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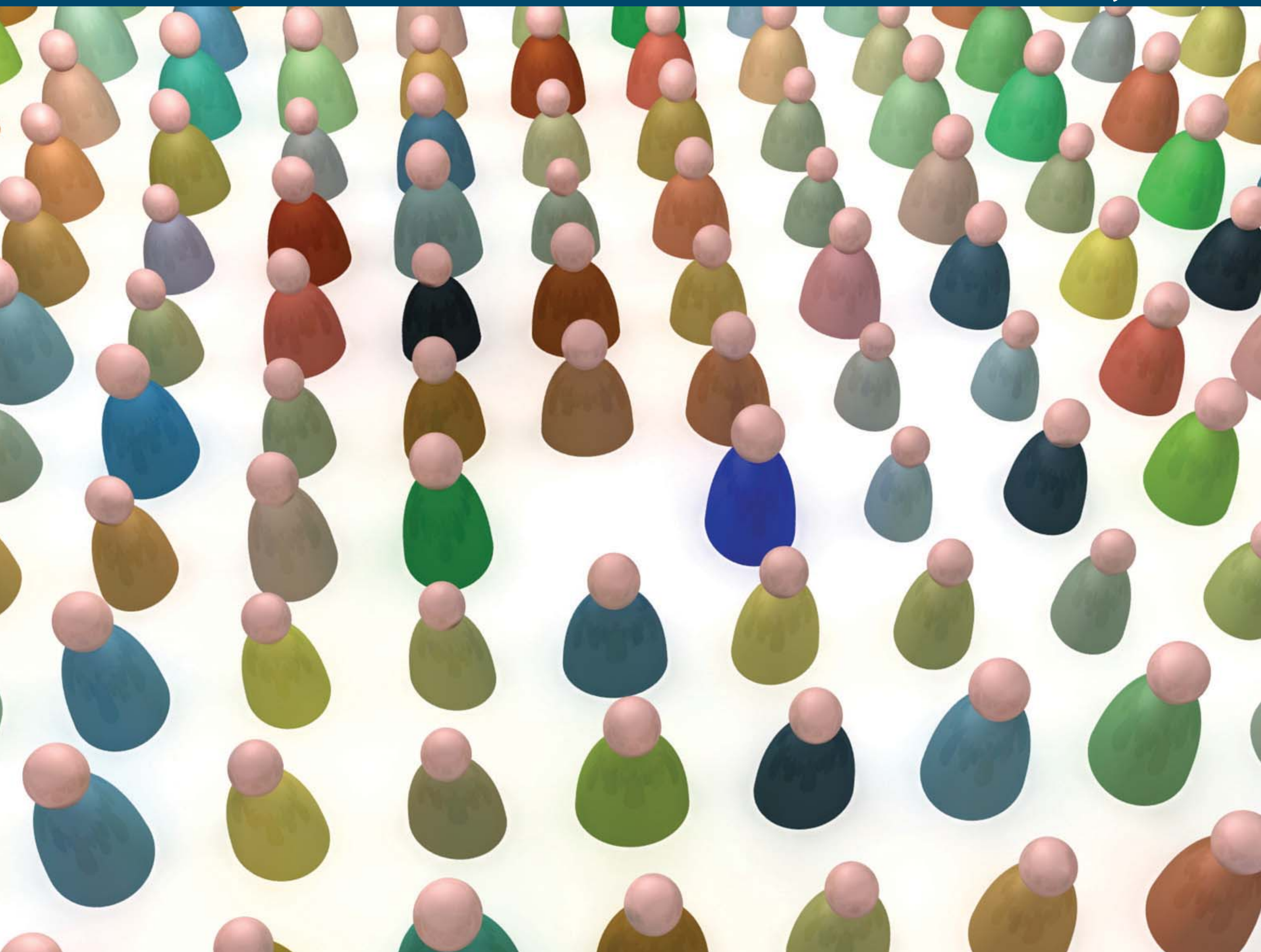

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Professor Les Mayhew, Cass Business School February 2009

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2 http://www.nkm.org.uk/

Executive Summary

One of the UK's great achievements is that people are increasingly living longer. One consequence is that the number of older people in society is increasing steadily as a proportion of the working age population. In addition to this the 'total support ratio', the ratio of the number of workers to the number of both young and old people, peaked in 2007 and is now in decline.

The significance of this is that a high total support ratio is often associated with periods of rapid economic growth as has occurred in the UK over the last decade or so, and which has also occurred, but on a much greater scale, in Asian economies such has China, India and Korea.

In Japan, the first Asian country to develop economically after the war and currently the most advanced ageing country in the world, the total support ratio peaked some time ago and its economy has been relatively static since.

In the light of these demographic facts this report investigates the economic challenges of an ageing UK population and considers it to be at a demographic crossroad. It estimates the potential downside of getting outcomes 'wrong' i.e. doing nothing based on current trajectories, but it also estimates the potential economic upside of getting outcomes 'right'.

Unusually for studies of this kind it focuses on three kinds of expectancy to build its case: life expectancy, healthy life expectancy and working life expectancy. It shows that a change in any one of these has important economic implications. For example it finds that if extra years are not being spent in good health, there are consequent implications for the cost of health and social care, pensions and social security benefits, and hence taxes.

Using a simple economic model the report shows that a passive ageing scenario based on current trends could bring economic problems in terms of higher taxes and falling standards of living, especially if long-term increases in wage productivity are not maintained. The worst case is that both GDP and GDP per capita could fall; the best case is that both could rise but for this to happen certain conditions need to be met.

One condition is that people need to work for longer. One way to achieve this is to increase state pension age but success is not guaranteed since pension age is no longer a reliable indicator of when people cease economic activity. For example a key finding is that labour participation rates drop significantly after age fifty, long before normal pension age.

The report finds that those with the longest working life expectancy at age 50 are more educated, home owners, married or co-habiting and in reasonable health. By contrast, reasons for economic inactivity in the 50+ age range include poor health and increased caring responsibilities (e.g. staying at home to look after older relatives or sick partners).

Another condition is for healthy life expectancy to increase concomitantly with life expectancy. If it does not there is a danger that healthy people of working age could eventually become a scarce commodity and therefore another barrier for the UK to contend with.

A failure to meet either of these conditions could also lead to a significant increase in the amount of replacement migrant labour coming into the UK in the next decades. The population is already projected to increase to 70m by 2025 but could easily be between 8m and 14m higher as this report shows, depending on one's assumptions.

One obstacle to extending working life expectancy is the large number of people, almost 3m, on long-term sick and disability benefits. It can be shown that the numbers involved are correlated with poor health and are therefore genuine to a degree, but physical health is not the only barrier to work as it was when the UK was predominantly a manufacturing economy with a large heavy industry sector.

Significantly, the reasons for claiming benefits is changing; whereas claimants were more likely in the past to be suffering from occupational related conditions, more claimants today receiving benefits have some form of mental illness or office related work conditions such as a bad back.

Part of the reasons for the large numbers on benefits relates to poor work incentives. A problem is that average earnings peak when a person is in their 40s and benefit replacement rates are quite high for large numbers in the 50+ age group who qualify for the relevant social security benefits.

The evidence for pursuing an alternative more healthy or active 'ageing trajectory' is compelling. If increases in healthy life expectancy and working life expectancy are able to keep pace with life expectancy, the future looks brighter and quantified estimates of the difference this could make are given. However, the analysis begs the question of what actions need to be followed in order to ensure that it will happen as conjectured.

The report finds that whilst much effort is being made to improve health through important prevention and educational programmes, the evidence for cost effectiveness is currently weak and needs to improve, partly since payoffs are long-term and uncertain (e.g. action on childhood obesity, heart disease, alcohol consumption, food additives, smoking cessation).

An alternative option for improving health would be to increase spending on healthcare (and there is always public pressure to do this), but data from around the world suggest that the impact could be negligible due to diminishing returns to health improvement at current levels of spending.

For example, the report suggests that a complete cessation of smoking would yield a far greater increase in healthy life expectancy and economic benefits than a 50% increase in healthcare spending (approximately £50bn a year).

A further alternative is to reduce inequalities in society since this is also associated with improved health and longevity. International examples of the impact this could have are given.

However, more work is needed to unpick these issues to establish what works best for the UK and what is cost effective from a strategic perspective of life/health/work balance.

Since each of the expectancies in the model presented in the paper (life/health/work) move gradually relative to their economic effects on national income, it is important to ensure that the UK moves along an 'active' path through the period of accelerated ageing rather than a 'passive' path that could result in economic stagnation.

For example, male and female labour participation rates have been under 65% for years but only a 2% increase/decrease in labour participation rates equates to 1 year increase/decrease in working life expectancy. This alone would make a significant difference to economic prospects.

Overall the findings indicate the need for greater linkages between policies so that changes in longevity or one of the other expectancies – crudely increasing longevity by one year - should be matched by changes in pension age, pension and benefit values, participation rates or healthy life expectancy.

Finally, in the current recession there is a danger that the hard fought gains in the labour market since the previous recession will be lost and that damage of previous cycles could be repeated, and so it is even more important to have a co-ordinated strategy.

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Introduction

One of great success stories in the UK is that people are living longer. Life expectancy at birth is now almost 80 years, having advanced 11 years since 1950 thanks to improvements in occupational health, health care, fewer accidents, and higher standards of living. This success in turn presents a huge opportunity for individuals if extra years are spent in prosperity and good health. As a recent Foresight report has demonstrated[3], tapping into the experience and skills of older adults can also benefit employers, public services and voluntary and civic organisations.

Indeed, realising the full potential of older citizens of the UK will be central to the Government's response to changing economic circumstances and the drive to build a strong, fair economy for the twenty-first century. However, the challenges posed by an ageing society do not rest solely with older citizens. Referring to the high levels of economic inactivity, the Black report (2008)[4] noted: "The sheer scale of people on incapacity benefits represents an historical failure of healthcare and employment support to address the needs of the working age population in Britain". In other words the health of the working age population is needed to sustain the economy of the whole population and this must not be overlooked as it is part of the solution.

Studies on population ageing usually take one of three forms: analysis of macro economic problems relating to the decline in the workforce; analysis of social security systems; and thirdly labour market studies, many focussing on older workers (Mackellar et al, 2004)[5]. In this paper, we tackle similar issues but do so from a health perspective. The hypothesis is that as a population ages health tends to deteriorate thus creating problems for the economy and so good health becomes a scarcer commodity leading to increased healthcare costs, high social security benefits and lost economic output. Hence it is important to quantify these effects and compare them with strategies that maintain or improve health.

The extent to which this will apply to the UK is additionally important for the following reasons. The UK is going though a very rapid period of population growth from around 55.9m in 1908 to a projected 71m by 2030. Over the same period the structure of the population will alter significantly with the population aged 65+, doubling from 8m in 1980 to 16m by 2030. The ratio of people aged 20-64 to 65+ was 3.7 in 2008, much the same as in 1980, but from now onwards it is due to go into rapid decline reaching 2.5 by 2030 as the population enters an era of unprecedented ageing. In addition to this, the UK total support ratio which is often associated with the rapid economic ascendancy of countries like Japan peaked in 2007(see Annex A)[6]. The rise up to 2007 is the result of falling fertility and the decline after 2007 is caused by the progressive retirement of baby boomers.

An explanation for such demographic transitions is as follows. Initially fertility is high and accompanied by low child support ratios (i.e. a small ratio of adults to children) as occurred after the war. With demographic transition, the proportion of working age population to total population increases, favouring labour supply and improved savings rates. The flipside occurs when fertility falls and the population ages and so that the low child support ratio gradually transforms into a low old age support ratio.

In between the total support ratio or TSR (the total working age population to the young plus old population) peaks and then declines, albeit along a slow glide path and so the demographic cycle is complete. It follows that the favourable labour market conditions created by the rise in the TSR needs to be replaced by other factors, such as full

3 Foresight Mental Capital and Wellbeing Project (2008). Final Project report – Executive Summary. The Government Office for Science, London.
4 Working for a healthier tomorrow (2008) Dame Carol Black, TSO, London.
5 MacKellar,L. Ermoliieva, T., Horlacher, D. and Mayhew, L. (2004)The economic impacts of population ageing in Japan. ESRI studies on Ageing, Edward Elgar.
6 The total support ratio, which is the ratio for the number of people aged 20 to 64 to the population <20 plus population 65+, peaked in 2007 after a steady rise for over 27 years.

employment and improved education and health levels in order to maintain economic growth[7].

The UK transition is on a smaller scale and lagging behind Japan by about 15 years but the potential consequences are no different. One obvious consequence is pressure to increase pension age. To maintain the old age support ratio at today's level of 3.7, UK state pension age would need to increase to 65.5 years in 2020, 66.5 years in 2025 and 67.5 years by 2030[8] (see Annex B). Built into this reckoning are assumptions that people will work longer and be more productive, because the alternative is that taxes will have to rise or the working age population would need to be bolstered through higher levels of migration rather than increased fertility.

The danger to economic growth is that historical trends in wage productivity will slow or stagnate for the following reason. Analysis shows that average earnings track changes in the 35-49 age groups, at which point earnings peak and that in 50+ age groups earnings decline. It is debateable whether the trend will be as mechanistic as this in the future, as the over 50s may have skills that are valued compared to today's over 50s. Nevertheless a demographic shift could render the possibility of stagnant wages a real possibility[9].

Growth will be determined by whether productivity of older workers is lower; or whether older workers provide an adequate replacement for younger workers. Labour competes in a global economy and firms can source their production in countries with a plentiful supply of low cost labour. Much will depend on the nature of the work and on skills e.g. old economy workers are 'burnt out' at an earlier age than knowledge workers in the 'new' economy (see Blake and Mayhew, 2007)[10]. Recent evidence for the degree of shift in age related earnings are given in Annex L. However, there are dangers lurking behind these simple assumptions which depend crucially on extra years spent in work being healthy years as well as on continued economic growth.

A pessimistic scenario is that an ageing population will simply increase the stock of unhealthy people resulting in lower productivity and more people under care. Poor health is not confined to older age groups and a significant number of working age adults are economically inactive due to long-term sickness and disability. Based on measures reported in this paper today there are 5.1 healthy adults aged 20+ for every unhealthy adult; by 2025 this could fall to 4.3 to 1 due to ageing.

To put this in perspective, there would either need to be an increase of 8m in the number of healthy adults in order to maintain the current balance, or healthy life expectancy at age 20 would need to increase by about 3.5 years given the expected increases in life expectancy (Annex C). Were we only to include healthy people below state pension age in this calculation we would find that increasing pension age would not be able to restore the level to 2007 levels since we would soon run out of healthy people! On the other hand this might be possible if there were only reasonable health improvements at every age in which case state pension age could be held at 68.

Of the £250bn the UK spends each year on healthcare, social security benefits and social care, about £30bn is spent on benefits for the long-term sick and disabled, and £20bn on social care. The share spent on healthcare for the long-term sick and disabled is harder to calculate but is somewhere in the region of £40bn. These figures suggest that average annual public expenditure on the estimated 7.3m long-term sick and disabled adults is around £10,000 to £13,000 per person per year depending on one's assumptions.

Social security benefits must be paid for through taxes or out of pocket expenditure. Benefits paid in kind such as caring activities are generally paid for by foregone wages and economic output depending on the age of the carer. If this already sizeable problem could be tackled by health improvements, it may be possible to redress some of the balance in these support ratios, at least in part. This requires both a more detailed understanding of the demographic trends in health, coupled with work and also some means of quantifying the scale that different health improvements and interventions could make to the equation.

7 E.g. see Demographic Transition and Economic Growth in China (2006). Cai Fang and Wang Dewen, Institute of Population and Labour Economics Chinese Academy of Social Sciences, wangdw@cass.org.cn
8 Current state pension age for men is 65 and for women 60. Pension age for women is due to be harmonised with men at age 65 from 2020. Further increases are not envisaged until after 2030 (see Pension Commission Report).
9 Overcoming the Barriers and Seizing the Opportunities for Active Ageing (2005) The Interdisciplinary Centre for Comparative Research in the Social Sciences, on behalf of the European Union (contract No: HPSE-CT-2001-000102)
10 Blake and Mayhew (2006) On the sustainability of the UK state pension system in the light of population ageing and declining fertility. *The Economic Journal*, 116 (June), f286–f305.

A difficulty is that there are numerous measures and definitions of health and so what we mean by ill health or disability is, to a considerable extent, arbitrary. We use terms such as morbidity, physical disability, self reported health, or benefit eligibility interchangeably. For reasons explained later, the main measure of health used here corresponds to a person that would qualify for one or more of the current sick and disability benefits depending on severity, but other measures and definitions are also employed (e.g. to enable international comparison, or with reference to morbidity rather than physical disability). Based on benefit eligibility, there are 2.8m adults that fall into our definition aged 20-64 and 4.5m aged 65+. Based on the age profiles of current claimants the equivalent figures in 2025 will be 3.1m and 6.6m.

With the sharp downturn in the old age support ratio and the rapidly expanding number of older people, the evidence suggests that we are on the threshold of a new era in UK history that is set to continue for the foreseeable future. The next 15 to 20 years provide the window of opportunity for putting in place the necessary policies and systems to support them. This paper is concerned with explaining these trends in some detail to provide:

- Estimates of the potential downside of getting outcomes wrong/ doing nothing based on current trajectories;
- Estimates of the potential economic upside of getting outcomes in later life right, with a focus on better health and greater participation (healthy, active ageing).

As is developed further below, the paper builds on and analyses three key quantities: life expectancy (LE), healthy life expectancy (HLE) and working life expectancy (WLE). Various hypotheses follow from changes in these quantities. For example a 'downside' scenario could be further rises in LE but no corresponding increases in HLE or WLE. This could significantly increase the health burden with corresponding falls in living standards and a rise in population due to increased demand for migrant labour. An 'upside' hypothesis, which we call the 'active ageing' scenario, would result in a narrowing in the gap in LE and HLE and increases in WLE. This would result in improved living standards and alleviate migration pressures.

Many important questions relate to these measures and the differences between them. For example, what does closing the gap between life expectancy and health expectancy by 2 years and extending labour participation rates beyond state pension age do for government expenditure/revenue and Gross Domestic Product (GDP) growth (the so-called healthy 'active ageing scenario')? Alternatively what does widening the life and health expectancy gap and holding labour participation rates constant do for government expenditure/revenue and GDP growth (the unhealthy, 'passive ageing scenario')?

The answers to such questions for the UK are crucial if the aim is to continue to increase GDP in a globally competitive world, but also to maintain or increase living standards (since the two are not necessarily the same thing). By the arguments put forward in this paper these objectives can be achieved by different means, but not all equally desirable: for example, (i) by simply allowing the population to grow unrestrained; or (ii) by pursuing a more orderly approach in which the full potential of the population is realised through better health and economic engagement.

We begin with a description of the general approach adopted and the necessary definitions, with illustrations of how well the UK compares with other countries on different measures of life and health expectancy. We then describe a simple model which predicts how the economy could behave based on different assumptions about life expectancy, health and working life expectancy. Scenarios presented use realistic assumptions informed by statistical trends in the input variables.

To do this we make use of different data sources. The first is the Rickayzen and Walsh disability model[11] which provides us with age and gender specific disability prevalence rates from age 20 by severity including projections based on different health scenarios; the second is the British Household Panel survey which we use to investigate life expectancy and healthy life expectancy from age 50 based on different socio-economic groups; and third is the ELSA[12] which we use to measure work participation levels from age 50 and the influence of various socio-economic factors on their levels.

The Rickayzen and Walsh model is useful for quantifying capability for work and benefit

11 Rickayzen, B. and Walsh (2002), A multi state model of disability for the UK: implications for need for long-term care for the elderly. *British Actuarial Journal*,8, II, pp. 341-392.
12 ELSA -English Longitudinal Study of Ageing http://www.ifs.org.uk/elsa/index.php

entitlement. It uses a scale of 0 (healthy) to 10 (severely disabled) and produces estimates of the population in each category. Of particular interest for the purposes of this paper is that a score of 1+ on the disability scale correlates almost perfectly with the main working age disability benefits, namely Incapacity Benefit, Disability Living Allowance or both (Annex F). Similarly persons scoring 6+ on the disability scale correlates with the number of people on post-65 disability benefits, namely Disability Living Allowance or Attendance Allowance.

In the real world the economy could be easily over-whelmed by other economic factors unrelated to demography, but ignoring demography would leave too much to chance. A key advantage of the simplistic approach taken is that it is possible to isolate the variables that support the general argument and draw simple conclusions. Based on the model, we show how changes to LE, HLE, WLE could affect various areas of government expenditure, taxes and GDP. We use the model to consider the changes needed to put the UK economy on an 'active aging path' in simplistic terms.

Background to health, work and life expectancy

There is no single source of data on LE or HLE that serves all purposes. Life expectancy is the average number of years of life remaining at a given age. Health expectancy is a generic term for any of a number of summary measures which use explicit weights to combine health expectancies for a set of discrete health states into a single indicator of the expectation of equivalent years of good health at a given age[13].

To make our arguments, we begin by comparing the UK on a range of published measures. These include the World Health Organisation (WHO), the ONS and the Human Mortality Database. Clearly our analysis needs to be more flexible and detailed than these data can provide. For example, we are interested in measuring life expectancy and healthy life expectancy at different ages and not just at birth, and we would like to be able to disaggregate these quantities into the experiences of different socio-economic groups and lifestyles.

We combine these measures to analyse the general effects of an ageing population on the UK economy of trends and changes in their relative values over time. In order to produce the insights we need, we use a simple uncluttered framework combining key variables rather than attempt to model the whole economy in detail. Hence LE is important because it affects how people plan their lives and spend their time, for example whether to invest for longer in education to save or to consume. A high HLE creates the necessary conditions for any economic activity to be undertaken and influences the decision to remain economically active for longer and thus increase WLE. Higher WLE is associated with economic growth, investment in research and development and improved quality of life.

LE is greater than HLE which in turn is greater than WLE. The first must be true and the second is generally true. The difference between LE and HLE can be interpreted as the number of years spent in ill health and disability (usually, but not exclusively at the end of life). The difference between HLE and WLE can be regarded as the healthy years spent in economic inactivity (broadly leisure, in retirement, caring, house keeping and education). From a societal point of view WLE can be thought of as being constrained by three factors: years in education, years spent in caring activities on behalf of others (mainly children and older people), and by law (e.g. minimum or maximum ages in the work force).

Healthy individuals are generally more productive than unhealthy ones and are more flexible in terms of the work they do and thus finding employment. A low HLE may conflict with a policy of 'active ageing' if it results in early withdrawal from economic activity ahead of pension age, and if HLE is less than pension age then a person may require financial support through the benefits system (i.e. disability benefits). The lesser the gap between LE and HLE, the lower is the prevalence of disability and ill health in society, whereas the greater the gap the more people will be dependent on health and social care and the more healthy people will be diverted into caring activities. Closure of the gap is also termed the 'compression of morbidity' and means that illness is compressed into a smaller number of years over the life cycle[14].

13 Disability-free life expectancy measures disability by looking at reported limitations in day to day activities such as work. The World Health Organization (WHO) defines a quantity known as HALE (health adjusted life expectancy). This is the average number of years that a person can expect to live in full health. HALE is calculated by subtracting from the life expectancy the average number of years in ill-health weighted for severity of the health problem. The first example of 'health expectancy' was published in a report of the US Department of Health Education and Welfare (Sullivan, 1971).

14 Fries, J.F. 1980 Aging, natural death, and the compression of morbidity. New England Journal of Medicine, *N Engl J Med. 303(3):130-5.*

A country which scores badly on any of these indicators in which the gap between any of them is excessively large, will therefore tend to suffer economically through low growth, productivity and potentially higher taxes. There is evidence of a strong impact of increased LE on economic performance, namely that increases in GDP per capita are associated with increases in life expectancy. The finding that LE increases with income, albeit at a diminishing rate, seems to hold regardless of whether studied at the global, national, community or individual level; but it also holds across demographic groups and in different economic contexts. This seems highly intuitive as life extension occurs at a diminishing rate and usually each extension costs more than the previous one. One question that arises is if improvements in LE were equally shared overall, would LE increase at a faster rate? It seems plausible that it would since potential gains in LE for those at the top of the LE tree are likely to be smaller than for those at the bottom.

It has been suggested that income inequalities could also have a direct impact on individual health and therefore LE (Kawachi et al. 1997)[15]. Hence, the observed correlation between LE and income inequality could be the result of diminishing returns or an actual causal effect, and in this regard several mechanisms have been proposed. It is argued, for example, that societies with sharper inequalities tend also to suffer from a lower level of social capital and mutual trust, which in turn might be detrimental to health. Due to the lack of social cohesion, individuals are exposed to higher crime or accident rates, which have a direct impact on health. Finally, unequal communities tend to be more polarized and might, as a result provide unequal access to public services (Arujo et al., 2008; Krugman, 1996; Zhao, 2006)[16].

Karlsson in an unpublished paper[17] has studied the relative effects that a difference in absolute income would make compared with a reduction in income inequality. He found for example that a $1,000 increase in the GDP per capita in the UK (at $29,462 in 2004, the latest year in the international dataset used) would have bought 0.11 additional life years. This figure could be compared with the estimated effect of a similar increase in India (GDP per capita $3,213) where the same increase in GDP would buy an additional life year. Similarly, reducing the UK income inequalities as measured by the Gini coefficient[18] (currently 0.32) to the lowest level recorded in 2004 (Sweden, 0.23) would increase life expectancy by 0.16 years. He notes that eliminating inequalities altogether would increase life expectancy by another 0.41 years provided the assumption of a linear effect for all levels of inequalities is correct.

Interestingly he points out that even though the inequality effect might appear to be more important than the absolute income effect, real increases in GDP of this magnitude occur in a much shorter space of time than it would take to reduce inequalities to achieve a similar result. He goes on to show that GDP per capita also produces similar effects on HLE, so implying that identical arguments will apply to HLE as apply to LE. This is important since it has been argued that findings of an association between inequality and health could be attributable to 'reverse causality' i.e. policies which improve health or educational attainment amongst the poor are also likely to reduce income inequalities.

The gap between life expectancy and healthy life expectancy

In international comparative terms UK LE and HLE is up with other developed countries as one might expect but it is not in the vanguard. The World Health Organization (WHO) for example shows that the gap between LE and HLE for different life expectancies at birth is more or less constant regardless of life expectancy and that the average years spent in poor health is equivalent to 10 years of life at birth. In developing countries with a low life expectancy a far greater proportion of life is therefore spent in ill health and disability than in more developed countries. For developing countries, low life expectancy and ill health tend to

15 Kawachi I., B. P. Kennedy, K. Lochner and D. Prothrow-Stith (1997), Social capital, income inequality, and mortality, *American Journal of Public Health*; 87:1491-1498

16 Araujo, M.C.; Ferreira, F.H.G.; Lanjouw, P. and Ozler, B. (2008), Local inequality and project choice: Theory and evidence from Ecuador, *Journal of Public Economics*, 92 (5-6): 1022-1046 ; Krugman, P. (1996). *The Spiral of Inequality*. Mother Jones (November/December): 44-49; Zhao, Z. (2006), Income Inequality, Unequal Healthcare Access, and Mortality in China., *Population and Development Review*; 32(3): 461-83.

17 Life Expectancy, GDP and Inequality (personal communication)

18 The Gini coefficient is a measure of statistical dispersion ranging in value from 0 to 1 and is used as a measure of income or wealth inequality. A value of zero corresponds to perfect equality (everyone having exactly the same income) and 1 to perfect inequality (where one person has all the income, while everyone else has zero income). Worldwide, Gini coefficients range from approximately 0.232 in Denmark to 0.707 in Namibia. More advanced economies tend to have a Gini coefficient of between 0.25 and 0.50.

be related to infectious diseases and in developed countries to the chronic diseases of older age.

Based on the concept of HALE (Health Adjusted Life Expectancy ~ see footnote 13), WHO shows that the UK is ahead of the US in HLE and LE but behind Japan which has both the highest LE and HLE in the world and also the smallest gap between LE and HLE. UK LE is 79 years, HLE 71 years (gap 8 years), LE in Japan is 82 years, HLE 75 years (gap 7 years) and for the US LE is 78 years, and HLE 69 years (gap 9 years). These data are based on a 2003 snapshot and do not therefore show how either LE or HLE are changing over time.

The Office for National Statistics (ONS) publishes statistics on HLE for Great Britain, which it defines as years of expected life in either good or fairly good health (based on general health) or free from long standing illness[19]. ONS data suggests that whilst both LE and HLE are increasing the gap between them is widening (Annex E provides further detail). Trend analysis of ONS data since 1981shows that:

- LE at birth will be 83.2 years in 2025 as compared with 79.1 years in 2005 (the latest year for which data are available), an increase of 4.1 years
- HLE will be 71.7 years at birth in 2025 as compared with 69.3 years in 2005 an increase of 2.4 years
- by 2025 the gap between LE and HLE will be 11.48 years compared with 9.75 years in 2005 equivalent to an average change of 28.8 days per annum

If correct, the above in turn implies 87.2% of life was spent in good or fairly good health in 2005 as compared with 86.2% that will be spent in 2025.

Disability-free life expectancy and disease-free life expectancy

The ONS uses other definitions of health based on being free of disability which tend to suggest more years are spent in disability though not necessarily in poor health. Using the Health Survey for England (HSE), Rasulo et al[20] compared two variants; one is disease-free life expectancy and the other disability free-life expectancy for the population aged 16 and over. The HSE includes questions on the occurrence of long-term and limiting long-term illness, and on the occurrence of conditions that require medicine to be taken regularly. Respondents with a long-term illness could list up to six illnesses while for each prescribed medicine the survey provided the corresponding disease under treatment.

The questions on long-term illness and medicine were used to obtain the wider measure of morbidity, which was called ‘life expectancy with disease’. The question on limiting illness, used for the computation of disability life expectancy, was included for the first time in 1997 when individuals reporting a long-term condition were also asked whether this condition was limiting their daily activities. Reported diseases and disabilities by survey respondents were aggregated into categories. These reflected a combination of trauma, chronic and long-term conditions, as well as infectious diseases and acute episodes.

The key results are shown in Table 1 and indicate that life expectancy is increasing for both males and females but the increase is larger for males, and that life expectancy with disease has increased more for males than for females. It is particularly noteworthy that most of the additional years are being spent with non-limiting diseases, which is slightly less of the additional years being spent with disability and that most additional years are being spent with co-morbidity as opposed to a single disease. For example, the co-morbidity category, ‘cardiovascular, respiratory or other chronic diseases, and other acute diseases’, was a significant cause for increasing both disabled and disease life expectancies.

For some purposes, such as estimating the demand for long-term care a more appropriate measure is disability-free life expectancy at age 65. International comparison shows that the UK does less well than competitors in either Japan or Germany. According the ONS, disability-free life expectancy at age 65 is 10 years, which is an improvement over recent years. However, this is below levels in Japan, Germany, Netherlands or Switzerland which all achieve over 12 years (OECD)[21].

19 Two types of HLE are routinely calculated from national General Household Survey based on either of the following questions: “Over the last 12 months would you say your health has been good, fairly good, or not good?” and LE free from limiting long-term illness based on : “Do you have any long-standing illness, disability or infirmity?”. The method used by ONS to derive health expectancy is known as the Sullivan Method (see Sullivan, D.F. (1971). A single index of mortality and morbidity. *HSMHA Health Reports*, 86:347-354.). See also Breakwell and Madhavi (2005) ‘Review of sources and methods’. Health Statistics Quarterly, 26.

20 Rasulo D. , L. Mayhew and B. Rickayzen: http://www.uptap.net/project23.html

21 Disability-free life expectancy is defined as the average number of years an individual is expected to live free of disability if current patterns of mortality and disability continue to apply. Disability definitions and measurements are only partly harmonised across countries.

Table 1:
Life expectancy, disease-free life expectancy and disability-free life expectancy at 16 in 1998 and 2008 in England

		males			females		
	Category of expectancy	1998	2004	Difference (years)	1998	2004	Difference (years)
A	life expectancy	59.7	61.5	1.8	64.5	65.7	1.2
B	disease free life expectancy	29.4	29.6	0.2	28.3	28.5	0.2
C	disability free life expectancy	44.4	46.1	1.7	46.1	47	0.9
D	years spent with disease	30.3	31.9	1.6	36.2	37.2	1
E	years spent with disability	15.3	15.4	0.1	18.4	18.7	0.3

2

Measuring disability

From an analytical standpoint all these measures suffer from the same disadvantage, namely that they do not relate to anything tangible such as whether a person is able to work or not, if a person is drawing benefits because of disability, and what the cost is to the public purse in terms of benefits, or extra health and social care. They are nonetheless interesting because they all indicate that whilst the UK performs well by international comparison, some of the evidence points to an increasing gap between LE and HLE.

We conclude by noting that variations in definitions, starting age etc. make it difficult to compare such pieces of evidence on a like for like basis, and so a more detailed and analytically rigorous approach is needed. The detail required depends on the problem being addressed, for example whether a person qualifies for social care or has satisfied benefit rules to be entitled to for example incapacity benefit, the frequency of use of medical services or going into a nursing home. Clearly different gradations of health are needed using a scale that covers all possible health states and therefore needs.

For this purpose we make use of the Rickayzen-Walsh model of disability (2002). This uses a scale of 0 (healthy) to 10 (severely disabled) and is based on Activities of Daily Living (ADL) rather than specific health conditions (the origins of the scale on which the model is based lay with an OPCS survey of disability of all adults in Great Britain[22]). A failure of one or more ADLs is likely to affect ability to work or need for care a requirement for healthcare irrespective of the underlying medical circumstances or aetiology. The model is useful because it recognises different health states that may trigger different responses from public services depending on the degree of severity. It enables us for example, to map benefits onto a disability scale and then estimate how alterations in disability over time might affect the number of people on benefits or to estimate the approximate demand for adult social care.

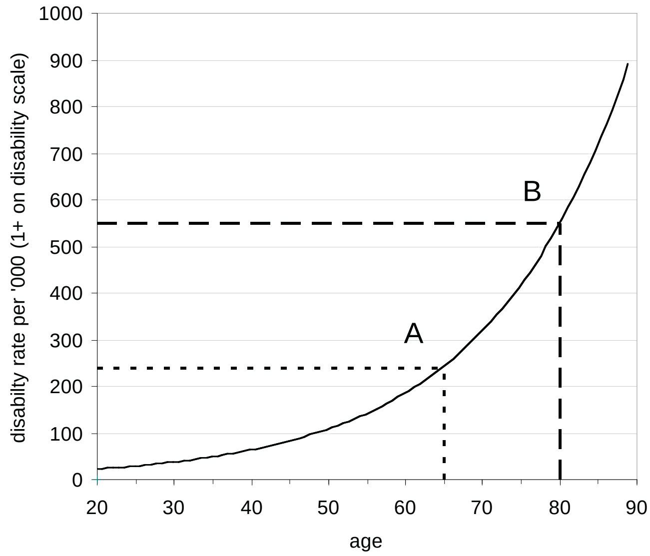
The model projects the future numbers of people in different disability states for males and females based on current UK population projections so we can estimate key indicators such as the ratio of healthy to unhealthy people as well as health expectancies. We use a so-called 'pessimistic scenario' based on the continuation of age specific disability prevalence rates (scenario A) and another more optimistic projection called the '1 in 10' (scenario O). This corresponds to improvements in HLE of one extra year every 10 years so that a person age x +1 at time t+10 would have the health of someone age x at time t.

According to the model, disability prevalence rates in the population increase exponentially with age as shown in Figure 1. This graph is for any disability scoring 1+ on the disability scale. At age 65 the rate is 24% (point A) and at age 80, 55% (point B) i.e. more than doubled. The rates do not differ substantially between males and females although the stock of females disabled is higher because females live longer and spend more years in disability than males. The significance of '1+' correlates highly with working age disability benefit numbers and so one quantity can be proximally estimated from the other (see Annex F).

According to interim life tables for 2005 to 2007, life expectancy for males and females at age 20 was 60 years and 63.3 years in 2025 based on a continuation of current trends. Table 2(a) shows the corresponding values of HLE defined for different disability states in 2007. It shows that the adult disability rate was 16.2% corresponding to approximately 9.7 years in disability for a person age 20 assuming present rates continue. This in turn corresponds to 5.2 'healthy' adults (zero on the disability scale) to 1 'unhealthy' adult (1+ on the

22 Martin, J., Meltzer, H. & Elliot, D. (1988). OPCS surveys of disability in Great Britain, Report 1, The prevalence of disability among adults. London: HMSO. The report gives examples of peoples disabilities at different points on the scale. For example, category 1: a man aged 59, deaf in one ear ; category 2 a woman aged 71 with angina and eye problems; category 6 a man aged 65 with arthritis in spine and legs, a slight stroke and heart condition.

Figure 1
General relationship between disability prevalence rates and age (source Rickayzen-Walsh model) ~ based on scenario A



disability scale). As Table 2(a) recognises, different levels of disability are applicable to different numbers of people so the ratios change. For example people deemed unhealthy scoring 2+ on the disability scale the disability rate falls to 13.1% and the H/U ratio increases from 5.2:1 to 6.6:1.

Table 2
Estimates of HLE and disability prevalence rates in 2007 and 2025 with corresponding estimates of disability prevalence rates and ratios of healthy to unhealthy adults based on the Rickayzen-Walsh model scenario A, 2007 and 2025, and scenario O, 2025

(a) 2007: Life expectancy at 20 equals 60 years (total disabled 7.3m)

disability scale cut off	HLE (disability free LE)	% disabled	adult years in disability	ratio H/U
1	50.2	16.2	9.7	5.2
2	52.1	13.1	7.9	6.6
3	53.3	11.0	6.6	8.1
4	54.5	9.1	5.5	10.0
5	55.6	7.3	4.4	12.7
6	56.7	5.4	3.2	17.6
7	57.6	4.0	2.4	24.1
8	58.4	2.6	1.6	37.2
9	59.0	1.6	1.0	61.2
10	59.6	0.6	0.4	166.9

Table 2(b) shows that in 2025, by which time the population will have aged considerably, the ratios become less favourable based on current disability prevalence rates (scenario A). Disability will affect 19% of the adult population based on 1+ on the disability scale with an average of 12 years spent in disability and a reduction in the H/U ratio from 5.2:1 to 4.3:1. This occurs because HLE has not advanced as fast as LE increasing by 1.1 years as compared with 3.3 years in life expectancy. Alternatively if there is a '1 in 10' improvement, HLE advances to 53 years and the disability rate is more or less as it was

(b) 2025: Life expectancy at 20 equals 63.3 years (total 9.7m)

disability scale cut off	HLE (disability free LE)	% disabled	adult years in disability	ratio H/U
1	51.3	19.0	12.0	4.3
2	53.5	15.5	9.8	5.4
3	55.0	13.1	8.3	6.6
4	56.4	10.9	6.9	8.2
5	57.7	8.9	5.6	10.3
6	59.1	6.7	4.2	14.0
7	60.1	5.0	3.2	18.9
8	61.2	3.4	2.1	28.6
9	62.0	2.1	1.3	46.1
10	62.8	0.8	0.5	124.5

(c) 2025 scenario O ('1 in 10' improvement, total 8.1m)

disability scale cut off	HLE (disability free LE)	% disabled	adult years in disability	ratio H/U
1	53.0	16.4	10.4	5.1
2	55.0	13.2	8.3	6.6
3	56.4	10.9	6.9	8.2
4	57.8	8.8	5.6	10.4
5	59.0	6.8	4.3	13.7
6	60.3	4.8	3.0	19.9
7	61.2	3.4	2.1	28.5
8	62.0	2.1	1.3	46.4
9	62.6	1.2	0.8	80.6
10	63.1	0.4	0.3	239.6

in 2007 and so is the ratio of healthy to unhealthy people. This is shown in Table 2(c).

A key feature of these tables is that disability is graded on a scale from least severe (1) to most severe (10). A person scoring 10 will need much more support than a person scoring one and so trigger different responses from relevant services. For example Nuttal (1984) used the scale to estimate the number of carers required by assigning a given number of hours per week depending on level of disability[23]. Applying the same calculations here, the implied number of whole time equivalent carers in 2007 is 3.3m rising to 4.6m in 2025 based on scenario A and 3.6m based on scenario O. These figures compare with the 2001 Census which found there were 4.2m full and part time carers and so the estimates seem reasonable. The sensitivity of the numbers of people with some form of disability to health improvements thus has important implications for key areas of public policy, an issue to which we now turn.

23 Nuttall, S. R., Blackwood, R. J. L., Bussell, B. M. H., Cliff, J. P., Cornall, M. J., Cowley, A., Gatenby, P. L. & Webber, J. M. (1994). Financing long-term care in Great Britain. *Journal of Institute of Actuaries, 121, pp 1–53.* The conversion factors are as follows: 1-2 : 5 hours of care per week (low requirement); 3-5 : 15 hours per week (moderate requirement);6-8 : 30 hours per week (regular requirement);9-10 : 45 hours per week (continuous requirement).

3

Impacts on public spending of changing demography and health

Before considering broader economic impacts of ageing, we consider the direct impacts on three major areas of public expenditure which combined account for 18% of GDP, and ask the question what difference an improvement in health would make to expenditure in each. The areas concerned are social security benefits, social care and health. Between them they cover a significant proportion of public spending on these three activities, but by no means cover all expenditure. They exclude for example out of pocket spending on medical insurance and private health and long-term care, and also the cost of informal care. These substantial elements of the picture deserve separate attention, although considerations concerning private expenditure on long-term care are covered in Mayhew (2008)[24].

(a) Social security

Total expenditure on social security benefits is running at £132bn a year or 8.5% of GDP including the cost of the state pension. Benefits consist of universal benefits such as Child Benefit; benefits based on claimant eligibility such as Disability Living Allowance (DLA) and Attendance Allowance (AA); contributory benefits such as Incapacity Benefit (IB)[25]; and means-tested benefits such as Income Support, Council Tax Benefit and Housing Benefit.

State pension age provides a watershed between working age benefits on the one hand and retirement age benefits on the other, and so in this section we draw the line for analytical purposes at age 65[26]. Expenditure on long-term sickness and disability benefits for the working age population accounts for £16bn a year (IB, DLA, Severe Disablement Allowance, and Industrial Injuries Benefit). This rises to £28.4bn if Carers Allowance and means tested benefits are included[27]. For the population over state pension age the state pension accounts for £67bn a year of which £7bn is Pension Credit; disability benefits for this age group (DLA, AA) add a further £7bn making £74bn[28].

Life tables compare survival rates, mortality rates and life expectancies at different ages for a hypothetical population of 100,000 and are an important tool used by actuaries and demographers. We use survival curves based on interim life tables for the UK for 2005-2007 to illustrate the segmentation of the adult population from age 20+ into separate social security benefit groups. We are interested here in the three main social security benefits which deal with long-term sickness or disability. These are IB, DLA for the under 65s, and AA and DLA for the population over 65.

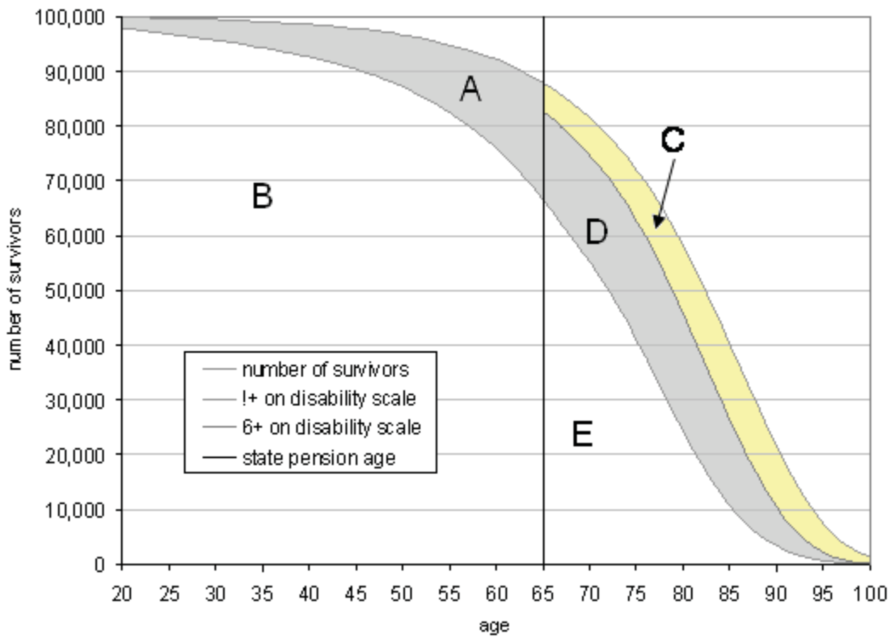
Figure 2, comprising both males and females, is split into 5 groups or segments (A to E) depending on whether they are over or under state pension age and according to the degree of disability on the 0-10 scale. It turns out that the population under 65 receiving IB, DLA or both is accurately defined by the population scoring 1+ on the disability scale[29], whereas the number receiving benefits age 65+ is defined by the population scoring 6+ on the disability scale (see also Annex F).

The groups are as follows:

- A population of working age scoring 1+ on the disability scale out of work and claiming long-term sick and disability benefits (2.9m people fall into this category).
- B population of working age scoring 0 on the disability scale and not claiming any long-term sick or disability benefits (32.6m)

24 Mayhew, L. (2009)The market potential for privately financed long-term care products in the UK. Actuarial Research Report, No188, Cass Business School.
25 Note that from 27 October 2008 Employment and Support Allowance replaced Incapacity Benefit and Income Support paid on incapacity grounds for new customers although will not affect the essence of the analysis presented here..
26 UK state pension age is currently 60 for women and 65 for men. Female state pension age is due to increase in stages from 2010 onwards to 65 by 2020. For illustrative purposes we use 65 in Figure 2 .
27 IB, SDA, IIB, CA, CTB, IS and HB. Source analysis prepared for the 'Black Report' (2008): 'Working for a Healthier Tomorrow,
28 State pension, Pension Credit, AA and DLA
29 In fact the numbers on these benefits are slightly under predicted. The reasons must be speculative but are probably due to administrative factors relating to the flow onto and off of these benefits and benefits switches between age 60 and 65 depending on gender.

Figure 2
Survival curve based on UK interim life tables for 2005 – 2007 (based on Government Actuary's Department [GAD] and Rickayzen-Walsh model). It shows segments of the population (A-E) by disability category and benefit entitlement ~ males and females (see text for segment definitions)



- C population who are aged 65+ and 6+ on the disability scale claiming disability benefits including Disability Living Allowance and Attendance Allowance (1.7m)
- D population aged 65+ who are between 1 and 5 on the disability scale and receiving the state pension (2.7m)
- E population aged 65+ scoring 0 on the disability scale (healthy) and receiving state pension (2.7m)

Factors affecting future spending

(i) Changes in demography and health

With demographic change but no changes to underlying disability prevalence rates the effects on benefit numbers are likely to be substantial as might be expected. Table 3 shows the number of people aged 20+ in different benefit states in 2007 and 2025 in which time the population is expected to grow along with the number of people of pension age. Table 3 shows the expected changes between 2007 and 2025 with the number scoring 1+ on the disability scale expected to increase by 0.3m (‹65) and 2.2m (65+), assuming a continuation in present disability prevalence rates (scenario A). The total number scoring zero, i.e. healthy, on the disability scale will increase by 2.2m (‹65) and 1.9m (65+).

With health improvements the picture changes significantly. The figures shown in column C are based on scenario O, a 1 in 10 improvement or equivalently an increase in HLE of 1 year every 10 at age 20. The results show more limited increases in numbers scoring 1+ or 6+ on the disability scale except in the 65+ category due to the much larger numbers of people in this age bracket. Particularly noteworthy is the rise in the number of people in the zero or healthy state at age 65+ which increases by 4m as compared with 1.9m under scenario A. This analysis suggests therefore that health improvements will be particularly beneficial to the 65 + population and could tend to limit the numbers in the 6+ on the disability scale which triggers Attendance Allowance.

Based on current pension and benefit rates, and ignoring means tested benefits, the total cost will increase by over a third from around £100bn p.a. to £137bn p.a. in 2025. Most of this increase will be in the 65+ age category as a result of increases in the numbers on pensions (categories C+D+E) and on disability allowances (category C). Note that these figures exclude proposals to re-link state pension to wages from around 2013, which would increase this figure. If there are health improvements in line with scenario O, then increases could be limited to £122bn p.a. mainly as a result of changes in the

Table 3
Numbers in different benefit states aged 20+ in 2007 and 2025 based on scenario A and scenario O

disability category	disability scale	Col A number of persons (millions) 2007 (scenario A)	Col B number of persons (millions) 2025 (scenario A)	difference (millions) (colB-colA)	Col C number of persons (millions) 2025 (scenario O)	difference (millions (colC-colA)
M&F 20-64	1+	2.9	3.2	0.3	2.7	-0.1
M&F 65+	1+	4.4	6.6	2.2	5.7	1.2
under 65+ (M&F)	6+	0.7	0.8	0.1	0.7	-0.1
65+ (M&F)	6+	1.7	2.6	0.9	1.8	0.1
M&F 20-64	0	32.6	34.7	2.2	35.1	2.6
M&F 65+	0	5.1	7.0	1.9	7.9	2.8

health state of the 65+ but also those of working age.

The ability to realise the health improvements required is constrained by a number of factors. A recent trend is for higher inflows of claimants with mental and behavioural disorders, and lower exit rates for this group explains their increasing importance within the overall caseload. For example, those with mental and behavioural disorders as a primary indicator accounted for over 40% of the total caseload in 2006 compared to 26% in 1996.

(ii) Effect of changes in state pension age

Planned changes to pension age up to 2020 and then further changes as proposed by the Pensions Commission will result in fewer people qualifying for the state pension and for Attendance Allowance and more qualifying for Incapacity Benefit (DLA is assumed to be unchanged). Entitlement to means tested benefits around this age will also occur, although harmonisation of state pension age should have the effect of simplifying what is a particularly complicated area of the social security system due to benefit switches and complex entitlement rules. What will be the effects on benefit expenditure?

We used the disability scale, scenario A and the 2007 population to estimate the hypothetical consequences on social security costs starting at a pension age of 60 and increasing it to 70. Table 4 shows gross and net annual costs of different assumed state pension ages on pensions, IB, DLA and AA (ignoring consequent changes to means tested benefits including Income Support, Council Tax and Housing Benefit and Pension Credit). The major saving is to state pension costs, but there are considerable offsets caused by increases in entitlement to pre-retirement age long-term sick and disability benefits.

This is due to there being larger rises in IB spending than a fall in AA spending. It shows for example that gross savings in pension costs at an assumed state pension age of 70 would be reduced by £5.4bn p.a. as a result. IC effectively became an early retirement benefit from the mid 1980s to mid 1990s and so how to reduce this tendency is likely to remain a key focus of public policy in future years as pension age increases (see also Annex G). A similar analysis for the population in 2025 shows larger pension savings and larger net savings overall due to population effects; note that the public spending dividend would be higher still if scenario O, health improvement, were to be used.

(b) Social and long-term care

Social care, including long-term care, covers a wide range of services provided both by local authorities and the independent sector to elderly people either in their own homes or in a care home. It also covers day centres which help people with daily living. Services to help with washing, dressing, feeding or assistance in going to the toilet are also included, as are meals-on-wheels and home-help for people with disabilities but it excludes nursing care i.e. care provided by health professionals such as nurses.

Most long-term care consumers are over age 80; for example, in England, almost 80 per cent of care home inhabitants belong to this age group (Bajekal,

Table 4
Approximate impact of changes to benefit expenditure as a result of hypothetical changes in state pension age based on the population in 2007

state pension age	pensions (£s bns p.a.)	sick and disability benefits pre-SPA (£s bns p.a.)	disability benefits post SPA (£s bns p.a.)	total net change (£s bns p.a.)
60	0.0	0.0	0.0	0.0
61	-3.4	0.6	-0.2	-2.9
62	-6.6	1.3	-0.3	-5.7
63	-9.8	2.0	-0.5	-8.3
64	-12.8	2.7	-0.6	-10.8
65	-15.6	3.3	-0.8	-13.1
66	-18.1	4.0	-1.0	-15.1
67	-20.8	4.7	-1.1	-17.2
68	-23.4	5.5	-1.3	-19.3
69	-26.0	6.3	-1.5	-21.2
70	-28.5	7.1	-1.7	-23.1

2002)[30]. Since increasing life expectancy causes this group to grow at a faster rate than the general retired population, it is certain that population ageing will make the current system of financing much more expensive. There is already a trend towards concentrating resources only on individuals with severe disability (Karlsson et al, 2004)[31].

Currently the UK spends around £19bn a year on social care of which £13.4bn (70%) is in institutional care and £5.7bn (30%) in home care (about 1.3% of GDP). The public sector accounts for 65% of all expenditure and the private sector 35%. Of private expenditure around 80% is spent on institutional care and 20% on home care. To these totals should be added the value of informal unpaid care by friends and relatives, which is estimated to be around £58bn or three times the value of formal care[32], so that the total cost of social care is approximately £77bn a year on this basis.

For our purposes a person who falls into the range 0-5 on the disability scale does not require long-term care and if 6+ on the scale is likely to qualify for Attendance Allowance. A person between 7 and 8.5 on the scale is adjudged to have failed 2 ADLs and between 8.5 and 10 is adjudged to have failed 3+ ADLs, where ADLs are activities of daily living[33,34]. A person with a severe disability is more likely to need nursing care than a moderately disabled person who could be supported at home. Figure 3 splits the population so as to identify those who score 7+ on the disability scale as follows:

- A population of working age scoring between 1 and 6 on the disability scale (5.5m, of whom 3.1m are 65+)
- B population of working age scoring 0 on the disability scale and not on sick or disability benefits or in long-term care (37.7m)
- C population age scoring 7+ on the disability scale who have failed 2+ ADLs and are potentially receiving some form of long-term care (1.8m, of whom 1.3m is 65+)

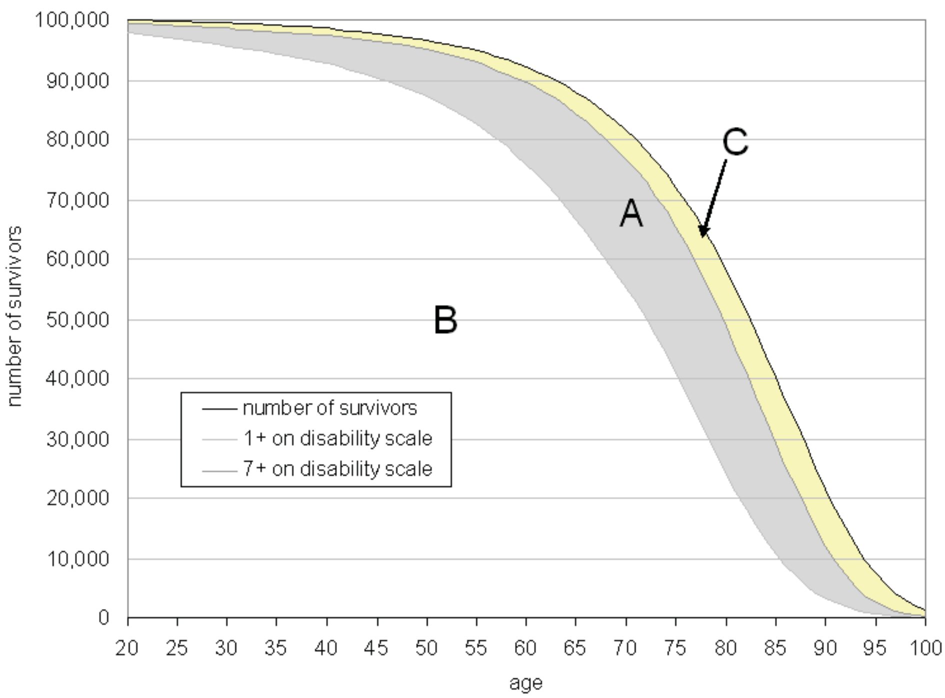
Table 5 shows the estimated number of disabled and severely disabled people aged 65+ in the UK in 2007 and 2025 based on the Rickayzen-Walsh model and Government Actuary's Department (GAD) population projections. It indicates an increase overall of around 58% from 1.3m 2007 to 2m in

30 Bajekal, M. (2002), Care Homes and their Residents, London: The Stationery Office.
31 Karlsson M., Mayhew, L., Plumb, R and Rickayzen, B. (2006), Future costs for long-term care. Cost projections for long-term care for older people in the United Kingdom, *Health Policy 75, 187-213*
32 Figures compiled from Long-term care for older people (OECD, 2005), the ONS, and from Karlsson et al cited above.
33 Being able to feed and wash and dress oneself, go to the toilet unaided, mobility (e.g. climb stairs) and transfer from bed to chair.
34 Dullaway and Elliot, 1998: Long-term care Insurance: A guide to Product Design and pricing. Staple Inn Actuarial Society.

Table 5
Current and projected number of moderate and severely disabled people aged 65+ by sex (source: based on Rickayzen-Walsh model)

65+	disability scale	2007 (scenario A) Males (000s)	Females (000s)	total	2025 (scenario A) Males (000s)	Females (000s)	total	% increase
moderate	7-8.5	199	373	572	350	524	874	52.8
severe	8.5-10	246	467	713	469	687	1156	62.1
total		445	840	1285	819	1211	2030	58.0

Figure 3
Survival curve based on UK interim life tables for 2005 – 2007 (source GAD and Rickayzen-Walsh model) with segmentation of population in to categories A-C according to disability and need for long-term care ~ males and females (see text for segment definitions)



2025 in moderate to severely disabled people aged 65+.

The important point here is that the long-term care market is expected to expand not only for institutional care but also for people with moderate disabilities. This would imply an increase in formal care costs to approximately £30bn from £19bn in formal care costs currently. However with health improvements under scenario O the increase in the number of moderate and severely disabled people would be reduced to around 1.7m people and associated costs of £23bn.

The number of residents in institutions and their level of disability is found in the Health Survey of England (HSE). The HSE's definition of 'severe disability' roughly corresponds to Rickayzen-Walsh definitions of 'moderate and severe' combined. Karlsson et al[35] find that, of the population aged 65+, around 17.5% of females and 6.5% of males are categorized as moderately or severely disabled are in nursing homes or residential homes on this basis (14% on average). The figures in turn imply an institutional population of around 125k, 83% of whom are female.

35 Future costs for long-term care – cost projections for long-term care for older people in the United Kingdom, cited above.

Females form a higher percentage because: (a) on average females are younger than male spouses/ partners and are commonly the main care providers for male partners who become severely disabled sooner; (b) females spend longer on average in severe disability than males; (c) females have a greater propensity to be more severely disabled than males; and (d) females live longer than males. It is hence the combination of these effects that pushes up female numbers in institutional care.

(c) Healthcare

The UK spends over £100bn a year of public expenditure on healthcare or about 7% of GDP. The long term trajectory for healthcare spending has been running at 2% p.a. above GDP growth for many years so healthcare is set to increase its share of GDP over time. Historically, healthcare consumption increases as supply is increased especially where healthcare services are free or of low cost. A greater part of this growth is due to increased factor costs particularly technology and more recently by labour costs. The effect of an ageing population is smaller but significant since it provides one of the catalysts for technological innovation (e.g. such as the introduction of dementia drugs, or body part replacement). Unlike social security and social care, healthy (short term sick) as well as unhealthy (long-term sick) people consume healthcare in large quantities.

Healthcare consumption is strongly correlated with age and gender with costs increasing exponentially with age. However, the additional healthcare resources (hospital beds, doctor visits, drugs etc) consumed by those with long-term conditions (1+ on the disability scale) is not measured explicitly, although is estimated to be between 2 and 4 times the consumption of healthy people (0 in the disability scale) per annum. Zweifel[36] and others have pointed out that proximity to death is a more important influence on health-care costs than age, suggesting that demographic change will not have as large an impact on future aggregate health expenditure as has been suggested. For illustrative purposes we therefore decided to distinguish people in their last year of life (about 600k).

We use the disability model to analyse healthcare costs by associating people of different ages and health status to consumption of healthcare services. For this purpose we make use of the Department of Health figures on average costs of healthcare for different age groups plus assumptions about the additional costs incurred by sick or disabled people. Figure 4 splits the adult population into 5 age groups A-E and then subdivides them into 5 further groups A'-E' for those scoring 1+ on the disability scale. Category F consists of people in their last year of life; it can be shown that this corresponds to 9.5+ on the disability scale. This partitioning is now used to make crude estimates of how an improvement in health could moderate healthcare costs in the future versus the alternative of present trends continuing. First however, Table 6 estimates the share of expenditure by each group A-F in the 20+ age range in 2007 based on these assumptions.

Our aim is to see what might happen with or without health improvements in 2025 in order to isolate if possible the effect of improving health (all figures approximate and therefore illustrative). The table shows that 37.7m age 20+ account for around 44.3% of expenditure and 6.8m who score 1-9.5 on the disability scale account for 22.9%. Group F comprising 0.6m people consumes 17.7% and the 14.7m in the 0-20 age group consume 15.2%.

For the sake of argument let us assume that nominal healthcare expenditure is a function of only population size, age and relative health (i.e. we ignore impact of technology and real growth). Based on projected increases in population, expenditure in 2025 would be £121bn as compared with £100bn in 2007 if current health trends are assumed, but with health improvements this would reduce to £104bn. The main reason is reduced expenditure on people scoring 1+ on the disability scale because there will be fewer of them in a healthy ageing scenario.

However, estimating healthcare costs is notoriously difficult, because consumption of healthcare tends to reflect the resources available and not underlying need. So to constrain actual demand to these totals would require health improvements in combination with supply side adjustments running in parallel. More detailed data and research are needed to flesh these arguments out.

36 Zweifely P., S. Felder, and M. Meiers (1999) Ageing of population and healthcare expenditure: a red herring? *Health Economics 1991;8(6):485-96*

Figure 4
Survival curve based on UK interim life tables for 2005 – 2007 (source GAD and Rickayzen- Walsh model) showing segments of the population (A-F) by disability category and healthcare usage ~ males and females. (see text for segment definitions)

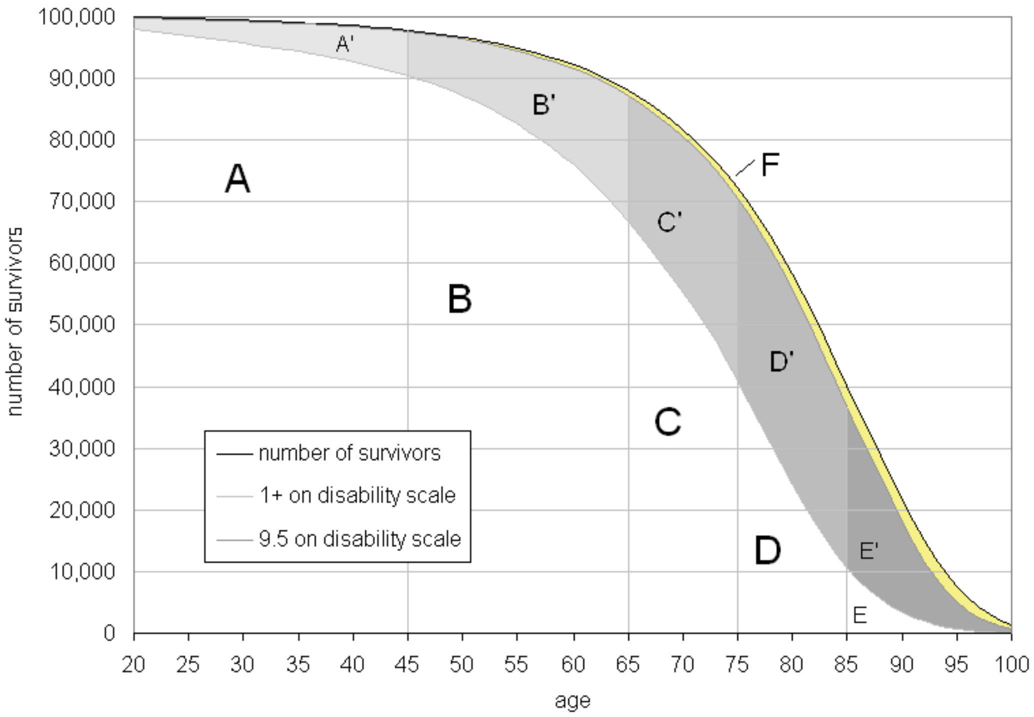


Table 6
Estimated breakdown of shares in healthcare expenditure by sub-group

zero on disability scale	Population (millions)	% share of expenditure	1-9.5 on disability scale	Population (millions)	% share of expenditure
A	19.7	26.5	A'	0.9	4.6
B	12.9	14.1	B'	1.9	8.2
C	3.4	2.7	C'	1.5	4.7
D	1.5	0.9	D'	1.7	3.9
E	0.2	0.1	E'	0.8	1.5
sub-total	37.7	44.3	sub-total	6.8	22.9
F	0.6	17.7			
0-20 age group	14.7	15.2			
total population	59.7	100.0			

4

Impact of poor health and increased longevity on taxes and the economy – a simplified model

The significance of these findings is illustrated with the aid of a highly simplified model of the economy. The description that follows is intended as a framework for investigating the effects on taxes, living standards and GDP as a result of changes in key quantities, such as life expectancy (LE), healthy life expectancy (HLE), working life expectancy (WLE) and wage productivity. The aim is to show how changes in one variable affect the economic variables of interest and scenarios that cause living standards and/or GDP or taxes to rise or fall (details of the model are included at Annex N).

Consider a situation in society in which the working age population crudely divides into one of two groups consisting of either healthy or unhealthy people. The unhealthy group do not work and receive financial support from the state or they are retired and receive a pension plus additional financial support for their disability.

The healthy group either work or are economically inactive and if they are retired they receive a pension. The economically inactive population are in caring roles, unpaid work, and full time education or simply in leisure.

Without loss of generality we focus on the population aged 20+ and define the following quantities from age 20: Expected total life, expected working life (alive and under state pension age), expected retired life (alive and over state pension age), expected healthy working life, expected healthy retired life. In this framework healthy life expectancy is simply expected healthy retired life plus expected healthy working life.

Variables are introduced for average earnings, pension value, and benefits rates so that we can derive values for taxes, GDP and GDP per capita dependent on the values of the quantities above for a population, in this case the UK. For simplicity we assume that total wages are a proxy for GDP (i.e. we ignore investment income, rents etc)[37]. The questions we wish to ask relate to the values all these quantities might take. This enables us to evaluate the importance of different variables in the model such as health and life expectancy and to relate them to financial quantities such as wage productivity and benefit rates.

We contrast situations at two points in time using numbers that approximately correspond with current experience and at a point in the future chosen arbitrarily to be 2025 for illustrative purposes. Typical questions would be by how much would taxes need to increase if there were an increase in life expectancy but no corresponding increase in healthy life expectancy, or what would be the effect on GDP/capita (a broad measure for standard of living) of a health improvement with other variables remaining the same?

The scenarios are designed to cover a range of possible futures and give graduated improvements in GDP/capita. Specific values for the quantities used in each scenario are given in Annex N. To give an example in 2007 the average wage was £23k, having grown historically at a real rate of around 2% over annum over the long term. The benefit rate is assumed to be £10k and corresponds with the lower end of earlier estimates based on current levels of benefit expenditure, health and social care. The state pension is valued at £5k p.a.

Assumed life expectancy, healthy life expectancy, and working life expectancy in the base period are fixed at 60, 50, and 42 years[38] respectively. This gives a tax rate of 29.4%[39] and after tax wage of £16.2k, a wage-GDP of £408bn based on the wage sum and a GDP/head of £9,077 (Table 7, row 1). Now consider the following 6 different scenarios based on a 2025 horizon which we compare to the baseline case:

37 A full blown demo-economic model would include the whole population, expenditure on defence, education, servicing debt etc and importantly non-wage GDP.
38 This is an estimate based on the Labour Force Survey (LFS) which shows that male WLE based on being classed as economically active is 39 years and females 37 years. If periods of unemployment are included the averages fall to 35 and 33 years respectively.
39 The average tax rate is based solely on the costs of health and social care, social security benefits and state pension.

1. Health deterioration: Health deteriorates and health expectancy falls to 49 years because of fall in health in pre-retirement age but life expectancy at 20 increases from 60 to 63 so that 14 years of life are spent in disability. Participation rates fall to 63%, and wages fall by 1% p.a.

2. Passive ageing scenario: Health expectancy improves 2 years from baseline, life expectancy increases to 63 years. Health gains accrue in pre- and post retirement age, years spent in disability widens to 11 years. Participation rate increases to 65% and wage productivity increases by 1% p.a. This scenario is seen as a likely scenario based on present indications.

3. Health gap unchanged but live longer: Life expectancy and healthy life expectancy increase to 63 and 53 years maintaining a 10-year gap. There is a 1% p.a. increase in wage productivity and a 2% increase in participation rates to 66%.

4. Health gap closes: Improvement in health expectancy closes gap to 9 years in disability. Gains in health expectancy accrue in working age, pension age increases by one year. Wages, pensions and disability benefits increase by 1% p.a. and participation rates increase to 67%.

5. Accelerated changes in life expectancy: Life expectancy at 20 increases to 66 years and health expectancy to 55 years with 11 years spent in disability. Labour participation rate increases to 67%, pension age by one year. Wages, pensions and benefits increase by 1% p.a.

6. Active ageing scenario: Life expectancy at 20 increases to 66 years and healthy life expectancy to 56 years maintaining baseline gap of 10 years in disability. Additional healthy years are spent in pre- and post retirement; pension age increases by 2 years. Participation rates increase by 3% and wages, pension and benefit rates by 2% p.a.

Scenario 6 is described as the 'active ageing' scenario because it delivers longer life, better health and wages but also higher benefits for disabled people for very little change in tax rates as compared with baseline[40]. The worst case is scenario 1 in which life expectancy continues to increase but the gap between LE and HLE expands by 4 years and participation rates go down. Here taxes increase by 15.8%. Clearly there is a multitude of other possible scenarios.

The implied change in tax rates and wages resulting from each scenario are given in Table 7 along side GDP/capita and wage-GDP. It shows that any scenario that involves improvements in health relative to life expectancy, increases in participation rates, or improvements in wage productivity delivers lower taxes and higher net wages, and greater GDP/capita etc.

In calculating wage-GDP[41] itself the results are scaled by the size of the population. The UK's population age 20+ is due to increase from 44.5m to 51.4m in the period and the whole population from 55.9m to 71.1m. The 2025 population is used in each of the scenarios except for the baseline. Four illustrative cases may be contrasted:

Table 7
Scenario results showing implied increases in taxes and changes in wage rates consequent on the assumptions given

scenario	LE @ 20	HLE @ 20	years in disability	partici-pation rate	average wage (£000s)	tax rate %	after tax wage (£000s)	GDP £ bns	GDP/ capita
base	60	50	10	0.64	23.0	29.0	16.3	408	9,077
1	63	49	14	0.63	19.2	44.8	10.6	355	6,910
2	63	52	11	0.65	27.5	25.2	20.6	555	10,786
3	63	53	10	0.66	27.5	24.2	20.9	563	10,952
4	63	54	9	0.67	27.5	27.8	19.9	572	11,118
5	66	55	11	0.67	27.5	30.1	19.2	560	10,892
6	66	56	10	0.67	32.8	29.5	23.2	669	13,005

40 For a more in-depth treatment of the concept of 'active ageing' see for example: 'Overcoming the Barriers and Seizing the Opportunities for Active Ageing Policies in Europe'. ICCR Vienna .http://www.iccr-international.org/activage/en/index.html
41 Gross domestic product (GDP) is the main measure of national income. In economic theory national income equals national expenditure which equals national product. Our simplified representation using a proxy based simply on wage income and so ignores other sources of income etc.

A As per scenario 1 with more years spent in disability. Wage-GDP falls despite expansion in population and GDP per capita falls and there is decline in participation rates. In other words, the wealth of the country and standards of living decline.

B As per scenario 2, the 'passive ageing scenario', with health improvement at older ages and modest wage and participation rate improvements. GDP and GDP per capita increase and tax rates would be reduced due to lower disability benefit payments.

C As per scenarios 3 and 4, improved health, wage productivity and participation rates deliver higher GDP and GDP/capita, but benefit and pension increases in scenario 4 reduce after tax wages as compared with scenario 3.

D As per scenarios 5 and 6, significantly improved participation rates, and higher wages offset cost increases in life expectancy. GDP and GDP/capita are increased to their highest levels of any scenario. Tax rates close to baseline level and benefit and pension rates are significantly increased. We call scenario 6 the active ageing scenario.

In summary, it must be emphasised that this simple model is not a predictive tool and is used only for indicative purposes and relies heavily on the assumption of a stationary population based on fixed relationships between the variables. A more sophisticated model would take into account the fact that the variables themselves are not independent of one another, so that for example average wages are a function of age and working life expectancy, and population size a function of life expectancy and birth rates.

A more sophisticated model would take into account the whole economy in which case it may be possible to show situations in which non-wage-GDP could compensate for declines in wage-GDP but this needs to be verified in further work. Nevertheless, the simple model is a useful tool for summarising how demography and the economy are linked, and how movements in their values can influence key economic indicators.

Variations based on socio-economic factors

To prepare for all possible eventualities, policy makers need to be able to calibrate social policy over the next few decades accordingly, but this requires a greater understanding of healthy life trajectories and disablement processes based on quantities such as LE, HLE and WLE. Currently there is no mechanism for quantifying the percentages of people that will be unable to work at higher retirement ages, whether healthy life expectancy as well as life expectancy is increasing, which sub-groups are the most vulnerable to sickness and disability, the extent to which risk is socially rather than biologically determined, and if risk in these cases can be manipulated through the policy process.

In this section we consider the implications of a index for comparing different types of lives which combines health work and life years. This index combines work life and health life balance in the following way:

$$I = \frac{e_w e_h}{e_l^2} \quad or \quad \frac{e_w}{e_l} \times \frac{e_h}{e_l}$$

Thus the index equals one when e_l equals e_h which equals e_w i.e. LE is the same as HLE and WLE (a person works until he/she drops!). HLE is assumed to be greater than or equal to WLE so that WLE cannot be positive if HLE is zero. The index is designed to capture the life time fulfilment and contribution of an individual measured in these terms.

A person with a low ratio implies higher health and benefit/pension costs compared with a person with a high ratio concentrated into the same life span. It also assumes for example that the value of health and work ratios are equivalent, which is an assumption that could be altered but for the moment we will assume they have equal weight.

Research by Karlsson et al (2009) (see footnote 42) derived 'individualised life tables' from which it was possible to determine values for LE, HLE and WLE for different population risk groups at age 50+. Using data from the British Household Panel Survey (BHPS) the population was split by gender, education level, cohabitation, work and health status age 50 into 64 sub-groups. Reasons for inclusion of these variables is that each was found to be statistically significant predictors of future LE, HLE and WLE.

This is confirmed by other research which shows that that marriage tends to increase life expectancy, and reduce the risk of psychological illness. It also shows a strong link between working life expectancy, educational level and health (Butt et al, 2008)[42]. In their research Karlsson et al define poor health as the failure of one or more Activities of Daily Living (ADLs) such as climbing stairs, or washing and feeding oneself. For educational attainment they define four levels of attainment: 1 ('O' Level), 2 ('A' level), 3 (university degree level), and level 4 none of these.

Based on 3 factors, 2 genders and 4 possible educational states there are 64 possible sub-groups all told that can be ranked from high to low based on the index. However, it makes sense to rank males and females separately since females spend time out of the labour market raising children which would distort the findings. The results shown in Annex K, Tables A4 and A5, contain many interesting findings. They show for example that 82.8% of males and 53% of females have an index value of 0.2 or above with value ranges from just above zero to 0.4 in the case of the highest ranked males. For example:

- The male category with the highest index value of 0.39 (row 1) are working, cohabiting, healthy males with education level 1. LE, HLE and WLE at 50 are 38.2, 31.6 and 18 years respectively. They comprise about 13% of the male population.
- The male category with the lowest index value 0.02 (row 32) is exact opposite (not cohabiting, unhealthy etc.) with education level 4. LE, HLE and WLE are 23.1, 6.5, and 1.8 years. They comprise 1.2% of the male population.

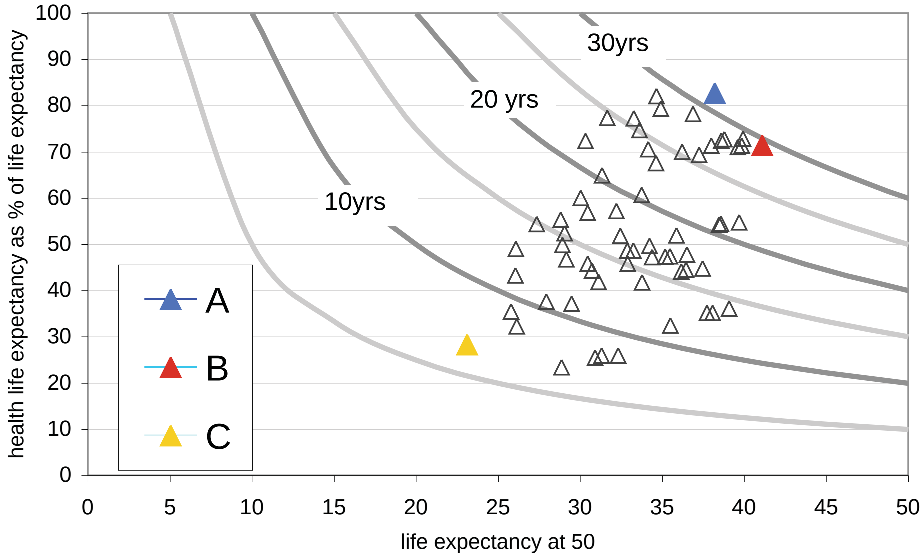
Similar results are reported for females.

- The highest female category with an index value of 0.3 is working, cohabiting, healthy females with education level 1. LE, HLE and WLE at 50 are 39.9, 29.1, and 14.8 years respectively. They comprise 8.4% of the female population.
- The female category with the lowest index value 0.01 (row 32) are again the exact opposite with education level 4 and an LE, HLE and WLE respectively of 28.9, 6.8, and 1.3 years. They comprise 1.3% of the female population.

The research demonstrates a degree of variability on all three measures in the given risk groups. Figure 5 is a plot of the percentage of remaining life spent in good health against life expectancy at 50. Each data point is a different sub-group and

Figure 5

Chart showing percentage of remaining life in good health as a function of life expectancy at age 50. Contours indicate equivalent states based on remaining years in good health and data points represent different socio-economic sub-groups



42 Karlsson, M, L. Mayhew, B. Rickayzen (2009) Individualised Life Tables: Investigating Dynamics of Health, Work and Cohabitation in the UK. *Jnl of Population Ageing 10,1007/S12062-009-9010-8*. Butt, Z., S.Haberman, R. Verral (2008) Calculating compensation for loss of future earnings: Estimating and using working life expectancy. *Jnl of the Royal Statistical Society A, 171, 4, 763-805*.

contours represent equal remaining years spent in good health. It shows there is considerably larger variability in HLE than there is in LE suggesting that HLE is the more malleable but also more problematic of the two. It means for example that two people with similar life expectancy at age 50 can spend significantly different proportions of their remaining life in good health. Highlighted are three data points as examples: A, a male ranked 1 on HLE who is highly educated, working, and cohabiting at age 50; B, a female who is ranked 2 not working at age 50 but highly educated and cohabiting; and C, a male ranked 64 with both low HLE and LE.

These findings do not necessarily indicate that by moving people from a group with a low index value into a group with a high index value will mean that they will adapt to the lives of those in the new group, since it is not a direct causal relationship. Being in any group is the consequence of a life time of experiences and social filtering processes that operate before reaching the age of 50 and so the opportunities to influence which groups of people fall into will depending on individual circumstances and life time opportunities. The results are nevertheless interesting in segmenting and quantifying sub-groups at more or less risk and are a useful context for framing social policy.

5

Implications for UK health and social policy

Previous sections have indicated the impact on public services that are in the front line when health starts to fail. It showed that based on current trends and whilst people are living longer the general level of health is likely to worsen due to the effects of ageing. It was shown that the economic consequences could be represented in a simple model that depended solely on the values of life expectancy, healthy life expectancy and working life expectancy.

To increase both GDP and standards of living, the need to improve healthy life and working life expectancies therefore appears inescapable and so a balanced long-term approach is needed. If improvements in health could be transmitted through the age structure then this is likely to redress the balance to a degree if one accepts the 1in 10 scenario proposed by Rickayen and Walsh. Results from the model were illustrated using scenarios chosen to reflect different trends in all three: living longer, working longer or staying longer in good health.

These scenarios reflected a time horizon of 2025 and are compared with a 2007 baseline. It was argued that on present trends LE is increasing faster than HLE, and that, as we show later, WLE is broadly static. The long-term trend does not therefore seem favourable in terms of taxes, standard of living and economic growth and scenario 1 is an example of what could happen in a worst case. At the opposite end by closing or at least maintaining the gap between HLE and LE, extending working life and increasing productivity at historical rates economic prospects are much improved (e.g. scenario 4 or 6).

The probability of any scenario occurring is contingent on a range of factors. For example an increase in working life expectancy is more difficult to achieve without accompanying improvements in health expectancy and labour demand; wage productivity is more difficult to sustain unless productivity of older workers in their 50s increases to levels of those in their 40s. We now work through some arguments that are barriers to improvements or opportunities that could make a difference if removed.

Increasing healthy life expectancy – barriers and opportunities

It is reasonable to assume that LE will continue to increase at historical rates over the immediate future and to all intents and purposes it should be taken as a 'given'. The issue of prolonging lives of people who are seriously ill or disabled is an important component of life extension, as are the care consequences of the increasing numbers of centenarians expected in the next decades. One reason for concern is that male life expectancy at age 50 is accelerating and is a key reason for supposing that current population projections will undershoot the true number of older people in years to come. This point is discussed further in a later section.

The evidence base for interventions that close the gap between LE and HLE is incomplete and fragmentary. We have not reached a stage in the state of the art where we can say that if we do x this will achieve y with an adequate degree of certainty and that progress is necessarily incremental and long-term. Claims for potential gains in health from initiatives often involve double counting of costs and sometimes exaggerated benefits for publicity effect. For example, estimates that heart disease costs the healthcare system £3.5bn[43] and stroke £2.3bn[44] are almost certainly inaccurate due to double counting due to co-morbidity and other effects.

One reason why LE has improved so much in the last 20 years is the success of medical interventions particularly in the area of managing heart disease. This has apparently had the effect of increasing the gap between LE and HLE (i.e. years spent with disease). The complementary strategy faced

43 British Heart Foundation fact sheet 2005
44 Burdens of Disease – a discussion document. Department of Health 1996.

with increasing LE is to increase HLE. Four main options arise: (i) improve HLE by spending more on healthcare; (ii) remove hazards in society and the work place that are known causes of ill health; (iii) promote social norms that encourage healthier lifestyles such as cohabitation and work; (iv) action on education and jobs (since these increase WLE as well as HLE). In the following sections we pick a few examples of each but these are by no means exhaustive.

Countries that spend more on healthcare generally have a higher HLE: however, studies that show gains in HLE flatten off as spend increases are based on cross-sectional data and do not take account of advances in medical technology. Nevertheless, it is interesting that a country like Japan can spend less than half the amount per capita as the United States and yet achieve an HLE of 75 years at birth as compared with 69 in the US. The UK which spends a similar amount on healthcare to Japan has an HLE of 71 based on data from the World Health Organisation (WHO). Differences in healthcare delivery, affordability, organisation and cost control are some of the underlying issues explaining the differences (e.g. countries with high proportion of private healthcare do less well), but also differences in lifestyles and degree of inequality.

Prevention is a general term used and refers to disease prevention although there does not appear to be a satisfactory way of measuring impact on HLE in a general way apart from using Quality Adjusted Life Years (QALYs)[45]. The onset of chronic disease may be regarded as inevitable in an ageing population since many other causes of death at earlier ages have fallen (e.g. accidents, infectious disease). Research shows that signs of chronic disease begin at an early age but take time to build up into a diagnosis. Once diagnosed a chronic diseases cannot be cured but can often be managed through medication and life style changes for many years.

More than 60% of all avoidable deaths are caused by cancer and cardiovascular diseases. The top 10 causes of avoidable deaths are heart disease, lung cancer, suicide and self-inflicted injuries, colorectal cancer, cerebrovascular diseases, road traffic injuries, chronic obstructive pulmonary diseases (COPD), breast cancer, diabetes and alcohol-related diseases. Life expectancy from age at diagnosis of a chronic disease such as heart disease is greater than with cancer although there have been significant improvements here too. In thinking about the benefit of health interventions it is useful to distinguish between those that promote life extensions in a diseased state and those which prevent the onset of chronic disease.

Interventions that prolong life in a disease state then need to be subdivided into those that allow people to continue work (e.g. those with hypertension, diabetes) and those that might not (e.g. a stroke). The onset of chronic disease varies by individual and may be related to life-style or to genetic factors and so the ability to delay disease will be an issue relating to both, one of which is more amenable to change than the other. If the average age of onset of all chronic disease could be delayed by one year, then reasonably this might translate into a one year improvement in HLE and so on.

Research shows that people diagnosed with chronic disease early in life have a reasonable life expectancy albeit in a diseased state, whereas people diagnosed with the same disease in the late stage of life have a shorter life expectancy and consume fewer health resources over the life course. For example a person diagnosed with COPD at age 70 has a 20% chance of dying within 3.3 years; if diagnosed at age 55 it is 9 years. The general hypothesis is that by delaying the onset of chronic conditions results in both a higher HLE and LE, but also a shorter gap in years between them.

It can be argued therefore that policies and actions that delay the onset of disease are likely to prove less costly in the long run than actions that deal with the consequences. Similar lessons were learnt in the 19th Century in combating infectious disease through the introduction of improved sanitation. In order to measure progress in HLE at a more detailed level it would probably pay to set up a bundle of indicators to monitor age specific new cases of chronic diseases such as hypertension, diabetes etc. but definitions would need to be rigorous for comparability purposes. Reduction in the incidence of these diseases at younger ages would be one way of measuring progress towards improvement in HLE.

Fries (1980) called this process the ‘compression of morbidity’ and claimed that ‘whether the period of morbidity is shortened depends very much on the average age of onset of the first marker (e.g.

45 Quality Adjusted Life Years, a measure used to evaluate the health benefits of different interventions such as new drugs.

diagnosis of hypertension or first heart attack)'[46]. The earlier the onset, the greater the likelihood of a second or third disease such as hypertension or diabetes occurring which has the effect further increasing healthcare costs through more doctor visits, prescriptions etc. (e.g. see Alder et al, 2005[47]). People with early stage diagnoses of one chronic disease at young ages are more likely to acquire further disease before deaths and so the burden of disease accumulates in this way and is spread out over more years.

Of all the risk factors, smoking remains the most important underlying causal factor in cases such as lung cancer, heart disease, COPD etc and is hence a major cause of avoidable deaths. Despite a long-term fall in adult smoking rates to around 25% today, smoking is estimated to account for around 110k deaths a year or around 18% of all deaths. Death from smoking related illnesses is more expensive than say death from serious stroke although there is a paucity of information on life time medical costs for different medical conditions. US research from a few years ago for example showed that life time medical costs of heavy smokers and drinkers were four times higher than for people with moderate habits[48].

A key question is by how much HLE (and in turn WLE) would improve if all smoking were to stop. Unpublished research by Karlsson et al[49] found that non-smokers enjoyed about 6 to 7 more years of HLE than smokers, and so a complete cessation of smoking would be expected to increase HLE by 1.5 years over a period of time based on a 25% adult smoking rate. Van Baal et al[50] found that HLE in what they termed a 'healthy living cohort' was 54.8 years for men and 55.4 years for women at age 20. For male smokers HLE was 7.8 years less and for females 6 years less. Crude calculations based on the relationship between HLE and healthcare spending show that it would require a 50% increase in health spending or about £50bn year to achieve the same effect (see Annex H).

Obesity, like smoking, is another major risk factor that has an adverse impact on health, but unlike smoking, obesity is on the increase. Obesity is a condition used to describe high levels of body fat and is associated with increased risk of morbidity and mortality. The Health Survey for England shows for example that the proportion of adults classed as obese has increased in the UK from 15% in 1993 to 25% in 2006. The same survey shows that the proportion classed as morbidly obese has increased from 0.8% in 1993 to 2.1% in 2006.

Obesity is associated with poor diet, reduced physical exercise and social factors as well as an increased risk of various life threatening chronic diseases. Studies have found for example that obese individuals are at increased risk of cancer, cardio-vascular diseases and diabetes and had the effect of decreasing life expectancy. Similarly the relationship between body mass index (BMI) and mortality show that risk of death increases when BMI is less than 20 kg/ m2 is optimal between 20 kg/ m2 and 25 kg/ m2 and is increasing for BMI categories above this[51].

A 34 year-old obese man was found to live on average 4 years less than men with healthy body fat levels and a woman 2 years less[52]. As obesity reduces the age of onset of chronic diseases, it means that HLE is reduced also but it is not known by how much. Research on the impact of obesity does not give figures for WLE but shows that that obesity exerts a large, statistically significant and negative effect on employment for both males and females after controlling for health[53]. It appears that the negative effect is greater for the severely obese than the obese, and greater for females than males.

The other major health challenge linked to ageing is mental health problems which are also to an extent co-related with other chronic diseases especially in older age. The recent Foresight report on mental health and wellbeing in the 21st century is an example of another recent Government report

46 Fries, J.F. 1980 Aging, natural death, and the compression of morbidity. *N Engl J Med. 303(3):130-5*. The Compression of morbidity paradigm envisions reduction in cumulative lifetime morbidity through primary prevention by postponing the age of onset of morbidity to a greater amount than life expectancy is increased, largely by reducing the lifestyle health risks which cause morbidity and disability.
47 The Chronic Disease Burden – An analysis of health risks and healthcare usage. (2005) Alder K, L. Mayhew, S Moody. R. Morris and R. Shah. Cass Business School, London.
48 Schroeder, S.A., J.A. Showstack, and H.E. Roberts (1979) Frequency and clinical description of high cost patients in 17 acute hospitals. *N Engl J Med 300:1306-11*
49 Cass Business School Press Release: Giving up smoking adds seven years to good health, June 2007.
50 Pieter HM van Baal , Rudolf T Hoogenveen , G Ardine de Wit and Hendriek C Boshuizen Estimating health-adjusted life expectancy conditional on risk factors: results for smoking and obesity *Population Health Metrics 2006, 4:14doi:10.1186/1478-7954-4-14*.
51 E.g. see Seidell J, Verschuren W, van Leer E, Kromhout D (1996) Overweight, underweight, and mortality. A prospective study of 48,287 men and women *Archives of Internal Medicine; 156: 958 – 963*; Bender R, Trautner C, Spraul M, and Berger M (1998) Assessment of Excess Mortality in Obesity *Am. J. Epidemiology; 147: 42 - 48*.
52 A study into the detrimental effects of obesity on life expectancy in the UK (2009) Richardson, J., L.Mayhew and B. Rickayzen. www.actuaries.org.uk.
53 The impact of obesity on employment by S. Morris, *Labour Economics, 2007, 14(3), 413-433*.

which has expressed health concerns about the ageing population[54]. It notes for example that "Dementia will have a substantial and increasing impact on individuals and families with the number of people affected doubling to 1.4m in the next 30 years". However, it also points out that mental health problems are also a factor at all ages, affecting specific sub-groups such as drug users, adolescents, the unemployed, and looked-after children.

In another report[55], the cost of dementia is put at £17bn a year and that if the onset of dementia "could be delayed by 5 years it would reduce deaths by 30k a year". This is an example of how delaying the onset of a long-term condition can save lives and reduce costs. A problem is that research on how mental health problems affect LE, HLE and WLE is lacking except in obvious cases such as suicide and therefore needs further work before its full impact can be assessed (there is no such assessment in Foresight). Almost certainly the issues need to be broken down into different conditions such as dementia but also into different sub-groups to understand and measure the long-term effects (e.g. by employment status, housing tenure, household characteristics, life style).

The ONS 2007 survey of adult mental health reports that the prevalence of mental health conditions requiring treatment has increased since 1993 from 14.1% to 16.4% of the adult population[56]. Mental health problems overlap in part with harmful drinking habits and illicit drug taking. According to the same survey 24.2% of adults exceed the limit for non hazardous drinking and 3.8% drink harmful quantities with rates the highest in the age range 16-34. Although illicit drug use in the last 12 months is reported by 9.2% of adults this increases to 24.3% in the 16-24 age groups and 19.6% between ages 25 and 34. Evidence that mental health is an increasing problem is also provided by the increased uptake in Incapacity Benefit by people citing mental health conditions (see next section).

Increasing working life expectancy – barriers and opportunities

Our simplified model showed that GDP per capita and GDP itself could be increased if WLE or HLE are increased. The model also showed that an increase in HLE is an important adjunct, because healthy people are more likely to be in work than unhealthy people so that strategies that promote both are more likely to be successful. There is research for example that shows that people in work enjoy better health than people out of work although clearly caveats must be applied since causation is bi-directional. However, it appears that the effect of ill health on the decision to retire is more important than the effect of retirement on ill health

Turning to WLE, a key bottleneck within the UK labour market is the high economic inactivity rate after the age of 48 with increasing levels of disability long before state pension age is reached. According to the Labour Force Survey, of the 36.3m people aged between 20 and 64 years 28.5m are economically active. Of the 7.8m economically inactive population 3.1m are classified as DDA[57] disabled, leaving 4.7m who are not. Of the 3.8m economically inactive aged between 48 and 64, 1.9m are DDA disabled, leaving 1.9m who are not (see tables A1 and A2 in Annex D).

As Annex D shows, inactivity rates accelerate as state pension age is approached and it is probable that the two are associated in some way. Some of the reasons for high inactivity rates for people aged 50 to 59 were analysed for this paper using ELSA[58] data (see Annex J). It shows that 26% of males and 28% of females had failed 1+ ADLs by their 50s and that 7.8% of males and 14% of females are carers. It finds that a male is 1.28 times more likely to work if he is educated and 2.87 times more likely if he is a home owner. In the case of females the equivalent odds are 1.72 times and 2.01 times.

Being long-term sick or disabled has a greater effect than individual caring responsibilities on work status. For example the analysis shows that a man is 7.14 times ***less*** likely to work if he has failed 1+ ADLs and a woman 4.35 times. By contrast a man is 1.46 times ***less*** likely to work if he is a carer

54 Foresight Mental Capital and Wellbeing Project (2008).Final Project report – Executive Summary. The Government Office for Science, London.
55 Living well with dementia: A National Dementia Strategy –Dept of Health Publication date 3 February 2009. http://www.dh.gov.uk/en/SocialCare/Deliveringadultsocialcare/Olderpeople/NationalDementiaStrategy/index.htm
56 Adult psychiatric morbidity in England, 2007: Results of a household survey. National centre for Social Research; Information Centre for Health and Social Care.
57 Definition under Disability Discrimination Act
58 English Longitudinal Study of Ageing.

and a woman 1.23 times ***less*** likely. Such direct evidence suggests a filtering process in which healthy educated home owners are more likely to be economically active in their 50s even if they have caring responsibilities and poor health.

Earlier estimates in this paper suggested an increase in demand for carers from 3.3 million whole time equivalents to 4.6 m in 2025 based on scenario A, but a fall to 3.6m based on health improvement scenario O. The probability of having elderly frail relatives tends to be higher in a person's 50s and so increased caring responsibilities could become a bigger barrier to work over time but health improvements could mitigate this[59]. Other evidence elicited from this analysis found for example that males were 1.4 times less likely to work if they were smokers and 2.12 times ***more*** likely if they were cohabiting. It was noteworthy that the same two variables had a neutral impact on females.

Health deterioration accelerates in this age range and there is a very close correlation on three independent measures: the LFS economically inactive disabled rate, the percentage of people on long-term sick and disability benefits, and anyone scoring 1+ on the Rickayzen-Walsh disability model (see Annex D, Figure A7). In terms of income it is noteworthy that average weekly earnings peak when a person is in their 40s; also the number of beneficiaries of tax credits which boost income for people in work falls notably after age 50 presumably as a result of dependent children leaving home[60].

Annex M considers the benefit replacement rates for people on the minimum income and average earnings and shows that for a person or couple claiming income support disability premium replacement rates are very high i.e. either income may need to be higher or benefits lower. Thus we have four factors that are affecting economic participation from an individual perspective: lower wage incentives, more caring responsibilities, increasing rates of disability, and impending state pension age.

Strong confirmation that mental health problems are replacing other conditions as a reason for economic inactivity is available from Incapacity Benefit data. The claimant load as a percentage of the working age population has increased from around 3% in the 1960s to over 7% today. However, a recent phenomenon is claimants citing mental and behavioural disorders which have increased both as a proportion of all new claimants and of the overall caseload. Those with mental and behavioural disorders as a primary indicator accounted for over 40% of the total caseload in 2006 compared to 26% in 1996. This trend represents a growing challenge as this group typically have poorer work records and prospects[61].

Benefit data also show that the probability of leaving benefits is lower for those who have been in receipt for more than 12 months which tends to apply to older workers than those with shorter durations. Factors on the demand side of the labour equation include the difficulties of finding jobs for people 50+ that have been made redundant as a result of previous economic downturns, company closures etc., and skill gaps between jobseekers and prospective employers. The causes of economic inactivity are therefore many but the net effect of both push and pull factors has been to constrain and dampen economic activity rates in this critical age range and so prevent a crucial extension to effective WLE.

To see how slow change can be in this area we need to look at labour participation trends. Average labour participation rates over the age range reached a peak in 1990 at around 63% before falling and remaining broadly static at 62% until 2002. Since then they have started to rise again and were at 64% in 2008. This masks significant differences between males and females with the rate of economic activity among males falling from 75% at its peak in 1990 and levelling out at 71% today. The rate for females increased rapidly up to 1990 from 47% in 1984 to 52 %. Since then it has increased more slowly to around 57% in 2008.

Since 1999 'Opportunity for All'[62] has presented an annual overview of Government action to tackle poverty and social exclusion. Although our focus here is on health it does report encouraging changes in participation rates for specific sub-groups with lower than average participation rates. For example rates for ethnic minorities have increase by 2.8% since 2000 to 60.1% and lone parents by 6.0% to 57.2%. The comparable figures for disabled people are an increase of 5.8% to

59 See also Carers, Employment and Services Report Series (2007), A series of reports produced by Carers UK and University of Leeds.
60 HMRC Child and Working Tax Credits Statistics December 2008 Table 3.1
61 Based on work undertaken for the 'Black Report': 'Working for a healthier tomorrow'(2008) HMG.
62 Opportunity for All: Indicators Update, DWP October 2007.

47.2%. This research shows that labour market policies can make a difference albeit at a slow rate of progress, although cynics might argue that it would have happened anyway due to favourable economic conditions.

To put these findings into a more strategic context, assuming a steady state with constant numbers of people entering the job market in their 20s, each 1% rise in participation rate would equate to around a 6 month increase in effective WLE. For males at age 20 current effective WLE is estimated to be 39 years and so an increase in participation rate of 2% over a period of time would be equivalent to an increase of 1 year. With theoretical working life expectancy of around 40 years based on state pension age for women and customary occupational retirement age for men, there is arguably room for increases in participation rates without having to increase pension age although the gap is narrow. However, built-in inertia through forced spells of inactivity and adverse employment prospects for older workers makes this theoretical limit very difficult to achieve.

LFS data on working beyond state pension age shows better news. Here participation rates increased from 8% to 11% for males and 7% to 12% for females between 1984 and 2008. From previous discussion, research shows that people with the longest effective WLE are educated, specialists, professionals, such as academics whose earnings tend to peak later in life and who are in better health. This suggests that investment in education and training pays off in terms of extending WLE in later career and is advantageous in finding a job after spells of absence form the labour force (e.g. to bring up children or look after elderly relatives).

Strategies aimed at reducing inequalities

As well as tackling individual areas of public health concern such as smoking, obesity and excessive drinking, there is substantial research linking ill health to social inequalities and deprivation. Inequalities are defined on several different levels for an individual, neighbourhood or society and measures of inequality include income, wealth, housing, education, access to services etc. These are usually known as 'underlying causes of ill health' rather than say smoking which is a 'direct cause' and often found in more deprived areas. Outcome measures for geographical areas are usually expressed in units of excess mortality (e.g. standardised mortality ratios), or health (healthy life expectancy) and there is a wealth of data that show huge variation across the country although there is as yet no targets for HLE (e.g. see Health Statistics Quarterly Vol. 40, 2008).

Lifting the worst performing areas to the levels of better performing areas and thus to the level of the best, is usually how inequality targets are framed. The Government target for England is to reduce the gap in LE at birth between the fifth of local authorities with the worst health and deprivation indicators (known as 'the Spearhead Group') and the population as a whole (England), by at least 10% by 2010. This is a tall order as at the local level the differences in life expectancy can be substantial. Research carried out in Birmingham in 2008 found male life expectancy at birth in Birmingham is 76.3 years (1.25 years less for England), but that the population sub-group with the lowest life expectancy were for males in social housing and council tax band A (the lowest value band for tax purposes) . For this group the life expectancy at birth is 69.5 years, nearly 7 years less than the mean male life expectancy at birth.

In 2004-2006, the relative gap in life expectancy at birth between England and the Spearhead Group was wider than at the baseline for the target (1995-1997) for both males and females. For males the relative gap was 2% wider than at the baseline (the same as in 2003-2005), for females 11% wider (compared to 8% wider in 2003-2005) . To achieve the target the gap needs to be 2.32% in 2009-2011 but an examination of trends in life expectancy at national level from 1950 onwards confirms the difficulty reducing variation at the national level.

The causal mechanisms connecting inequalities to poor health are more indirect and diffuse than they are for chronic diseases but statistical associations between inequalities and poor health outcomes are convincing. Comparative European studies show that the UK has higher income related inequality than all other countries apart from Portugal. The contribution of different reasons for this have been analysed by van Doorslaer and Koolman using an interesting and novel modelling approach .

63 Birmingham: Adult mortality and life expectancy (2008). MHA Ltd. www.nkm.org.uk
64 Health Inequalities Target Monitoring – Life expectancy at birth, source: Department of Health
65 Eddy van Doorslaer and Xander Koolman: Explaining the differences in income-related health inequalities across European countries (email: vandoorslaer@bmg.eur.nl). Department of Health Policy & Management, Erasmus University, 3000 DR Rotterdam, The Netherlands

The Government has introduced a wider range of measures to tackle the problem and is not simply targeting life expectancy which should be regarded more as one outcome measure based on a whole raft of social policies. Briefly, they include equal opportunities legislation designed to combat gender, age, race and religious discrimination and action in areas such as child poverty, education etc., which if successfully addressed can also be expected to improve health over time by transporting people into groups that, as previous discussion demonstrated, leads to a fuller and healthier life.

We have already noted that international evidence suggested that HLE is improved by improving GDP and reducing inequalities. In a recession as living standards stagnate or fall, reducing inequalities becomes more important as a health stabiliser and employment for maintaining income. So the issue becomes one of whether these policies taken together will achieve improved health and at the same time be recession proof. There is no reason to suppose that they will not, but how fast and whether the actions taken will be enough is another question.

6

Limits to life

Policy makers are pulled in two directions. At one extreme they wrestle with the problem of how society will be able to cope with the burgeoning numbers of elderly in terms of healthcare costs and pensions, and at the other, of promoting a healthy living and risk-avoiding culture so that people are able to live longer active and more productive lives. We have reached the present position in which the majority of UK citizens live until they are at least 80 years old as a result of many factors and influences spread over 150 years. In coming decades the number of centenarians will increase into the thousands which obviously has significant implications for caring services.

Two questions that arise from this analysis therefore is whether there is a maximum life span and what happens if our current projections are wrong? On the first question there is a split of opinion. One camp says that there must be biological limits to life expectancy and it is only a matter of 'when' and not 'if' the limit is reached (e.g. see Olshansky, 2001[66]). The other camp points to the fact that there has been an unbroken linear rise in life expectancy of about three months a year for at least 150 years and that there are no signs of this abating (Oeppen and Vaupel, 2006). They show that in the leader board of life expectancies, the position has changed many times over the years with, for example, New Zealand in the first half of last century leading the way, then Scandinavia, briefly Switzerland, and now Japan[67].

On the second question, looking at present trends, it seems fairly certain that the rapid improvements in life expectancy are set to continue for the time horizon under consideration in this paper and will affect some of the conclusions (e.g. see Annex I). So rapid have the improvements been that official population forecasts have become increasingly inaccurate especially at older ages. Accompanying increases in working life expectancy and healthy life expectancy have not been as fast. Cass researchers found for example, that GAD 1981 male population projections of the 50+ age group become increasingly inaccurate within 10 years, and out by almost 30% after 20 years.

Most of the recent errors are concentrated in the oldest ages. GAD itself has reviewed the errors (see Population Trends 28, 2007), noting that: 'the implications of projection accuracy will differ for different users' and the largest errors are 'for the very young and very old'. However, GAD is in good company since many demographic agencies throughout the world have experienced similar problems in that they have failed to capture the rapid expansion in longevity at older ages.

Major decisions on policy depend on the accuracy of future financial estimates which in turn depend on population forecasts that are assumed to be fairly accurate. A simple example would be changes to state pension age which were last altered in the 1990s in order for males and female age to be equalised at 65 from 2020[68]. The analysis in this paper shows that the then forecasts would not have anticipated the pressures to make further increases between 2020 and 2030.

Tests using a novel population projection methodology under development at Cass Business School, obtained more accurate results than GAD using data from 1981 and 1991 to project the actual (i.e. known) population in 2001[69]. It then used the model to compare results with published GAD forecasts for 2020 to see what difference it would make on the assumption that projection performance would be better. Since there are different trends in life expectancies between males

66 Prospects for Human Longevity (2001) S. Jay Olshansky,* Bruce A. Carnes, Aline Désesquelles, *Science, Vol 291, Issue 5508, 1491-1492 [DOI: 10.1126/science.291.5508.1491]*

67 Oeppen, J. and J.W.Vaupel (2002) Broken Limits to Life Expectancy, *Science, 29 6 (5570), 1029-1031*. The oldest verified person to have ever lived was French woman Jeanne Louise Calment with a confirmed lifespan of 122 years 164 days.

68 As a result of the decision in Barber, Pensions Act 1995 s.62 was passed to provide that an occupational pension scheme which does not contain an equal treatment rule is treated as including one. This provision is treated as having had effect in relation to any pensionable service on or after 17th May 1990. As a consequence, phasing in of equal ages for start of State Pensions takes place between 2010 and 2020 (Pensions Act, 1995)

69 Whither human survival and longevity: The shape of things to come. Mayhew L. and D. Smith forthcoming actuarial research paper. Cass Business School

and females, it was necessary to model them separately.

Using the same assumptions as GAD about birth rates and migration but different assumptions for mortality at age 50+, the Cass model showed an excess of 0.48m males and 0.11m females or 0.59m altogether over GAD, so the results are closer on females but much wider apart on males for whom life expectancy has been increasing faster. These differences are shown in Tables 8 and 9 separately for males and females, but do not include the oldest old (>90 years) where there is more uncertainty.

To put this into perspective the value an extra 0.59m people indicated by the Cass model would add each year about £2.9bn to the cost of the state pension alone. The apparent accuracy of the Cass model over the GAD projections in the period from 1980 does not guarantee its greater accuracy in the period to 2020; however, in framing and costing future policy it suggests it would be wise to check current estimates.

Table 8
Comparison of male population projected from 2001, model versus GAD

age	GAD 2020	Model	Diff	Diff %
50-59	3,788,205	3,809,512	21,306	0.56%
60-69	3,014,841	3,111,925	97,084	3.22%
70-79	2,324,314	2,504,966	180,653	7.77%
80-89	978,574	1,164,099	185,525	18.96%
total	10,105,934	10,590,502	484,568	4.79%

Table 9
Comparison of female population projected from 2001, model versus GAD

age	GAD 2020	Model	Diff	Diff %
50-59	3,962,913	3,963,685	771	0.02%
60-69	3,203,880	3,202,956	-924	-0.03%
70-79	2,632,919	2,645,805	12,886	0.49%
80-89	1,344,369	1,442,493	98,124	7.30%
Total	11,144,081	11,254,939	110,858	0.99%

7

Conclusions

Life expectancy is increasing rapidly and will continue to do so in the time horizon of this analysis. The UK population will age rapidly from now on as the old age support ratio goes into long-term decline (ratio of adults of working age to the population aged 65+). This paper finds that the implications of these demographic changes are significant and should not be underestimated.

In 2007 there were 3.8 people aged 20-54 for every person aged 65+; based on official population projections this will fall to 2.8 by 2025 but it could be 2.7 if life expectancy continues to increase at present rates. In order to restore that balance to the value in 2008 would require 14m extra people of working age or a net population addition of 0.8m people per year from 2008. However, based on maintaining the ratio between healthy and unhealthy people suggests a lower but still very high figure of 8m extra people.

Migration, an indicator of labour shortages, has increased in recent years due in part to EU expansion and favourable economic conditions as Figure 6 shows. Whereas in the 1960s there was net outflows of population the trend has switched to net inflows currently running at 0.25m a year. Migration is sensitive to economic factors and net inflows may fall during the present recession but the underlying labour shortages will exert significant migration pressures for the foreseeable future as the population ages.

Most people would agree that population additions on the implied scale would be disproportionate and an unacceptable strain on UK resources and social structures; moreover it would lead to its own long-term problems as migrants themselves aged.

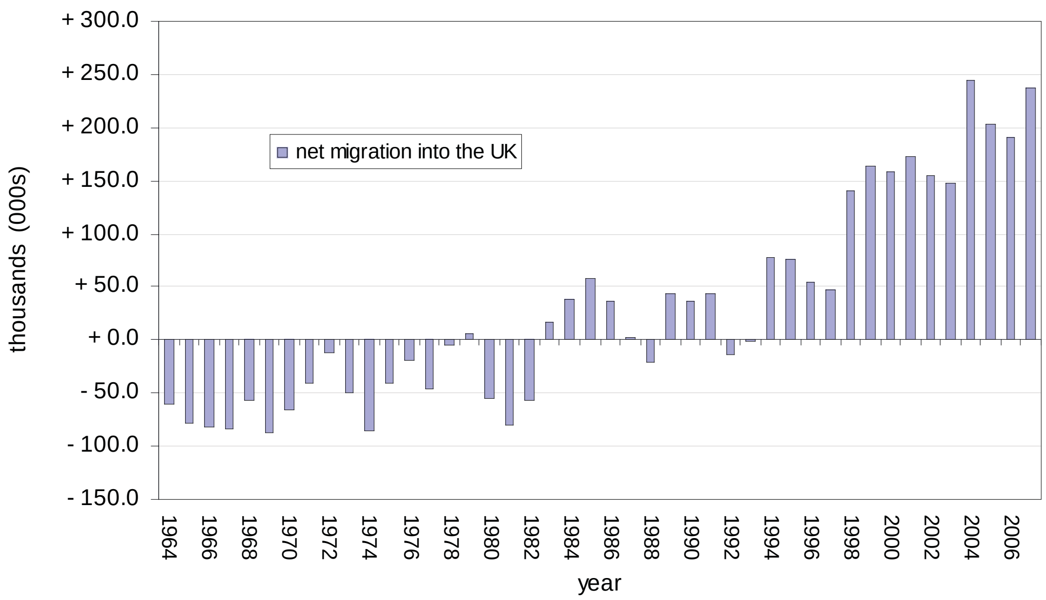
To support the additional numbers of older people indicated from present projections will require a number of things to occur.

Firstly there needs to be improvements in healthy life expectancy that match or preferably exceed increases in life expectancy. Increases in healthy life expectancy relative to life expectancy will reduce the need for healthcare, older people's services, and social security benefits and hence the tax burden. It will increase the pool of people available for work and enable people, if they wish to work beyond retirement age albeit in a more limited capacity.

As Fries has pointed out chronic disease has become the norm in older populations and measures that can limit the age of onset of chronic disease will concentrate morbidity into fewer years and limit the increasing phenomenon of co-morbidity (multiple chronic diseases) which results in more impairment, medical care, demands for older people services etc.

Spending ever more on healthcare may be self-defeating. Investing more in preventing disease may be a better investment but improved metrics are

Figure 6
Net migration into the UK 1964 to 2006 (000s)



needed to measure the long-term effectiveness of prevention policies. Clearly, removing from society harmful risk factors will have wider benefits. Smoking is a classic example. More gains in healthy life years would be obtained from a complete cessation of smoking than would be achieved by increasing healthcare spending by 50%. However, there is a strategic weakness in this area as prevention programmes are not as well evaluated as for example are the economic benefits of new drug treatments. With the exception of a few areas, we do not know how many extra healthy life years are gained for each £1 of expenditure on prevention.

Secondly, there needs to be an increase in working life expectancy comparable to increases in healthy life expectancy. Presently far too many people become economically inactive before normal retirement age. It is observed for example that people with the longest working life expectancy tend to be educated, cohabiting, and home-owning and being healthy at age 50. Conversely people aged 50+ are less like to be in work if they have caring responsibilities (usually elderly relatives but also partners) or are unhealthy, a situation that applies to approximately 30% of males in this age range and 37% of females (depending on the measure and data source used).

In these circumstances changes in pension age are arguably unlikely to succeed if people vote with their feet and leave or are pushed to leave work before pension age. For many people incomes before state pension age pension is topped up by working age social security benefits (Incapacity Benefit, Carers Allowance, Disability Living Allowance, Income Support, Council Tax Benefit and Housing Benefit). As pension age is increased this will continue and expenditure will be higher unless labour participation rates are increased. One unwelcome effect of this will be to offset anticipated public expenditure gains from increasing female state pension age to 2020 and then beyond.

It is calculated that participation rates would need to increase by at least 2% in order to increase working life expectancy by 1 year, but we calculate that the increases will need to be higher than this. Low participation rates in the 50+ age range are one of the bottlenecks identified that prevents this happening. We have not analysed labour demand issues in this paper in detail but the fact that average wages tend to peak in a person's mid-40s may lead to negative associations with employment and further reduce incentives to work. Benefit replacement rates start to look attractive after 50 especially for people in low paid jobs and may provide another inducement not to undertake paid work.

Labour participation rates have been slowly recovering since peaking in 1989 and are now back to the levels then. The difference is that males rates have fallen and female rates have risen. Given that the damage caused to participation rates in the past are linked to earlier recessions, it would be deeply ironic if the hard fought gains in rates in recent years were to be undermined by the current recession and thus lead to another extended period of either stagnant or falling participation rates.

In conclusion, the demography of the UK is changing rapidly and the signs are that population in the mid-2020s will exceed official forecasts. The current UK population of around 60.6m is projected to increase to 68.9m by 2025, and will be higher still if migration rates continue and current trends in life expectancy are maintained. To put this into a wider context, every extra million people accounted for corresponds to a city the size of Birmingham!

There are hence four key economic messages from this analysis:

1. If the UK is to succeed economically in the coming decades, increases in life expectancy need to be balanced by improvements in working life expectancy and healthy life expectancy, although there is some flexibility since to a degree they are interchangeable.

2. Failure to do so could lead to increased migration pressures increasing the UK population still further. To some extent higher productivity may offset these pressures but since older workers are less productive than younger workers this cannot be guaranteed.

3. While a growing population will lead to greater GDP it may not translate into improved GDP per capita, and under some scenarios living standards could fall and taxes rise steeply.

4. An 'active-ageing' scenario on the other hand would result in a more manageable population, and both increased living standards and GDP growth. This would involve balanced improvements in health and working life expectancy and supply side conditions to enable people to work longer and live healthier lives.

Overall the tone of this paper has been pessimistic in outlook. To some extent the arguments presented fly in the face of the generally received wisdom that living longer is a mark of a successful society and therefore a 'good' thing. Old age is rightly celebrated but it will not be celebrated in coming decades unless there are accompanying changes in healthy life expectancy and working life expectancy. The problem is that one year of extra life is being valued by society the same, whether it is a 'healthy' or 'unhealthy' life year. However, the analysis has also shown that relatively small changes in healthy life expectancy and working life expectancy can make a big difference.

A difficulty is that that HLE and WLE move very slowly over time and is the result of a combination of factors in some cases acting over decades. This suggests that governments should 'proof' social policies to ensure that ones that extend life expectancy are balanced by policies that extend health and working life expectancy. The evidence of this paper is current policies appear to be more successful at increasing life expectancy than they do at increasing working life expectancy or healthy life expectancy. In demographic terms, the UK is at a turning point but the real crunch is still a few years hence. This suggests there is a window of opportunity in which to change direction to one based on the 'active ageing' scenario above.

In conclusion, this paper has shown that the accumulation of healthy life years is preferable to the accumulation of unhealthy life years, but this needs to change faster if the challenges of an ageing population are to be met. A further problem is that health is measured in different ways but the metrics used in this paper suggest that there are gradations of health and that different metrics are needed for different purposes (not all unhealthy life years are equivalent). Finally there are signs that the received wisdom that we are living longer but also living healthier and longer are also changing. As the OECD recently noted:

'One of the main policy implications that can been drawn from the findings of this study is that it would not be prudent for policy-makers to count on future reductions in the prevalence of severe disability among elderly people to offset completely the rising demand for long-term care that will result from population ageing' (Long-Term Care for Older People, OECD, 2005)

Annex A

Changes in the UK and Japanese old age, young age and total support ratios

This annex compares changes in demographic support ratios in the UK and Japan. In Japan the definition differs slightly with young persons defined from 0-14 instead of 0-19. The old age support ratio is defined as the number of people aged 65+ divided by the number aged between 15 and 64; the young person support ratio is defined as the number of persons aged 15-64 to the number aged 0-14; and the total support ratio to the number aged 15-64 divided by the number aged 0-14 plus the number aged 65+.

Typically countries will go through three demographic stages characterized sequentially: (i) a phase with a low child support ratio, and high old-age dependency ratio; (2) a point when the old age and young age support ratios cross each other; and (3) a phase with a high child support ratio and a low old age support ratio.

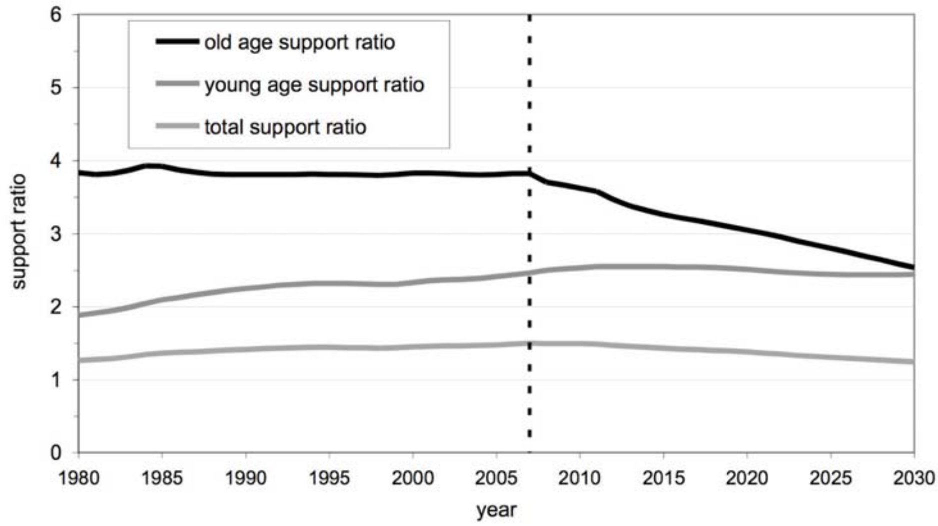
We find that the pattern of change in support ratios is similar in both countries although Japan had relatively much fewer older people than the UK at the start of the periods under consideration. Both countries initially experienced spurts in fertility with large rises in the numbers of young people, Japan more so than the UK. Figure A1 shows changes in the three support ratios from 1980 and expected changes to 2030 for the UK.

It shows that the old age support ratio is fairly constant up to 2007 when it stood at 3.8 (4.2 based on 15-64) after which it enters into a steep decline and is due to reach 2.5 (2.8 based on 15-64) in 2030. The young persons support ratio increases over the period peaking in 2012, whereas the total support ratio peaks in 2007 (2007, based on 15-64).

As shown in Figure A2 the old age support ratio in Japan was over 12 at the start of the period in 1950 falling to 3.1 in 2007, and is due to fall further to 2.0 by 2030. The old age and young age support ratios meanwhile cross each other in 1998. It is noteworthy that in Japan the total support ratio peaked in 1992 at 2.4 and in the UK in 2007 at 2.0 in equivalent units, 15 years later. From a comparative viewpoint it means the UK has had 15 more years to reach the same turning point.

i) United Kingdom

Figure A1
Changes in (a) the UK old age support ratio (20-64)/65+; (b) young age support ratio (20-64)/ (0-19); and (c) the total support ratio (20-64)/ ((0-19) +65+) between 1980 and 2030



ii) Japan

Figure A2
Changes in (a) the Japanese old age support ratio (15-64)/65+; (b) young age support ratio (15-64)/65+; and (c) the total support ratio (15-64)/ ((0-14) +65+) between 1950 and 2030. Note: Japanese young person's support ratio based on 0-14 year olds

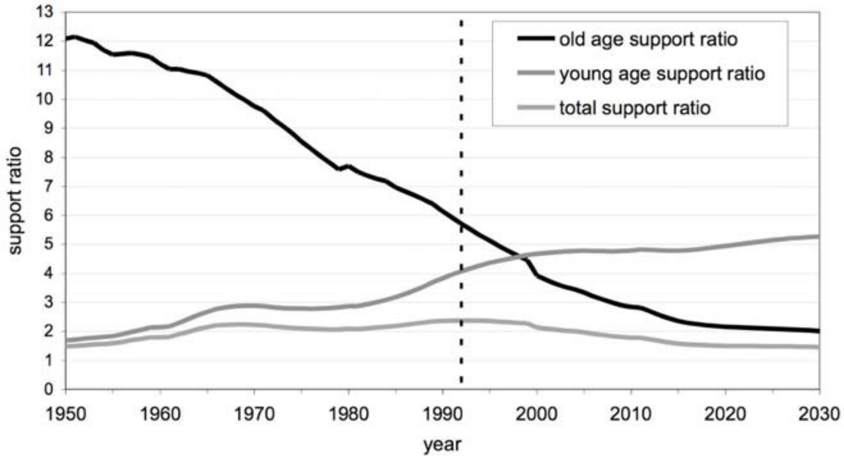
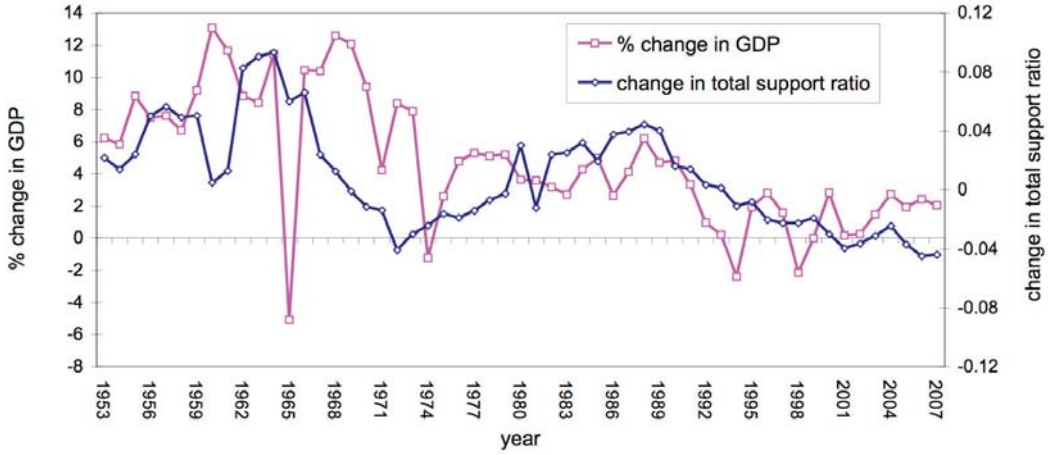


Figure A3
Chart showing the percentage change in GDP and annual change in the total support ratio (Japan 1953 to 2007)



In economic terms the larger number of working age people relative to the young and old population tends to result in higher levels of economic activity since more people are economically active. This is sometimes called the demographic dividend and is generally associated with higher economic output, saving and hence investment[70]. In practice, it is difficult to separate out long-term dividend effects from short term economic effects in economic data. To date we only have the Japanese experience to go by over a sufficiently long period.

However, Figure A3 provides some evidence for a 'dividend' effect. It plots year on year percentage change in GDP from 1953 to 2007 and annual changes in the total support ratio. Briefly, following the war the Japanese economy boomed reaching real growth rates of 12% per annum in the mid 1960s and therefore comparable with China today.

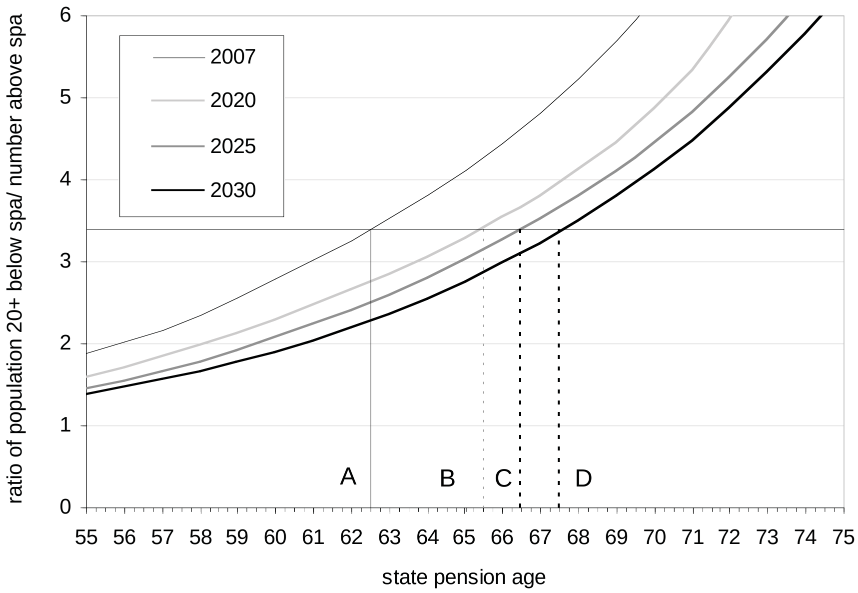
70 e.g. see Demographic Transition and Economic Growth in China (2006). Cai Fang and Wang Dewen Institute of Population and Labour Economics Chinese Academy of Social Sciences, wangdw@cass.org.cn http://iple.cass.cn/file/Demographic_Transition_and_Economic_Growth_in_China.pdf

By the 1990s growth rates fell to 2% before stagnating and going into recession in 1994 and 1998. The chart shows that net additions to GDP tended to increase with the value of the total support ratio although the recessionary effects and stagnation of the 1990s have their origins in the asset bubble of the early 1990s. In all probability the changing Japanese demography and economic stagnation are connected as various research seeks to demonstrate (e.g. see McKellar et al, 2004 ~footnote 5)

Annex B

Effect of changes in state retirement age on old age support ratio

Figure A4
Shows the ages to which state pension age (SPA) would need to be raised in order to maintain the same old age dependency ratio as in 2007. Key: A=62.5 (2007); B=65.5 (2020); C=66.5 (2025); D=67.5 (2030)



State pension age (spa) is currently 65 for males and 60 for females and notionally 62.5 for males and females. Figure A4 shows that in 2007 at age 62.5 there were 3.3 persons aged 20-64 for every person over this age (point A). Between 2010 and 2020 female pension age will increase by 6 months each year until it reaches 65, the same as males in 2020.

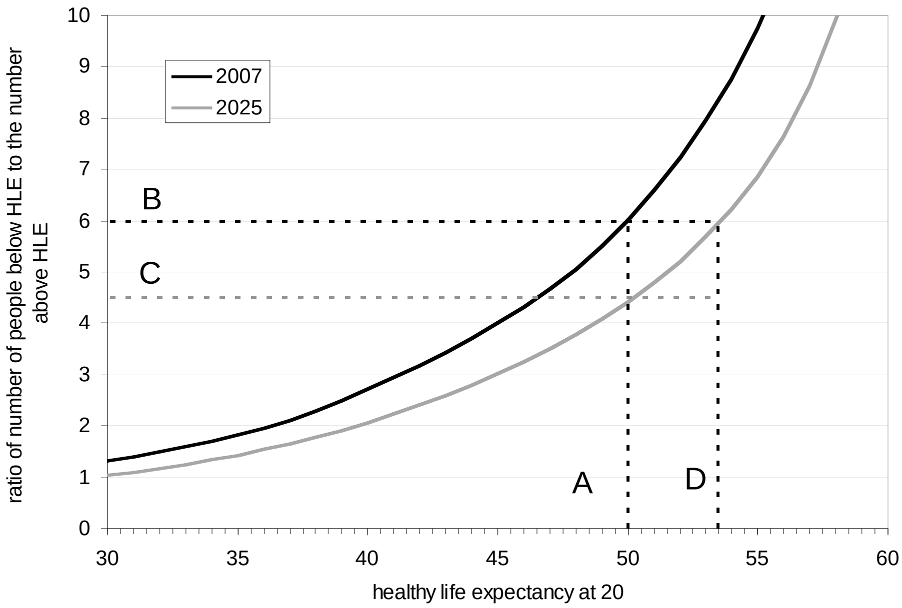
Figure A4 shows that to maintain the dependency ratio where it was in 2007 joint pension age in 2020 would need to rise to 65.5 years (B), 66.5 years by 2025 (C), and to 67.5 years by 2030(D). By contrast the Pension Commission proposed increases in state pension age to 66 by 2030, 67 by 2040 and 68 by 2050, although their calculations were based on different criteria compared with here.

Annex C

Health support ratio

Annex C shows how pension age would need to change in order to maintain the same dependency ratios as for 2007 in 2025. A health adjusted support ratio is based on the number of healthy people below healthy life expectancy (HLE) to the number of people aged above HLE, where HLE is defined as the number of expected years in good health at age 20. Figure A5 plots this ratio against HLE based on the UK population in 2007 and the projected population in 2025. It shows the current value of HLE in 2007 (point A, 50 years) for which a support ratio of 6 is indicated (point B). If there are no improvements in health, this ratio will slip to 4.5 (point C). To restore the ratio to its value in 2007 the chart shows that there would need to be a 3.5 year increase in HLE (point D).

Figure A5
Relationship between the ratio of people below healthy life expectancy at age 20 to the number of people aged above healthy life expectancy at age 20 in 2007 and 2025



Annex D

Labour market participation

Table A1 provides a breakdown of UK economic activity based on people aged 20 to 64 in the UK between July 2007 and June 2008. Of the 36.3m total, 7.8 m are economically inactive, and of these 3.1m are classified as 'LFS (Labour Force Survey) disabled'.

As Figure A6 shows, the rate of economic activity among males fell from 76% at its peak in 1990 and has leveled out at around 71% since. The rate for females increased rapidly to 1990 from 47% in 1984 to 52 % since when it has increased at around 0.3% per annum to 57% in 2008. The aggregate of males and female participation rates remained broadly static at 62% until 2002 since when it has increased to 64% by 2008.

Table A1

Breakdown of UK labour market activity by population category between ages of 20 and 64 (millions)

Employment category	Males (millions)	Females (millions)	Total (millions)
economically active	15.4	13.1	28.5
economically inactive of which	2.6	5.2	7.8
DDA disabled	1.4	1.7	3.1
not DDA disabled	1.2	3.5	4.7
Total	18.0	18.3	36.3

Figure A6

Chart showing trend in percentage of population economically active by male and female

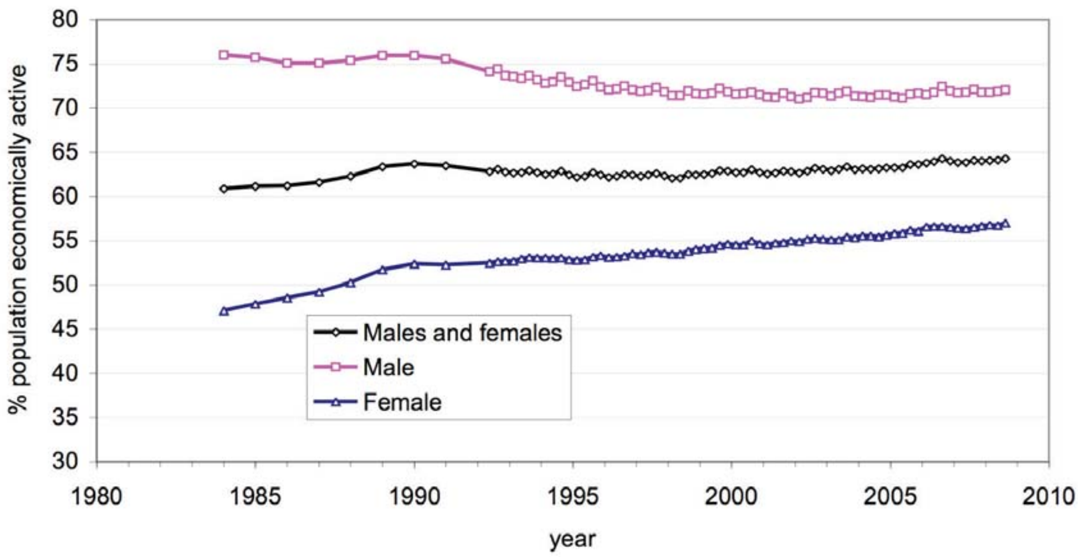


Figure A7
Chart showing trend in % of population economically active by age for males and females (A male state pension age; B female state pension age)

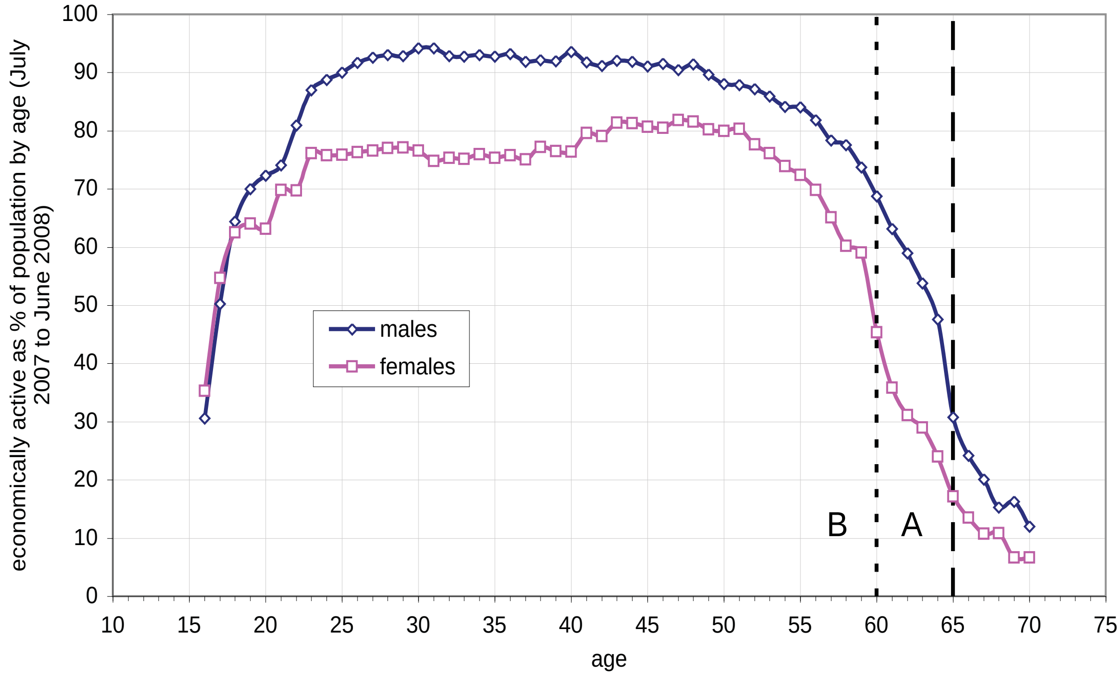


Figure A7 breaks down participation rates by single year of age. The pattern of economic activity by age shows that male activity rates are higher at every age from 20 onwards. From age 40, male activity rates start to decline whereas female rates increase until age 50. After 50 there is an accelerated decline in both male and female rates especially after age 60. Beyond 65 years the decline slows down but data are more unreliable after age 70. However, to put this into perspective international comparison show that Japan has the highest labour participation rate after age 65 at 20%; the UK is around 7%, and France 1%.

The complementary chart in Figure A8 shows the joint male-female pattern for economic inactivity and clearly indicates the acceleration in inactivity rates post 50. Also included are rates based on the LFS calculated from the number classified as DDA disabled. The gap between the economic inactivity rate and the DDA disabled inactivity rate is a minimum at age 48 when it falls to 5%, suggesting that the majority of people who can work are economically active at this age. After 48 the gap widens as age 65 approaches as greater numbers of healthy as well as unhealthy people withdraw from economic activity. Of the 12.6m people in this age group 3.8m are economically inactive, of which 1.9m are DDA disabled and 1.9m are not (see Table A2).

Table A2
Population aged 48-64 by activity status and gender (millions)

Employment category	Males (ms)	Females (ms)	Total (ms)
economically active	4.8	4.0	8.8
economically inactive of which	1.4	2.4	3.8
DDA disabled	0.9	1.0	1.9
not DDA disabled	0.5	1.4	1.9
total	6.2	6.4	12.6

Figure A9 shows in more detail the correspondence between the LFS inactive disability rate, claimant rate for long-term sick and disability benefits and the rate based on 1+ on the disability scale produced by the model. The chart shows that all three series, LFS, benefit rates and 1+ on the disability scale, give an almost identical picture. Thus three independent sources of data, the LFS DDA economically inactive, the percentage on long-term sick and disability benefits, and the Rickayzen-Walsh disability number produce similar findings.

Figure A8
Chart showing trend in % of population economically active by male and female; LFS rate for DDA disabled by age; benefit rate for people on long-term sick and disability benefits (A male state pension age; B female state pension age)

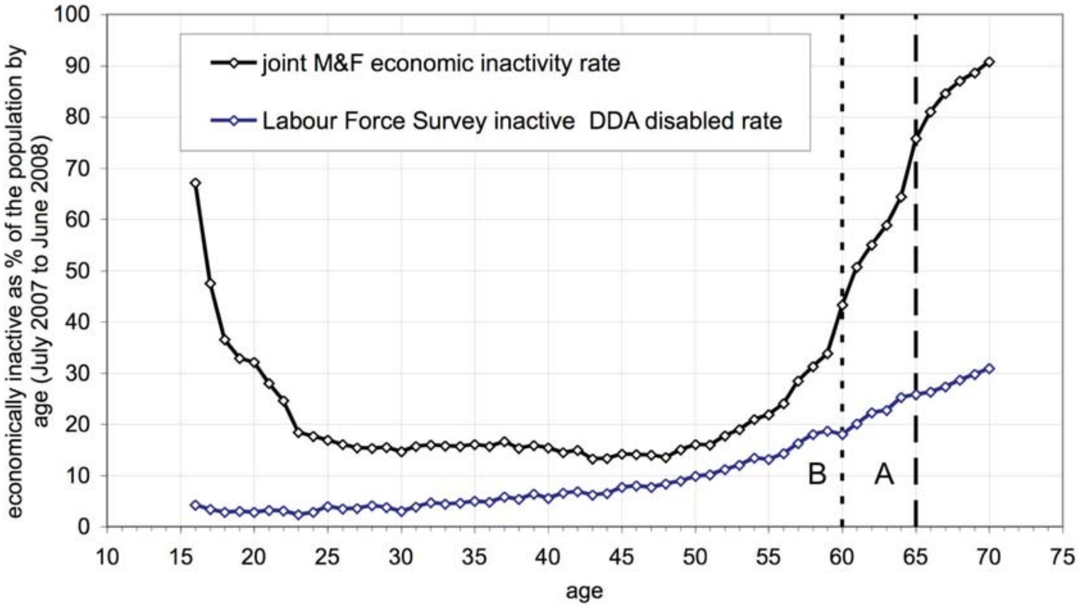
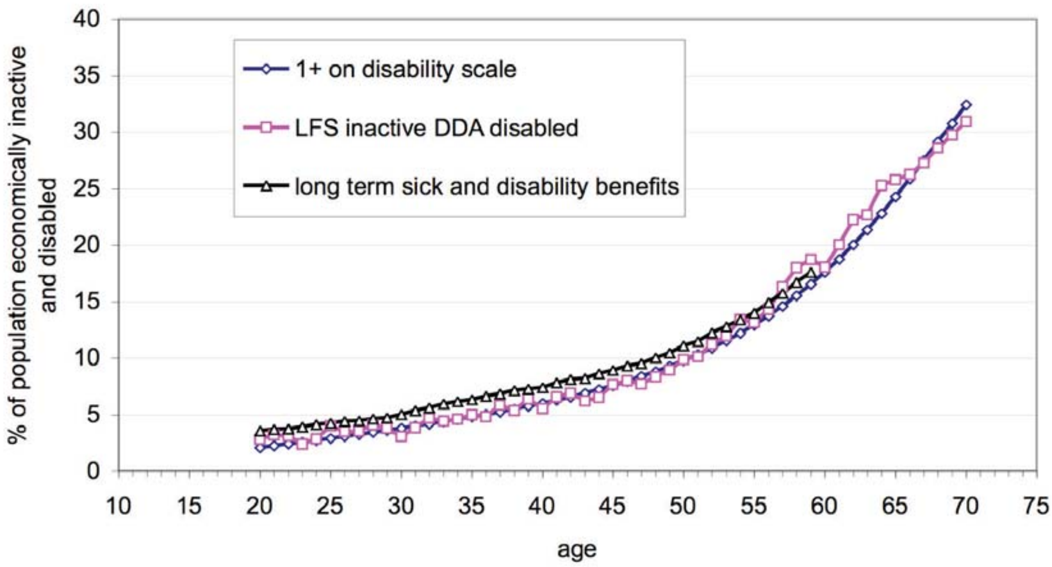


Figure A9
Percentage of the population disabled and economically inactive according to the LFS, benefit claimants and the Rickayzen-Walsh model from age 20 to 70



Annex E

Trends in life expectancy and healthy life expectancy

Figure A10
Chart showing trends in life expectancy and healthy life expectancy since 1980 and trend projections

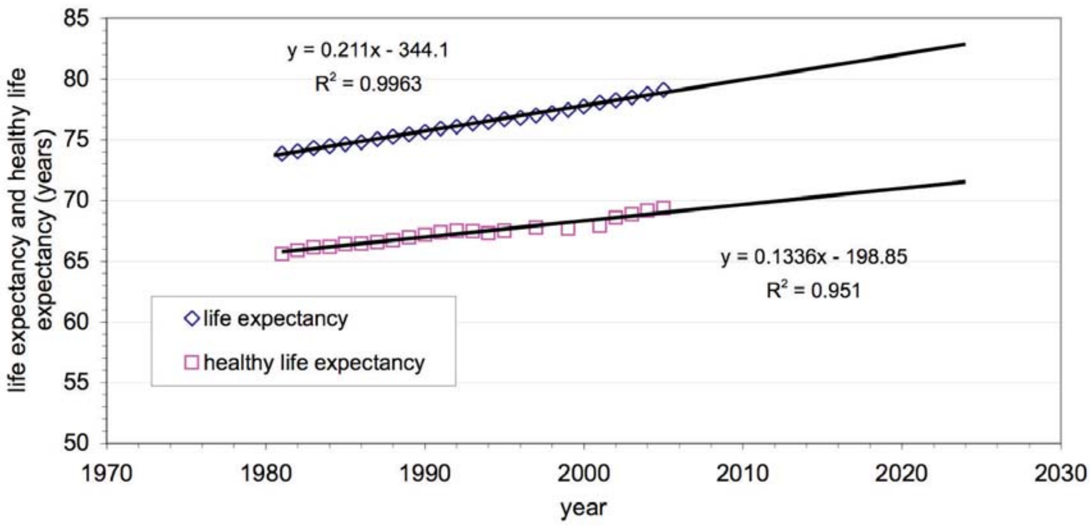


Figure A10 is a graph of three in joint male and female life expectancy (LE) and healthy life expectancy (HLE) at birth (source ONS). Analysis shows that life expectancy has increased at 77 days per year since 1980 and HLE at 49 days per year increasing the gap by 28 days per year. In 2007, for example, the gap between LE and HLE at birth was 10.1 years. Based on the trends given, the gap will increase to 11.5 years by 2025. Interestingly, the gap between LE and HLE exhibits an upward trend not only in absolute terms: the proportion of life spent in ill healthwill increase from 12.7% in 2007 to 13.8% in 2025.

Notes to graph

1. *Source for Life Expectancy: Government Actuary's Department.*
2. *Source for Healthy Life Expectancy: Office for National Statistics.*
3. *General Household Survey (GHS) question is used to calculate good and fairly good general health rates: Q. Over the last 12 months would you say your health has on the whole been good, fairly good, or not good?*

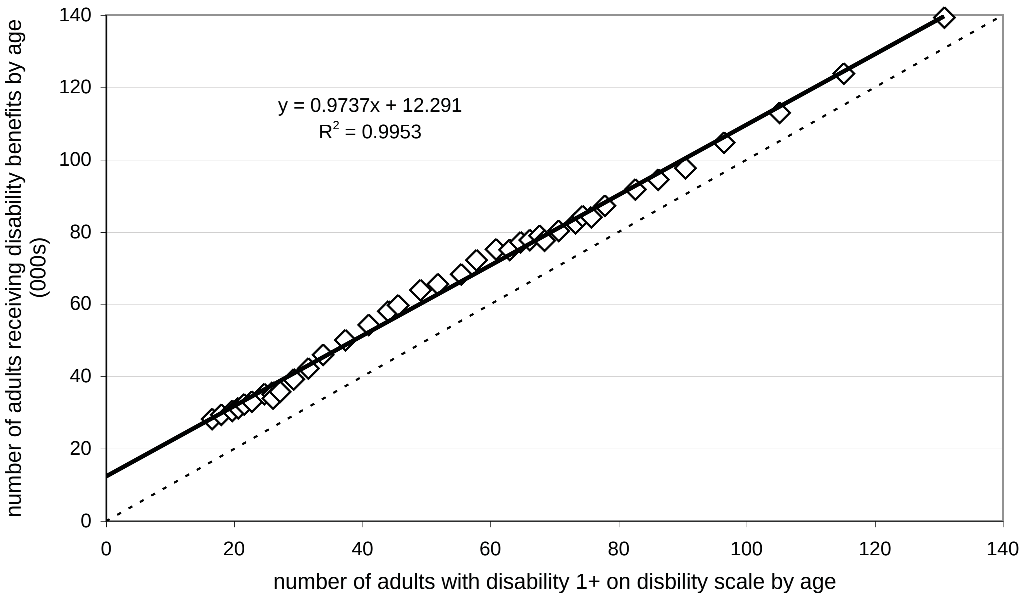
(The GHS was not conducted in either 1997 or 1999. The resulting modifications to the annual series of HLE data are: a) no data points are calculated for the years 1996, 1998 and 2000; b) the data points for 1997 and 1999 are each calculated on just two years of GHS health data, 1997 on 1996 and 1998 data and 1999 on 1998 and 2000 data).

Annex F

Statistical relationship between long-term sickness and disability benefits and disability scale for age ranges 20-64 and 65+

Figure A11

Chart showing trends in life expectancy and healthy life expectancy since 1980 and trend projections



The total annual cost of long-term sick and disability benefits in the UK is around £15.5bn with another £1.2bn for Carers Allowance. If to these totals, means tested benefits are added comprising Income Support, Housing and Council Tax benefits the total increases to £28.4bn a year (about 2% of GDP)[72].

Figure A11 shows the relationship between the numbers at each age claiming either Incapacity Benefit, Disability Living Allowance or both from age 20 to 64 against the number of people scoring 1+ on the Rickayzen-Walsh disability model using Scenario A.

It shows that the numbers of disabled predicted by the model and the number of beneficiaries are closely correlated. The number of beneficiaries exceeds the number predicted on the disability scale at each age by a constant amount and could be the result of several factors relating either to the benefits, or to the measurement scale (delays in flows off benefit, over claiming).

Figure A12 shows: i) the number of DLA benefits in payment by age; ii) the number of Attendance Allowance payments and iii) persons scoring 6+ on the disability scale.

Compared with benefits for those aged 20-64 the situation at age 65+ is more complex due in part to benefit rules and benefit switches between ages 60 and 65 and the mixing of people with different levels of disability.

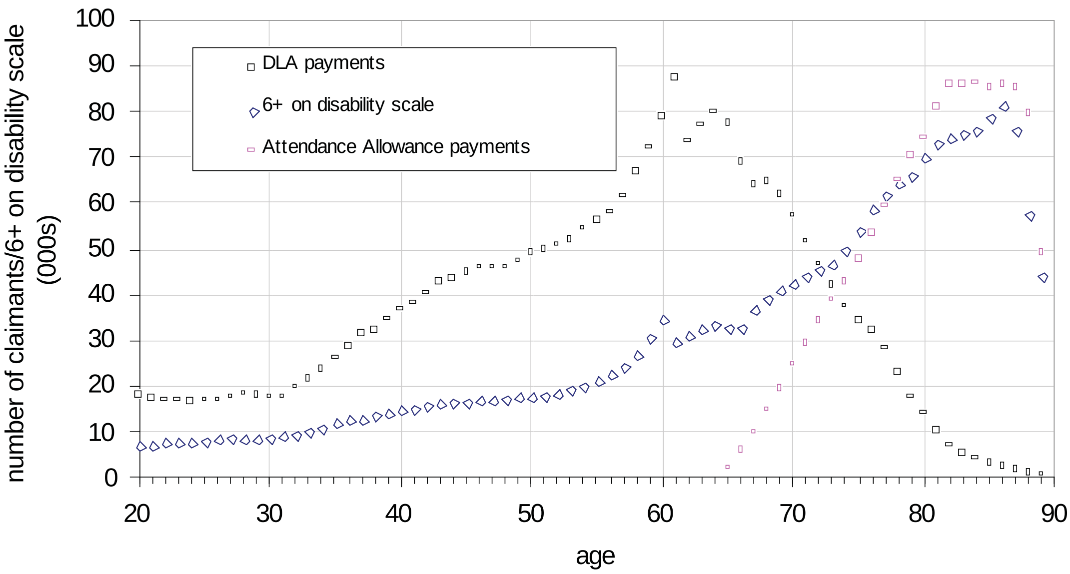
The model overestimates the number of Attendance Allowance payments between ages 65 and 75 and under predicts them at age 80+. However, aggregated over all ages and both benefits the

72 Dame Carol Black's Review of the health of Britain's working age population 'Working for a healthier tomorrow' (2008) Department of Health and Department for Work and Pensions.

model produces similar numbers of people with severe disabilities to the number of claimants. However, more work is needed to align the benefits in payment with the number of disabled in this age range.

Figure A12

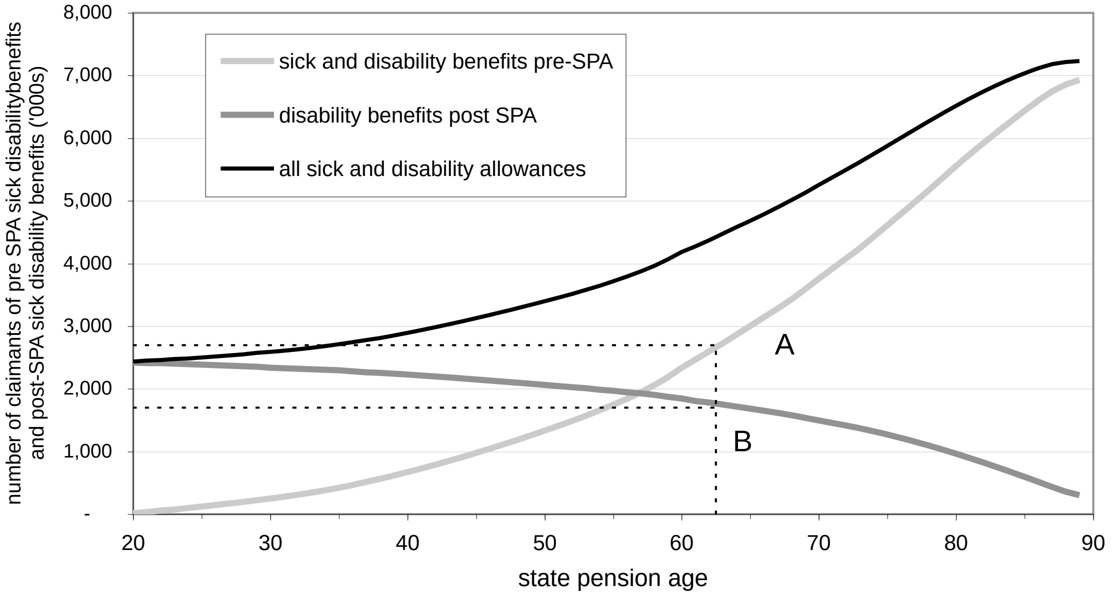
Chart showing the number of DLA and AA payments with age and the number of persons scoring 6+ on the disability scale based on the Rickayzen- Walsh model



Annex G

Impact on benefits and state pension costs of rises in state pension age

Figure A13
General relationship between the cost of long-term sick and disability benefits and changes in state pension age



Increases in state pension age (SPA) will potentially affect the numbers of people receiving either working age long-term sick and disability benefits or post-retirement age disability benefits post-SPA. If rules are unchanged it would be expected that the number of people taking up pre-SPA benefits would increase and the number taking up post-SPA benefits decrease.

This effect is shown in Figure A13 which plots the estimated number of allowances for different assumed values of SPA starting at age 20. Points A and B denote the number of working age allowances in payment at current (joint M&F) pension age (about 2.8m) which comprises mainly Incapacity Benefit and Disability Living Allowance and the number of post retirement age allowances (1.7m) which comprises Attendance Allowance and Disability Living Allowance.

The broad effect of rises in SPA will be to reduce the cost of state pensions in payment and increase the cost of disability benefits as this chart shows. The amounts will depend on the value the state pension versus the value of the benefits in question. Table 4 in the main text gives some illustrative values of this effect for different assumed state pension ages between 60 and 70 years.

Annex H

Healthy life expectancy (HLE) as a function of per capita spending on healthcare

Figure A14
The relationship between healthcare spending and HLE for every country in the world based on WHO data ($ppp = purchasing power parity)

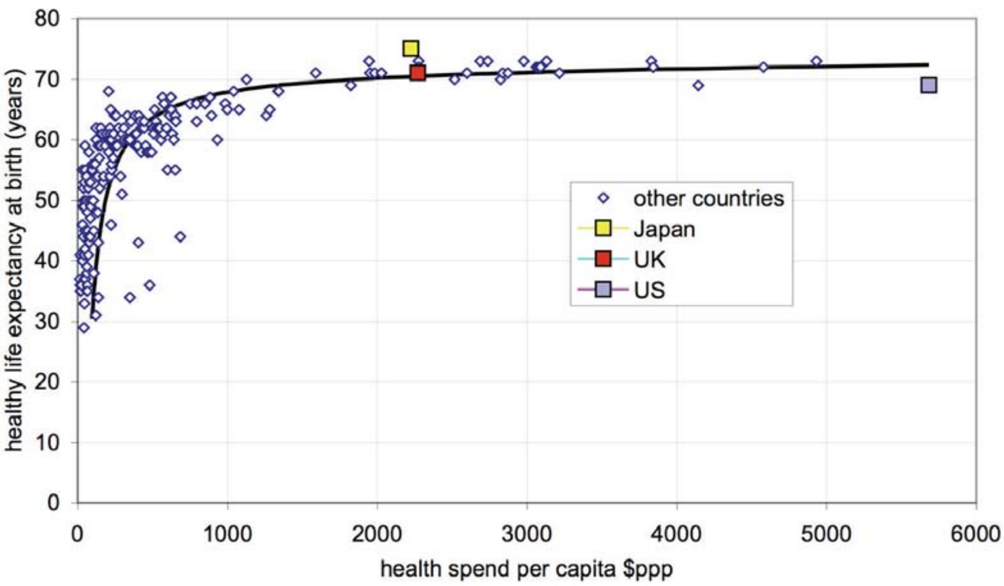
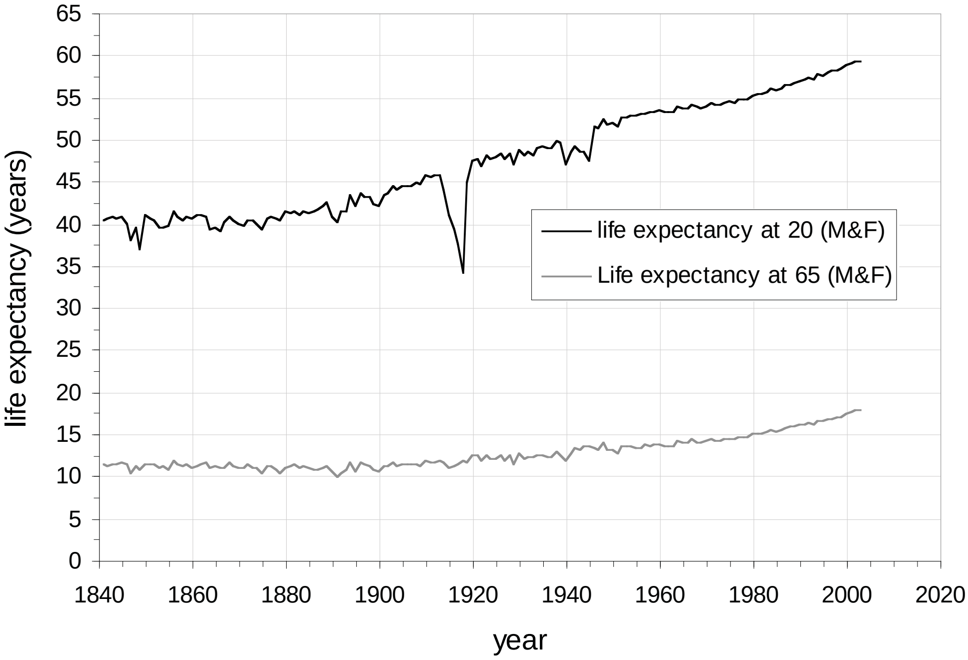


Figure A14 shows the relationship between healthy life expectancy (HLE) at birth and expenditure per capita on healthcare based on 2003 data (source: WHO). It shows that HLE increases rapidly initially up to around $500 after which diminishing returns set in. The UK spends around the same as Japan which has the highest HLE in the world. The US which spends nearly $6000 a year has an HLE which is less than in the UK.

Annex I

Trends in life expectancy at age 20 and 65

Figure A15
Trends in life expectancy (M&F) from 1841 to 2003(the steep dip in life expectancy at 20 includes the effects of the influenza pandemic and First World War)



Until 1880 life expectancy at 20 was around 40 years, after which it increased apart from during two world wars (Figure A15). An influenza pandemic contributed to steep falls in 1918-19. By 1960 it was increasing at 33 days a year and by 2000 43 days a year. Until 1978 the rate of growth in life expectancy at age 65 was less than that for 20 year olds, but then reached parity in this year at 31 days per year. Since then life expectancy among the 65+ has advanced further and in 2000 was increasing at 52 days a year as compared with 43 days a year for 20 year olds.

A comparison of changes in life expectancy at age 50 between males and females shows some important trends. As is seen from Figures A16 and A17, life expectancy for males is accelerating faster than for females. Although still not as high as for females, male higher life expectancy in recent decades led us to calculate that current population projections for males are being underestimated by 0.5m in 2020 and by 0.11m for females. Mostly this will be concentrated in the age range 70+ for males and 80+ for females.

Figure A16

Graph showing increase in male life expectancy at 50: 1952 to 2001 for England and Wales with fitted regression

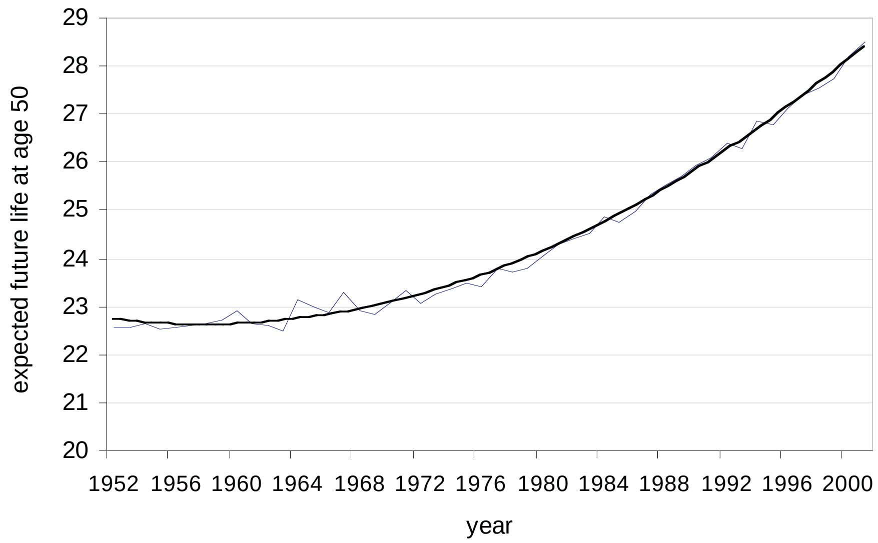
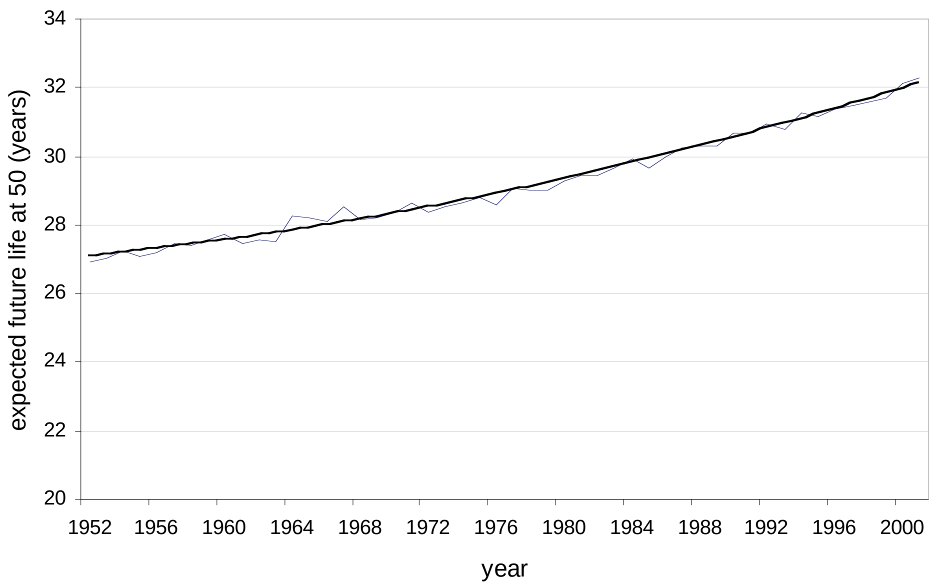


Figure A17

Graph showing increase in female life expectancy at 50: 1952 to 2001 for England and Wales with fitted regression



Annex J

Social factors associated with work status in 50-59 age range

The tables analysed in this annex are called risk ladders. They are partitions of the population split according to different combinations of 'risk factors', such as being sick. The purpose of this Annex is to analyse factors that are associated with or influence the decision to work in the age range 50-59 years. Using ELSA (English Longitudinal Study of Ageing), data on work status were extracted along with the following variables: whether (B) educated, (C) failed 1+ ADLs, (D) a carer and (E) a home owner. Health is measured from ELSA by the failure of 1 or more ADLs (activities of daily living). Two additional variables were also incorporated: whether a smoker, and whether cohabiting. The analysis was undertaken separately for males and females.

Males aged 50-59

Table A3 is called a 'risk ladder'. Each row represents a different combination of the four variables (B to E) for a sample of 4786 males aged 50-59. The number of cases in the second column shows the sample size of each group and may be taken as an indication of their relative size in the population as a whole (since ELSA is based on a representative sample of older people). The variable combinations are ranked from the group with the highest percentage in work (row 1) to the group lowest percentage (16). For example in row 2 with 2067 home-owning males, 92.5% are in work. In row 16 with 31 males with 1+ failed ADLs and who

Table A3

Male risk ladder showing the % in full or part-time work given the risk factors indicted in the columns. 'Y' indicates that given risk factor applies

case	sample	B - education	C- failed 1+ADLs	D- carer	E- home owner	% in full or part time work	lower CI%	upper CI%
1	5	Y		Y		100.0	54.9	100.0
2	2067				Y	92.5	91.3	93.6
3	954	Y			Y	91.3	89.3	93.0
4	58	Y				89.7	78.8	96.1
5	231					82.7	77.2	87.3
6	123			Y	Y	81.3	73.3	87.8
7	97	Y		Y	Y	74.2	64.3	82.6
8	202	Y	Y		Y	73.3	66.6	79.2
9	26	Y	Y	Y	Y	69.2	48.2	85.7
10	6	Y	Y	Y		66.7	22.3	95.7
11	575		Y		Y	58.4	54.3	62.5
12	24			Y		54.2	32.8	74.4
13	39	Y	Y			48.7	32.4	65.2
14	62		Y	Y	Y	48.4	35.5	61.4
15	286		Y			28.3	23.2	33.9
16	31		Y	Y		22.6	9.6	41.1
total	4786	1387	1227	374	4106	80.7	79.5	81.8

are carers only 22.6% are in work. Since the sample sizes in each risk combination can vary considerably 95% confidence intervals are also shown in the final two columns.

The overall rate for being in work is 80.7% and compares almost exactly with the rate reported in the LFS for the same age range, suggesting that ELSA is a reliable source for these kinds of data. Taken together, the results show that 29% of males in this age range are educated (1387/4786), 26% have failed 1+ADLs, 7.8% are carers, and 86% are home owners.

The groups with the highest representation in Table A3 are educated home owning males (row 2, 2067 cases 43.2% of sample) and the least represented are educated males with caring responsibilities (row 1, 5 cases 0.1% of sample).

Regression analysis shows that a man is:

- 1.28 times more likely to be in work if he is educated
- 0.14 times if he has failed 1+ ADLs
- 0.45 times if he is a full or part time carer
- 2.87 times he is a home owner.

All variables were statistically significantly different from 1 (i.e. no effect) at the 95% confidence level. Smoking status and cohabitation were incorporated as part of a bigger model using the same previous variables. It was found that a male smoker was 0.7 times less likely to be in work, but 2.2 times more likely to work if cohabiting.

Females aged 50-59

The analysis was repeated for females. The equivalent risk ladder is shown in Table A4. It shows that 71.4% of females are in work compared with 80.7% of males. The LFS reports that 70% of females are in work and so again the results highly comparable. In other respects the results tend to be broadly similar in terms of risk order. Overall, 21% of females are educated, 28% have failed 1+ADLs, 14% are carers, and 84% are home owners. Working status is strongly associated with being a home owner.

Thus a woman is:

- 1.72 times more likely to be in work if educated
- 0.23 times if she has failed 1+ADLs
- 0.81 times if she is a carer
- 2.01 times if a home owner

It is observed that a woman is more likely to juggle work and caring responsibilities than a male but slightly less likely to work if she is a home owner. Unlike males it was found that smoking and cohabitation status makes no significant impact on work status.

The results show that the largest group represented are healthy, home owning females with no caring responsibilities and not educated (row 4, 2452 cases 41.9% of sample). The least represented are unhealthy educated females with caring responsibilities (row 11, 9 cases 0.2% of sample).

Table A4
Equivalent risk ladder for females

case	sample	B - education	C- failed 1+ADLs	D- carer	E- home owner	% in full or part time work	lower CI%	upper CI%
1	13	Y		Y		100.0	79.4	100.0
2	782	Y			Y	85.8	83.2	88.2
3	116	Y		Y	Y	81.9	73.7	88.4
4	2452				Y	81.5	79.9	83.0
5	53	Y				79.2	65.9	89.2
6	354					76.6	71.8	80.9
7	378			Y	Y	74.3	69.6	78.7
8	213	Y	Y		Y	70.9	64.3	76.9
9	36	Y	Y	Y	Y	66.7	49.0	81.4
10	71			Y		60.6	48.3	72.0
11	9	Y	Y	Y		55.6	21.2	86.3
12	137		Y	Y	Y	51.8	43.1	60.4
13	775		Y		Y	50.5	46.9	54.0
14	35	Y	Y			42.9	26.3	60.6
15	59		Y	Y		32.2	20.6	45.6
16	367		Y			24.3	20.0	29.0
total	5850	1257	1631	819	4889	71.4	70.3	72.6

Annex K

Individualised tables of 'Life Balance Index'

The tables in this annex show results based on the Life Balance index for people in different situations at age 50. The partitioning variables are educational level, whether in a job at age 50, whether cohabiting or healthy. Separate results are presented formales and females. The value of the index ranges from zero to one and is defined as:

$$I = \frac{e_w e_h}{e_l^2} \quad or \quad \frac{e_w}{e_l} \times \frac{e_h}{e_l}$$

Where e_l life expectancy at 50, e_h healthy life expectancy, and e_w working life expectancy. Thus the index equals one when e_l equals e_h which equals e_w i.e. life expectancy (LE) is the same as healthy life expectancy (HLE) and working life expectancy (WLE). HLE is assumed to be greater than or equal to WLE so that WLE cannot be positive if HLE is zero. The index is designed to capture the lifetime fulfilment and contribution of an individual measured in these terms.

Tables A5 and A6 list values of the index for males and females in descending order of magnitude. Thus in row 1 one of Table A5 the group with the highest index value of 0.39 are males in educational level one, who are working and cohabiting and healthy at age 50. They comprise 13% of the sample population. It is noteworthy that the first 13 rows are groups that are all in work and that the first 8 rows are groups that report good health. Those with the lowest index values are associated with low educational attainment, were not working at 50, not cohabiting and reporting poor health.

Similar findings are reported for females but because they are more likely to take time out of the labour market than males their index values are lower. Thus the highest ranked female group with an index of 0.27 is in educational level 1, is in work at age 50, is cohabiting and is healthy. This group comprises 8.4% of the sample. Numerically the largest male and female groups are all in the top 5 in the rankings. These groups account for 68.7% of all males and 54% of all females.

Table A5
Life balance index for males based on life expectancy, healthy life expectancy and working life expectancy at age 50

males	% of population	educational level	working at age 50	cohabiting at age 50	healthy at age 50	LE (years)	HLE (years)	WLE (years)	Index value
1	13.0	1	Y	Y	Y	38.2	31.6	18.0	0.39
2	24.2	2	Y	Y	Y	34.7	28.4	15.3	0.36
3	18.9	3	Y	Y	Y	34.9	27.7	15.4	0.35
4	0.9	1	Y		Y	38.0	27.1	17.8	0.33
5	11.7	4	Y	Y	Y	31.6	24.5	13.3	0.33
6	0.6	2	Y		Y	34.1	24.1	15.1	0.31
7	2.0	3	Y		Y	34.6	23.4	15.3	0.30
8	1.0	4	Y		Y	31.3	20.3	13.0	0.27
9	2.9	1	Y	Y		32.2	18.4	14.3	0.25
10	3.4	2	Y	Y		28.8	16.0	11.8	0.23
11	4.2	3	Y	Y		29.0	15.2	11.9	0.21
12	2.1	4	Y	Y		26.1	12.8	9.8	0.18
13	0.2	1	Y			34.4	16.3	13.0	0.18
14	1.1	1		Y	Y	36.9	28.8	7.8	0.17
15	0.4	2	Y			30.7	13.6	10.4	0.15
16	0.1	3	Y			31.1	13.0	10.5	0.14
17	1.3	2		Y	Y	33.3	25.7	5.6	0.13
18	1.5	3		Y	Y	33.6	25.1	5.7	0.13
19	0.1	4	Y			27.9	10.5	8.4	0.11
20	1.9	4		Y	Y	30.3	22.0	4.1	0.10
21	0.2	1			Y	33.8	20.5	5.3	0.10
22	0.4	1		Y		32.4	16.8	5.9	0.09
23	1.2	2			Y	30.0	18.0	3.5	0.07
24	0.7	2		Y		28.9	14.4	3.9	0.07
25	1.2	3			Y	30.4	17.3	3.6	0.07
26	0.5	3		Y		29.1	13.6	4.1	0.07
27	0.0	1				29.5	11.0	4.5	0.06
28	1.7	4			Y	27.4	14.9	2.4	0.05
29	0.6	4		Y		26.0	11.3	2.7	0.05
30	0.5	2				25.8	9.2	2.9	0.04
31	0.4	3				26.1	8.4	2.9	0.04
32	1.2	4				23.1	6.5	1.8	0.02
total % or average	100.0	2.5	85.7	88.3	82.5	33.4	24.9	13.4	0.30

Table A6
Life balance index for females based on healthy life expectancy and working life expectancy at age 50

females	% of population	educational level	working at age 50	cohabiting at age 50	healthy at age 50	LE (years)	HLE (years)	WLE (years)	Index value
1	8.4	1	Y	Y	Y	39.9	29.1	14.8	0.27
2	12.7	2	Y	Y	Y	38.8	28.2	12.9	0.24
3	22.1	3	Y	Y	Y	38.6	28.0	12.6	0.24
4	9.8	4	Y	Y	Y	36.2	25.4	10.9	0.21
5	1.0	1	Y		Y	39.7	21.8	13.6	0.19
6	2.9	1	Y	Y		34.2	17.0	12.8	0.19
7	1.3	2	Y		Y	38.6	21.0	11.8	0.17
8	1.6	3	Y		Y	38.5	20.9	11.5	0.16
9	3.6	2	Y	Y		33.2	16.2	10.9	0.16
10	6.0	3	Y	Y		32.9	16.0	10.6	0.16
11	1.9	4	Y		Y	35.9	18.6	9.8	0.14
12	3.5	4	Y	Y		30.5	14.0	8.9	0.13
13	0.5	1	Y			39.1	14.1	12.1	0.11
14	0.3	2	Y			38.1	13.4	10.3	0.10
15	1.6	1		Y	Y	41.1	29.4	5.5	0.10
16	0.6	3	Y			37.7	13.3	10.0	0.09
17	0.5	4	Y			35.5	11.5	8.4	0.08
18	1.5	2		Y	Y	39.8	28.4	4.1	0.07
19	4.3	3		Y	Y	39.6	28.2	3.8	0.07
20	4.0	4		Y	Y	37.2	25.8	2.8	0.05
21	0.2	1		Y		37.4	16.8	4.3	0.05
22	0.3	1			Y	36.5	17.5	3.9	0.05
23	0.6	2		Y		36.4	16.2	3.2	0.04
24	0.9	2			Y	35.5	16.8	2.8	0.04
25	2.0	3			Y	35.2	16.6	2.6	0.04
26	0.9	3		Y		36.2	16.0	2.9	0.04
27	3.4	4			Y	32.9	15.1	1.9	0.03
28	1.3	4		Y		33.8	14.1	2.1	0.03
29	0.2	1				32.3	8.4	3.0	0.02
30	0.3	2				31.3	8.1	2.1	0.02
31	0.5	3				30.9	7.9	2.0	0.02
32	1.3	4				28.9	6.8	1.3	0.01
total % or average	100.0	2.7	76.78	83.2	76.71	37.8	24.0	11.4	0.19

Annex L

Changes in average weekly earnings

This Annex considers recent changes in average earnings by age in order to test the hypothesis of whether there are differential shifts by age between 1997 and 2008. The data used combine males and females and so the patterns will differ slightly in the detail if analysed separately.

Figure A18 shows the typical pattern of the earnings cycle with average weekly earnings increasing and peaking in the 40s before declining. Analysis indicates that the age at which earnings peak has changed from 43.7 to 44 .3 years over the period.

Figure A19 shows percentage changes in weekly earnings by age. If relative earnings were unchanged the curve would be flat; in fact its shows that earnings for younger workers have increased more slowly than earnings for those aged 35+.

Between 35 and 50 the curve flattens but there is some evidence for higher percentage increases at age 50+, but more years of data are needed to establish a firm trend.

Figure A18
Average weekly earnings by age 1997 and 2008

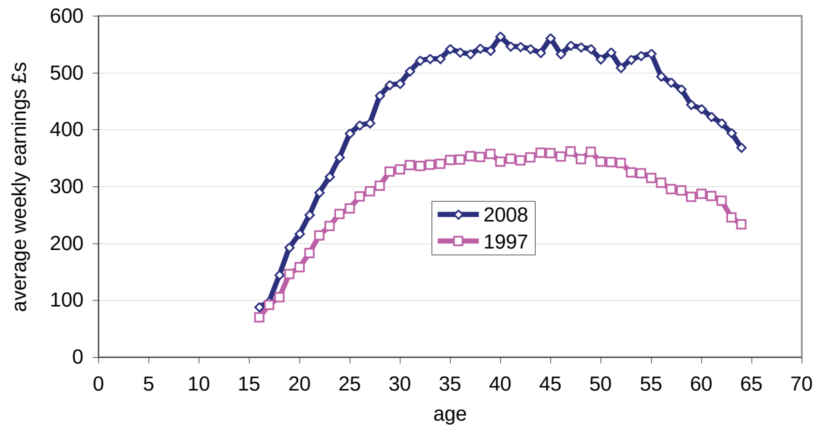
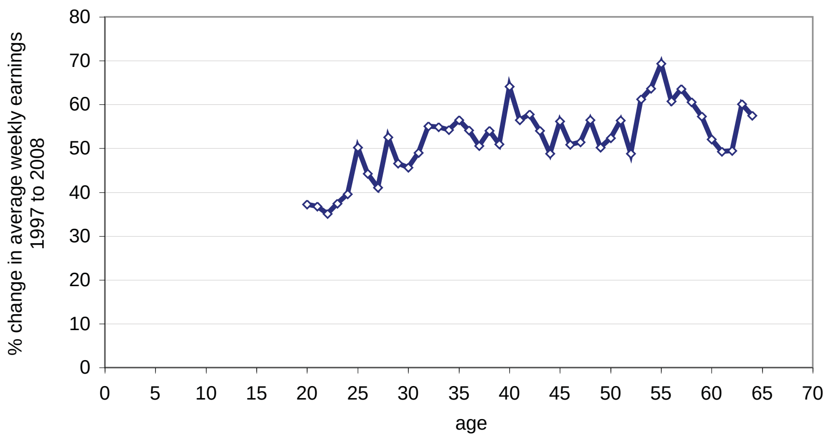


Figure A19
Percentage changes in weekly earnings by age: 1997 to 2008



Annex M

Benefit replacement rates – two examples

The UK social security system is highly complex; as far as households with one or more disabled persons is concerned a distinction can be drawn between households that do not qualify for means tested benefits and those that do. In the first case persons may be eligible for Incapacity Benefit/ Severe Disablement Allowance and/or for Disability Living Allowance, the main disability benefits even if household income is above the relevant means tested threshold.

For households below the threshold and not in work the DWP produces tax benefit tables for households of different types (but not all types). Included in the tables is the benefit replacement rate – defined as the ratio of the amount of money a person would earn in work for different levels of weekly income (including tax credits that are due for people on low income) versus what they would receive on means tested benefits after housing costs.

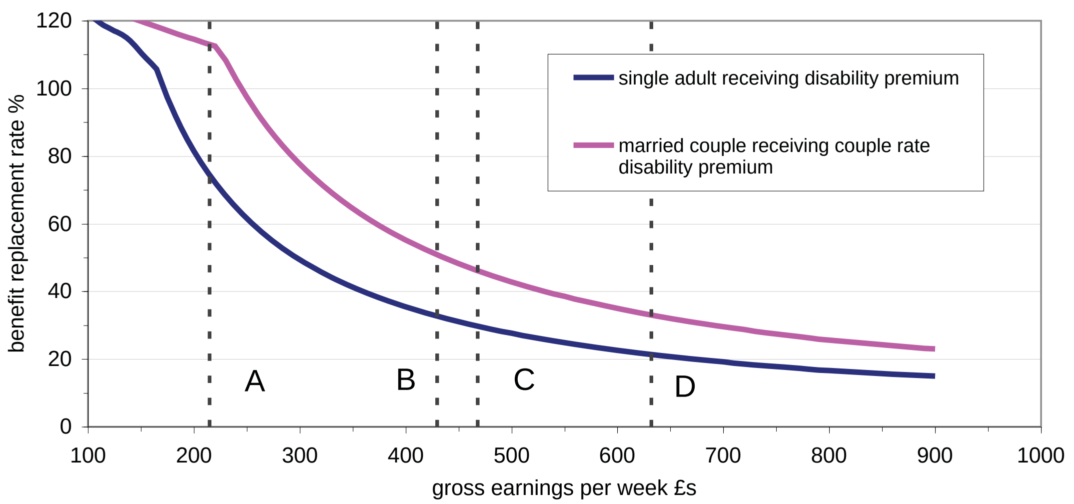
Since we are mainly interested in 50+ households it is assumed they will not have dependent children, although further examples could be constructed on this basis. In these cases households will also receive working tax credit, child tax credit and other benefits such as child care, and so benefit replacement rates will tend to be lower; i.e. it may pay better to be in work.

The following two examples show the replacement rates at different levels of income for two types of household in which there are no children and there is entitlement to a disability premium[73]:

1. a single person households age › 25 years who is an local authority tenant and receives the single person disability premium
2. a married couple household age ›25 who are local authority tenants, who receive the couple disability premium

Figure A20 shows benefit replacement rates against gross weekly income. Superimposed are four levels of weekly earnings: A, a single person working 40 hours based on the minimum wage of £5.37 per hour; B, what a couple would earn both in work based on the minimum wage; C, the average

Figure A20
Benefit replacement rates versus gross earning per week



73 There are different levels of premium. To qualify one needs to qualify for Incapacity Benefit/ Severe disability Allowance or Disability Living Allowance. The standard premium is £25.85 a week and £36.85 for a couple. Enhanced premiums are also possible.

weekly earnings for a woman age 50 in 2008; D, the average weekly earnings for a man aged 50 in 2008.

The results show that a single person (A) who qualifies for incapacity benefit would receive about 70% of what he/she would earn in work before commuting and other work related costs based on the minimum wage; (B), a couple would receive about 60% based on both working at the minimum wage.

If only one worked at the minimum wage in a couple household the graph shows they would be better off on benefits. At the average levels of earnings, C and D, the replacement rates are under 50% in a couple household if a woman is the only earner, and around 30% if a man is the only earner. If both earn the average wage the benefit replacement rates fall to below 20%.

A further important consideration apart from the benefit to wage ratio is the nature of the work; if low paid, casual and short term an individual could be better advised to stay on benefits because of the effects of benefit qualifying rules, administrative time lags to re-apply for benefits and for cash flow reasons. The examples appear to suggest therefore that work incentives for people in such types of household are very low.

Annex N

Simple economic model

Consider a situation in society in which the working age population crudely divides into two groups consisting of either healthy or unhealthy people. The unhealthy group does not work and receive financial support from the state or they are retired and receive a pension plus additional financial support for their disability.

The healthy lives are divided into those of working age and those who are retired. Those of working age will either work (and receive a wage) or are economically inactive (and received no benefit under this model); those who are retired receive only the basic pension. The economically inactive population is in caring roles, unpaid work, full time education or simply in leisure.

Without loss of generality we focus on the population aged 20+ and define the following quantities (all values calculated at the same point in time):

e_l = expected total life

e_w = expected working life (alive and under state pension age)

e_r = expected retired life (alive and over state pension age)

e_{hw} = expected healthy working life

e_{hr} = expected healthy retired life

e_h = healthy life expectancy

We observe the following identities:

$$e_l = e_w + e_r$$

$$e_l = e_{hw} + (e_w - e_{hw}) + e_{hw} + (e_r - e_{hr})$$

In words:

Expected life

=

expected healthy working life + expected unhealthy working life + expected healthy retired life + expected unhealthy retired life

Other quantities of interest are the proportion of sick and disabled in the stable population and the proportion of healthy people:

$$d = \frac{(e_l - e_h)}{e_l}$$

$$h = \frac{e_h}{e_l} = 1 - d$$

Where $e_l - e_h$ equals the expected years in disability

Assume that when in the status of 'ill or disabled' people cannot work. Further, assume that benefit payments received is the value of benefits and care received. Define the following:

a = participation rate (% of healthy lives of working age that work)

w = average wage

p = pension

b_w = sickness benefit paid to people of working age

b_r = sickness benefit paid to people of retired age in addition to pension

Individual level

We can consider the average individual aged 20 and get the following results (assuming no inflation) for the lifetime wages earned and benefits received:

i) total wage: $w_{sum} = e_{hw}aw$

ii) total benefit received when working age: $b_{wsum} = (e_w - e_{hw})b_w$

iii) total pension received when retired: $p_{sum} = e_r p$

iv) total additional benefit received when retired and in ill-health: $b_{rsum} = (e_r - e_{hr})b_r$

Assuming no investment return, then the tax rate t needed for the individual to be 'self supporting', i.e. they pay sufficient tax when working to pay for their benefits, is:

$$t = \frac{b_{sum} + p_{sum} + b_{rsum}}{w_{sum}}$$

Population

If we assume that the population is stable, i.e. stationary with constant births and deaths, then we can simply calculate aggregated values for the entire population by multiplying the above variables by the factor:

$$f = \frac{P_{20+}}{e_l}$$

Where P_{20} is the population age 20+

Total aggregated wage is then: $w_{sum} f$

Total benefit paid to population of working age is: $b_{wsum} f$

Total pension paid to population of retired age is: $p_{wsum} f$

Total additional benefit paid to retired population who are ill is: $b_{fsum} f$

Then assuming that benefits are paid on a PAYG (Pay As You Go) basis (i.e. no surplus fund is built up) then the tax rate, t is

$$t = \frac{(b_{wsum} + p_{sum} + b_{rsum})f}{w_{sum} f} + \frac{(b_{wsum} + p_{sum} + b_{rsum}}{w_{sum}}$$

i.e. the same as the individual rate.

For large periods one or more of these values will be constant. For example, if we assume no changes to the working population, wages or benefits then both w_{sum} and b_{wsum} are constant. If we increase life expectancy in old age but keep the number of years spent in ill-health the same then p_{sum} changes but not b_{rsum}. The benefit of this model is that by isolating the constituent parts one can see the true effect of increasing only one of the variables.

Gross Domestic Product (GDP)

Assuming GDP can be represented by total wages then

$$GDP = e_{hw} aw \frac{P_{20+}}{e_l}$$

and GDP per capita by:

$$g = \frac{GDP}{P_{20+}} = \frac{e_{hw}}{e_l} aw$$

This states that the GDP per capita is equal to the proportion of the population that is healthy and of working age multiplied by the percentage of this potential working population who actually work multiplied by the average wage. Therefore GDP per capita increases if the:

- proportion of population that is classed as working age increases i.e. if state pension age is increased
- proportion of population of working age that is healthy increases
- proportion of healthy working age that work increases
- average wage increases (as this is the proxy of GDP)

Table A7 shows the values of the input variables used to generate the scenarios in the main text. Table A8 shows the impact of a given change in any input variable on GDP, GDP/capita and the tax rate whilst holding the other variables constant. Wages at base line are set at £23k p.a.; pensions at £5k p.a.; other benefits (social security, health) at £10k p.a.

Table A7
Table of expectancies used in scenarios in text

scenario	e_l	e_h	e_w	e_r	e_{hw}	e_{hr}	years of life spent in disability	years in retirement in ill health	years of working age in ill health
base	60	50	40	20	37	13	10	7	3
1	63	49	40	23	36	13	14	10	4
2	63	52	40	23	38	14	11	9	2
3	63	53	40	23	38	15	10	8	2
4	63	54	40	23	38	16	9	7	2
5	66	55	41	25	39	16	11	9	2
6	66	56	41	25	39	17	10	8	2

Table A8
Table showing impacts of a 1 year or 1% increase in the model variables

	effect of a +1yr or 1% change		
quantity	GDP	GDP/capita	tax rate%
e_l	-1.6	-1.6	6.0
e_w	0.0	0.0	0.6
e_r	0.0	0.0	-0.6
e_{hw}	2.7	2.7	-6.3
e_{hr}	-2.7	-2.7	6.7
e_k	1.4	1.4	-5.7
a (+1%)	1.6	1.6	-1.5
w (+1%)	1.0	1.0	-1.0
p (+1%)	0.0	0.0	0.6
b_r (+1%)	0.0	0.0	0.2
b_w (+1%)	0.0	0.0	0.2
P20 + (+1%)	5.0	0.0	0.0

Annex O

Terms of reference

Demographic background

1) Demographic trends and impact on key social and economic variables
   - population ageing (including accuracy of current ONS projections)
   - dependency ratios
   - healthy to unhealthy support ratios
   - changes in the gap between LE and HLE
   - longevity at different ages including oldest old
   - immigration
   - cohort effects (e.g. are younger people as healthy at the same stage of life as their parents)
   - labour participation rates

1b) Summarise impact of these trends on key economic and social outcomes, including:
   - economic outcomes
     - welfare benefit expenditure
     - public service expenditure
     - tax revenue
     - labour market productivity
     - GDP growth/ economic output
     - GDP per capita growth
   - social outcomes
     - numbers in poor health
     - numbers requiring social care
     - numbers of carers required
     - health inequalities

2a) Assess policy levers that might be available to modify 'adverse' trends over the medium term. Of particular interest are levers that can influence
   - (economic) participation rates, such as
     - default retirement age
     - state pension age
     - benefits and tax policy
   - healthy life expectancy , such as
     - regulatory health measures (e.g. at work, in the home, in school, smoking cessation)
     - health policies aimed at lifestyles (awareness, access to advice)

Key to assessing the policy levers that work will be pinpointing underlying drivers, such as
   - for (economic) participation rates
     - employment policies (job finding, job creation, flexible working, carers)
     - education and retraining (long-term unemployed, carers returning to work)
   - for health life expectancy:
     - social and medical factors – employment, cohabitation, education, better treatments, physical exercise (opportunities), over the life span
     - behavioural and social factors - e.g. smoking, mental illness, obesity, poverty gap, inequalities in wealth/income (barriers)

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