The Cost of Living Longer: Projections of the Effects of Prospective Mortality Improvement on Economic Support Ratios for Fourteen More Advanced Economies

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Abstract

The aims of this paper are threefold; (1) to forecast mortality for a wide range of more developed countries from 2010-2050; (2) to project the effects of the forecast mortality patterns on economic support ratios assuming continuation of current fertility, migration and labour force participation; and 3) to calculate changes to labour force participation which would offset these effects. The mortality forecasts are prepared for fourteen countries using the Poisson Common Factor Model proposed by Li (2013). The mortality forecasts show that the projected gains in life expectancy are greatest in Japan, Australia and East-Central Europe, and are least in Netherlands, North America and Sweden. Preliminary results for the projections show that the support ratios are projected to fall most over the period to 2050 in Japan, East-Central and Southern Europe, and least in Sweden and Australia. However, except for Poland, some recovery i support ratios is projected for the East-Central and Southern European countries post 2050. The dependency of the estimated effects of mortality improvement on support ratios and the initial age structure and the assumed levels of fertility, migration and labour force participation is discussed.

Introduction

The economic implications of prospective population trends, particularly the aging of populations, are important concerns for contemporary more developed societies (Kupiszewski et al. 2006, Australian Government 2002, 2007, 2010, UNPD 2010, Bloom, Canning and Fink, 2010, Saczuk, 2013). These economic implications include those for public expenditure on pensions, social security, health and aged care and on the proportionate size of the economically active population. In this paper we restrict our attention to the latter: we consider prospective changes in economic support ratios for an extensive range of more developed countries.
The prospective age changes of populations will be affected by fertility and migration trends, both past and future, as well as by both past and future mortality trends. The effects of these changes on economic support ratios will also depend on prospective age-specific patterns of labour force participation. However it would appear that the potential effects of prospective changes in mortality have not received the same attention as either potential variations in migration or potential changes in fertility.

Therefore we focus on the effects of prospective mortality change. We highlight the international variability of these effects. Such variability is to be expected both because of the between-country variability in projected mortality change and because of the international variability in base populations, future fertility, future migration and future labour force participation rates, all of which interact with the effects of mortality change. Just as past mortality changes will affect future changes in population age structure, and hence economic support ratios, so future mortality changes over a specified period of time will affect support ratios beyond the end of that period. Hence we also consider the very long run implications of mortality changes through consideration of the stable populations to which there would be convergence under the (purely hypothetical) maintenance of constant end-of-period values for all data inputs, and model-based estimates of the paths of convergence (Guest and Parr 2014).

Recent Mortality Trends

Our mortality forecasts are based on extrapolative methods, and will therefore reflect recent past mortality trends. In 2010 Japan has the highest overall life expectancy at birth, after impressive increases for males (averaging 0.24 years per year) and especially for females (0.28

years per year) over the preceding 40 years (Wang et al., 2012). Australia also saw moderately fast increases over this period. In Europe, average improvement since 1970 has been very fast in Portugal, moderate in Italy, Switzerland, Spain, and the UK, and slow in the Netherlands and Sweden. After stagnation or even – for males – declines over 1970 to 1990, life expectancy at birth increased dramatically from 1990 in the East-Central European countries Czech Republic, Hungary and Poland (0.27-0.33 for males and 0.23-0.26 for females since 1990); Bijak (2013) outlines some of the health policy and other factors contributing to these changes. Improvements since 1970 have been slow in the USA and Canada. It can be observed that for most countries, male improvements have outstripped female improvements.

Data and Method

Method

The living standard at a specified point in time, $(C/N)_t$, can be expressed using the following framework:

$$\left(\frac{C}{N}\right)_t = \left(\frac{C}{Y}\right)_t \left(\frac{Y}{L}\right)_t \left(\frac{L}{N}\right)_t \qquad (1)$$

where t indicates the time period and the other symbols in this identity refer to the following national aggregates: C is consumption of goods and services, N is the effective number of consumers (either total population or a needs-weighted population, for example as defined by Cutler et al. 1990), Y is output of goods and services (gross domestic product, GDP), and L is employment (for example, total hours worked). The ratio C/N is consumption per capita, C/Y is the consumption share of GDP, Y/L is average labour productivity, and L/N is the employment to population ratio. In this paper we restrict our attention to projections of the support ratio, L/N. The value of $\left(L/N\right)_t$ can be decomposed as the sum of age-specific components:

$$\frac{L_t}{N_t} = \sum_x H_{x,t} \frac{E_{x,t}}{S_{x,t}} \frac{S_{x,t}}{N_{x,t}} \frac{N_{x,t}}{N_t} \qquad (2)$$

where $H_{x,t}$ denotes hours worked per employed personin age and sex group x at time t and hence $L_t = \sum_x H_{x,t}\, E_{x,t}$, $E_{x,t}$ is the number of employed persons in age and sex group x at t, S_x is the number of people in of the labour force in age and sex group x at t, and $N_{x,t}$ is the population in age and sex group x at t, and N_t is the total population at t.

In this paper for each country we consider projections for the following measures of the support ratio:

(1) The ratio of hours worked to total population

(2) The ratio of hours worked to a (consumption) weighted population, using the weights proposed by Cutler et al (1990)[1].

Projections of population $N_{x,t}$ are prepared using the standard cohort component method (e.g. Pollard et al. 1990), and projections of hours worked by applying assumed future age and sex specific labour force participation rates $S_{x,t}/N_{x,t}$, employment rates ($E_{x,t}/S_{x,t}$), and mean hours worked per employed person $H_{x,t}$ to the projected numbers in the population by age. The effect of projected mortality change is calculated by comparing the projected values of L/N for a projection using our best estimates of forecasted future mortality to those produced by a projection with the same assumptions for fertility, migration and labour force participation but which also assumed mortality rates remain constant at the levels for the base year of the projection (i.e. 2010).

The forecasts of mortality are developed using the Poisson Common Factor method of Li (2013). This is a coherent forecasting method, and was applied here to ensure coherence between sexes, with each individual country forecasted independently (see Appendix A for details of the methodology).

For all countries we firstly consider projections over the period 2010-2050 and comparison of projected trends under the forecast mortality change with those projected with mortality constant at the 2010 level (and identical assumptions for fertility, migration and labour force participation). Secondly we consider the stable populations to which the populations would converge if the values of the fertility, mortality, migration and labour force participation were to

[1] Cutler et al. (1990) apply a weight of 0.72 to the 0-19 population, 1.00 to the 20-64 population and 1.27 to the 65 and over population.

remain constant at the 2050 levels used, and their contrasts with those generated by mortality at 2010 levels (Pollard 1973, Cerone 1987, Espenshade et al. 1982). This is because the projected mortality change between 2010 and 2050, in addition to contributing to population change between 2010 and 2050, will have implications for population change post 2050.Finally we consider valuations of the effect of the forecast change in mortality over the entire long run path towards the stable population, using a method developed by Guest and Parr (2014). The Guest-Parr method additionally requires the formulation of assumptions for a social discount rate, ρ, which allow an equivalisation of the social value of consumption at different time points and the very long run rate of productivity growth, g (Samuelson 1958) (see Appendix B for details of the Guest-Parr method). Values of 2.0 per cent per annum for ρ and 1.5 per cent per annum for g were adopted for all countries.

We consider patterns for the following countries; Australia, Canada, Czech Republic, Hungary, Italy, Japan, Netherlands, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom, and United States of America. The choice of countries was restricted to more developed countries for which all the requisite data inputs could be identified. We endeavoured to select a range of countries which were diverse in terms of their geographical regions and in their recent mortality trends, giving preference for inclusion to countries with larger populations over those from the same region with smaller populations.

Data

The mortality forecasts were based on data from the Human Mortality Database (HMD 2013). The population, fertility, migration, and labour force data were sourced from the websites of a range of international agencies (United Nations, OECD, Eurostat) and official national data sources.

Assumptions

Base Population

The proportionate age distributions of the base (2010) populations differ significantly (Table 1). The United States, Australia, the UK, the Netherlands, Sweden and Canada have the highest percentages aged under 20 years, whilst Japan, the Southern European countries (Italy, Spain and Portugal), and the East-Central (Czech Republic, Hungary and Poland) have the low percentages in this age range. In contrast, for the percentage of its population aged 65 or over Japan has the highest value, followed at a distance by Italy. The United States, Australia and Poland have the lowest initial percentages aged over 65. The range of variation for the percentage of population in the main working age range (20-64) is fairly small. The percentages in this age range are highest for the East-Central countries and for Spain, and lowest for Sweden, and Japan.

Fertility

The fertility assumption for all countries is that all age-specific fertility rates remain constant at the 2010 level. The assumed Total Fertility Rates are highest for Sweden, and for three of the mostly English-speaking countries (Australia, UK and USA) (Table 1). Japan, the East-Central and Southern European countries have the lowest fertility levels.

Net Migration

For all countries annual net migration in total and by age and sex was assumed constant at the average level for the 2006-2010[2] period. Where net migration was positive the absolute numbers of migrants by age and sex were used, whilst for the two countries with negative net migration, Japan and Poland, constant age-specific net migration rates were applied. The choice of the average migration over this period as opposed to the level of the most recent year was made in view of quite significant year-to-year volatility in net migration. In terms of the absolute numbers the assumed net migration to the United States far exceeds that for all other countries considered. Spain and Italy, Australia, Canada and the UK all had net immigration over 200,000. When viewed as a rate per 1000 population net migration is highest for Spain, Switzerland and Australia, followed by Canada, Italy, and Sweden.

Mortality Projection

The Poisson Common Factor method of Li (2013) (Appendix A) was applied to each individual country independently, to produce forecasts that are coherent between the sexes. The method

[2] Following US Census Bureau (2013) in the apparent absence of suitable data for the United States an assumed level of 725,000 per annum was applied to the proportionate age and sex distribution of net international migration for Canada

imposes coherence in projected male and female mortality for the same country. Following Booth et al. (2002) the length of the fitting period used varied somewhat between countries. For some countries the overall mortality trend (measured by K_t) has changed quite considerably in the recent past, particularly for the Czech Republic, Hungary, and Poland. As a result, for these countries fitting periods around 20 years or even less have been used. Data availability can also impose restrictions on fitting period. In all other cases, a fitting period starting in either 1970 or 1980 was used depending on patterns in the mortality trend. The number of additional factors, *n*, was determined separately for each country based on the criteria outlined in Appendix A, and projection commenced from the actual rates in the final year of the fitting period.

Labour Force Participation

Our labour force projections used the average values over the period 2006-10 for age and sex specific labour force participation, employment, and hours worked per employed, shown in Table 2. Following the Global Financial Crisis (GFC) in 2008 there were significant increases in unemployment rates in some countries, most notably those in Southern Europe. Thus the values of labour force participation measures we use represent averages of pre and post-GFC values. Age-standardised measures of labour force participation are used in order to purge the potentially significant effects of the between-country variation in population age distributions from the comparisons.

The key values to note in Table 2 are the standardised mean hours per person aged 15 and over in the two right-hand columns. These values are weighted sums of the products of age-specific labour force participation rates, employment rates and the mean hours worked per employed person. Unsurprisingly for every country we studied the average hours worked per male exceeded the average per female. Surprisingly the range of variation between countries for males is greater than for females. For males Japan has by far the highest average number of hours per person. This reflects its high participation rate, low unemployment and an unusually high average hours worked per employed male (across some age groups the averages exceed 48 per week). The English-speaking countries, Switzerland and the Czech Republic also have high hours worked per person. Except for the Czech Republic these countries have above average male labour force participation rates, all have above average hours worked per male employed, and in the case of Switzerland and Australia low unemployment rates are also a factor. Hungary, Italy, Poland, and Spain have the lowest hours worked per male. This is the product of their lower male participation rates, higher unemployment rates and lower mean hours per employed.

Swedish females have the highest mean hours worked per person, a pattern driven by their much higher participation rate (Table 2). The USA, Canada and Portugal also have high average hours per female. For USA and Portugal females it is due to a relatively high participation rate and a relatively high hours average worked per employed female. For females in Canada it is driven by relatively high participation rate and a slightly higher than average employment rate. Italy has the lowest hours worked per female, primarily due to a much lower labour force participation rate. Despite a high female participation rate and a low unemployment rate, the Netherlands has one of the lowest hours worked per female. This is driven by an unusually low average hours per employed, a pattern linked to widespread part-time work. Spain also has a low average hours per female, due to its low participation rate and high unemployment rate.

There are some considerable between-country differences in the pattern of variability of hours worked per person by age (not shown). For both males and females in the 15-19 age group Switzerland has the highest average hours per person, with Australia, Canada and the UK also having relatively high values. Switzerland, Japan, Portugal, Australia, the UK and the USA have the highest values for males and females aged 20-24. For males aged between aged 25 and 59 the hours worked by Japanese men far exceed those for the other countries. For females Portugal has the highest hours worked over the main reproductive ages (i.e. 25-39), whilst for those between the ages of 40 and 59 the Czech Republic, and Sweden have the highest rates. For males in the 60-64 age range Japan, Switzerland and Sweden have the highest values, whilst for females in this age range Sweden, and the USA have the highest values, followed by Japan. For both sexes Japan and the USA have the highest hours worked for males aged over 65.

Results

Mortality Projections

At the start of the projection period in 2010 for both sexes the greatest differences in life expectancy at birth are between the Eastern European countries and the other countries, with the former having significantly lower values (Table 3). Japan has the highest life expectancy at birth for both sexes. Life expectancies for the United States, whilst higher than those for Eastern Europe, are noticeably lower than those for the Western European countries and the other mostly English-speaking countries.

The results of the mortality projections show that in all the countries we consider between 2010 and 2050 the increase in male life expectancy at birth is expected to be greater than that for females (Table 3): convergence between male and female mortality is expected due to the use of the Poisson Common Factor Model. Except for males in the USA, the projected increases in life expectancy are greater between 2010 and 2030 than between 2030 and 2050.

For both sexes the greatest increases in life expectancy at birth are projected to occur in Japan, followed by three East-Central European countries (Table 3, Figures 1 and 2)). The projected gains in life expectancy in Australia and the UK are also relatively large. For both sexes the Netherlands has the smallest projected increase in life expectancy at birth. The projected gains in life expectancy at birth are also relatively small for the North American countries and Sweden for both sexes, and for Spanish females.

Figures 1 and 2 show the widening gap between the projected life expectancies at birth for Japan and those for the other countries. For females the projected life expectancy at birth in 2050 for Japan is projected to be a huge 5.3 years greater than the next highest country (Australia). By 2050 for both sexes Australia is projected to have significantly higher life expectancy at birth than all the European countries we consider. The East-Central European countries are projected to still have lower life expectancies in 2050 than most of the Western European countries for both sexes, although the gaps will be significantly smaller. However for both sexes in 2050 life expectancy at birth for the Czech Republic is projected to exceed those for the USA, the Netherlands, and Portugal, and for females life expectancy at birth is also projected to be greater in Poland than in the United States.

For Japan, relatively steep decreases in central death rates are projected for all age groups and both genders. For most ages increases in male to female age-specific mortality ratios are projected, with the exceptions being at the two extremes of the age range (under 10 and over 90). For the East-Central European countries mortality declines are projected for all age and sex groups. However the reductions in the $\log(m_x)$ are projected to be considerably more rapid in the younger ages than in the older ages. Male to female ratios for mortality rates are projected to remain more or less constant for all age groups. The projected patterns of mortality improvement for Australia and the UK exhibit similarities with the fastest decreases in $\log(m_x)$ occurring below age 20 and in the 40-79 age range (more so for 40-59 year olds in Australia), with little change for 20-39 year olds. For the USA and Canada deteriorating mortality is projected for the over 90 age range. For the Netherlands for both sexes projected reductions in $\log(m_x)$ are greater in the younger ages than in the older ages, and male to female ratios in age-specific mortality are projected to increase slightly. Table 4 shows that for both sexes life expectancy at age 65 is projected to increase most in Japan. Of all the countries we consider the USA has the smallest projected increase in life expectancy at age 65 for males, and for females only the Netherlands has a smaller projected gain than the USA.

Projected Changes in Support Ratios to 2050

In 2010 Japan, Switzerland, and the Czech Republic have the highest support ratios (Table 5). These patterns reflect the relatively age-specific high hours worked per person in these countries (Table 2). For the Czech Republic a favourable age structure is also a factor, whilst in Japan the high initial hours worked to population ratio is despite its proportionately very large over 65 age group (Table 1). For both forms of the support ratio, Italy has the lowest value by a significant margin, a pattern which reflects its relatively low hours worked per person for males and particularly for females, as well as its large relative population aged over 65. The Netherlands, and Hungary also have relatively low support ratios. These countries all have low standardised hours worked (Table 2).

Between 2010 and 2050 the support ratios are projected to decrease in all the countries we consider. This result is driven by the projected ageing of these populations over this period. For every country the decrease according to the consumption needs-weighted measure is greater than that for the unweighted measure.

Poland and Japan are projected to experience the greatest decreases for both forms of the support ratio over the period 2010 to 2050 in absolute terms (Table 6). This reflects the rapid ageing produced by very low fertility, rapidly improving mortality, particularly in the older ages, and net outmigration, particularly by young adults. Two East-Central European countries, the Czech Republic and Hungary, also have relatively large decreases in support ratios, as do the three Southern European countries. These are all countries with very low fertility. In 2010 this very low fertility would have been beneficial to the support ratios, by reducing the proportionate size of the child and young adult ages. By 2050 the effect of very low fertility extends more widely across the life span, and any beneficial effects on the support ratio accordingly are much reduced.

Sweden has the smallest projected decrease in the support ratio. The USA, Australia, the UK and the Netherlands are also projected to have relatively small decreases (Table 6). These countries share a pattern of relatively high fertility and significant net immigration. A slower rate of population ageing combined with relatively high rates of labour force participation in the older ages are other contributory factor behind Sweden's maintenance of its support ratio. For most countries the projected reduction in the support ratio is greater between 2010 and 2030 than between 2030 and 2050. The exceptions are the three East-Central European countries, Portugal, Spain and Japan.

By 2050 Switzerland and Japan are projected to have the highest labour force to population ratio, followed by the Czech Republic, USA, Australia, and Sweden (Table 5). These countries have relatively high age-standardised labour force participation rates (Table 2). The projected support ratio defined relative to the age-weighted population for Japan is significantly worse than for the other afore-mentioned countries, due to its much older projected population. Italy is projected to still have the lowest value for both forms of the support ratio. This is linked to its very low rates of labour force participation, especially for females. However, by 2050, as a result of its large projected reductions between 2010 and 2050, Poland is projected to have the second lowest value for both forms of the support ratio. Hungary, Spain and the Netherlands are also projected to have relatively low projected support ratios.

Support Ratios for Terminal Stable Populations

Since the forecast mortality declines not only affect support ratios during the 2010 to 2050 period but also will affect those beyond 2050, Table 5 also presents the support ratios for the stable populations produced by the assumed levels of fertility, migration and labour force participation and with mortality at the forecast level for 2050 and Table 7 the differences between these support ratios for the terminal stable populations (TSP) and the 2010 and 2050 values. For nine of the fourteen populations we consider the stable population support ratios are below those for 2050. The countries in which greatest reductions in the support ratios between 2050 and the terminal population, Australia and Sweden have relatively high fertility and net immigration, and hence relatively young projected populations. The countries for which the ratios for the terminal stable population are higher than for 2050, Czech Republic, Hungary and Italy and Portugal, all are countries with very low fertility, low but positive net immigration and relatively rapid mortality improvement which is concentrated in the younger ages. The reductions in support ratios over the entirety of the transition between 2010 and the terminal stable population are largest, both in absolute and in percentage terms, for the two countries with very low fertility, net outmigration and rapid mortality improvement, Poland and Japan. In Poland the percentage decreases (of 24.6 per cent for the unweighted L/N and 30.9 per cent for the weighted measure) are particularly large. However, due to the projected post 2050 recoveries in support ratios, the differences between the support ratios of the initial and terminal are lowest for two other countries with very low fertility, Portugal and Hungary.

As a result of the recovery in its value the Czech Republic has the highest support ratios for its terminal stable population, followed by Portugal, USA and Switzerland. Japan ranks only fifth. Italy still has the lowest support ratios. Due to the large projected reduction, Poland has the second lowest support ratio for its terminal stable population. The Netherlands and Spain also have relatively low values.

The Effects of Mortality Improvement on Support Ratios

Table 7 shows that in all the countries we consider projected mortality change, according to our best estimates, contributes to the projected reduction in the support ratio over the period from 2010 to 2050. The projected effects of mortality improvement are greatest for the Czech Republic and Japan. These are also the two countries in which the forecast increases in life expectancy are greatest (Table 3). In Japan the projected improvements in mortality at older ages are especially large relative to those for other countries, and this contributed to the detrimental effects of mortality improvement on the support ratios. Since labour force participation by Japanese females is much lower than for males, the particularly large forecast improvements in female mortality are also a factor in the reduction of the support ratio. Moreover the effect of this mortality improvement is magnified a population age structure which even in 2010 is the oldest in the World and which ages very rapidly largely. The effects of projected mortality improvement are also relatively large for Poland and Hungary, both also countries in which the forecast improvements in life expectancy are large and which are projected to age rapidly.

In absolute terms Sweden, USA, Canada, the Netherlands and Australia have the smallest projected "mortality effects" on their support ratios. Except for Australia, the forecast improvements in life expectancy in these countries are relatively small. All these countries have somewhat younger populations and slower rates of ageing which are linked to relatively high fertility and net immigration by young adults. Their relative youthfulness elevates the effects of mortality improvement on the working ages relative to those on the post-retirement ages.

The proportionate contribution of the forecast mortality improvements to the reductions in the support ratios is greatest for the Czech Republic (44.8% for the reduction in L/N and 41.6% of the reduction for L/N*) and for the UK (42.1% and 43.5% respectively) and Hungary (40.4% and 37.7%). For the Czech Republic and for Hungary these are proportionate to large total reductions in the support ratios, whilst for the UK they are relative to a small reduction. The contributions of mortality are smallest for Spain, Sweden, Canada, Portugal and Poland. The first three of these countries have relatively small forecast improvements in life expectancy. The latter two have very low fertility and an absence of immigration.

For all countries and both forms of the support ratios the projected effect of mortality change are negative both for the 2010 and for the 2030 to 2050 period, except for Sweden for the unweighted measure for 2030 to 2050. For all countries except for Sweden the support ratio lowering effects of mortality change are greater between 2030 and 2050 than between 2010 and 2030. This would be linked to the effects of mortality change becoming increasingly concentrated on the post retirement ages and the increasing weight placed on the post-retirement age groups due to population ageing.

Guest-Parr Valuations of the Effects of Mortality

Using the method of Guest and Parr (2014) we evaluate the effect of the forecast mortality changes between 2010 and 2050 conditional on fertility, migration and labour force participation remaining at the assumed levels throughout future time, on there being no further mortality improvement post 2050 and assuming a net social discount rate of 1.5% per annum.

The values in the “Total Social Value” column of Table 9 represent the effect of the projected mortality change over the entire transition towards the terminal stable population as a multiple of the consumption value of one hour worked per week per capita (i.e. ignoring differences between countries in labour productivity). By this measure the effect of the projected size of the effect of mortality change is greatest for Japan, followed by the three East-Central European countries. The projected effect of mortality change is smallest for the United States, the Netherlands, Canada and Sweden.

The values in the fourth column of Table 9, which show the “mortality effects” expressed as percentages of the value of the constant mortality series, indicate the (immediate and sustained) percentage increases (relative to the 2006-2010 average level) in labour force participation which would compensate for the effect of the forecast change in mortality, if the percentage increases were uniformly spread across all age and sex groups. The greatest value is 7.8 per cent for Poland. This indicates that in Poland an increase of labour force participation on 7.8 per cent would be needed to compensate for the forecast mortality improvement. Japan has the second largest (relative to its higher participation rate) value in percentage terms, followed by the two other East-Central European countries. The North American countries have the smallest percentage changes in labour force participation required to offset forecast mortality improvement, followed by the Netherlands and Sweden.

The final column of Table 9 effectively shows the “mortality effects” as a percentage of the 2010 GDP, and serves to indicate the very large magnitudes of these effects if sustained over the very long run.

Conclusions

Whilst for all the countries we consider life expectancies, both for males and for females, are forecast to increase, the forecast patterns of improvement are diverse. The gap between the highest (Japan) and lowest (Hungary) life expectancies at birth is forecast to increase over time. Life expectancy for Australia is forecast to exceed those for European countries, with the differences increasing over time. Within Europe our forecasts show a narrowing of the life expectancy gaps between Western European countries and East-Central European countries, with life expectancies for the Czech Republic exceeding those of two West European countries by

2050. The forecast increases in USA life expectancy are relatively slow and our best estimates indicate that by 2050 they may even fall below those for the Czech Republic for both sexes and for females also for Poland. The forecast patterns of improvement by age are similarly diverse. These forecasts are essentially based on extrapolations of recently observed trends.

The projections show that, in the absence of changes in participation rates, fertility or migration, economic support ratios will decrease in all the countries we consider. However the magnitude of the decrease varies considerably between countries, with the largest projected reductions (for Poland and Japan), depending on the choice of measurement of the support ratio, being two or three times more than double times the smallest reductions) over the very long run. The largest reductions are projections for countries which assume the continuation of very low fertility and also net outmigration and therefore in which annual births decrease indefinitely. Whilst over the period to 2050 the reductions in support ratios are generally greater in very low fertility countries, for those which also have net immigration recoveries in the support ratios are projected post 2050, as an immigration-created floor for births is created and differences in population numbers between age ranges increasingly become smaller and the product of immigration and mortality. Thus the projections indicate the potential long-run benefit of positive immigration for the age structures of countries with persistently very low fertility. They also show the potential for analyses which only consider the more immediate future (eg 40 years) to create a misleading impression of prospective support ratio trends for very low fertility countries. Our paper is distinctive in its attempt to isolate the effects of forecast improvement in mortality on support ratios. The projections show, unsurprisingly,thatthe effects of the forecast improvements in mortality are generally to decrease support ratios. For all the countries we consider the effect of forecast mortality improvement contributes less than half the projected reduction in the support ratio between 2010 and 2050. However, the effects of mortality will increase in importance over time as the population ages.

Another distinctive feature of our paper is its application of a method, recently developed by Guest and Parr (2014), to provide a single-figure index of the cumulative effect over time of mortality change on the support ratio. The results illustrate the large size of the mortality effects cumulated over the very long run and some of the combinations of changes in labour force participation which could compensate for these effects. The changes can be calculated conditional on the distribution of participation rate changes between age groups and the gradient of the changes over time. A number of more developed countries, including Australia and the UK, have recently sought to increase retirement ages and labour force participation more broadly in response to prospective increases in longevity and population ageing more generally (Australia 2010). The method used can evaluate the magnitude of increases which are needed.

It is important to note that the projected effects of mortality are conditional on the assumed future levels of fertility, migration, labour force participation, the initial age structure of the population and the assumed rates of discount: for any one country the effect of mortality improvement would be smaller if labour force participation rates in the later working ages increased or if net immigration increased. Similarly the changes to participation which could counterbalance the mortality changes also depend on the values of the other demographic and economic variables in the model.

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Technical Appendix A: The Poisson Common Factor Method for Forecasting Mortality Coherently

The mortality projections were prepared using the Poisson Common Factor method of Li (2013). This appendix summarises the specification of this model.

Considering a particular country and assuming that the force of mortality is constant within each age-time cell and so is equal to the central death rate, Li (2013) uses:

$$D_{x,t,i} \sim \text{Poisson}\left(e_{x,t,i}\, m_{x,t,i}\right), \qquad (1A)$$

$$\ln m_{x,t,i} = a_{x,i} + B_x\, K_t + \sum_{j=1}^{n} b_{x,i,j}\, k_{t,i,j}\ , \qquad (2A)$$

in which $D_{x,t,i}$, $e_{x,t,i}$, and $m_{x,t,i}$ are the number of deaths, central exposed-to-risk, and central death rate at age *x* in year *t* for sex *i* (*i* = 1 for females and *i* = 2 for males). The parameter $a_{x,i}$ depicts the overall mortality schedule across age for sex *i*, $B_x\, K_t$ is the common factor for both sexes, and $b_{x,i,j}\, k_{t,i,j}$ is the j^{th} additional sex-specific factor. The common factor represents the main long-term trend in mortality change for both sexes, and the additional factors represent the short-term discrepancy from the main trend for each sex. More specifically, K_t is the time-specific mortality index of the common factor with B_x as the age-specific sensitivity measure, and $k_{t,i,j}$ is the time component of the j^{th} additional factor with $b_{x,i,j}$ as the age-specific sensitivity measure. There are a total of *n* additional factors. The Lee-Carter model as applied within a Poisson framework (Brouhns et al, 2002) can be regarded as a special case of the PCFM, in which the common factor is set to zero and there is only one sex-specific factor (i.e. *n* = 1).

The parameters are estimated by (conditional) maximum likelihood via an iterative updating scheme, under the constraints $\sum_x B_x = 1$, $\sum_t K_t = 0$, $\sum_x b_{x,i,j} = 1$, and $\sum_t k_{t,i,j} = 0$. The number of additional factors, *n*, is determined based on the Bayesian Information Criterion (BIC) values, the residual plots, the trends of the additional parameters, and the amount of data being studied.

The mortality index K_t is modelled by a random walk with drift as usual:

$$K_t = \mu + K_{t-1} + \varepsilon_t\ , \qquad (3A)$$

where μ is the drift term and $\varepsilon_t \sim \mathrm{N}\left(0, \sigma^2\right)$ is the error term. The computed drift term is often negative, which indicates a general mortality improvement over time. The time component of an additional factor is modelled by an autoregressive (AR) model of order *p*:

$$k_{t,i,j} = \alpha_{0,i,j} + \alpha_{1,i,j}\, k_{t-1,i,j} + \alpha_{2,i,j}\, k_{t-2,i,j} + \ldots + \alpha_{p,i,j}\, k_{t-p,i,j} + \omega_{t,i,j}\,, \tag{4A}$$

where $\alpha_{0,i,j}$, $\alpha_{1,i,j}$, … , $\alpha_{p,i,j}$ are model parameters and $\omega_{t,i,j} \sim \mathrm{N}\left(0, \nu_{i,j}^2\right)$ is the error term. Future death rates (in year $t > T$) are then projected as:

$$\hat{m}_{x,t,i} = m_{x,T,i} \exp\left(B_x\left(\hat{K}_t - K_T\right) + \sum_{j=1}^{n} b_{x,i,j}\left(\hat{k}_{t,i,j} - k_{T,i,j}\right)\right), \tag{5A}$$

in which the projection starts with the latest set of data in year *T*. The resulting male-to-female ratio of death rates (in year $t > T$) can be expressed as:

$$\frac{\hat{m}_{x,t,2}}{\hat{m}_{x,t,1}} = \frac{m_{x,T,2}}{m_{x,T,1}} \exp\left(\sum_{j=1}^{n} \left(b_{x,2,j}\left(\hat{k}_{t,2,j} - k_{T,2,j}\right) - b_{x,1,j}\left(\hat{k}_{t,1,j} - k_{T,1,j}\right)\right)\right). \tag{6A}$$

This ratio converges to a constant if the projected time components $\hat{k}_{t,1,j}$ and $\hat{k}_{t,2,j}$ converge as well. Accordingly, the choice of the AR(*p*) model's order is based on (a) the partial autocorrelation functions (PACF) of the time component; (b) the autocorrelation functions (ACF) of the residuals; and (c) whether the time component approaches a constant in the projection. The last criterion ensures that the death rates of females and males at each age do not diverge in the long run.

Technical Appendix B: The Guest-Parr Method for Socially Evaluating Very Long Run Demographic Paths

Guest and Parr (2014) propose a method which may be used to evaluate very long run effects of contrasts in demographic processes and their effects on population age structure and of labour force participation on living standards, defined as national consumption per capita. The framework it uses is as follows:

$$\frac{C_t}{N_t} = \frac{C_t}{Y_t}\frac{Y_t}{L_t}\sum_x H_{x,t}\,\frac{E_{x,t}}{N_{x,t}}\,\frac{N_{x,t}}{N_t} \qquad (1B)$$

where C_t is consumption of goods and services at time t, N_t is the effective number of consumers (either total population or a needs-weighted population (eg as defined by Cutler et al. 1990 or according to age profiles of consumption for the relevant population see National Transfer Accounts Project (2014)), Y_t is output of goods and services (gross domestic product, GDP), and L_t is employment (for example, total hours worked). The ratio C_t/N_t is consumption per effective consumer, C_t/Y_t is the consumption share of GDP, Y_t/L_t is average labour productivity, and L_t/N_t is the employment to population ratio or support ratio, which is equal to one minus the total dependency ratio. $H_{x,t}$ denotes hours worked per employed person in age and sex group x at time t and hence $L_{x,t} = \sum_x H_{x,t} E_{x,t}$ where $E_{x,t}$ is the number of employed persons in age and sex group x, and $N_{x,t}$ is population in age and sex group x. In (2) the population age-structure affects living standards through the age-specific variation in $H_{x,t}$ and $E_{x,t}/N_{x,t}$. In order to isolate the role of L_t/N_t,, C_t/Y_t is assumed to be invariant to population age structure and Y_t/L_t grows at a constant rate, g, which is determined independently from the age composition. Hence the living standard at t is:

$$\frac{C_t}{N_t} = \frac{C_0}{L_0}\left(1+g\right)^t \frac{L_t}{N_t} \tag{2B}$$

The value of a projected population over the entire path of future values of t is:

$$V = \left(\frac{C_0}{L_0}\right)\left[\sum_{t=0}^{\infty}\left(\frac{1+g}{1+\rho}\right)^t\left(\frac{L_t}{N_t}\right)\right] \tag{3B}$$

ρ is a social discount rate which equivalises living standards for future time points t to values at the start point for the projection, 0, and depends on judgements about the social value of the consumption of present relative to future generations (Samuelson 1958).

Each value of C_t/N_t can be decomposed as follows:

$$\left(\frac{C_t}{N_t}\right) = \left(\frac{C_{s,t}}{N_{s,t}}\right) + \left[\left(\frac{C_t}{N_t}\right) - \left(\frac{C_{s,t}}{N_{s,t}}\right)\right] \tag{4B}$$

where ($C_{s,t}/N_{s,t}$) is a constant which equals the living standard for the "terminal" stable age distribution of the projection series. Accordingly the value of the series is expressed as two components: a "stable population component" and a "transition path component". Substituting from (4B) into (3B):

$$V = \left(\frac{C_0}{L_0}\right)\left[\sum_{t=0}^{\infty}\left(\frac{1+g}{1+\rho}\right)^t\left(\frac{L_{s,t}}{N_{s,t}}\right) + \sum_{t=0}^{\infty}\left(\frac{1+g}{1+\rho}\right)^t\left[\left(\frac{L_t}{N_t}\right) - \left(\frac{L_{s,t}}{N_{s,t}}\right)\right]\right] \tag{5B}$$

And the difference in social values of any two demographic projections, A and B, can be expressed as the sum of a "difference in stable population components" plus a "difference in the transition path components".

$$V(A) - V(B) =$$
$$\left(\frac{C_0}{L_0}\right)\left[\sum_{t=0}^{\infty}\left(\frac{1+g}{1+\rho}\right)^t\left(\left(\frac{L_{s,t,A}}{N_{s,t,A}}\right) - \left(\frac{L_{s,t,B}}{N_{s,t,B}}\right)\right) + \sum_{t=0}^{\infty}\left(\frac{1+g}{1+\rho}\right)^t\left(\left[\left(\frac{L_{t,A}}{N_{t,A}}\right) - \left(\frac{L_{s,t,A}}{N_{s,t,A}}\right)\right] - \left[\left(\frac{L_{t,B}}{N_{t,B}}\right) - \left(\frac{L_{s,t,B}}{N_{s,t,B}}\right)\right]\right)\right] \tag{6B}$$

Here A refers to the projection in which mortality changes according to the forecast and B the projection with mortality constant at the initial (2010) values. Thus V(A) – V(B) evaluates the very long run effect of the forecast mortality change.$V(A) - V(B)$ is finite when $\rho > g$ in which case the value of the "stable population component" in (6B) is simply calculated as the sum of a geometric series. The elements of the "transition path component" can be calculated for values of *t* up to and including the last calculated value T. The residual element of the "transition path component" of the value can be estimated through model-based imputation. Polynomials involving only negative powers of t were fitted to the elements of the valuation between 0 and T and the residual element estimated from the integral of this function between T and ∞.

Solution analyses calculating changes to future labour force participation (or migration or fertility or labour productivity) which would produce changes in value equal to the estimated effect of mortality on social value may then be performed.

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Tables and Figures

Figure 1 Projected Change in Male Life Expectancy at Birth 2010-2050

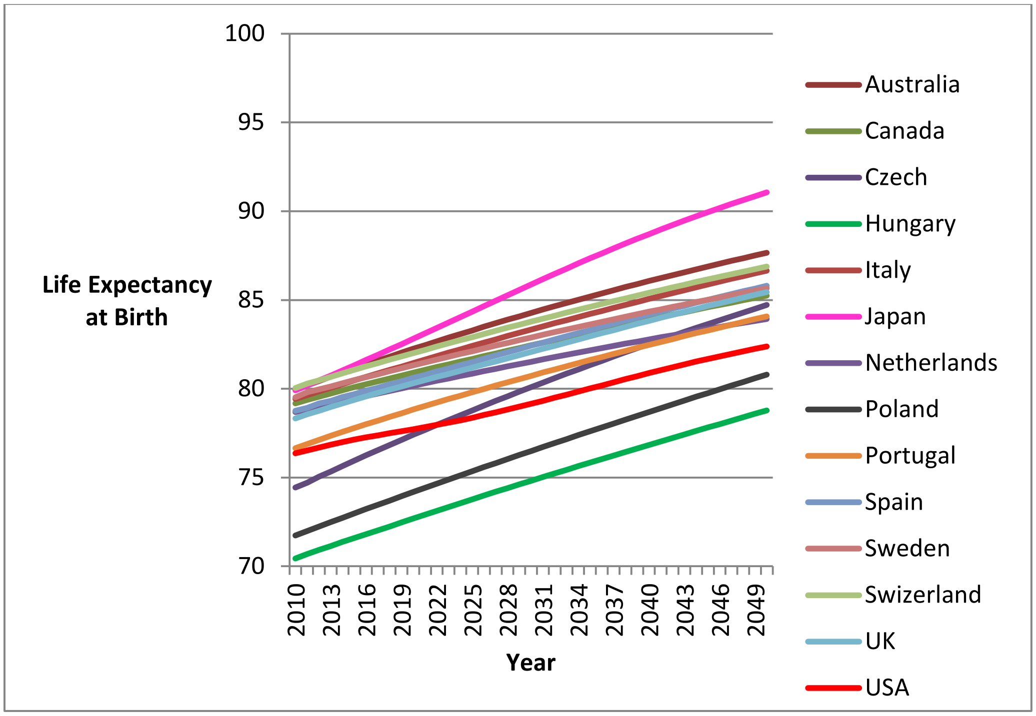

Figure 2: Projected Change in Female Life Expectancy at Birth 2010-2050

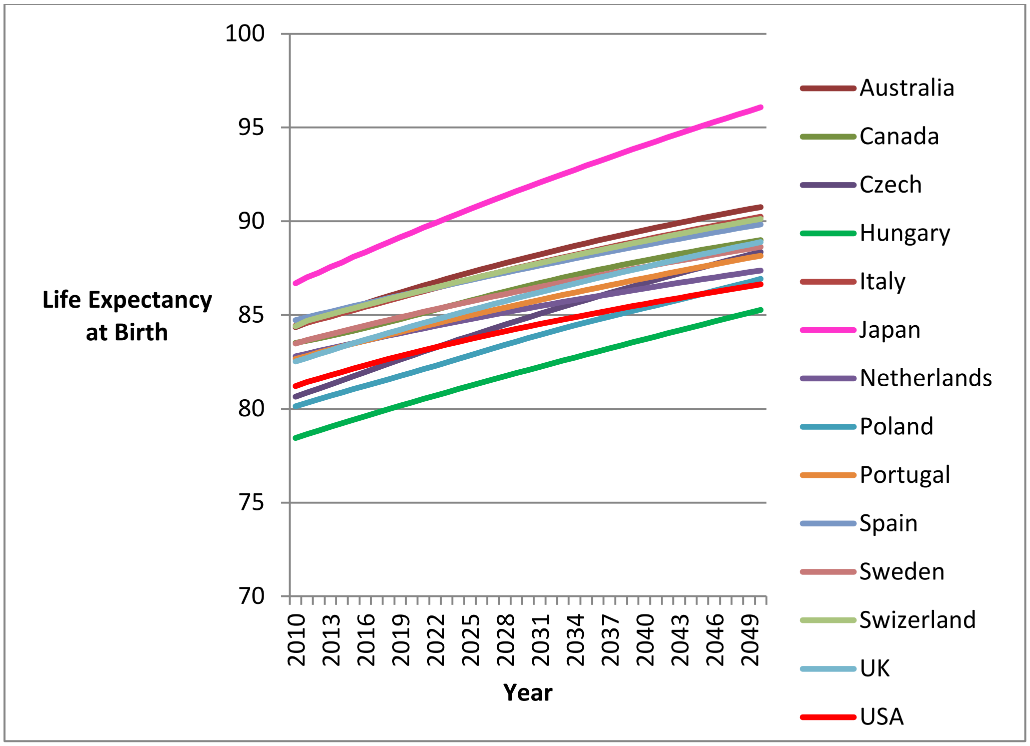

Table 1: Summary Measures of Input Demographic Data

Country	Total Population in Millions (2010)	% Aged 0-19 (2010)	% Aged 65+ (2010)	TFR	Annual Net Migration in Thousands	Net Migration Rate (per 1000)
Australia	22.3	25.7	13.5	1.95	234.6	8.8
Canada	33.5	23.3	14.8	1.64	200.2	6.0
Czech Rep.	10.5	20.1	15.2	1.46	59.3	5.6
Hungary	10.0	20.8	16.6	1.32	21.6	2.2
Italy	60.3	19.0	20.2	1.41	382.3	6.3
Japan	128.1	17.9	23.0	1.32	-54.9	-0.4
Netherlands	16.6	23.7	15.3	1.75	33.2	2.6
Poland	38.2	21.8	13.5	1.36	-27.7	-0.7
Portugal	10.6	20.5	17.9	1.35	13.5	1.3
Spain	46.0	19.8	16.8	1.41	425.4	9.2
Sweden	9.3	23.4	18.1	1.91	54.8	5.9
Switzerland	7.8	21.0	16.8	1.47	70.4	9.0
UK	62.0	23.8	16.5	1.92	203.5	3.3
USA	309.4	26.9	13.1	1.93	725,000	2.3

Table 2: Age-Standardised* Labour Force Participation Rates, Employment Rates, Hours Worked Per Employed Person and Hours Worked Per Person Aged 15+

Country	LFPR (%)		Employment Rate (%)		Mean Hours Worked Per Employed		Mean Hours Worked Per Person Aged 15+	
	Male	Female	Male	Female	Male	Female	Male	Female
Australia	71.5	58.9	95.5	95.5	39.2	29.7	27.7	17.3
Canada	70.6	62.7	92.5	93.9	37.9	31.4	25.5	19.2
Czech Rep.	65.7	52.2	93.2	91.3	41.2	37.1	26.9	19.0
Hungary	56.7	46.6	89.9	89.7	39.4	37.2	21.1	16.6
Italy	60.7	41.5	92.2	89.3	40.3	33.5	23.3	12.6
Japan	74.2	54.2	95.0	95.8	43.0	33.5	32.2	18.0
Netherlands	71.4	60.4	96.6	96.0	32.8	22.3	24.5	14.1
Poland	60.3	48.8	91.0	89.6	40.5	35.8	23.5	16.8
Portugal	68.2	58.5	91.8	89.8	39.4	35.6	25.6	19.5
Spain	66.4	51.3	87.6	85.0	40.6	34.6	24.1	15.3
Sweden	71.5	66.0	92.1	92.0	36.2	31.2	25.4	20.6
Switzerland	75.0	64.3	96.6	95.8	37.8	27.0	29.1	17.7
UK	70.7	59.2	92.8	94.6	38.9	29.1	27.1	17.5
USA	70.5	59.2	92.3	93.4	39.4	34.9	26.5	19.7

*****: Direct standardisation using persons aged 15+ in Australia by age as the standard.

Table 3: Projected Life Expectancy at Birth for Males and Females for Selected Countries 2010, 2030 and 2050

Country	Life Expectancy at Birth 2010	2030	2050	Absolute Change 2010-2050	Percentage Change 2010-2050
Males					
Australia	80.0	84.3	87.7	7.7	9.6
Canada	79.2	82.4	85.2	6.1	7.7
Czech Republic	74.4	80.1	84.7	10.3	13.8
Hungary	70.5	74.8	78.8	8.3	11.8
Italy	79.4	83.3	86.7	7.2	9.1
Japan	79.9	85.9	91.1	11.2	14.0
Netherlands	78.7	81.5	83.9	5.2	6.7
Poland	71.7	76.5	80.8	9.1	12.6
Portugal	76.7	80.7	84.1	7.4	9.7
Spain	78.8	82.4	85.8	7.0	8.9
Sweden	79.5	82.9	85.7	6.1	7.7
Switzerland	80.0	83.8	86.9	6.8	8.6
UK	78.3	82.1	85.5	7.1	9.1
USA	76.4	79.2	82.4	6.0	7.9
Females					
Australia	84.4	88.1	90.8	6.4	7.6
Canada	83.5	86.6	89.0	5.5	6.6
Czech Republic	80.6	84.9	88.4	7.7	9.6
Hungary	78.4	82.1	85.3	6.8	8.7
Italy	84.4	87.7	90.2	5.8	6.9
Japan	86.7	91.8	96.1	9.4	10.8
Netherlands	82.8	85.4	87.4	4.6	5.5
Poland	80.1	83.8	86.9	6.8	8.5
Portugal	82.7	85.7	88.2	5.5	6.7
Spain	84.7	87.5	89.8	5.1	6.0
Sweden	83.5	86.4	88.6	5.2	6.2
Switzerland	84.4	87.6	90.1	5.7	6.8
UK	82.5	86.1	88.9	6.4	7.7
USA	81.2	84.4	86.6	5.4	6.7

Table 4: Projected Life Expectancy at Age 65 for Males and Females for Selected Countries 2010, 2030 and 2050

	Life Expectancy at Age 65			Absolute Change 2010-2050	Percentage Change 2010-2050
Country	2010	2030	2050		
Males					
Australia	19.2	22.0	24.4	5.2	27.0
Canada	18.7	20.4	22.3	3.5	18.9
Czech Republic	15.3	19.0	22.3	7.0	45.5
Hungary	14.0	16.6	19.4	5.4	38.2
Italy	18.3	21.1	23.6	5.3	28.9
Japan	19.1	23.9	28.2	9.1	47.6
Netherlands	17.5	19.3	21.0	3.5	20.0
Poland	14.9	17.9	21.0	6.1	41.0
Portugal	17.2	19.9	22.3	5.1	29.9
Spain	18.3	21.1	23.7	5.4	29.3
Sweden	18.2	20.5	22.4	4.2	23.3
Switzerland	18.8	21.5	23.8	5.0	26.8
UK	18.1	20.4	23.0	5.0	27.5
USA	17.9	19.1	21.1	3.2	18.1
Females					
Australia	22.1	24.7	26.8	4.6	21.0
Canada	21.8	23.5	25.2	3.4	15.6
Czech Republic	18.8	21.8	24.6	5.8	31.1
Hungary	18.1	20.5	23.0	4.8	26.7
Italy	21.9	24.2	26.3	4.4	20.2
Japan	24.2	28.4	32.1	8.0	33.0
Netherlands	20.8	22.4	23.8	3.0	14.3
Poland	19.1	21.7	24.1	5.0	26.2
Portugal	20.6	22.8	24.7	4.2	20.3
Spain	22.2	24.3	26.1	4.0	18.0
Sweden	21.0	23.1	24.8	3.8	17.8
Switzerland	22.0	24.4	26.3	4.3	19.4
UK	20.7	23.3	25.5	4.8	23.3
USA	20.5	22.4	23.8	3.3	16.2

Table 5: Projected Values of Support Ratios Incorporating Forecast Changes in Mortality

	2010		2030		2050		Terminal Stable Population	
Country	L/N	L/N*	L/N	L/N*	L/N	L/N*	L/N	L/N*
Australia	18.2	18.9	17.1	17.5	16.8	16.9	15.5	15.3
Canada	18.4	18.8	16.6	16.5	16.3	16.0	15.9	15.6
Czech Rep.	19.6	19.9	18.8	18.7	16.8	16.2	17.5	17.0
Hungary	15.6	15.9	15.1	14.9	13.5	13.0	14.4	14.1
Italy	14.8	14.8	13.4	13.1	12.5	12.0	12.6	12.2
Japan	20.1	19.9	18.7	17.8	16.9	15.9	16.2	14.8
Netherlands	15.6	16.0	14.1	14.0	13.9	13.7	13.8	13.7
Poland	17.1	17.5	15.8	15.6	13.5	12.9	12.9	12.1
Portugal	18.7	18.9	17.6	17.3	16.0	15.2	17.1	16.7
Spain	16.9	17.1	15.5	15.4	13.9	13.5	13.9	13.5
Sweden	18.1	18.4	17.0	17.3	17.0	17.1	15.7	15.6
Switzerland	19.3	19.6	18.2	18.1	17.4	17.0	16.7	16.2
UK	17.7	18.1	16.4	16.5	16.0	16.0	15.5	15.3
USA	18.4	19.2	17.4	17.7	17.2	17.2	16.7	16.4

Notes: L/N is the ratio of total hours worked per week to total population.

L/N* is the ratio of total hours worked per week to consumption needs-weighted population

Table 6: Projected Changes in Support Ratios for 2010-2030, 2030-2050, and 2010-2050

Country	Change 2010-2030		Change 2030-2050		Change 2010-2050		Percentage Change 2010-2050	
	L/N	L/N*	L/N	L/N*	L/N	L/N*	L/N	L/N*
Australia	-1.1	-1.3	-0.4	-0.6	-1.4	-1.9	-7.9	-10.3
Canada	-1.8	-2.3	-0.3	-0.5	-2.1	-2.8	-11.3	-14.8
Czech Rep.	-0.7	-1.2	-2.1	-2.5	-2.8	-3.7	-14.4	-18.6
Hungary	-0.6	-0.9	-1.6	-1.9	-2.1	-2.8	-13.6	-17.7
Italy	-1.4	-1.6	-1.0	-1.2	-2.3	-2.8	-15.8	-19.0
Japan	-1.4	-2.0	-1.8	-1.9	-3.2	-4.0	-15.9	-19.9
Netherlands	-1.5	-2.0	-0.2	-0.3	-1.7	-2.3	-10.9	-14.1
Poland	-1.3	-2.0	-2.3	-2.7	-3.7	-4.7	-21.3	-26.6
Portugal	-1.1	-1.7	-1.6	-2.1	-2.7	-3.7	-14.6	-19.7
Spain	-1.4	-1.7	-1.6	-1.9	-3.0	-3.6	-17.6	-21.0
Sweden	-1.0	-1.1	0.0	-0.2	-1.0	-1.3	-5.7	-7.1
Switzerland	-1.1	-1.5	-0.8	-1.1	-1.9	-2.6	-9.9	-13.1
UK	-1.3	-1.6	-0.4	-0.5	-1.6	-2.1	-9.3	-11.6
USA	-1.0	-1.5	-0.3	-0.5	-1.2	-2.0	-6.7	-10.4

Table 6: Projected Differences in Support Ratios Between 2010 and the Terminal Stable Population and Between 2050 and the Terminal Stable Population

	Change 2010 to TSP		% Change 2010 to TSP		Change 2050 to TSP		% Change 2050 to TSP	
Country	L/N	L/N*	L/N	L/N*	L/N	L/N*	L/N	L/N*
Australia	-2.7	-3.6	-14.8	-19.0	-1.3	-1.6	-7.7	-9.5
Canada	-2.5	-3.2	-13.6	-17.0	-0.4	-0.4	-2.5	-2.5
Czech Rep.	-2.1	-2.9	-10.7	-14.6	0.7	0.8	4.2	4.9
Hungary	-1.2	-1.8	-7.7	-11.3	0.9	1.1	6.7	8.5
Italy	-2.2	-2.6	-14.9	-17.6	0.1	0.2	0.8	1.7
Japan	-3.9	-5.1	-19.4	-25.6	-0.7	-1.1	-4.1	-6.9
Netherlands	-1.8	-2.3	-11.5	-14.4	-0.1	0	-0.7	0.0
Poland	-4.2	-5.4	-24.6	-30.9	-0.6	-0.8	-4.4	-6.2
Portugal	-1.6	-2.2	-8.6	-11.6	1.1	1.5	6.9	9.9
Spain	-3	-3.6	-17.8	-21.1	0	0	0.0	0.0
Sweden	-2.4	-2.8	-13.3	-15.2	-1.3	-1.5	-7.6	-8.8
Switzerland	-2.6	-3.4	-13.5	-17.3	-0.7	-0.8	-4.0	-4.7
UK	-2.2	-2.8	-12.4	-15.5	-0.5	-0.7	-3.1	-4.4
USA	-1.7	-2.8	-9.2	-14.6	-0.5	-0.8	-2.9	-4.7

Table 8: Projected Effect of Mortality Change on Support Ratios for 2010-2030, 2030-2050, and 2010-2050

	2010-2030		2030-2050		2010-2050		Percentage of Change Due to Mortality 2010-2050	
Country	L/N	L/N*	L/N	L/N*	L/N	L/N*	L/N	L/N*
Australia	-0.2	-0.2	-0.3	-0.5	-0.5	-0.7	34.3	35.1
Canada	-0.1	-0.2	-0.4	-0.4	-0.5	-0.6	23.6	22.6
Czech Rep.	-0.4	-0.6	-0.8	-1.0	-1.3	-1.5	43.4	40.5
Hungary	-0.4	-0.5	-0.5	-0.6	-0.9	-1.1	40.4	37.7
Italy	-0.2	-0.3	-0.4	-0.5	-0.7	-0.8	28.3	28.5
Japan	-0.4	-0.6	-0.8	-0.6	-1.2	-1.2	36.9	29.4
Netherlands	-0.2	-0.2	-0.3	-0.4	-0.5	-0.6	29.6	28.4
Poland	-0.3	-0.4	-0.6	-0.8	-0.9	-1.1	25.2	24.0
Portugal	-0.2	-0.3	-0.5	-0.6	-0.7	-0.9	25.6	24.2
Spain	-0.2	-0.3	-0.4	-0.5	-0.7	-0.8	21.8	22.3
Sweden	-0.3	-0.2	0.0	-0.1	-0.2	-0.4	22.3	26.9
Switzerland	-0.2	-0.3	-0.5	-0.6	-0.7	-0.9	36.6	34.8
UK	-0.2	-0.3	-0.5	-0.6	-0.7	-0.9	42.1	43.5
USA	-0.1	-0.1	-0.3	-0.4	-0.4	-0.5	28.5	26.5

Table 9: Components of Value of Effects of Projected Effect of Mortality Change for Selected Countries

	Difference from Baseline Series[a,b]			Difference in Total Value[a]	
Country	Stable Population Component	Transition Path Component	Total Social Value	As % of Social Value of Constant Mortality Series	As % of Social Value for 2010[c]
Australia	-194.8	53.0	-141.8	-4.2	-954.9
Canada	-146.7	27.0	-119.7	-3.6	-782.5
Czech Rep.	-256.2	-10.4	-266.2	-7.0	-1,521.7
Hungary	-181.9	-11.1	-193.0	-6.4	-1,360.3
Italy	-152.4	11.5	-140.9	-5.2	-1,140.9
Japan	-319.1	34.0	-285.1	-7.7	-1,756.1
Netherlands	-126.1	17.8	-108.3	-3.7	-793.2
Poland	-242.7	10.9	-231.8	-7.8	-1,804.1
Portugal	-136.2	-8.1	-144.3	-4.1	-841.8
Spain	-153.2	9.2	-144.0	-4.8	-1,048.5
Sweden	-166.1	-38.2	-127.7	-3.7	-811.7
Switzerland	-168.1	11.3	-156.8	-4.3	-936.8
UK	-204.6	40.7	-163.8	-4.9	-1,083.2
USA	-156.0	49.9	-106.0	-3.0	-652.4

Notes: a. Using L/N relative to unweighted population, with g = 1.5% p.a. and ρ = 2.00% p.a.,
b. Multiple of consumption value of 1 hour worked per week per capita.
c. As percent of 2010 *L/N* for country.