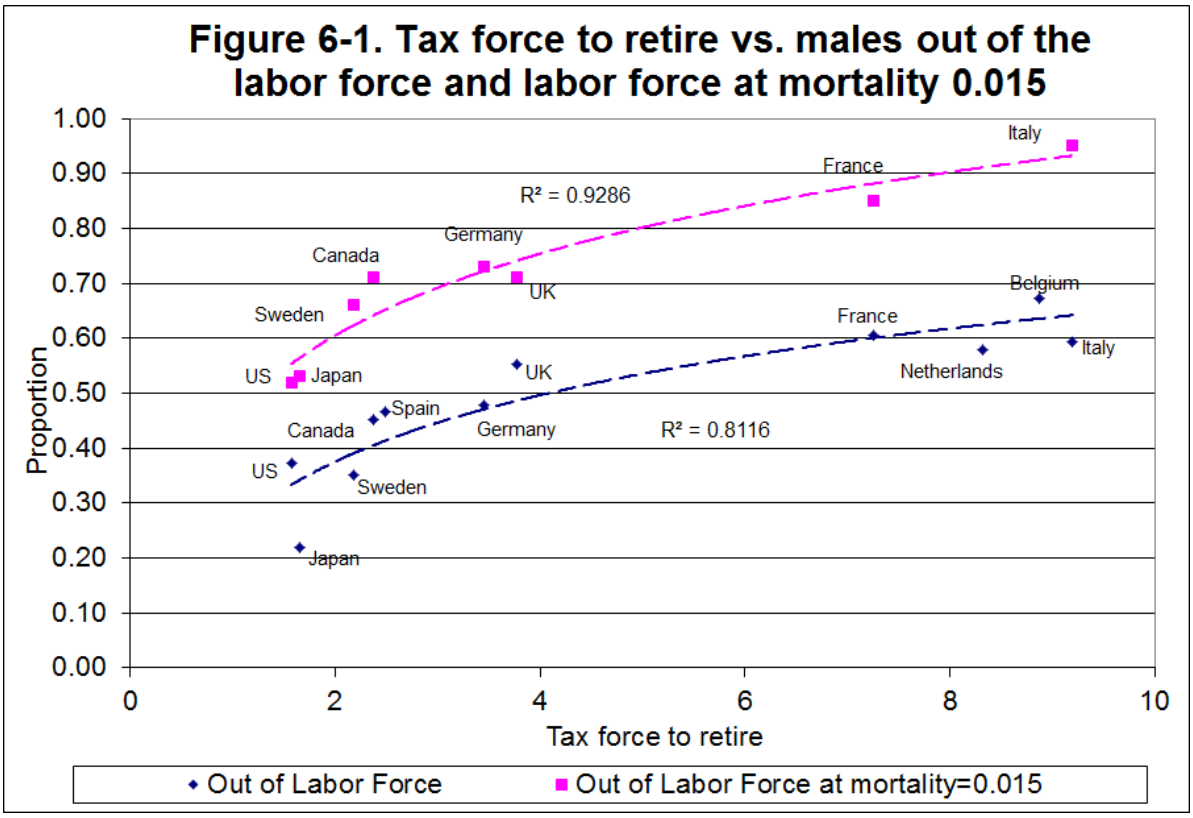
6. Capacity to Work and Social Security Incentives to Retire

The findings of the International Social Security Project reported in Gruber and Wise (1999) show that a large fraction of the difference across countries in the employment of men 55 to 65 is explained by differences in the provisions of the social security systems in the countries. In that analysis the inducement to retire is measured by the tax force to retire, that captures the strength of the inducement to retire at older ages.[8] Here we compare the tax-force to retire versus employment from the Gruber and Wise study with our findings here on employment versus mortality. We believe that our findings support the interpretation of mortality as a measure of work capacity.

Consider these two relationships—(1) the relationship between the tax force to retire and the proportion of men 55 to 65 not in the labor force and (2) the relationship between the tax force to retire and the proportion of men not in the labor force when the mortality rate is 1.5 percent. Both are shown in Figure 6-1. The first relationship—the lower line in the figure—is the relationship reported in Gruber and Wise (1999). In France, the Netherlands, Belgium, and Italy with the greatest tax force to retire, 60 to 70 percent of men 55 to 64 are not in the labor, whereas in the United States, where the

[8] The tax force to retire takes the implicit 'tax' for retirement at each age, which is the one-year accrual of public pension wealth divided by the wage. These taxes are summed across ages between the age of early retirement eligibility to age 69 to arrive at the tax force to retire. These tax force values reflect the structure of the social security systems in place in the 1990s. See Gruber and Wise (1999) for more detail.

tax force to retire is much lower, only about 37 percent of men in this age group are out of the labor force.



The second relationship—the upper curve in Figure 6-1—plots data from this paper. It shows the relationship between the tax force to retire and the proportion of men not in the labor force when the mortality rate is 1.5 percent (the data shown in Figure 4-3). Although these data are not available for all countries, the figure shows that the incentive effects inherent in social security pension plans are a strong determinant of work by age and a strong determinant of work by health (mortality); one relationship essentially mimics the other. We conclude from these two relationships that mortality as a measure of health means the same thing in France and Italy as it does in the U.S. If the tax force to retire were the same in France and Italy as in the U.S., the relationship suggests that work at older ages would be about the same in France and

Italy as in the U.S. And, work when health is the same (here using a level of 1.5 percent mortality for health) would be about the same in France and Italy as in the U.S. Or put another way, if plan provisions were similar, work by mortality ("health") would be about the same in Italy and France as in the U.S.

Thus it would appear that the mortality capacity to work is essentially the same in Italy and France as in the United States. This analysis suggests that it is the difference in retirement policy that creates the difference in employment at a given mortality level and not differences in the capacity to work. Recall from Figure 3-3 that at low mortality levels, corresponding to younger ages, the employment rate was virtually the same across the countries. Only at older ages, with higher mortality rates, did differences in employment at given death rates emerge. It is at these older ages that the social security retirement inducements to retire have their strongest bite.

In short, Figure 6-1 offers evidence that differences across countries in employment, including differences in employment at given levels of mortality, seem to be determined in large part by differences in the policy inducement to retire inherent in social security plan provisions across countries. Differences in employment seem not to be related to health differences as captured by mortality. Moreover, if the policies that induce retirement were the same across countries employment at given mortality levels would be very similar across countries. It is unlikely that differences in work capacity at given mortality levels generate observed differences in employment across countries.

7. Conclusions

We have explored the relationship between health and employment, using mortality as a measure of health. Mortality is available for long time series, comparable within countries over time and comparable across countries and point in time. Mortality is also strongly related to SAH within countries and, when transformed to difference out country-specific SAH response effect, is also rather strongly related to mortality over time across countries. Mortality is also strongly related to the Poterba-Venti-Wise health index. We believe that these features of mortality tend to support its use as a measure of health across countries. We document very large decreases in mortality over the 1957 to 2007 period, but these gains are not in general reflected in gains in employment rates for older workers. For a given level of health measured by mortality, employment rates vary substantially through time and across countries. This suggests that observed employment differences across countries at older ages are unlikely to be explained by health differences or the capacity to work at older ages.

Finally, we calculate the potential gain in employment if men in 2007 worked as much per level of mortality as men in 1977. Compared to 1977, American men 55-69 in 2007 would need to 3.71 years more to attain the employment level of men in this age group in 1977. Or put another way, if men 55-69 in the United States in 2007 had worked as much as men in this age interval worked in 1977 at each mortality rate they would have worked 47 percent more than they did in 2007.

Using 2007 United States as a base, we find that French men in 2007 would work 4.62 years more if they worked as much as American men at each level of

mortality. That is, if French men between 55 and 69 in 2007 worked as much as American men in this age range at each mortality rate in 2007, French men would work 71 percent more than they did in 2007. In contrast, Japanese men work slightly more than American men, given mortality. By these measures, the capacity to work has increased substantially through time and differs substantially across countries.

Appendix: Data sources

Mortality

The source for mortality data is the Human Mortality Database (2011). These data have been put together on a consistent basis through time and across countries. Full documentation is available at www.mortality.org. We use the data provided for the twelve countries under consideration in our paper. We use the provided death rates, which are calculated as the ratio of the death count to those exposed to risk of death. The exposure to risk calculation involves an adjustment between the population count at the beginning and the end of period, as described in Appendix E of the methods protocol in the Human Mortality Database. In practice for our purposes, this adjustment matters very little compared to a 'raw' death rate calculated as the ratio of deaths to beginning population count. For years with multiple measures available (owing mostly to geography changes resulting from treaties or wars), we take the measure corresponding with the newer geography. Data are available for individual ages, and also in 5-age groupings (50 to 54; 55 to 59; 60 to 64 etc.). We make use of both the individual and 5-age aggregations.

The death rates are calculated as:

$$M_{ay} = \frac{D_{ay}}{E_{ay}},$$

where M_{ay} is the death rate at age *a* in year *y*; D_{ay} is the estimated number of deaths for that age and year, and E_{ay} is the estimated person-years lived by persons of that age in that year. The death estimates differ from the raw counts because of the allocation of deaths of unknown age across the population, among other technical

adjustments. In particular, deaths are often reported in 1x1 Lexis squares in the raw data. These are split into Lexis triangles using a regression imputation. In practice, this makes little difference for the age ranges we consider, since upper and lower Lexis triangles are not systematically different at these ages. See the Human Mortality Database methods protocol by Wilmoth, Andreev, Jdanov, and Glei (2007). The adjustments to the denominator incorporate the population count at the beginning and end of the period

Employment

The employment data come from two sources. One source is OECD Statistics: http://stats.oecd.org/Index.aspx. (Accessed October 8, 2011.) The other source is data collected for the International Social Security project (Gruber and Wise 1999, 2004, 2007; and Wise 2011). The employment data come from individual countries' microdata surveys and the sources can be found in the individual chapters for each country. In this paper, we make use in particular of data from Canada, the United States, and France. For Canada, the source of the data is the Labour Force Survey. For the United States, it is the Current Population Survey. For France, it is the French Labor Force Survey (Enquête sur l'Emploi).

Health

The self-assessed health data for the United States in Figure 1-1 come from the National Health Interview Survey, which has consistent annual data on self-assessed

health from 1972 to 2009. The SAH data for the other countries comes from the individual country chapters described in Wise (2012).

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