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

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**ABSTRACT**

While longevity increased substantially over the last 50 years and health at older ages has improved, labor force participation at older ages has declined. We use mortality rates as a marker for the "health capacity" to work at older ages in 12 OECD countries. Mortality rates can be compared across countries and over time within the same country. For a given level of mortality, we find employment rates of older men vary substantially through time and across countries. At each mortality rate in 2007, if men in France worked as much as men in the United States, they would work 4.6 years more over ages 55 to 69 than they actually did. Comparing the work and mortality of American men in 2007 to the base year of 1977, the same calculation yields 3.7 years more work. These findings suggest a large increase in the health capacity to work, as measured by mortality. The relationship between cross-country mortality and changes in work over time at older ages is weak, suggesting the take-up of this extra capacity to work has varied. However, the dispersion in employment given mortality is strongly influenced by the retirement incentives inherent in public pension programs.

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Countries around the world are facing two intertwined long-run phenomena. First, health—and longevity—have improved substantially over the past three or four decades. Second, labor market participation among the elderly has declined substantially. Assuming that improved health increases the productive capacity of older persons, this improvement in capacity has not been translated into increased work. Persons may choose to retire at younger ages and take more leisure at older ages because of greater individual wealth accumulation while working and thus the ability to pay for retirement expenses over a longer period of time. In this case when the decision is solely one of individual choice to save while young to provide for more years in retirement, then a policy response may not be an issue. However, if the decision to reduce work results instead from labor market and retirement policies, and much of the pension and health care support in retirement is a public expense then the possibility of adopting social and economic policies to facilitate greater use of the increased productive capacity of older persons becomes an important option.

In this paper, we explore the use of mortality as a measure of health and the capacity to work at older ages. Our approach is preliminary, broad, and cross-national. We explore the relationship between work at older ages and mortality. We think of mortality as one, but not the only, indicator of health. Mortality is an important indicator of health that is comparable over time within countries and comparable across countries. To be clear, we sometimes refer to "mortality health" and treat mortality as an indicator of the capacity to work, although we fully understand that mortality is not a comprehensive indicator of either. Mortality is a sharp health event—in some senses the ultimate health shock. A focus on mortality necessarily misses more subtle health changes that are well known to have an impact on labor market attachment, like physical or mental impairment. However, we believe that mortality is useful because the clarity of its definition yields internationally comparable results, and data are available over long stretches of time for all countries.  There is also a strong relationship between mortality and other health events. We show below that there is a strong relationship between within-country change in self-reported health over time and the change in mortality.

We compare results across twelve OECD countries for which relatively long time-series of labor force and mortality data are available.[1] The cross-national comparisons aim to shed light on the dispersion across countries in work at older ages given mortality health. We then relate this dispersion to previous evidence on the cross-country strength of retirement incentives embedded in social security programs.

Our analysis is based on data for the fifty year time period 1957 to 2007, for each of the twelve countries. We focus primarily on data for the ages 60 to 64, since in many countries the greatest transition between work and non-work occurs in this age range. We utilize the data 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 emergence of female labor market participation tangles time series and cross-cohort trends, so the case of men is for our purposes a cleaner sample.

[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 (Milligan and Wise 2011).

We begin by discussing prior research on mortality and work at older ages. We then explain further our choice to focus on mortality as a measure of health or capacity to work. The improvements in mortality through time are then documented graphically, using a variety of approaches. We then briefly present the time series trends in employment rates at different ages to establish the cross-country differences. The focal point of our analysis brings together the mortality and employment changes by comparing employment at given levels of mortality across time and across countries. This analysis yields a calculation of the health capacity to work, relative to a benchmark year within a country or a benchmark country for cross-country comparisons. We then compare the results found here to previous estimates of the strength of public pension plan incentives to retire.

The contributions of the paper are threefold. First, we make the case for a focus on mortality as one measure of health and the capacity to work. Second, the international comparisons of mortality and employment changes present new evidence on the dispersion of both health and employment at older ages over time within countries and across countries. Third, our construction of a measure of the mortality-capacity to work at older ages is novel, and shows substantial and informative variation across time within countries and across countries.

## 1. Previous research

The improvement in mortality in developed countries is a well-known phenomenon. 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 health is best, and life expectancy longest, in Japan; the United States is among the lowest on both measures. While informative, their findings come from cross-sectional analysis and are not necessarily inconsistent with our results looking both within country through time as well as across countries.

As employment at older ages has dropped in the last half century, research has considered the causes of these changes. A series of cross-country studies (Gruber and Wise 1999; 2004; 2007) investigated the impact of social security provisions on retirement, finding that inducement to retire inherent in social security policy provisions are very strongly related to work at older ages. Blöndal and Scarpetta (1999) reproduced the Gruber and Wise (1999) analysis for more OECD countries. Lumsdaine and Mitchell (1999) provide a summary of the literature. More recently, von Wachter (2012) prepared a meta-analysis of the impact of financial incentives on the labor supply of older workers.

## 2. Mortality and health

The broad concern of our work is the relationship between health and work at older ages and how it differs across countries. Two problems confront researchers attempting to study 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 the study of longer-run phenomena. 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 the availability of data again make comparisons difficult.

We use mortality to overcome these problems. Consistent data on mortality are available for very long time series—stretching back to the 18th century in some countries. This allows the construction of data series that enable long-run analysis. Moreover, these data are internationally comparable. Because of the binary and definitive nature of death, no cultural or linguistic cross-country differences hinder analysis.

The primary shortcoming of mortality to measure capacity for work is its severe nature. Much more subtle health problems can inhibit labor force participation, whether it is a physical disability such as back-ache or an illness requiring difficult treatment such as cancer. Internationally comparable long time-series on other health indices could provide further analysis and comparison of findings with alternative health measures, but these measures are not widely available for long periods and all such measures are subject to country-specific response effects.  We believe that mortality provides a guide that, while imperfect, is an important marker for long-run trends in health.

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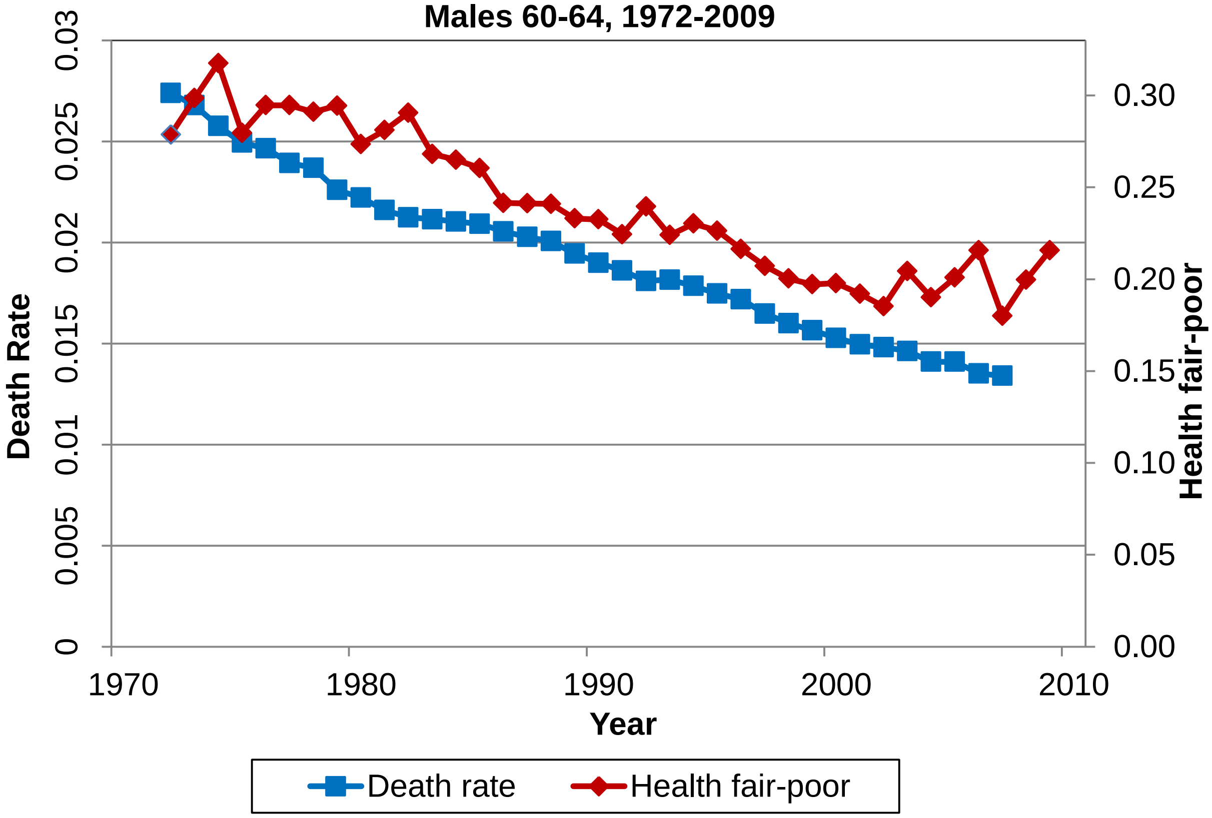
[2] See Kapteyn et al. (2007) and King et al. (2004) for recent discussions of the problem of cross-cultural comparability.

Another concern may be the quality of mortality data. Preston, Elo, and Stewart (1999) find that misreporting of age can bias death rates downward. However, the bias only tends to emerge among the oldest (age 75 plus). Our paper concerns those in the age 60-64 age range for the most part, so our analysis should be relatively unaffected by this bias.

To establish the link between mortality and other measures of health, we provide evidence for the United States. We then discuss the more extensive and cross-country evidence in Milligan and Wise (2011).

**Figure 1: Mortality and Self-Assessed Health for American Males 60-64, 1972-2009**




Note: The data for mortality come from the Human Mortality Database and the self-assessed health data are from the National Health Interview Survey. There is also more information in the data appendix.

Figure 1, shows mortality (measured here and in the rest of this paper by period death rates) and self-reported health rates for men age 60-64 in the United States. Death rates are graphed on the left-hand axis, and the proportion responding that self-assessed health is ‘fair or poor’ is graphed on the right-hand axis. Between 1972 and 2002, mortality declines 45.9 percent from 0.027 to 0.015. Over the same time period self-assessed health (fair or poor) declines 33.6 percent from 0.279 to 0.185. Since 2002, mortality has continued to decline while self-assessed health has been more volatile.

Looking across countries, Milligan and Wise (2011) find a very strong relationship between the percent change in mortality over time and the percent change in self-assessed health over time. The same data also show country-specific self-assessed health effects, revealed by the differences in levels of self-assessed health relative to mortality levels. Figures like Figure 1 for Sweden, the Netherlands, and Canada in Milligan and Wise (2011) show similar trends between mortality and self-assessed health, although the relationship seems not to hold up for the UK. For Japan, measures such as feeling ‘not good or sick’ and limitations in Activities of Daily Life show a correspondence with mortality. Baker and Milligan (2011) and Milligan (2011) show similar results for Canada and the United States, respectively.

As mentioned above, Crimmins, Garcia, and Kim (2010) find only weak cross-sectional ties between health and life expectancy when they look across countries. This may result from a confounding relationship between health and mortality, with other country-specific factors driving both. In contrast, the comparisons we make are both across and within-country, so country-specific factors can be set aside. Our findings that health improvements line up with mortality improvements within-country are not inconsistent with their findings.

In future work we will explore the possibility that mortality may serve as an anchor with which to compare other health measures over time. For example, do differences between mortality levels and self-assessed health levels across countries serve as measures of country-specific response effects? How do they compare, for example, with much more detailed comparisons based on vignettes made by Kapteyn, Smith, and Van Soest (2007)?

## 3. Mortality improvements

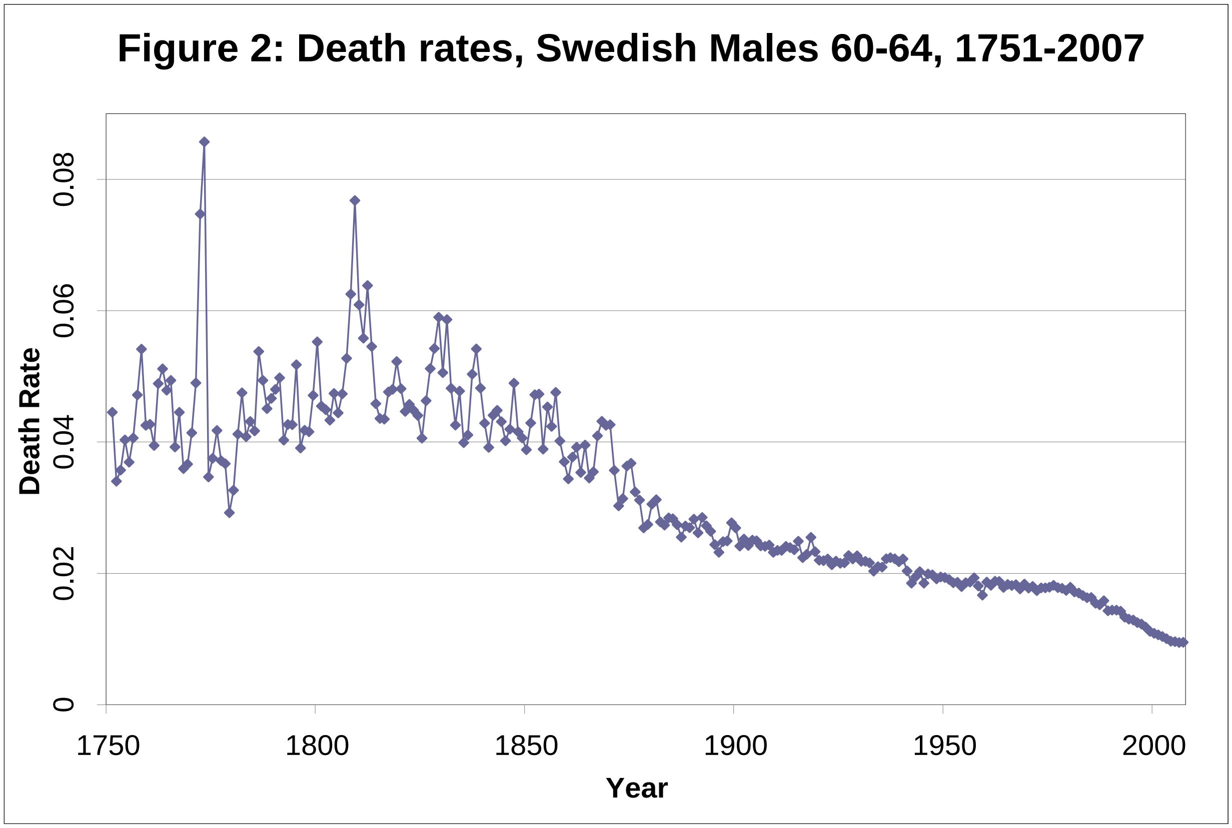
In this section we document the tremendous improvements in mortality that have characterized most developed countries over the last half century. We measure mortality using data from the Human Mortality Database. The death rates are calculated as:

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

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.[3] The adjustments to the denominator incorporate the population count at

[3] 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 beginning and end of the period. Importantly, the same methodology is applied to all countries and all years in the database.

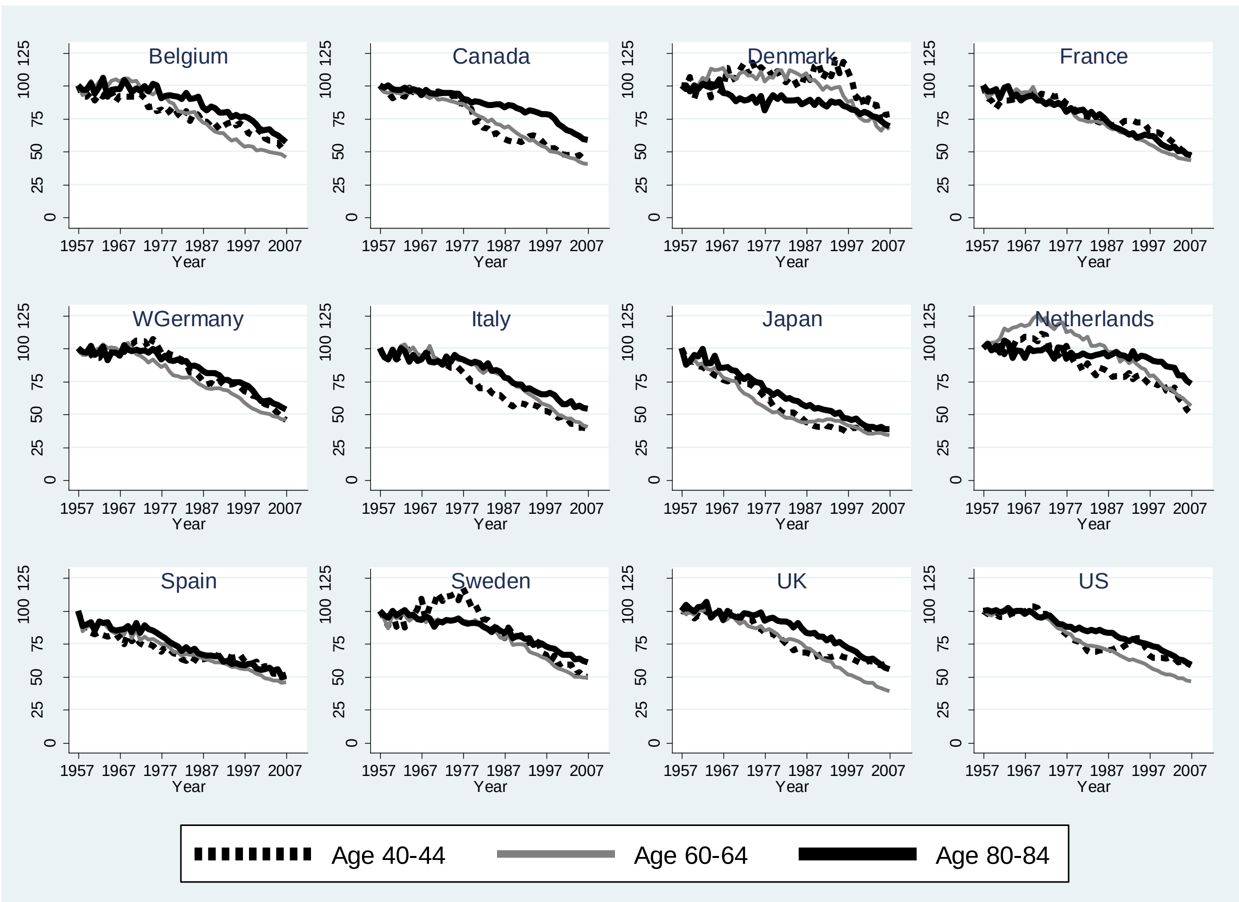



Note: Data come from Human Mortality Database.

Mortality has improved tremendously through time in most developed countries. To open this discussion, we take the country among our twelve with the longest span of data available—Sweden has data back to 1751. Figure 2 shows the death rates for Swedish males aged 60-64 from 1751 to 2007. Over the first 100 years of the sample, death rates are quite volatile and if anything show an upward trend. However, from

1850 onward, death rates decline.[4] There is a particular quickening in the decline for Sweden starting in 1980. In the subsequent graphs, we explore how these trends are mirrored (or not) in the other eleven countries in the period 1957-2007 for which we have data for all the countries.

## Figure 3: Male mortality 1957-2007 across age groups

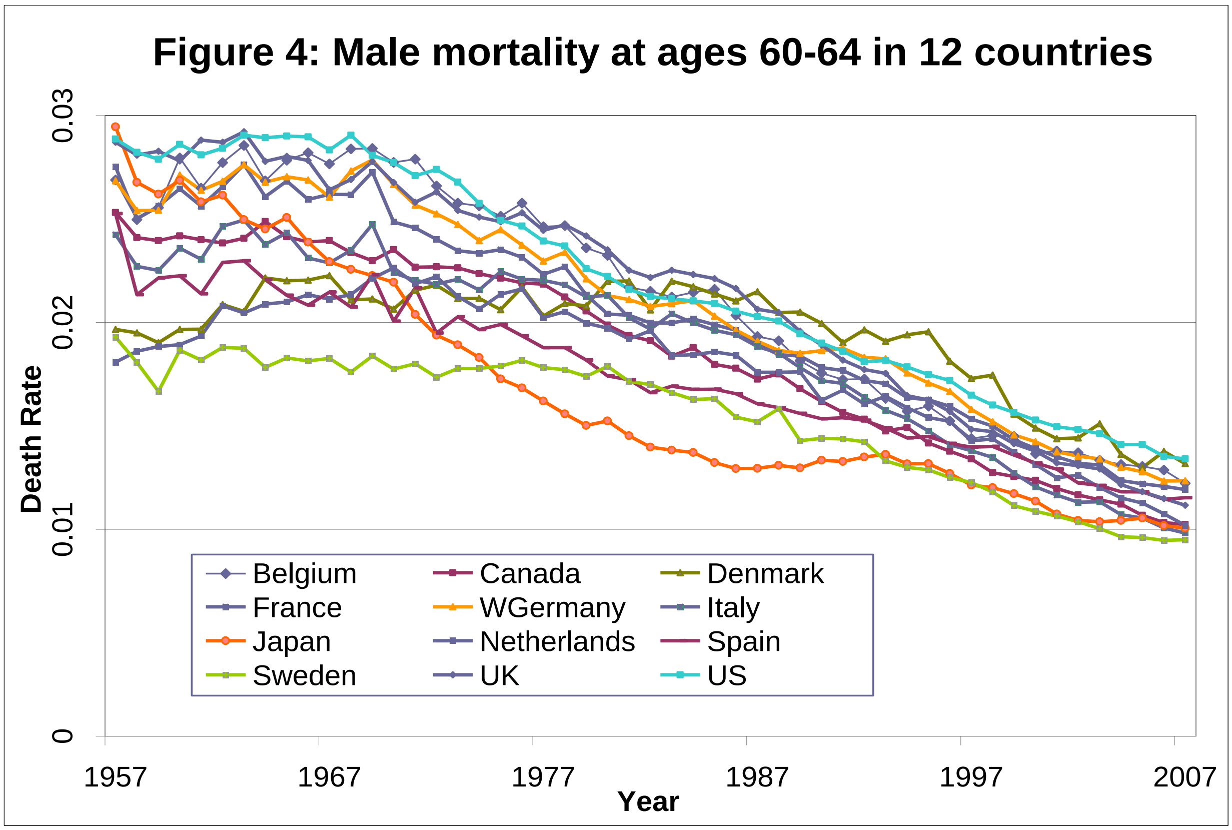



Note: Data come from Human Mortality Database.

Figure 3 shows how the trends vary across countries through time by age group, using men age 40-44, 60-64, and 80-84. For each of these age groups, a different line

[4] The spikes in 1772 and 1809 correspond to periods of political change relating to the beginning and end of the rule of Gustav III and Gustav IV of Sweden. See Barton (1986).

is plotted, starting at an index level of 100 in 1957. All are graphed on the same scale. For the most part, the impression across countries is of fairly similar improvement in mortality across age groups. Some exceptions are age 40-44 in Sweden and Denmark which display elevated mortality and age 80-84 in Canada which shows a slower decline than other ages. However, for the most part the trends seen for ages 60-64 are consistent with other ages, and show improvement over the 1957-2007 period.




Note: Data come from Human Mortality Database.

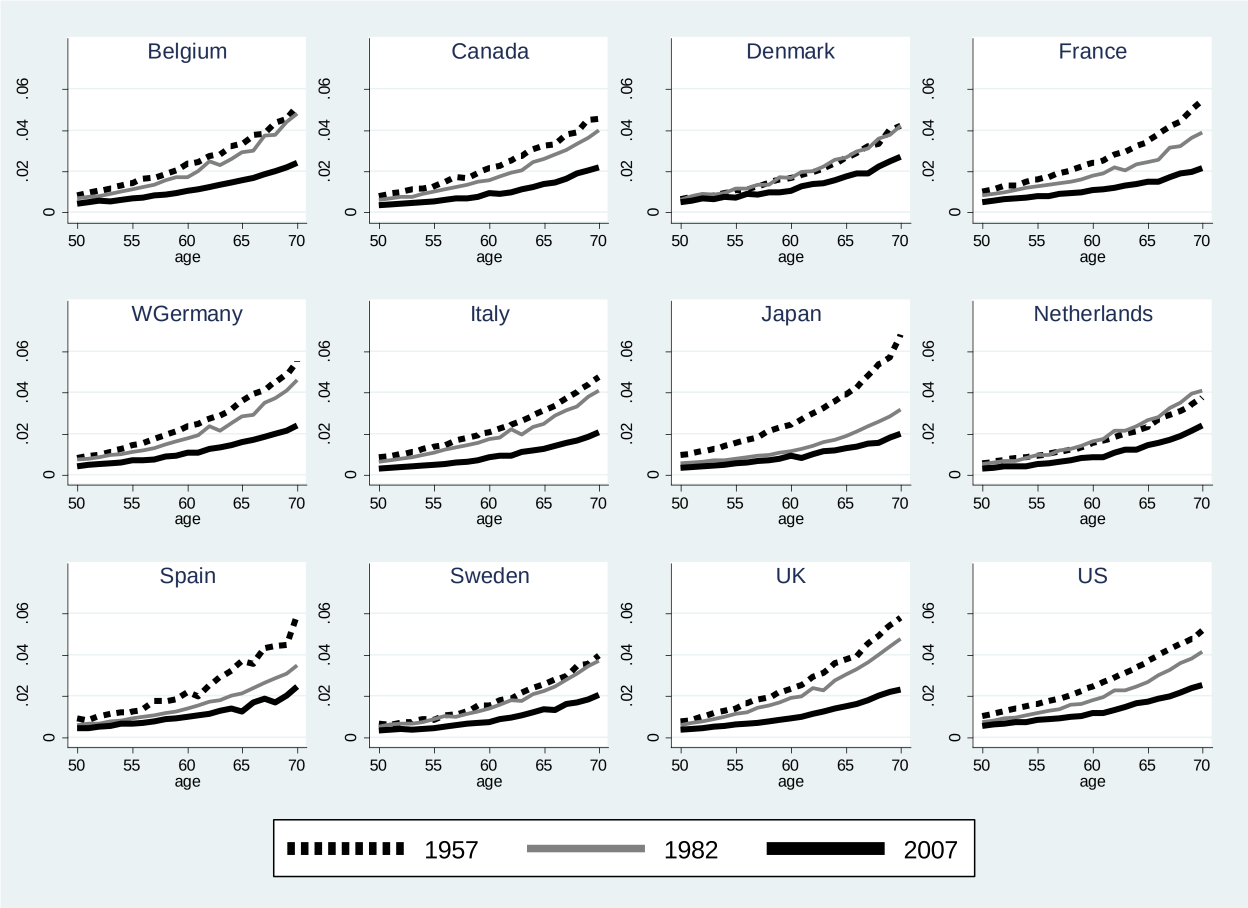
The extent of these improvements is shown in Figure 4, which graphs the death rates through time for the age interval 60-64. Seeing individual lines in this graph is difficult, but the intent of the graph is to show the dispersion across countries. In 1957, the standard deviation for the death rate across 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. Countries like Denmark, the Netherlands and Sweden which had the lowest death rates in 1957 exhibiting the smallest gains between 1957 and 2007.[5]

Another way to view the mortality improvements is to graph the age-specific death rates in different years. Figure 5 does this for 1957, 1982, and 2007 for the ages from 50 to 70. All countries show substantial gains over the 50 year period, but there are differences. Japan and Spain have stronger improvement in the first 25 year period, while the other countries have more improvement in the second 25 year period. Sweden and Denmark show almost no change at all from 1957 to 1982.

A concise way to summarize these gains in mortality is to quantify the gain in terms of years lived. We consider a base age and year, and ask for each subsequent year at what age mortality attains the same level of mortality as the base age and year. We set the base year as 1957. For example, we ask at what age the death rate is the same as for 60 year olds in 1957. In Belgium, the age 60 death rate in 1957 was 0.0236. This level of mortality in 2007 was not reached until age 69.85.[6] This is effectively a gain of 9.85 years; a Belgian man in 2007 at age 69.85 'feels like' a man at age 60 in 1957, in terms of mortality.

[5] Milligan and Wise (2011) explore this convergence more by showing that the rate of change is negatively related to the initial level of mortality.
[6] 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.

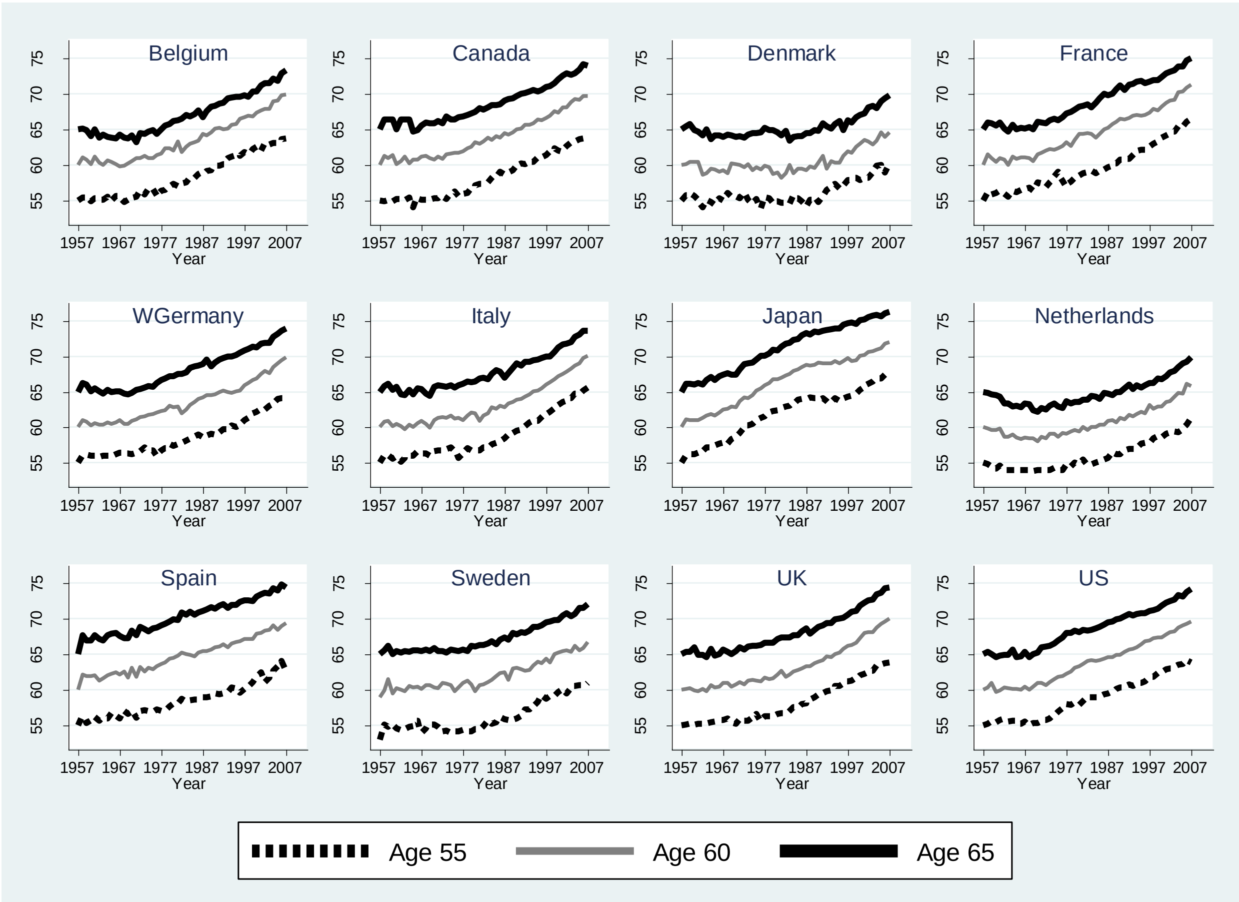
## Figure 5: Across age mortality in 1957, 1982, and 2007




Note: Data come from Human Mortality Database.

Calculations like the foregoing were made for each country for ages 55, 60, and 65. The results are graphed in Figure 6. All countries show gains over the 50 year period for all three ages. The gains are substantial—at age 60 they range from 11.96 years in Japan to 4.59 years for Denmark. As seen earlier, the gains are concentrated in the second half of the 50 year period in most countries, with Japan being a notable exception.

## Figure 6: Age of equivalent mortality, 1957-2007




Note: Authors' calculations based on data from the Human Mortality Database.

The results at age 60 are summarized in tabular form in Table 1. The mortality at age 60 in 1957 and 2007 is shown, along with the percentage change and the age gain. For the United States, the 9.59 year gain corresponds to a 16 percent increase on the age 60 base. This is a substantial increase.

Notice also that the percentage gain in mortality at age 60 ranges from about 40 percent in Denmark to 61 percent in the United Kingdom. If mortality were taken literally as an indicator of the capacity to work, these health mortality data would suggest that the capacity to work has increased substantially over the 1957 to 2007 period.

**Table 1: Gains in Mortality at age 60, 1957-2007**

| Country | Mortality 1957 | Mortality 2007 | Percentage change | Age Gain | Percentage Change |
|---|---|---|---|---|---|
| Belgium | 0.0236 | 0.0105 | 55.4% | 9.85 | 16.4% |
| Canada | 0.0214 | 0.0093 | 56.8% | 9.65 | 16.1% |
| Denmark | 0.0166 | 0.0105 | 36.9% | 4.59 | 7.7% |
| France | 0.0239 | 0.0107 | 55.4% | 11.25 | 18.8% |
| Italy | 0.0206 | 0.0084 | 59.5% | 10.02 | 16.7% |
| Japan | 0.0242 | 0.0091 | 62.5% | 11.96 | 19.9% |
| Netherlands | 0.0153 | 0.0083 | 45.6% | 5.84 | 9.7% |
| Spain | 0.0219 | 0.0096 | 55.9% | 9.41 | 15.7% |
| Sweden | 0.0152 | 0.0071 | 53.4% | 6.73 | 11.2% |
| UK | 0.0233 | 0.0091 | 60.8% | 10.06 | 16.8% |
| US | 0.0246 | 0.0118 | 52.2% | 9.59 | 16.0% |
| WGermany | 0.0234 | 0.0107 | 54.3% | 9.81 | 16.3% |

Notes: Authors calculations based on data from Human Mortality Database.

This possibility is 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% less 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 this section we have documented the gains in mortality at older ages for men in our twelve selected OECD countries. There have been substantial improvements in mortality at all ages over the 50 year period from 1957 to 2007, although the magnitude of this improvement shows some variation across countries. The goal for the rest of the paper is to explore how these improvements in mortality are reflected in changes to the labor market participation of men across countries.

## 4. Labor force attachment

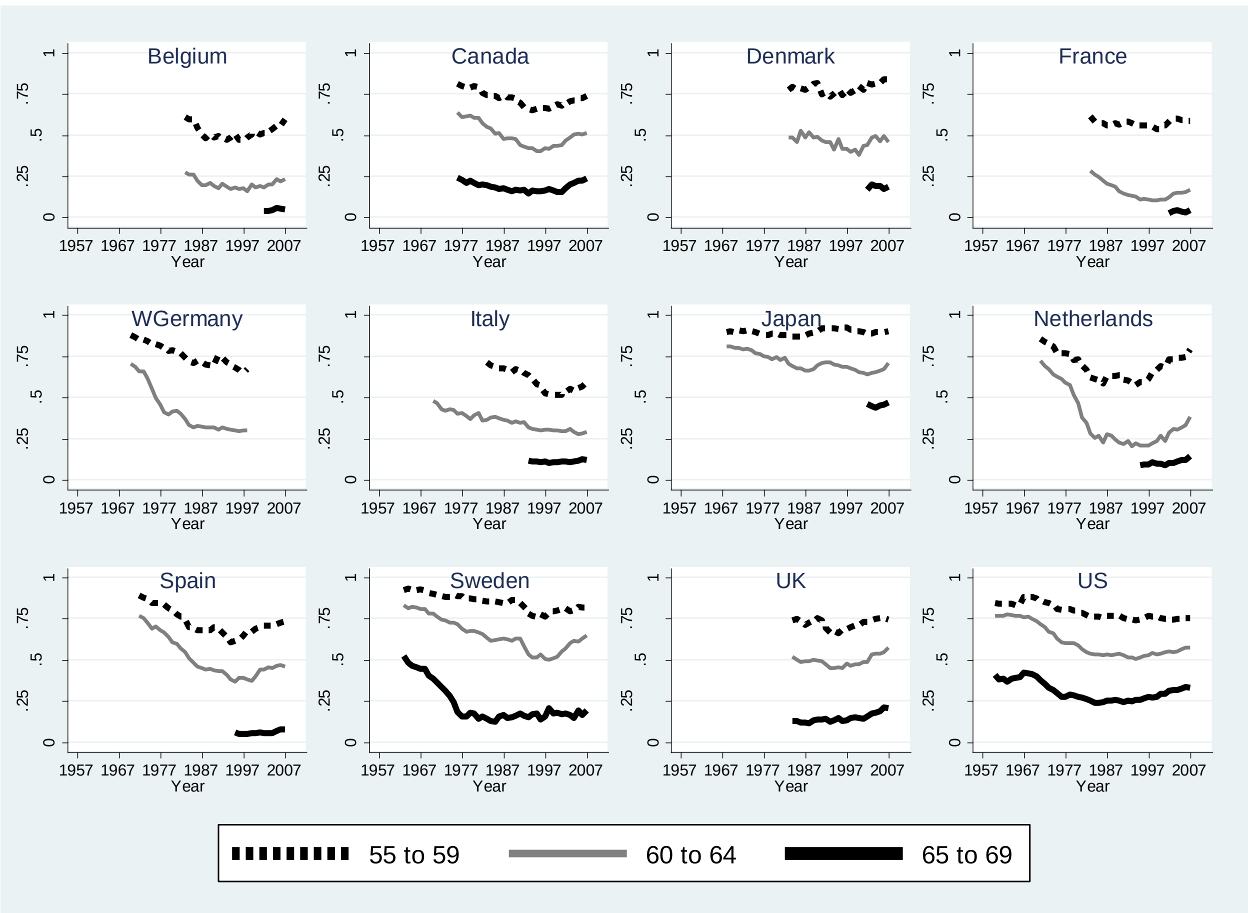
The decline in labor market attachment of older workers over the last 50 years has been well-documented. Here we graph the most recent comparable data on employment rates for older males for each of our countries.

The data for employment are drawn from the OECD.[7] Figure 7 shows the employment rates for males in each of the countries for age ranges 55-59, 60-64, and 65-69. The time-span available for the data varies substantially across countries, ranging from a start year of 1960 for the United States to 1984 for the United Kingdom. In all cases, the last year is 2007. Both the changes and the levels of employment rates vary substantially across countries. A common feature of the data in each of the

[7] Details are provided in the data appendix.

countries is a local minimum in the employment rate in the mid-1990s. But that minimum varies greatly across countries. For the 60-64 age group, the minimum ranges from 10.4 percent in France to 64.0 percent in Japan. The minimum is 50.5 percent in the United States.

## Figure 7: Employment rates, selected ages




Notes: Data from OECD.

For a longer time period, we can refer to earlier work. Time series data compiled by participants in the International Social Security Project extended back to the early 1960s for most of the countries.[8] These data show that in the early 1960s the employment rate of men 60 to 64 was between 70 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. 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.[9]

## 5. Mortality and employment

We now turn to the main results of the paper—a comparison of changes in employment to mortality gains. The goal is to consider whether the gains in "work capacity" have been matched by gains in employment. We do this first by presenting scatter plots relating the gains in mortality and employment, then by plotting mortality and employment rates age-by-age for a given year and country.

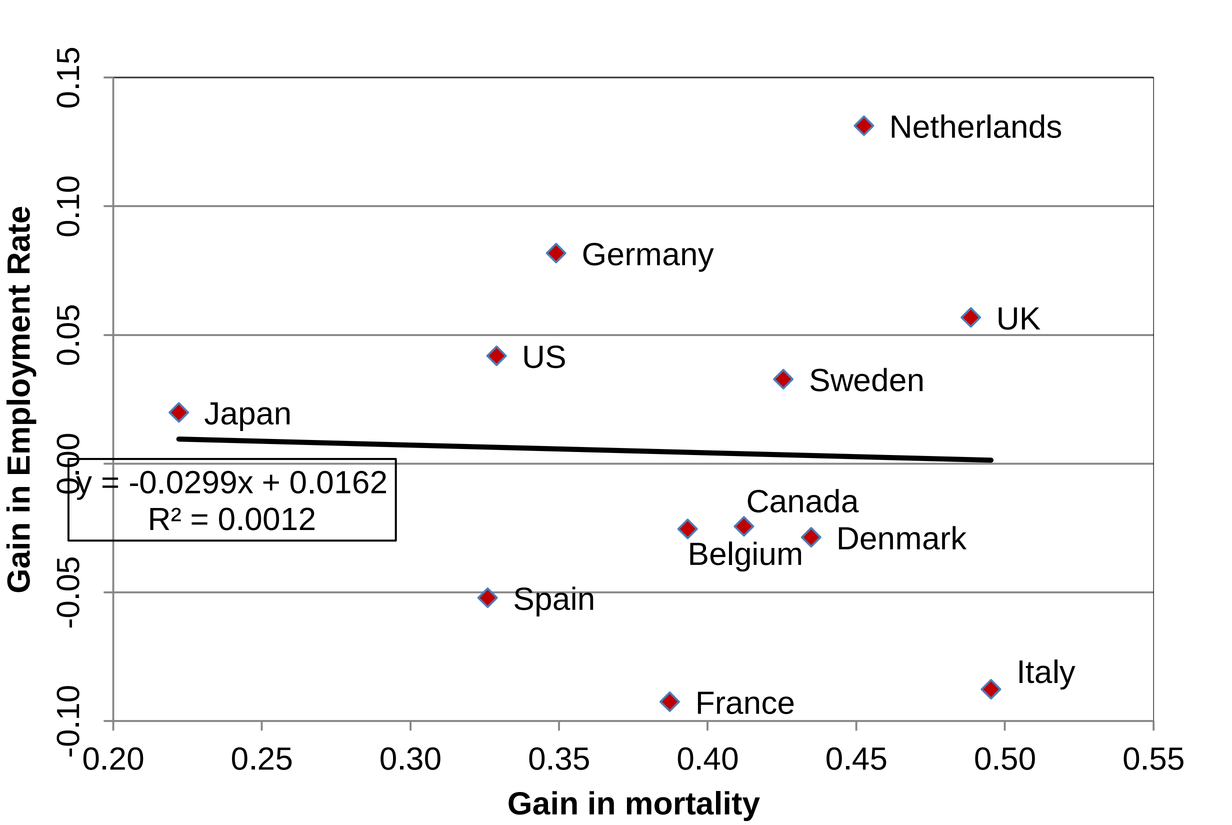
### *5.1 Change in mortality versus change in employment*:

Figure 8 plots the change in the employment rate to the gain in the death rate for age 60-64 males between 1984 and 2007. This 24 year time span is the longest period for which data are available each of the twelve countries. The line in the graph is an

[8] See Gruber and Wise (2007).
[9] Schirle (2008) shows that for several countries, a desire for joint retirement lead to later male retirement when female employment increased.

OLS regression line of the data points.  There is substantial variation in the gains in the death rate, with Italy and the UK showing twice the gain of Japan. However, these large differences in the mortality gains are not reflected in employment gains. The regression line looks flat. The OLS slope coefficient is -0.03, which is not statistically significant (*p*-value is 0.916).

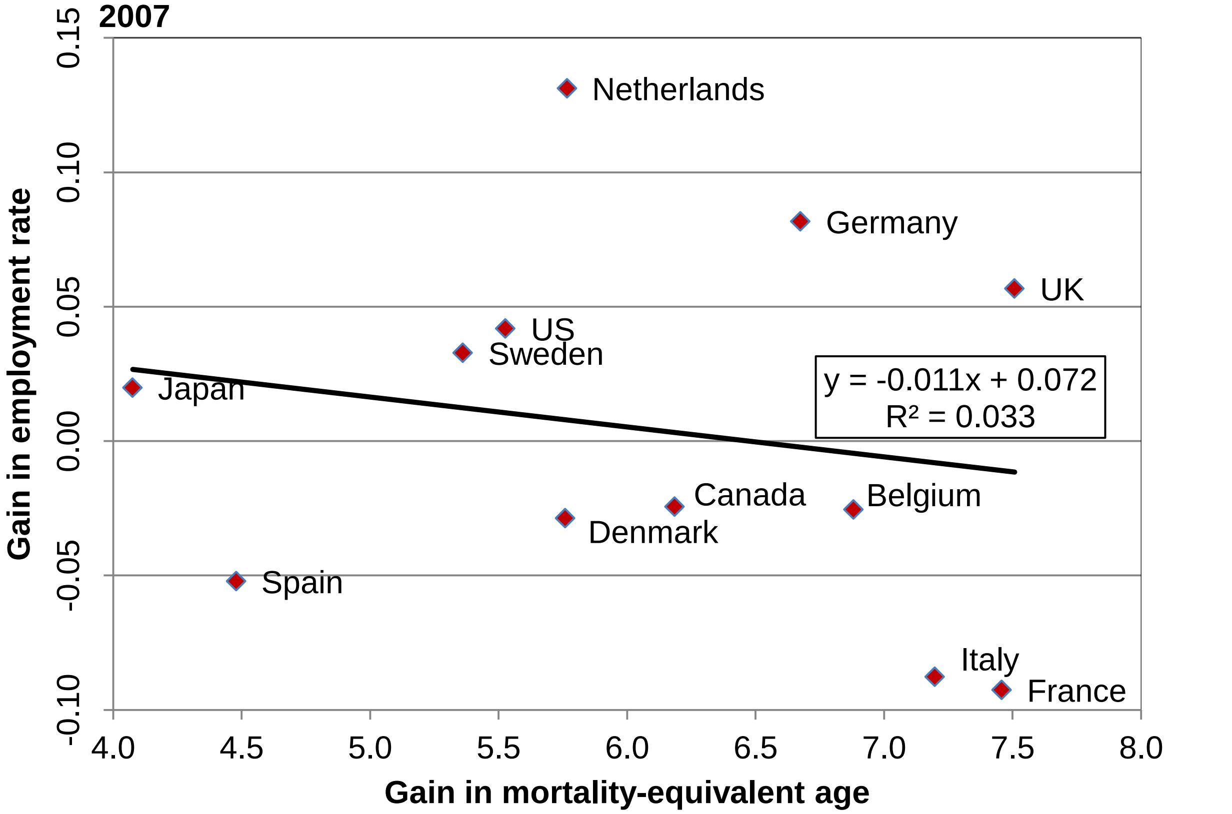
**Figure 8: Employment rate gain vs. mortality gain, 1984-2007**




Notes: Authors calculations based on data from Human Mortality Database and OECD.

We repeat the scatter plot in Figure 9 but using the gain in mortality-equivalent age for the base year of 1984 and base age of 60. Again, there is little evidence of a relationship, with a coefficient of -0.011 (*p*-value is 0.570). It appears that the extra productive capacity indicated by reduced mortality is unrelated to changes in employment.

**Figure 9: Employment gain verus gain in mortality-equivalent age, 1984-2007**



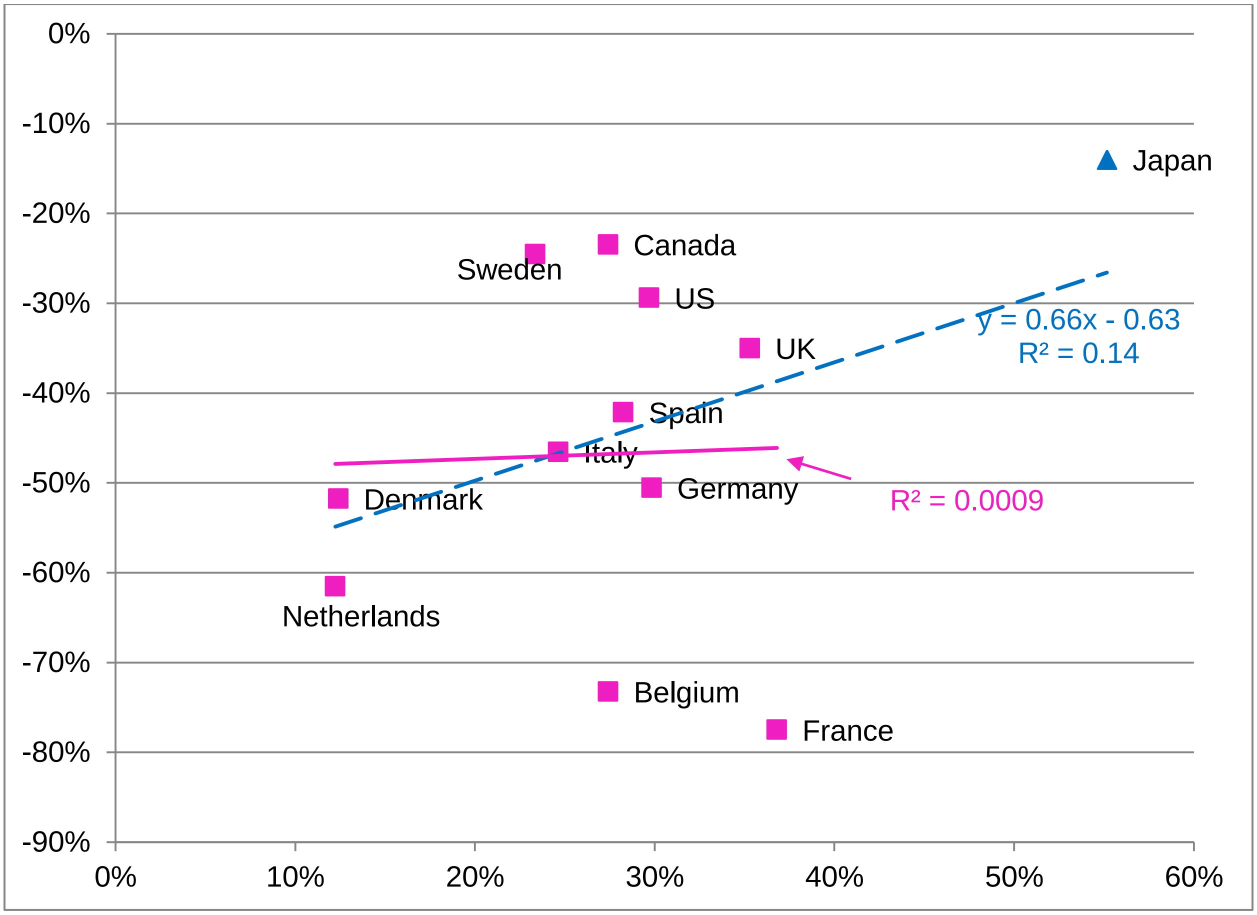

Notes: Authors calculations based on data from OECD and Human Mortality Database.

*5.2 Change Over Time in Employment by Mortality*:

Still another way to look at the data is to consider the percent decrease in labor force participation versus the percent increase in life expectancy. Figure 10 shows the percent increase in labor force participation versus the percent increase in life expectancy for men 60 to 64 between the early 1960s and the early 2000s. The employment data in this figure are based on data compiled by participants in the International Social Security Project. The mortality data were taken from OECD Health

Data 2006.[10] Excluding Japan there is essentially no relationship between the two series. When Japan, which appears as an outlier in these data, is included the relationship is positive, but even in this case the relationship is not statistically different from zero (*p*-value is 0.223).

**Figure 10: Change in Labor Force Participation versus increase in life expectancy at 65 for men**



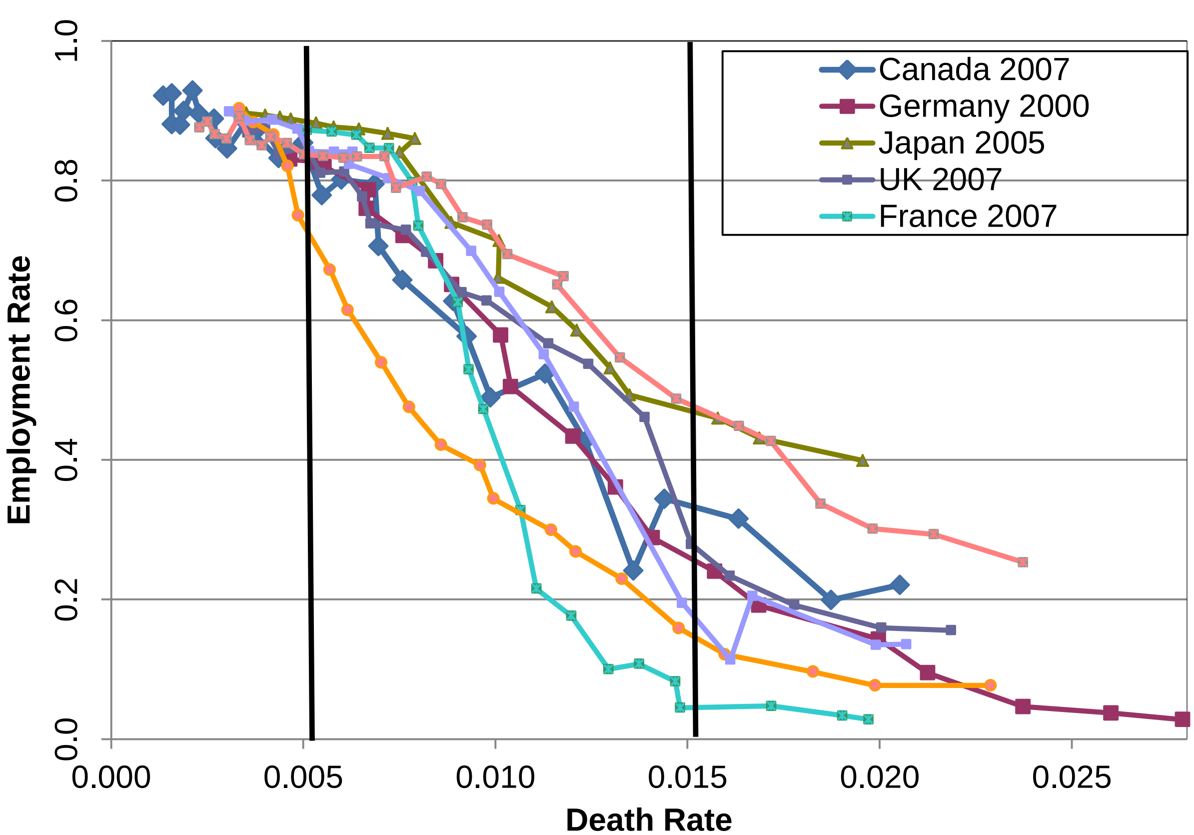

Notes: Data drawn from International Social Security Project and OECD.

[10] More detail on the data from the International Social Security Project is available in the Appendix.

Although these data show essentially no relationship between the decline in labor force participation and the increase in life expectancy over the period, the data can be used to show a very strong relationship between the decline in labor force participation the inducement to retire inherent in country social security programs. We will explain and emphasize this relationship below.

An alternative way to picture the employment-mortality relationship is to 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 11: Employment and Mortality**

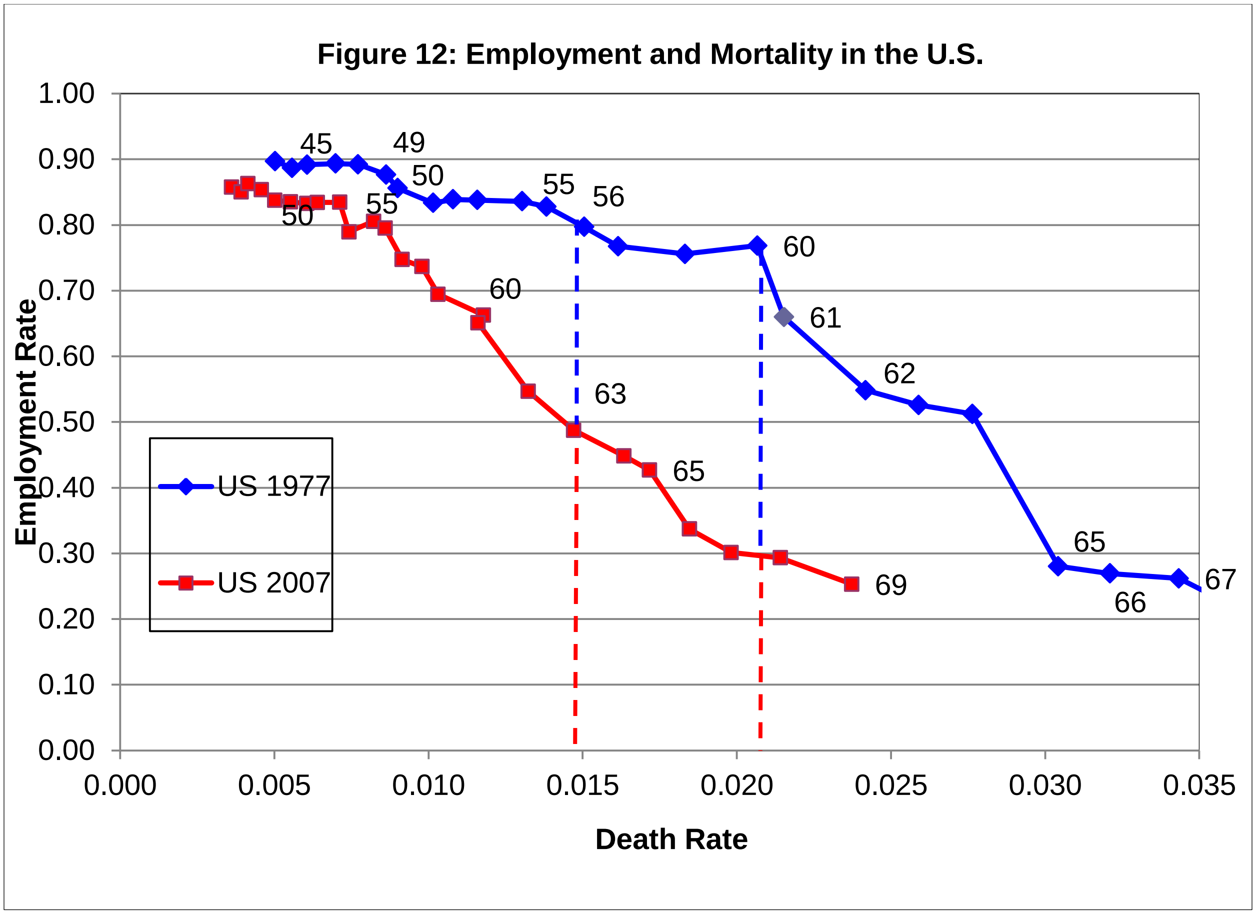



Notes: Employment data from International Social Security project. Mortality data from Human Mortality Database.

Figure 11 displays this plot for eight different countries, using data drawn from Milligan and Wise (2011). We plot data 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 0.005—there is little difference across countries in the employment rate. However, there is increasing dispersion across countries as the death rate increases. 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 48 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 these ages.

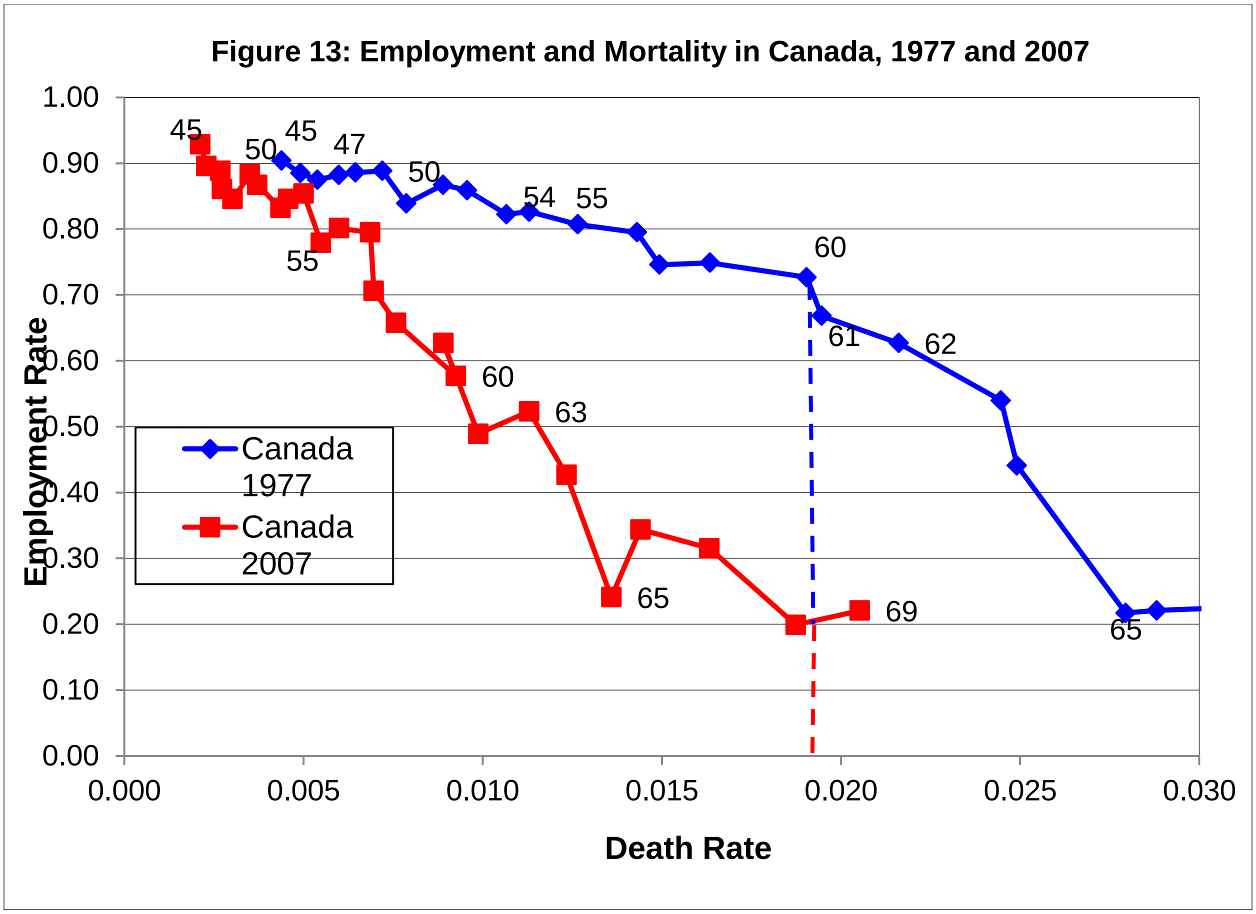
The next two plots show the differences in employment by mortality in 1977 and 2007 for the United States and for Canada respectively. The ages at which the death rates are observed in the two countries range from 45 to 69, with lower death rates at the left associated with younger ages.

Figure 12 displays the data for the United States in 1977 and 2007, with ages labelled for selected data points. At ages younger than 50, with low death rates, the data are clustered at an employment rate of about 0.85 for both years. However, as the death rate reaches 0.01 the data for the two years diverge. 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.



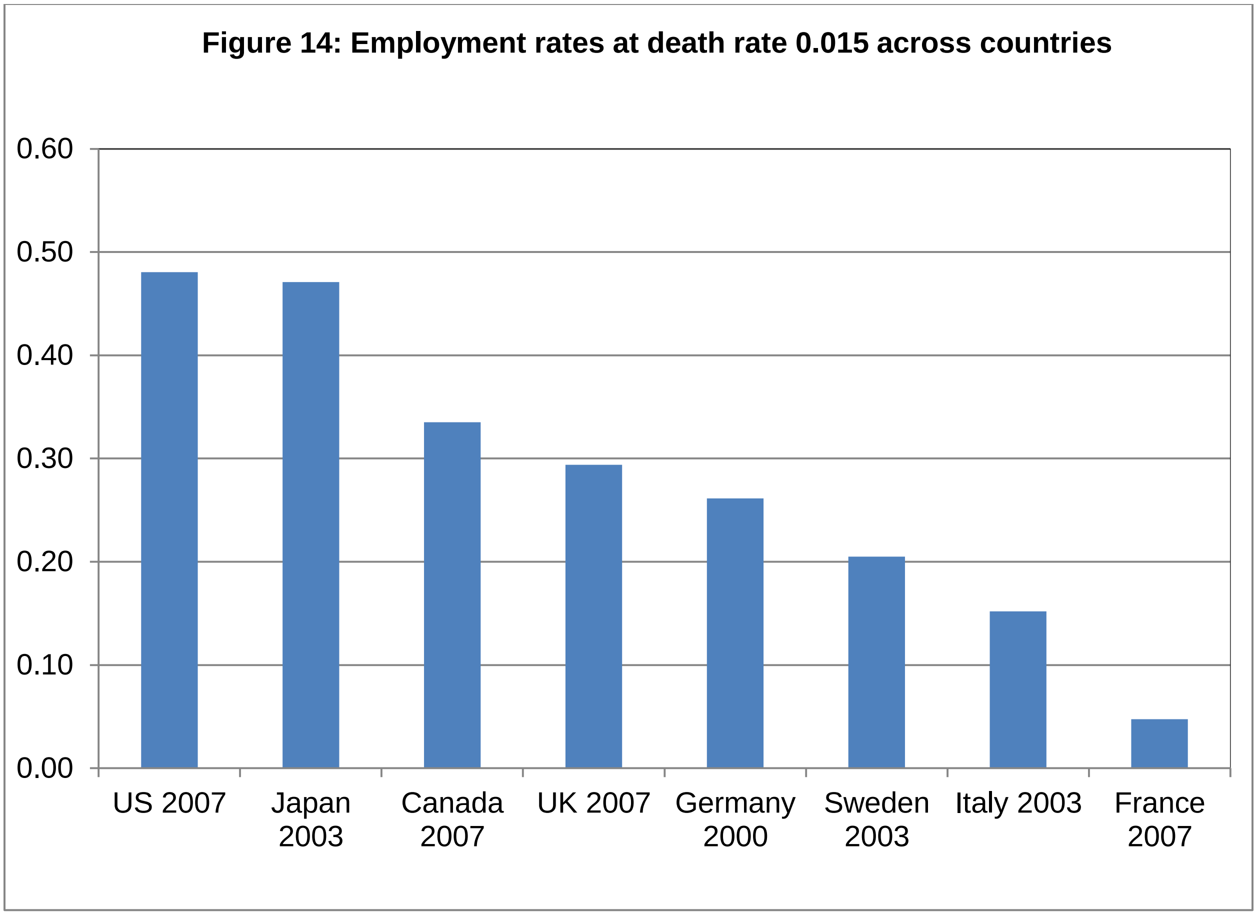

Notes: Data come from Current Population Survey and Human Mortality Database.

The data for Canada in Figure 13 shows a similar pattern. Employment rates are about 0.85 in both years when death rates are very low. But there is a growing divergence thereafter. At age 60, the employment rate in 1977 is 0.727 and the death rate is 0.019. But at that same death rate in 2007, the employment rate was only 0.199—a drop of more than 50 percentage points in the employment rate for this level of mortality.




Notes: Data come from Labour Force Survey and Human Mortality Database.

To get a broader picture of the divergence in employment, we consider again the dispersion in employment across countries at a given death rate. Figure 14 shows the employment rates for the country-year combinations from Figure 11, at the particular death rate of 0.015. In 2007, the employment rate was 0.481 in the United States at the 0.015 death rate level. In contrast, for France in 2007, the employment rate was only 0.135 at that same level of mortality. The other countries and years lie between.




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

In short, the employment-mortality data reveal two important findings. 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 mortality health.

## 6. Discussion: Putting the Results in Context

To put the findings above in context we now explore the results in two distinct ways. We first present a 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. We then compare our results here to previous work on social security incentives and retirement.

### *6.1 Calculating Capacity to Work:*

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 health, there is wide dispersion in employment rates across countries. Putting these two findings together, a counterfactual calculation can clarify the magnitude of the observed changes.

We first consider data from the US employment-mortality plot in Figure 12. Using that data, we ask what the gain in employment would be if at each level of mortality, 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 12 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. The difference between the employment rate in the comparison year and the base year is recorded. Then we move on to the next age of the comparison year. At the end, we sum across ages to determine the change in the mortality capacity to work relative to the base year.

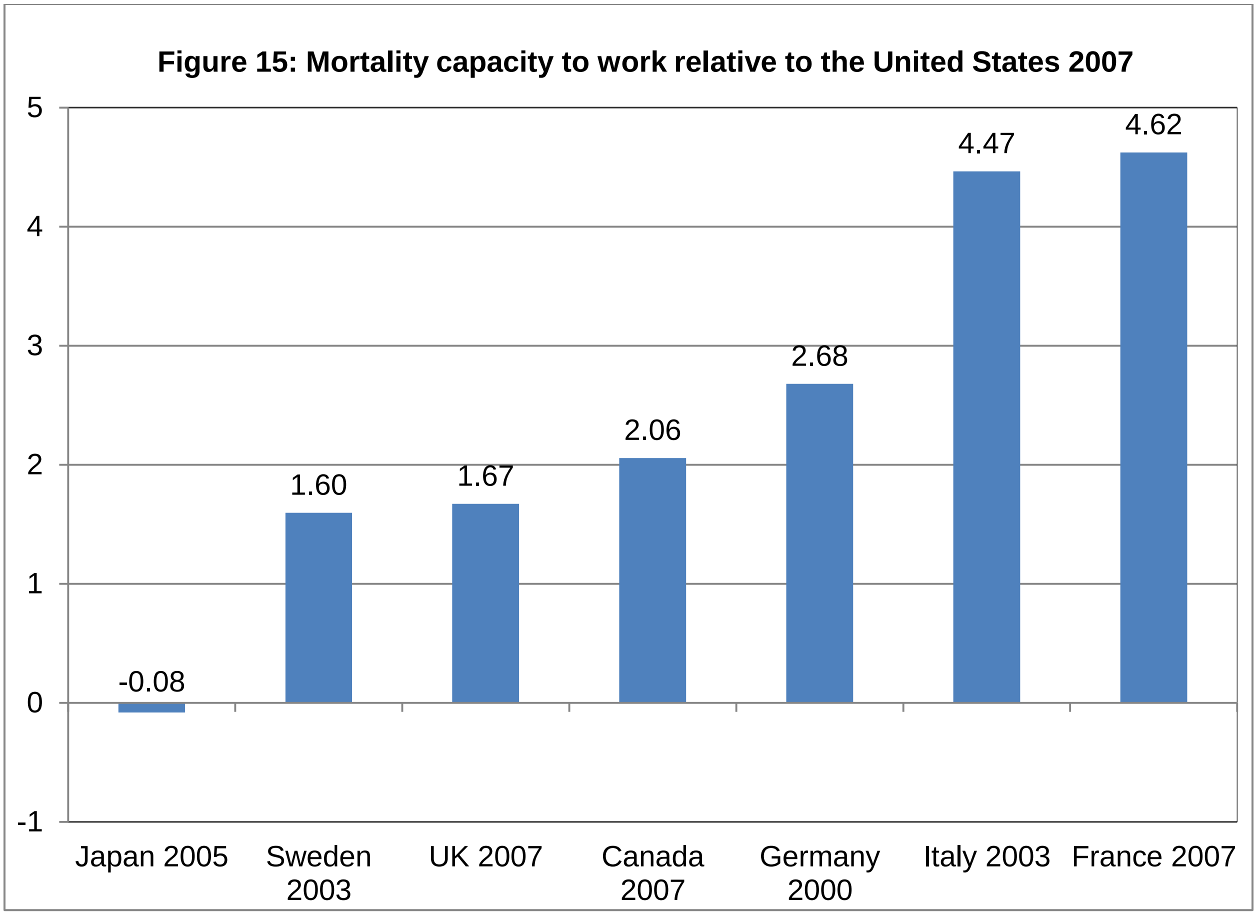
**Table 2: Gains in mortality capacity to work**

| | 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 the Human Mortality Database and from the 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 age 69.

We present the results of two such sets of calculations in Table 2. The left-hand panel of Table 2 considers the United States in 1977 as the base year and compares it to the United States in 2007. Looking back at Figure 12, 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 than in 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.

The right-hand panel of Table 2 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 have worked 4.625 years more than they did in 2007.




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

Figure 15 shows the results of calculations like those detailed in Table 2, but for all of the countries in Figure 11 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.

We consider these differences in the "capacity to work" to be quite large. Relative to a forty year work life, a gain in work capacity of more than four years represents a ten percent increase. We emphasize that these differences in relative "capacity to work" should not be taken as indicators of how much should be worked (in a normative sense) in any particular country, which will depend on individual country preferences and policies.

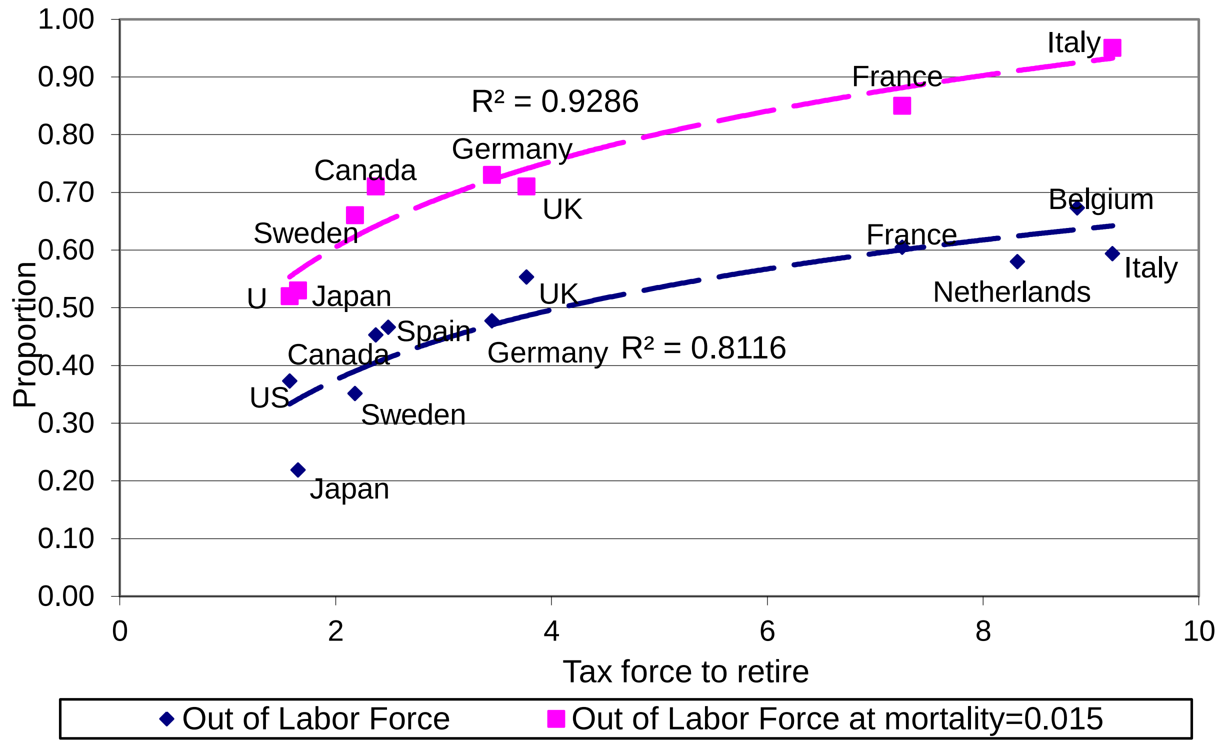
*6.2 Social Security Incentives and Retirement*:

The findings of the International Social Security Project reported in Gruber and Wise (1999) show that a large fraction of the difference in the employment of men 55 to 65 is explained by differences in the provisions of the social security systems in the two 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.[11] Here we compare the tax-force to retire versus employment from the Gruber and Wise study with our new findings on mortality.

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

[11] 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.

**Figure 16: Tax force to retire vs. males out of the labor force and labor force at mortality 0.015**



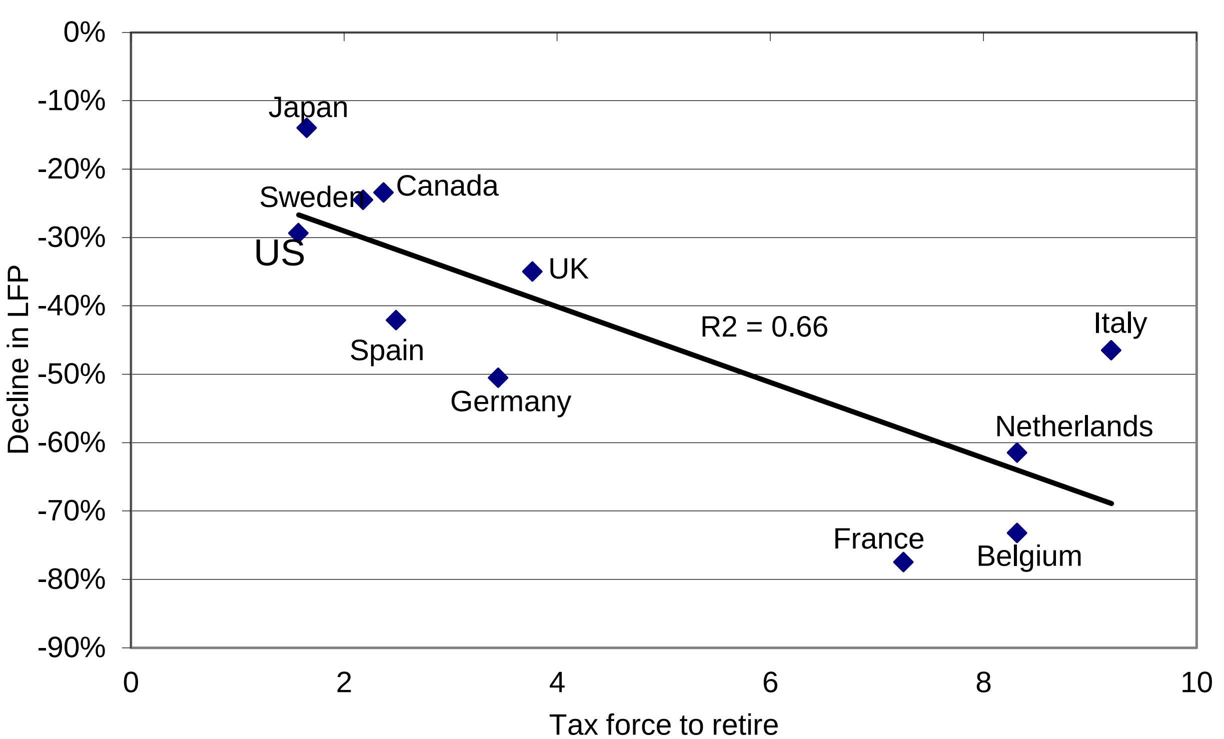

Notes: Authors' calculations using data from International Social Security Project and Human Mortality Database.

The second relationship—the upper curve in Figure 16—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 14). 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 in France is essentially the same 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. Recall from Figure11 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 program retirement inducements have their strongest bite.

Further, recall that Figure 8 shows no relationship between reductions in mortality and gains in employment across countries, and that Figure 9 shows no relationship between reductions in mortality-equivalent age and gains in employment. However, there is a very strong relationship between the tax force to retire inherent in social security program provisions and the change in employment. Figure 17 shows the relationship between the decline in labor force participation and the tax force to retire. Again, the data show a strong effect of difference across countries in retirement policy and the change in labor force participation between the 1960s and the early 2000s.

**Figure 17: Reduction in labor force participation of men age 60-64 versus tax force to retire**




Notes: Data taken from International Social Security project.

In short, Figure 16 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.

Is there more direct evidence of the relationship between mortality and the capacity to work? As discussed above, Milligan and Wise (2011) report a substantial within-country correspondence between the trend in self-assessed health and the trend in mortality. This provides a more direct link between mortality improvements and the capacity to work.

## 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, internationally comparable, and correlated with more subtle measures of health. We argue that because of these features mortality is a particularly useful for making “mortality health” versus employment comparisons across countries and time. We document very large decreases in mortality over the 1957-2007 period, but these gains are not reflected in employment rates for older workers. For a given level of mortality health, 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 males in a comparison group worked as much per level of mortality as persons in a base group worked. American men 55 to 69 in 2007 would have worked 3.71 years more if they had worked as much at each mortality level as they did in 1977. Using 2007 United States as a base, we find that French men in 2007 would have worked 4.62 years more if they had worked as much as American men worked at each level of mortality in 2007. In contrast, Japanese men work slightly more than American men, given mortality. Thus the mortality capacity to work has increased substantially through time and differs substantially across countries.

Countries around the world continue to examine the impact of their social safety net programs such as public pensions and disability insurance on the transitions between work and retirement. Our findings suggest that large differences in employment at older ages persist across countries given similar health levels, providing substantial scope for policy to influence work decisions.

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**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. We use the provided combined 5-age data for ages 60-64 (and other 5-year age groups) for most purposes, and the single age data in some analyses.

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; Milligan 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 come from the National Health Interview Survey, which has consistent annual data on self-assessed health from 1972 to 2009.