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STRATEGY & CHANGE

SHADES OF GRAYING

RESEARCH TACKLING THE GRAND CHALLENGE OF AGING FOR EUROPE

THE HAGUE CENTRE FOR STRATEGIC STUDIES AND TNO

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PAPER N° 2013•16
ISBN/EAN: 978-94-91040-82-5

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The TNO and The Hague Centre for Strategic Studies (HCSS) program Strategy & Change analyzes global trends in a dynamic world affecting the foundations of our security, welfare, and well-being.

The program attempts to answer the critical question: what are the policies and strategies that must be developed to effectively anticipate these emerging challenges?

Strategy & Change provides both a better understanding and feeds the agenda for a sustainable future society.

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'AGING IS NOT LOST YOUTH BUT A NEW STAGE OF OPPORTUNITY AND STRENGTH.'

BETTY FRIEDAN (1921-2006)

THE GRAND CHALLENGES PROJECT

Over the past century, Europe has become more and more prosperous. We are healthier, richer, safer and live longer than ever before. But there is a downside to this success: it poses new challenges that threaten our future wellbeing. Ironically, many of these challenges are the price we pay for progress. Our economic growth comes at the cost of a changing climate and resource scarcity; new technologies breed new types of international organized crime; modern lifestyles lead to new diseases; increasing life expectancy puts pressure on public finances; and new production patterns lead to food safety concerns. Policy makers, researchers, companies and citizens in Europe need to devise ways to deal with these trends. The Grand Challenges project aims to further the debate by looking at how we can use research and development to tackle the most pressing societal challenges to Europe's future. We show how these developments may have an impact on Europe's future and look at the potential of applied science to address these challenges and create new opportunities for European societies.

EXECUTIVE SUMMARY

The effects of aging on our societies and economies come in many shades. Living longer lives in better health is clearly a sign of success. And some sectors are set to profit from a rise in the number of older people. At the same time aging poses clear challenges, most notably rising public expenditure. Coping with such problems, while capitalizing on opportunities, is a pressing task, in which research has a key role to play. To help societies become more resilient, this report indentifies ways for Europe to rejuvenate research and tackle the challenge of aging.

CHALLENGES AND OPPORTUNITIES

In coming years, European countries will see their population turn gray. The most commonly used measure for aging is the old-age dependency ratio (OADR), or people over 64 as a percentage of those typically in the working-age population (15-64). All European countries will have higher OADR scores than 40% in 2050. That means for every 10 people in the workforce, there will be at least 4 older than 64. Individual countries are graying at different speeds and up to different levels. In Germany, Italy, Spain and Portugal, OADR will likely rise with 30-40% to over 60%. Many eastern European countries will see similar increases. In other parts of Europe, such as the UK and Scandinavian countries, the rise will be less strong, between 15-20%, reaching around 40% in total. Though Europe is aging rapidly, it is by no means the only region experiencing such a demographic shift. In some Asian countries like South-Korea, Japan and China, old-age dependency is expected to increase to 51%, 43% and 40% respectively in 2050.

To estimate the impact of aging, we take a 'business as usual' approach. We extrapolate current policies and make no assumptions on other actions governments could take to mitigate effects. We list the following key opportunities and challenges.

OPPORTUNITIES

- Some public expenditure items may fall due to aging, most notably education and unemployment benefits, which are expected to drop on average by around 0,5% of GDP by 2050.
- Graying is a worldwide growth market. It opens up new business opportunities for companies.
- Although in need of further study, aging may have other positive impacts, such as reducing our CO_2 footprint.
- Aging may increase the reservoir of social capital. Skills, knowledge and experience that come with age may prove useful to societies, both in economic and non-economic terms.

CHALLENGES

- Without a fundamental change of existing policies, aging will weigh heavily on government budgets. Health care, long-term care and pension expenditures are all predicted to increase, while labor markets will shrink.
- Globally speaking, the aggregate impact on public age-related expenditure is likely to be among the highest in the EU. On average, long-term care, health care and pension expenditure are projected to rise by more than 4% of GDP.
- Aggregate impact on government expenditure (i.e. including positive effects on education expenditure and employment-benefits) will differ throughout Europe. Interestingly, three EU-member states, Poland, Latvia and Lithuania, are projected to see age-related expenditure drop. By contrast, Luxemburg, Slovenia, and the Netherlands will see severe public expenditure increases of over 8% of GDP.
- Other macro-economic effects include the increase of government debt and possible deterioration of sovereign credit ratings.
- Effects on social inequalities are more difficult to foresee. Intergenerational tensions may rise and redistribution issues may feature more prominently on political agendas.

ONGOING RESEARCH

To get a picture of current aging-related research activities, we look at R&D programs at EU-level and at private sector and academic research.

EU-RESEARCH

EU-level research is mostly geared towards ICT and health projects. Such research is generally resource-intensive, with high expected benefits in terms of disease prevention and improving the independence of older people are. The focus on aging and ICT and health also reflects the awareness of related business opportunities. Research on aging and related socio-economic issues receive proportionally less funding. Focus areas are the impact of socio-economic factors on the total years lived in good health, and research on the sustainability of the social welfare state. Other research areas include housing, mobility, education and social security. A push towards strengthening interdisciplinary research seems underway, which is reflected in the emergence of new coordinating initiatives at EU-level.

PRIVATE SECTOR RESEARCH

Aggregate figures on private sector research are hard to come by. Most activity seems to come from ICT companies, the pharmaceutical industry and insurance companies. Increasingly, public-private partnerships are the preferred form of conducting research. The not-for-profit sector, such as charities and NGOs, focus much more on the socio-economic issues of aging.

ACADEMIC RESEARCH

Looking at the performance of academic institutions, bibliometric data indicates a strong geographical concentration of aging research in the US. At the same time, the US does far worse with regards to impact-scores than many European countries. On average, publications from the UK, Denmark, Norway, the Netherlands, and Belgium have more impact. Looking at top aging research institutes, six European universities rank in the top-25 on impact scores.

REJUVENATING AGING RESEARCH

Although there is no silver bullet in terms of a strategy to tackle the challenge of aging, we note several guidelines that can help to strengthen research agendas.

THE UPSIDE OF AGING

Research should take note of the positive effects of aging. The value of older people is huge, both in financial and non-financial terms. Among other things, they posess large 'reservoirs' of social capital, can make companies more profitable, and perform voluntary work. Making these assets visible is a task for research. Other possible positive effects of aging, for example on the environment and international security, merit further study.

Furthermore, aging offers economic opportunities. Graying is big business. The rising share of elderly citizens worldwide should be viewed as a growth market. Capitalizing on such opportunities now may offer a 'first mover advantage'. To make the most of this, we need to think of new and innovative products that target the growing group of older people, while keeping in mind that the elderly are not a homogenous population.

INTERDISCIPLINARY AND INTERGENERATIONAL

Aging is a multifaceted phenomenon that requires interdisciplinary and intergenerational study. Research into the effects of an aging population on intergenerational relationships is lagging behind actual demographic shift. Policy responses to graying populations would benefit from a studying the social effects of demographic shift, so as to preempt and diffuse possible tensions and capitalize on potential benefits. Research can furthermore help in devising better prevention plans and studying drivers of aging and ill-health.

SUSTAINABILITY

Ensuring the sustainability of the social welfare state will require more targeted innovation, especially in the field of social studies. One of the key questions is how to improve labor productivity. A solution could be to ask the elderly to pay more for their health care and other benefits, while simultaneously increasing the involvement of the private sector. In addition, ethical questions over the limits to medical treatment of the elderly need to be addressed.

INTRODUCTION

Aging is first and foremost a success story. The fact that more people live longer lives in better health is in itself a positive development. However, this success also leads to new problems for governments and societies. For example, older people are often in lesser health and governments of aging countries see their budgets squeezed by rising health and pension expenditure. The challenge is to deal with such 'shades of graying', especially for Europe, where some of the most rapidly aging countries are located.

It is increasingly apparent that 'business as usual' is not an option, with governments looking for ways to deal with such challenges. In this, research has a key role to play. This report examines how science can tackle the adverse effects of aging and harness the opportunities it may offer. A first chapter provides a view of what the future of aging may mean for European countries. We will look at the main effects and provide a 'monitor' which visualizes possible impact. A second section looks at ongoing research in areas related to aging, such as ICT and health. We take stock of research initiatives at the EU-level, in several member states and in the private sector. In addition, an overview is presented of 'centers of excellence' – the frontrunners in aging research. A third and final part identifies research areas that can play a key role in dealing effectively with the challenges and opportunities of a graying society.

1 THE CHALLENGES AND OPPORTUNITIES OF AGING

This chapter discusses the possible impact that aging may have for Europe. An initial paragraph looks at the success of aging and provides a map of the relative share of elderly inhabitants in nations worldwide. In a second section, we zoom in on the challenges graying may pose for European countries. We will pay specific attention to economic and health impacts and provide a map that shows projected effects on public expenditure.

1.1 AGING AS A SIGN OF SUCCESS

Aging and economic development are interrelated. High-income countries generally have a relatively high proportion of elderly people. This is due to two parallel trends. First, economic progress goes hand in hand with falling fertility rates. The richer people are, the fewer children they tend to have; this inverse correlation is clear throughout the world.[1] Poorer countries are often marked by high birthrates and low longevity. Second, wealth increases people's health. In poorer societies, low health literacy and smaller government budgets mean that diseases are more dispersed, diets less varied and healthy, and people tend to die at younger ages.[2] These two trends lead to a changing population pyramid as economic development progresses – illustrated in the figure below.

1 'Fertility and Living Standards: Go Forth and Multiply a Lot Less,' *The Economist*, October 29, 2009, http://www.economist.com/node/14743589.

2 Colin D Mathers et al., 'Healthy Life Expectancy in 191 Countries, 1999,' *The Lancet* 357, no. 9269 (May 26, 2001): 1685–1691, doi:10.1016/S0140-6736(00)04824-8.

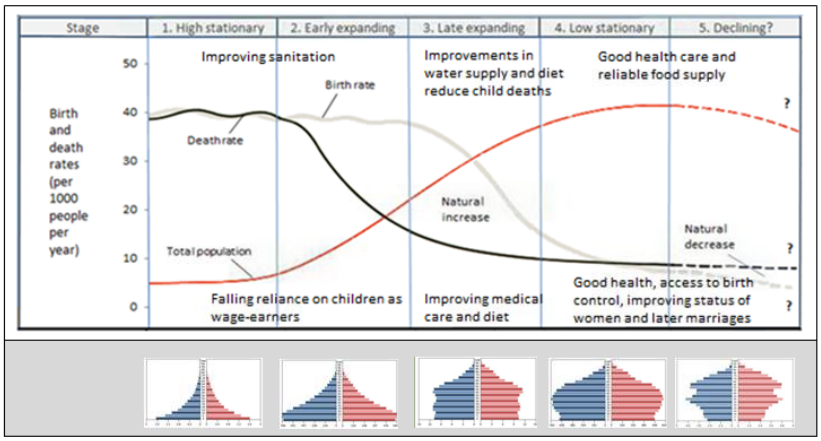


FIGURE 1: FIVE STAGES OF POPULATION TRANSITION. THE GRAPH AT THE TOP SHOWS BIRTH- AND DEATH-RATES, AND TOTAL POPULATION. THE TABLE BELOW LISTS FURTHER EXPLANATIONS. THE FIGURES AT THE BOTTOM DEPICT THE CORRESPONDING POPULATION PYRAMIDS.

Over the past century, countries currently classified as developed have moved away from high fertility and mortality, to a low fertility and mortality society. The chart below illustrates this trend over the past 50 years in Europe. In coming decades, fertility rates are predicted to remain stable, while life expectancy is projected to continue to rise.

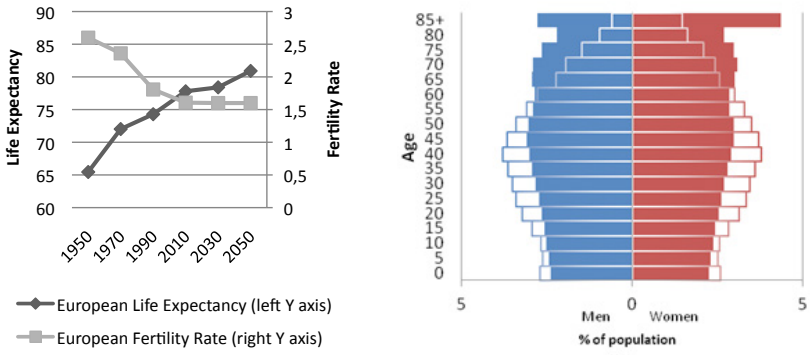


FIGURE 2 LEFT: PAST AND FUTURE DEVELOPMENTS OF LIFE SPAN AND FERTILITY RATE FOR EUROPE (EUROSTAT 2012/ UN 2004). RIGHT: PROJECTION OF DEVELOPING POPULATION PYRAMID. OUTLINE: 2010, SOLID: 2050 (EUROSTAT 2012/ UN 2004)

Most European countries are thus expected to see the relative share of elderly increase (see Figure 2). The common measure for 'grayness' of a country is its 'old-age dependency ratio' (OADR): the share of people over 64 to the number of people typically included in the labor force (15-64). In Europe, the OADR is predicted to increase from about 1 to 4 in 2010 to over 1 to 2 in 2050.[3] This is the result of a shrinking youth cohort brought on by lower fertility rates, meaning that Europe's population will not increase significantly in the future, and will eventually decline (see later, Figure 4).[4] In the next few decades, this effect will be exacerbated by the aging of the baby-boom generation.

Although aging is often associated with increasing expenditures for governments and drag on economic growth (on which more in the paragraphs below), there are positive economic effects as well. With regards to government finances for example, aging could lead to reduced expenditure on education. This would be mainly due to the shrinking size of younger populations leading to a smaller number of students[5]. In addition, with a shrinking labor force, so will, *ceteris paribus*, jobless rates decline and thus expenditure on unemployment benefits. As we will see later, whereas EU-27 governments spent an average of 1,1% of GDP in 2010 on unemployment benefits, Eurostat suggest this could drop to 0,7% in the next 50 years (see also Figure 3).

Next, aging may also open up new business opportunities. The business of graying is a growth market. And as we will illustrate in the next paragraph, it is a phenomenon that affects more and more countries worldwide.

3 'Eurostat - Tables, Graphs and Maps Interface (TGM) Table,' accessed April 25, 2013, http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&language=en&pcode=tsdde511&plugin=1.

4 Projections do differ. For example, while Eurostat predicts a more or less stable population in the Netherlands in the coming decades, the Dutch statistical bureau foresees an increase of about 1 million people.

5 This picture is complicated however by the fact that, although demand for 'traditional' forms of education for younger cohorts will probably drop, the demand for education in later stages of life may increase. Currently, education at later stages of life is more often considered a private or commercial affair (i.e. paid for by older people themselves or the companies they work for), whereas education of younger generations is predominantly viewed as a public matter.

Furthermore, older people often have high purchasing power. Several sectors are well positioned to capitalize on these opportunities. Some sectors, such as ICT and health, but also insurance and leisure, are likely to fare well if they manage to adjust to the changing demand from the elderly for products and services tailored to their needs.[6] And as some reports have pointed out, older people contribute in many ways to the profitability of companies, from experience and knowledge to loyality.[7]

Another valuable effect of aging may be that it increases social capital related to old age. Many elderly perform substantial contributions in the workplace, in families and communities at large. Furthermore, they possess skills that are beneficial to our economies.[8] This reservoir of accrued social capital ranges from knowledge and information, to understanding of processes and acquired experience. Tapping into this reservoir may offer societies new opportunities.

Finally, graying may reduce our CO_2-footprint. A recent report that studies the effect of aging on emissions in the US, expects a reduction in the long run. Emissions do tend to increase by age, up to around 65.[9] Thereafter, use of some energy-intensive goods and services diminishes, such as transportation, whereas for others it continues to rise, for example electricity and natural gas consumption. The latter is related to the fact that nowadays more elderly people live alone, and thus make use of a relatively large living space per person. In the medium term, overall CO_2 emissions are expected to increase because of aging, due to the baby-boom cohort reaching 60, the age when average energy usage is highest. In the long term however, when the top-heavy distortion of the population

6 See for example *Seniorwatch 2: Assessment of the Senior Market for ICT Progress and Developments* (European Commission, April 2008), http://ec.europa.eu/information_society/activities/einclusion/docs/swa2finalreport.pdf.

7 'Managing a Healthy Aging Workforce: a National Business Imperative' (CIPD, March 2012), http://www.cipd.co.uk/binaries/5754ManagingageingworkforceWEB.pdf.

8 Simon Biggs, Laura Carstensen, and Paul Hogan, 'Social Capital, Lifelong Learning and Social Innovation,' in *Global Population Ageing: Peril or Promise?* (World Economic Forum, 2012), 39–41, http://www.hsph.harvard.edu/pgda/WorkingPapers/2012/PGDA_WP_89.pdf.

9 *Individual CO2 Emissions Decline in Old Age*, Social and Behavioural Sciences (Munich: Max Planck - Gesellschaft, November 7, 2011).

pyramid by the aging baby-boom generation will have ebbed away, aging may actually lower total greenhouse gas emissions.[10]

MONITOR 1: THE AGE OF NATIONS

That aging is to an extent a sign of economic development becomes clear when we visualize OADR scores for countries worldwide. The map below depicts OADR figures for 2050.[11] It shows that European societies around that time will be among the 'grayest'. It also shows that other parts of the world, especially some Asian countries like South-Korea, Japan and China, will see massive old-age dependency increases in coming decades (in absolute terms 51%, 43% and 40% respectively).

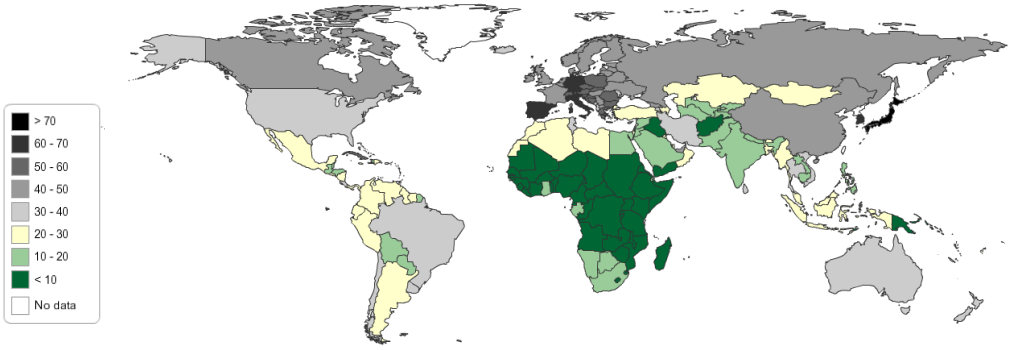
The economic situation in a country is a good but crude measure for predicting how aged a country is. In poorer parts of the world, most notably in Africa, high fertility rates will keep societies relatively 'green', reflected in low OADR scores. This is not to say other factors, such as government policies and cultural and religious influences do not play a role. For example, although India is experiencing rapid economic development (and is predicted to continue to grow in coming years), it is expected to have a comparably young population up until 2050. Though the country experienced dropping fertility rates after the 1970s[12], these are still much higher than in neighboring China. The latter has seen a rapid drop in fertility rates, which some authors argue has dipped below replacement levels since the 1980s due to its 'one-child policy'.[13] This has led to a marked graying of the Chinese population.

10 Brantley Liddle, 'Consumption-driven Environmental Impact and Age Structure Change in OECD Countries: a Cointegration-STIRPAT Analysis,' *Demographic Research* 24, no. 30 (May 27, 2011): 479–770.

11 An interactive version of the monitor, including a full methodology, is available at http://projects.hcss.nl/monitor/.

12 Gale Fay and Stephanie Fashey, *Youth in Transition: The Challenges of Generational Change in Asia. Proceedings of the Biennial General Conference of the Association of Asian Social Science Research Councils (15th, Canberra, Australia, 2005)* (United Nations Economic and Social Commission for Asia and the Pacific, Bangkok (Thailand).; Academy of Social Sciences in Australia, Canberra., 2005).

13 'The Child in Time,' *The Economist*, August 19, 2010, http://www.economist.com/node/16846390.



MAP 1: THE AGE OF NATIONS: OADR WORLDWIDE (2050)

If we zoom in on Europe, we see uniformely high OADR scores of over 40%. Still, large differences remain. Germany, Italy, Spain and Portugal are projected to have the largest share of elderly citizens in 2050, with scores of over 60%. These countries are confronted with a rapidly aging population and will see their old age dependency ratio rise over 30% from 2010 to 2050. Other countries are foreseen to experience more limited, but nevertheless large increases. The UK, France, Scandinavian countries and the Netherlands are predicted to have 'lower' OADR scores ranging between 40 and 50%. The speed at which these countries age may be less rapid, but is still substantial. For example, according to the forecast of the European Commission, the UK and Sweden will see increases of about 15% up to 2050.

These predictions can serve to get a good first impression on the graying of nations. At the same time, aging is not a uniform process that can be captured by looking at OADR figures alone. And as we will see in the next section, apart from it being a 'sign of success', it has a shadow side as well.

1.2 SHADES OF GRAYING

What will aging mean for European citizens and governments? Though the future is, by its very nature, impossible to predict, we can make some estimations. Below, we first look at effects on public expenditure. We will also present a map showing how government budgets in selected countries are projected to be affected by aging. Thereafter, we look at several other, more societal, effects that are more difficult to quantify.

EFFECTS ON PUBLIC EXPENDITURE

Below we look at how aging affects labor markets, social security, and health. The chart below summarizes the impact of aging from 2010 to 2060 for the European Union, as calculated by Eurostat. It shows that, on the one hand, spending on education and unemployment benefits is projected to decrease slightly, while expenditure on pensions, health care and long-term care is expected to increase significantly.

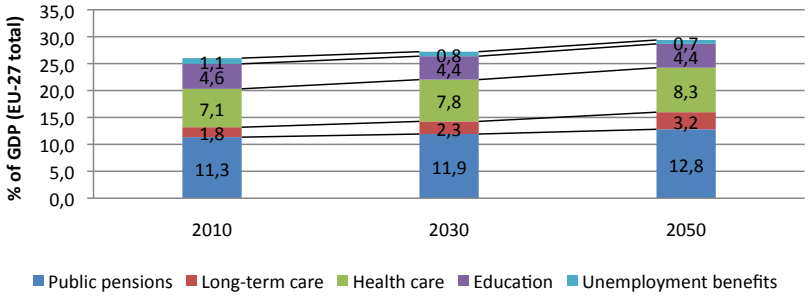


FIGURE 3 LEFT: PROJECTED IMPACT OF AGING ON GOVERNMENT EXPENDITURE (EUROSTAT 2010). RIGHT: PROJECTED EXPENDITURE CHANGE IN % OF GDP BETWEEN 2010-2050

LABOR MARKETS

Aging in Europe will mean, under equal conditions, that the labor force will decrease. Figure 4 illustrates that the working-age population in Europe is expected to decline from 67% in 2010 to about 57% in 2050.[14] In addition, the share of younger workers will drop compared to older workers. Up until 2020, EU total labor force is still expected to increase. Thereafter, labor supply will contract by almost 12%, or 27.7 million people. At the same time, individual member state projections differ widely. For example, whereas Eurostat expects that Ireland could see its labor force increase by around 25%, due to a combination of high fertility rates and a young population, Romania may well face a steep drop of 38.5% (due to low life expectancy and low fertility rates).

14 It should be noted that this prediction rests on a continuation of the status quo and doesn't include any changes in pension age.

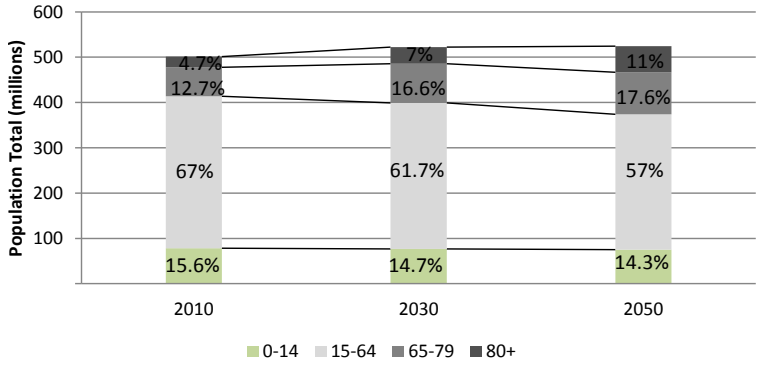


FIGURE 4: POPULATION PROJECTIONS PER AGE COHORT (EUROSTAT 2010)

The double development of decreasing youth cohorts and increasing numer of elderly, may have serious ramifications for the macro-economic competitiveness of European countries. Aging will likely squeeze government budgets. A smaller labor force generally means less economic activity and thus less opportunity to raise taxes. At the same time, the demand for age-related social services will increase (on which more below). As the European Commission expects, shrinking labor markets could, in most EU-27 countries, decrease labor productivity and thereby act as a drag on economic growth.[15] This is not to say that, as is a commonly held belief, productivity decreases after a certain age. Though some studies do point to such an effect and the resulting pay-productivity gap[16] (meaning wages of elderly are disproportionally higher than those of younger workers), others dispute such an effect.[17] The argument here is rather that aging, by shrinking the labor force, hampers productivity.

15 *The 2012 Ageing Report: Economic and Budgetary Projections for the 27 EU Member States (2010-2060)*, European Economy (European Commission (DG ECFIN) and the Economic Policy Committee (AWG), 2012), http://ec.europa.eu/economy_finance/publications/european_economy/2012/pdf/ee-2012-2_en.pdf.

16 Misbah T. Choudhry, *Age Dependency and Labor Productivity Divergence* (Quaderni del Dipartimento di Economia, Finanza e Statistica, 2013), http://www.ec.unipg.it/DEFS/uploads/qd_113_web.pdf; V egard Skirbekk, 'Age and Individual Productivity: A Literature Survey,' *Max Planck Institute for Demographic Research*, WP 2003-028 (August 2003), http://www.demogr.mpg.de/papers/working/wp-2003-028.pdf.

17 Jan C. van Ours and Lenny Stoeldraijer, *Age, Wage and Productivity*, Discussion Paper Series (IZA Institute for the Study of Labor, February 2010), http://ftp.iza.org/dp4765.pdf.

A shrinking labor force can lead to scarcity of labor and skills. For example, demand is expected to increase for workers in long-term care, which refers to a 'range of services required by persons with a reduced degree of functional capacity, physical or cognitive, and who are dependent for an extended period of time on help with basic activities of daily living'.[18] The OECD predicts we will need twice as much workers in long-term care in coming decades in almost all OECD countries (see Figure 5).[19] Adapting education programs and lifelong learning in such a way as to adjust our societies to this need may be difficult, especially in light of a shrinking labor market. This means that despite the previously mentioned benefits of aging, such as new market opportunities, such opportunities may be mitigated by the difficulties associated with labor supply shortages.[20]

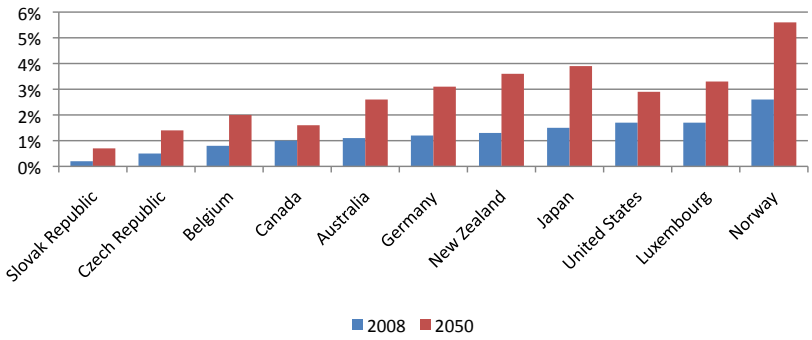


FIGURE 5: PROJECTED DEMAND FOR LONG TERM HEALTH-CARE WORKERS FOR SELECTED OECD COUNTRIES (2008-2050) (OECD: HTTP://WWW.OECD.ORG/TAX/PUBLIC-FINANCE/36085940.PDF)

18 For an overview of LTC expenditure per age group see *Projecting OECD Health and Long-term Care Expenditures: What Are the Main Drivers?*, Economics Department Working Papers No. 447 (OECD, 2006), 48.

19 F. Columbo et al., 'Help Wanted? Providing and Paying for Long-Term Care' (OECD and European Commission, 2011), http://www.healthyageing.eu/sites/www.healthyageing.eu/files/resources/47836116.pdf.

20 'Population Aging: Economic and Social Dimensions' (Roslyn Kunin & Associates, Inc, October 2009).

Another 'hidden' element of care-giving is informal care –providing unpaid care. In general: the more governments reduce healthcare provision, the more care is provided in informal ways. As a consequence, labor participation is heavily affected. The lower the formal care provision, the more people take on the care of their friends, family members, and neighbors themselves. Such care-provision is hard to quantify, but of large value – both in financial and non-financial terms. Conversely, as one report notes, 'increase in government formal care expenditure is a cost-effective way of increasing the labour force participation rates'.[21]

PENSIONS AND BENEFITS

One of the major effects of aging will be that pressure on social security systems will increase. As is shown in Figure 3, the European Commission predicts that public pension expenditure in the EU may rise from 11.3 % of GDP to 12.9 % over the period 2010 to 2060.[22] When looking at individual member states, estimations are often much more extreme. Countries such as Slovenia and Cyprus are foreseen to see increases of more than 7%, due to large OADR increases and, additionally in the case of Cyprus, increases in coverage ratios under current policies. At the same time, in Denmark, Italy and Poland decreases are expected, largely due to dropping coverage and benefit ratios.[23]

As has been noted before, the impact of aging on social security spending is not all negative *per se*. Unemployment benefits, for example, are likely to decrease due to aging. That said, these positive effects are relatively modest. The European Commission foresees this will have a positive effect on EU-wide GDP of around 0.3%.

21 Tarja K. Viitanen, *Informal and Formal Care in Europe* (IZA Institute for the Study of Labor, February 2007).

22 *The 2012 Ageing Report: Economic and Budgetary Projections for the 27 EU Member States (2010-2060)*.

23 All these figures can be found in our online GeoRisQ monitor, available at http://projects.hcss.nl/monitor/.

HEALTH AND HEALTH-CARE COSTS

There is some debate about how aging is related to the overall health situation in a country and healthcare expenditure. For the most part, spending will be influenced by the extent to which increases in life expectancy will be spent in good health, leading to a so-called 'compression of morbidity'. In an ideal situation where added life years are not spent in worse than average health, the added burden of aging on healthcare spending per citizen will negligible. This compression of morbidity effect seems to explain the phenomenon of aging to a certain extent. While generally speaking, the older people get, the more likely they are to suffer from chronic diseases (see Figure 6 below), aging also goes hand in hand with increasing health at later stages of life. Thus the health situation over *generations* improves. Even though we are more prone to fall ill at later stages of our own lives, older people nowadays are healthier than they were some decades ago.

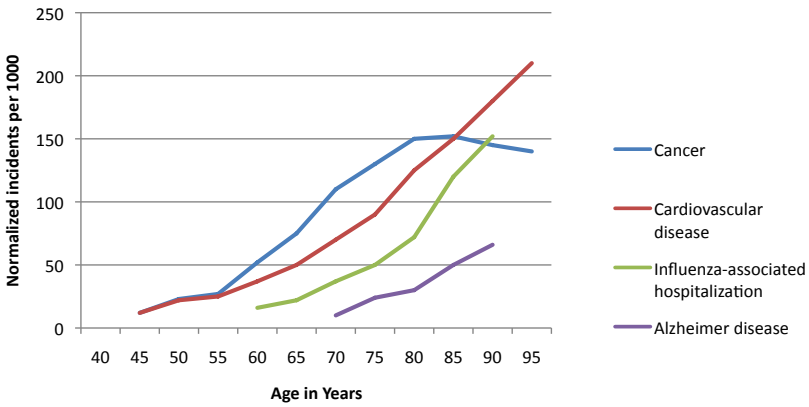


FIGURE 6: THE INCIDENCE OF MAJOR CHRONIC DISEASES RISES EXPONENTIALLY WITH AGE, AS SHOWN: CARDIOVASCULAR DISEASE (RED LINE), CANCER (BLUE LINE), ALZHEIMER DISEASE (PURPLE LINE) AND INFLUENZA-ASSOCIATED HOSPITALIZATION (GREEN LINE)

That said, the amount of older citizens in European societies is likely to increase so dramatically that it will lead to the rise in health-care expenditure noted at the start of this section. Looking at predictions of the European Commission, health-care spending is projected to increase by 1,2% of GDP, from 7,1% in 2010 to 8,3% in 2060. The aging effect will be

especially felt in the field of *long-term* care, which is therefore often listed as a separate expenditure post. With the graying thus also comes a shift in health-care provision, away from short-term and acute needs to more long-term treatments targeted at chronic diseases.[24] Nevertheless, although aging is likely to put pressure on government budgets, it is *one* factor among many. Other drivers, such as unhealthy lifestyles and technological developments, play a major role as well. The availability and demand of more sophisticated and expensive treatments for example, is a well-established driver of health-care costs.[25]

Finally, another factor affecting the health of the elderly is environmental change. Changing climatological conditions such as the proliferation of extreme weather events such as heat waves, are expected to affect older people disproportionally. The heat waves that struck France in 2003 were a case in point, with most of the almost 15000 people that died being elderly.[26]

24 See for example Joshua M. Wiener and Jane Tilly, 'Population Ageing in the United States of America: Implications for Public Programmes,' *International Journal of Epidemiology* 31, no. 4 (2002): 776–781, doi:10.1093/ije/31.4.776.

25 See our report by Eline Chivot, Maarten Gehem, and Lingemann Stephanie, *Taking Care of Our Health - Research Tackling Europe's Grand Challenge of Future Health Issues*, Strategy & Change (The Hague Centre for Strategic Studies and TNO, 2012).

26 Daniela D'Ippoliti et al., 'The Impact of Heat Waves on Mortality in 9 European Cities: Results from the EuroHEAT Project,' July 16, 2010, http://www.ehjournal.net/content/9/1/37.

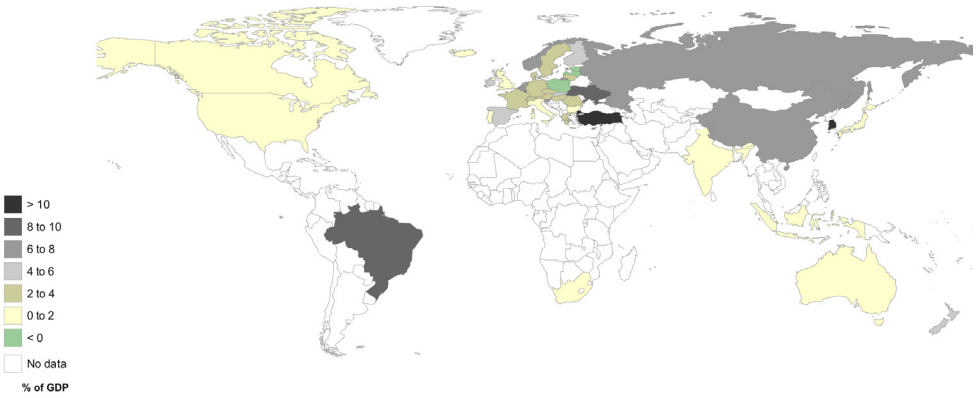
MONITOR 2: SHADES OF GRAYING

In this monitor, we show aggregated data on age-related expenditure for countries worldwide. The resulting maps helps to visualize the countries on which the brunt of the aging falls hardest.[27] Projections for age-related expenditure can serve as a good indicator for the changes needed to maintain sustainable government finances. The projections assume no policy changes. Obviously, this does *not* mean we assume governments will not act. But by looking at the effects of aging on government budgets under current policies, we get a good measure for comparing countries and the efforts they will need to make to cope with aging.

Two budget items are most directly affected by aging: pensions and long-term care. Since projections are not available for all countries worldwide, and aging is likely to become an issue especially for developed and developing parts of the world, our monitor focuses on countries in these regions in particular. Apart from showing figures for Europe, we also looked at other high-income countries (the US, Canada, Australia, South Korea, and Japan) as a benchmark. In addition, we added scores for a group of developing countries that are graying in varying degrees. This allows us to gauge aging challenges developing countries may face and puts the (future) situation in Europe in perspective. On the basis of data availability and relevance, we included the BRICS-countries (Brazil, Russia, India, China and South Africa) and two other developing countries: Turkey and Indonesia. When we look at how the public expenditure on these two items is projected to change from 2010 to 2050, we get the map below. A full methodology is available in the Annex.[28]

27 It should be noted that the focus of these maps is solely on *public* expenditure. It thus does not take into account private expenditure, nor any reserves a country may hold for funding its (future) expenditure. For example, the Netherlands is known for its sizable pension funds, which, it may be argued, makes its pension system more sustainable. Such individual country differences have not been incorporated in this monitor, since they are difficult to quantify and to compare. By choosing the simple measure of government expenditure in percent of GDP, we get figures that are easily comparable.

28 This paragraph is based on our more elaborate and interactive 'Shades of Graying' monitor, which is available on http://projects.hcss.nl/monitor/.



MAP 2: 2010-2050 CHANGE IN PENSION AND LONG-TERM CARE EXPENDITURE FOR COUNTRIES WORLDWIDE (% OF GDP)

The map shows different shades of gray in Europe. Again, Europe is by no means unique. South Korea and Turkey come out as the two countries that will be affected the most by steeply rising pension and long term care expenditure and high government debt. The first will see a very sharp increase in OADR. For Turkey, old-age dependency ratios are foreseen to *triple* from 8.8 in 2010 to 28.2 in 2050. Second, Turkey has very young retirement ages (the effective retirement age corresponds to the minimum of 44 for women and 47 for men[29]). And third, Turkey is known for its generous and easily accessible pension benefits.[30] Of course, these policies are likely to be changed so as to avert the predicted hike in government expenditure. The high increases in expenditure of Ukraine can be explained by the toxic combination of an early retirement age and a large informal sector that excludes many workers from paying benefits.[31]

29 Dirk Verbeken, 'The Pension Reform Challenge in Turkey,' *ECFIN Country Focus* 4, no. 3 (February 16, 2007).

30 Ibid.

31 Marek Góra, Oleksandr Rohozynsky, and Oxana Sinyavskaya, *Pension Reform Options for Russia and Ukraine: A Critical Analysis of Available Options and Their Expected Outcomes* (Berlin: ESCIRRU, February 2010), http://www.diw.de/documents/publikationen/73/diw_01.c.353450.de/diw_escirru0025.pdf.

Also China is predicted to be heavily affected, mostly due to rising pension costs. This holds even more for Brazil, with predicted pension increases of over 7% up to 2050. This is due to the relatively high pension coverage of over 80%[32], high eligibility ratios and a more than tripling of OADR, from 10.4% to 33.4% in 40 years. As for India, total aging-related expenditure is very low due to low proportion of elderly, and low eligibility and replacement rates. In coming decades it is expected to even drop further. This is due to recent pension reforms. And finally, Russia is expected to face a 6.8-point increase in public expenditure from 8.1% of GDP in 2010 to nearly 15% in 2050. This is mainly due to the fact that OADR in 2050 will be 2.3 times that of 2010. In addition, pension funds face high deficits, due to pension evasion via informal work.[33] Nearly 30% of pensioners claim benefits before the established retirement age (the effective average is estimated to be 52–54 years for women and 54–58 for men).[34]

For Europe, we also aggregated data on spending on health, education and unemployment benefits.[35] The scores for European countries on all five age-related expenditure items is depicted in Map 3. Some countries are projected to experience large economic difficulties, most notably the Netherlands, Slovenia and Luxemburg, which without policy changes may see expenditure increase by more than 8% of GDP. All have elaborate

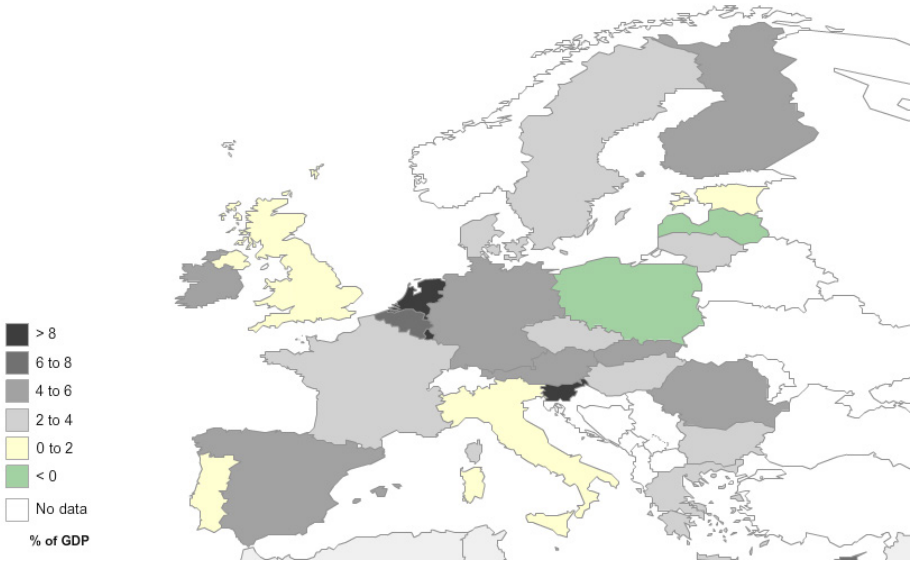
32 Fiscal Affairs Department, *The Challenge of Public Pension Reform in Advanced and Emerging Economies* (International Monetary Fund, December 28, 2011), 34, http://www.imf.org/external/np/pp/eng/2011/122811.pdf.

33 The Russian Statistics agency published figures in July 2012 stating a third of Russian workforce was employed in the informal sector Evgeniya Chaykovskaya, 'Third of Workforce Is Informal - Rosstat,' *The Moscow News*, July 26, 2012, sec. Business, http://themoscownews.com/business/20120726/190001587.html. See also: Oksana Teplinskaya and Kate Ryzhkova, 'Russia's Pension System: Problems and Challenges,' *World* (The Voice of Russia, January 4, 2012), http://english.ruvr.ru/radio_broadcast/34718245/63167543/.

34 See conditions on page 7, Frank Eich, Charleen Gust, and Mauricio Soto, *Reforming the Public Pension System in the Russian Federation*, IMF Working Paper (International Monetary Fund, August 2012), http://www.imf.org/external/pubs/ft/wp/2012/wp12201.pdf.

35 It should be noted that a country-level overview of the impact of aging flattens out some disparaties aging will have. Within countries certain areas will be grayer than others. For example, it seems likely that cities in Europe will experience much faster aging than rural areas.

pension systems and face high OADR increases. In other European countries, Sweden, the UK, France and many Eastern European countries, the effects of aging are predicted to be less severe – though still sizeable at between 2% and 4 %. At the same time, some countries are expected to face a positive effects on their budgets. Poland and Latvia might see aging-related expenditures drop. In Poland, policy measures have been implemented that lead to lower coverage ratios– i.e. the average pension as a share of the average wage. In Latvia the decline in age-related expenditure reflects recent measures taken by the Latvian authorities to ensure the sustainability of the pension system.



MAP 3: 2010-2050 CHANGE IN AGING-RELATED EXPENDITURE (PENSIONS, EDUCATION, UNEMPLOYMENT BENEFITS, HEALTH CARE AND LONG-TERM CARE), AS A % OF GDP

OTHER IMPACTS

Alongside the impact of aging on labor markets, pensions, benefits, and health issues, there are several other likely effects. For example, businesses in other fields may face decreasing demand for their products and services, as will likely be the case for the construction sector.[36] Aging may, by expanding government spending and decreasing tax raising possibilities, also **increase government debt**. It is interesting to note that Standard & Poors is already predicting that, if no drastic measures are taken, the credit rating of countries will be seriously affected. The figure below shows, for example, that under current policies all triple-A countries will lose this status in coming decades.[37]

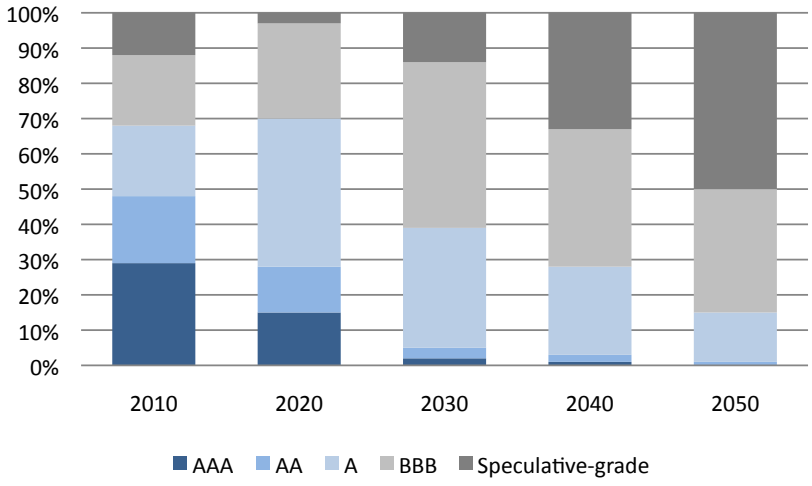


FIGURE 7: SIMULATED DEVELOPMENT IN G20 SOVEREIGN RATINGS DISTRIBUTION FROM 2010-2050 (NO-POLICY-CHANGE SCENARIO)

36 Stephen Sweet et al., *Talent Pressures and the Aging Workforce: Responsive Action Steps for the Construction Sector Responsive Action Steps for the Construction Sector*, Industry Sector Report (The Sloan Center on Aging & Work, July 2012), http://www.bc.edu/content/dam/files/research_sites/agingandwork/pdf/publications/TMISR05_Construction.pdf.

37 Standard & Poor's, 'Mounting Medical Care Spending Could Be Harmful To The G-20's Credit Health,' January 26, 2012, http://www.standardandpoors.com/ratings/articles/en/eu/?articleType=HTML&assetID=1245328578642.

Aging societies may exacerbate **intergenerational issues**. With OADR figures going up, intergenerational solidarity may be put to the test - something that is already visible in many rapidly aging countries. As one author writes, this may radically alter interests and interest-representation in society by, for example, putting 'stress on the middle generation [i.e. those in between younger and older cohorts], and result in the older and younger generations competing for their support.' Thus distribution issues are increasingly an intergenerational question.[38] Signs in this direction are already becoming apparent, with intergenerational issues in the Netherlands for example featuring high on the political agenda. In recent years, both a '50+ party' and a youth movement called the G500 have been created to vocalize the interests of elderly and younger cohorts respectively. Nothwithstanding, other authors, while recognizing the differences in policy demands between generations, suggest that health and health care remain important 'shared values' capable of surmounting tensions between the young and old.[39] Additionally, there is some debate over whether an increasingly visible older generation might decline intergenerational tensions, e.g. because of increased intergenerational contact.[40] Indeed, there is no consensus in the literature over what the effects of an aging population will be on intergenerational relations[41], with many authors highlighting the disproportionate lack of academic attention on the discrimination of older people ('ageism') compared to other types of discrimination that may cause societal tensions.[42]

Housing demands change with age. Societies with an increasing share of elderly citizens will thus experience a growing need for accommodation tailored to their needs. Nowadays, the elderly are more likely to live in

38 Chiara Saraceno, 'Social Inequalities in Facing Old-age Dependency: a Bi-generational Perspective,' *Journal of European Social Policy* 20 (2010): 32–44, doi:10.1177/0958928709352540.

39 Susan McDaniel, '2. Intergenerational Interlinkages: Public, Family, and Work,' in *Aging and Demographic Change in Canadian Context*, Cheal, David (Toronto, Canada: University of Toronto Press, 2002), 22–71. (36)

40 Michael S. North and Susan T. Fiske, 'An Inconvenienced Youth? Ageism and Its Potential Intergenerational Roots.,' *Psychological Bulletin* 138, no. 5 (2012): 982–997, doi:10.1037/a0027843. (989)

41 R. H. Binstock, 'From Compassionate Ageism to Intergenerational Conflict?,' *The Gerontologist* 50, no. 5 (September 13, 2010): 574–585, doi:10.1093/geront/gnq056.

42 North and Fiske, 'An Inconvenienced Youth?'.

small, single-person households, prefer flats over houses, renting over buying and like to live close to healthcare facilities.[43] Partly due to aging, the number of single person households is expected to increase in the future. At the same time, total housing demand will decline, because people are less likely to change housing after the age of 60. This will have consequences for some economic sectors, most notably for construction companies.

Another effect concerns **mobility**. Elderly people are generally less mobile, travel less on a daily basis and (contrary to what is often assumed) make less touristic trips.[44] Aging will therefore likely lead to lower transport consumption, although this effect may be weakened by more traveling of both wealthy and healthy segments of the elderly population, something which is currently already visible in north-western Europe.[45] On average, older people make more use of public transportation. This makes it likely that demand for public transport will increase in aging societies. Furthermore, ensuring accessibility of transportation will become especially important for such societies.[46] In addition, demand is expected to rise for products and services tailored to meet the specific mobility needs of gradually more dependent persons and people suffering from chronic diseases.[47]

There is also speculation on the wider **strategic and security ramifications** of aging. Some researchers argue that economic stress caused by aging may lead to relative decline of economic power, thereby changing the ability of states to set up the capacities needed to advance their strategic

43 Viola Angelini and Anne Laferrere, *Residential Mobility of the European Elderly*, CESifo Working Paper Series (Social Science Research Network, December 24, 2010), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1730059. Based on data provided by Survey of Health, Ageing and Retirement in Europe (SHARE), 2009.

44 *Environment and Ageing: Final Report* (European Commission Directorate-General Environment, October 20, 2008), http://ec.europa.eu/environment/enveco/others/pdf/ageing.pdf.

45 Ibid., conclusions in pp. 28-29.

46 Focus Groups European Commission, 'The Future of Transport,' February 20, 2009.

47 Working Group on Ageing, *Older Persons as Consumers*, Policy Brief (UNECE United Nations Economic Commission for Europe, November 2009), http://www.unece.org/fileadmin/DAM/pau/_docs/age/2009/Policy_briefs/3-PolicyBrief_OlderPersons_Eng.pdf.

goals and deal with security issues.[48] If governments resort to cutting defense expenditure due to increasing pressures on their budgets, this may further shift the international power balance. Some authors argue that this could strengthen US-hegemony, since other parts of the world will age faster.[49] A change in the international power balance may indeed be brought about, due to emerging economies, Russia and China in particular, feeling the effects of an aging population. The predicament of China 'getting old before getting rich' has been around since the 80s, pointing towards the hampering effect that graying may have on Chinese economic development (problems funding pensions, health care provisions, a shrinking labor market).[50]

Others see aging as a stepping-stone for a 'geriatric peace'.[51] Some have argued aging may diminish the potential for a major international war.[52] All these projections differ widely and are tentative to a high degree. It is questionable if aging by itself will have such a definite impact on the power balance of states, or if it will put pressure government funding to such extent that states will resort to cutting defense budgets.[53]

48 Richard Jackson et al., *The Graying of the Great Powers: Demography and Geopolitics in the 21st Century*, Global Ageing Initiative (Center for Strategic & International Studies, March 2008), http://www.agingsociety.org/agingsociety/publications/public_policy/CSISmajor_findings.pdf.

49 Mark L. Haas, 'America's Golden Years? US Security in an Aging World,' in *Political Demography: How Population Changes Are Reshaping International Security and National Politics*, ed. Jack A. Goldstone, Eric P. Kaufmann, and Monica Duffy Toft (Boulder, CO: Paradigm Publishers, 2012).

50 Sui-Lee Wee, 'China Risks Getting Old before It Gets Rich,' *Reuters*, April 27, 2011, http://www.reuters.com/article/2011/04/27/us-china-demography-idUSTRE73Q1SC20110427; 'China's Predicament,' *The Economist*, June 25, 2009, http://www.economist.com/node/13888069.

51 Mark L. Haas, 'A Geriatric Peace? The Future of U.S. Power in a World of Aging Populations,' *International Security* 32, no. 1 (Summer 2007): 112–147.

52 Christian Leuprecht, 'International Security Strategy and Global Population Aging,' *Journal of Strategic Security* 3, no. 4 (2010): 27–48.

53 Jack A. Goldstone, 'Population Aging - More Security or Less?,' in *Political Demography: How Population Changes Are Reshaping International Security and National Politics*, ed. Jack A. Goldstone, Eric P. Kauffmann, and Monica Duffy Toft (Boulder, CO: Paradigm Publishers, 2012).

1.3 CONCLUSION

Aging is a success first and foremost. The fact that we live longer and healthier lives than ever before is the result of improving wealth and health. In coming years, European countries will experience a collective graying of the population, with predictions of almost 30% of the population being above 65 in 2050. Large individual differences remain, with Germany, Italy, Spain and Portugal seeing extreme OADR-figures in 2050 of over 60%, and many eastern European countries facing large increases as well. Other countries such as the UK and Scandinavian countries are likely to experience less strong OADR increases, although figures rise to over 30% in all countries.

We took a 'business as usual' approach, in which we made no assumptions with regards to the policies governments could implement to mitigate the risks and capitalize the chances aging offers. Below we list several key opportunities and challenges.

OPPORTUNITIES

- Some public expenditure items may drop due to aging, most notably education and unemployment benefits.
- The graying of our societies is a worldwide growth market. It opens up new business opportunities for companies.
- Aging may increase the reservoir of social capital. Skills, knowledge and experience that come with age may prove useful to societies, both in economic and non-economic terms.
- Aging may have other positive impacts. Though such claims are tentative at most, graying may for example reduce our CO_2-footprint.

CHALLENGES

- Without a fundamental change of policies, aging may weigh heavily on government budgets. Health care, long-term care and pension expenditures are all predicted to increase. Labor markets will decline.
- Our Shades of Graying monitor shows that the aggregate impact on public age-related expenditure is likely to be among the highest worldwide in Europe. It is safe to say that within Europe, the impact will differ. Countries like Poland and Latvia are projected to see age-related expenditure drop. Other countries, such as the BeNeLux countries, are projected to see extreme rises in expenditure if no measures are taken.

- Other macro-economic effects include the increase of government debt and possible deterioration of sovereign credit ratings.
- Effects that are more difficult to quantify (but are not therefore less real) concern social inequalities, with intergenerational tensions possibly rising and redistribution issues featuring high on political agendas.
- Housing and mobility preferences will shift in aging societies. This may offer both difficulties for sectors dependent on the current make-up of the population (e.g. the construction sector), while offering opportunities to companies capitalizing on these needs (e.g. some ICT companies).

2 RESEARCH ON AGING

What graying will mean for Europe will partly depend on our ability to develop new and innovative ways to deal with the challenges it poses and the opportunities it offers. Any strategy aimed at providing solutions to an aging society cannot neglect the value of research – from keeping older people independent for longer through home-care solutions, to self-monitoring of the health of elderly people, and programs to improve their physical activity. This chapter provides an overview of the status quo of such research activities, with a specific focus on European programs. We first set out general trends in the funding of aging research. Thereafter, we focus on R&D programs at an EU-level and in the private sector, and finally we will list some academic centers of excellence in aging research.

2.1 RESEARCH RESPONDING TO AGING

There are different ways of classifying the vast and sometimes diffuse fields of aging research.[54] Table 1 provides one way of classifying aging research that takes this variety into account.

	UNDERSTANDING	PREVENTING	COPING	THEORIZING
BIOLOGICAL (PATHO) PHYSIOLOGY	**Biogerontology** Why and how we age	**Lifespan** Preventing or slowing aging and related health problems to extend life	**Healthspan** Treating age-related health problems	THEORIES OF AGING
SOCIAL PSYCHOLOGICAL BEHAVIORAL	**Aging Societies** The behavioral effects of aging on individuals and society	**Active Aging** Addressing problems such as discrimination	**Care** Best practices in administering care for the elderly	
ECONOMIC DEMOGRAPHIC	**Aging Populations** Why societies age and how economic effects	**Addressing Aging** Migration, retirement ages, birth rates	**Health Systems** Managing health care delivery for the aged	

TABLE 1: MAIN RESEARCH AREAS FOR AGING

54 See for example Alex Zhavoronkov and Charles R. Cantor, 'Methods for Structuring Scientific Knowledge from Many Areas Related to Aging Research,' PLoS ONE 6, no. 7 (July 22, 2011): e22597, doi:10.1371/journal.pone.0022597.

The table serves well to distinguish two things. First, research can focus on several *stages* of aging: from trying to understand the onset, to preventing and coping with issues surrounding aging – and a more 'meta-field' that studies aging in a more all-encompassing and theoretical way. Secondly, there are different *dimensions* of aging. These can be roughly grouped into three categories. One field of research focuses on the biological/(patho) physiological apsects of aging, through examining the process of aging and associated diseases. A second research area approaches aging from a societal perspective or looks at behavioral/psychological aspects. Finally, a third research area looks at the economic and demographic aspects of aging.

Funding figures for aging research along the lines of these domains are scarce. To get an idea of which fields receive the most attention, we looked at one database that catalogues aging research. Though the database is not exhaustive and is still in development, it lists over half a million projects and schemes in aging research, including their budgets, from the US National Institutes of Health (1991-2010), the European Union (2000-2010) and the National Research Council Canada (2008-2010).[55] Figure 1 shows an aggregate picture of all aging research listed on the website. There is heavy focus on research related to 'natural sciences', which mostly corresponds with biological aspects of aging. Within this, aging-related diseases such as certain cancers and Alzheimer's, account for around half of the almost $150 billion of aging projects listed under natural sciences. A much smaller part ($10 billion) of selected aging studies are of a more theoretical nature. Social sciences research amounts to just over $8 billion – which includes physical and mental studies; care system access; psychological studies; population studies; and research related to the quality of life of the elderly. About the same sum has been allocated to other topics, including training and improving research infrastructure.

55 'International Aging Research Portfolio - Research Areas Summary,' accessed April 25, 2013, http://www.agingportfolio.com/categories/summary/.

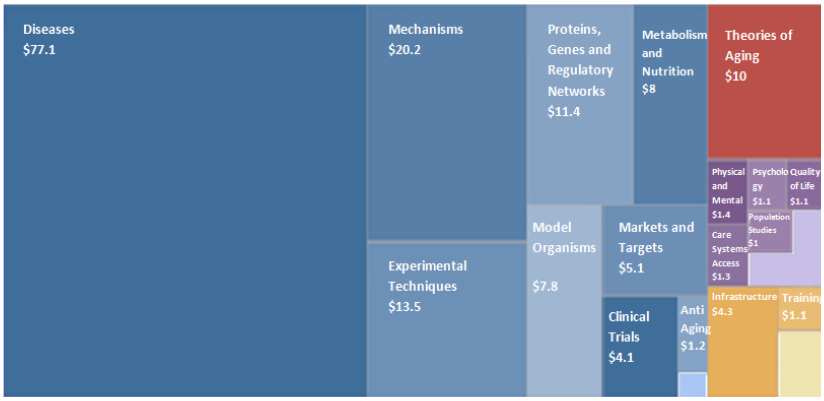


FIGURE 8: RESEARCH INTO AGING BY TOPIC AND FUNDING IN US$ BILLION: NATURAL SCIENCES, THEORY, SOCIAL SCIENCES AND OTHER (SOURCE: HTTP://WWW.AGINGPORTFOLIO.COM/CATEGORIES/SUMMARY/)

Though the picture is not exhaustive and the classification of research projects is sometimes somewhat arbitrary, the aggregate picture is clear: aging research is mostly a matter of trying to understand, deal with and prevent diseases from a biological point of view. Within the field of biomedical research, which closely relates to the 'natural sciences' block above, we can furthermore show some trends over time. Based on a search on fundingtrends.org, a website that charts yearly funding for biomedical projects worldwide, the trend depicted in Figure 11 emerges.[56]

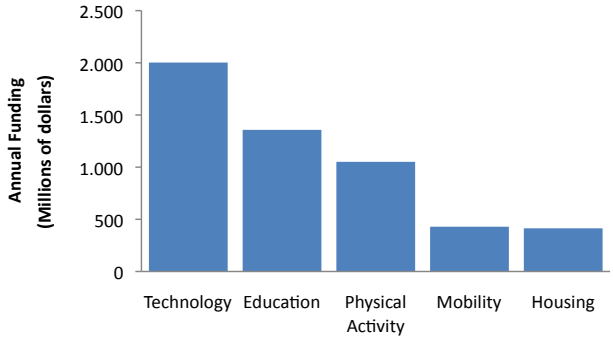


FIGURE 11: AGGREGATE FUNDING OF AGING RESEARCH PROJECTS (1991-2010, IN USD)

56 'Trends Comparison,' accessed April 25, 2013, http://www.fundingtrends.org/?keywords=aging.

The figure shows the aggregate funds spent over the period from 1991-2010. Aging research with technological aspects received most funding, with over $2 billion, followed by education (around $1.4bn), physical activity (just over $1bn) and mobility and housing ($430m and $413m respectively).

2.2 EU RESEARCH

In this section we provide an overview of the focus and budgets of EU research on aging. Funding is fragmented and spread out over different areas.[57] We first look at two most important research areas, health and ICT, and then discuss other research topics. The table below provides a brief summary of most important research programs and budgets.

PROGRAM	THEME	PERIOD	BUDGET
FP7	ICT and ageing well	2007-2013	€91 (-2012)
	Health (and eHealth)	2007-2013	€350m[58]
	Other research areas		€75m
Public Health Programme		2008-2013	
Knowledge Innovation Community	Innovation for healthy living and active aging	2014-2020	€254m
JPI More years, better lives	All relevant sectors	2010	-
AAL Joint Programme	ICT	2008-2013	€700m
CIP	ICT and ageing well / eHealth	2007-2013	€60m
EIP AHA	All relevant sectors	2012	-
Horizon 2020	All relevant sectors	2014-2020	

TABLE 2: EU AGING RESEARCH PROGRAMS

57 In line with this the operational plan for the European Innovation Partnership on active and healthy ageing mentions the 'mapping of research, funding schemes' as one of its goals. See Steering Group, Strategic Implementation Plan for the European Innovation Partnership on Active and Healthy Ageing, Working Document (Brussels: European Commission, November 17, 2011), 9, http://ec.europa.eu/research/innovation-union/pdf/active-healthy-ageing/steering-group/implementation_plan.pdf.

58 Aging first priority in 2012: Stephane Hogan, *Orientations for Work Programme 2012*, Health Theme 2012 orientation paper (Bern: European Commission, July 7, 2011), http://www.euresearch.ch/fileadmin/documents/events2011/Health_Applicants_Hogan.pdf. Until that time, 123 was spent on ageing and health, see: Peter Wintlev-Jensen, *European Innovation Agenda ICT & Ageing* (European Commission, June 13, 2012), http://en.vleva.eu/sites/en.vleva.eu/files/events/bijlages/plenary_peter_wintlev-jensen.pdf.

Aging has featured highly on EU policy agenda's. It is no coincidence that 2012 was nominated the *European Year for Active Ageing and Solidarity between Generations*. This attention is also visible in research grants. One of the most important areas of aging research is health. Within the EU Framework Programmes (FP), the research framework of the European Union, this has traditionally been the focus. Funding has steadily increased. Under FP5, €190m was made available for research on *Ageing Population and Disabilities*. In the following FP, around €123m was spent under the programs *Human development and ageing* and *Scientific Support to Policies*. Under FP7, research on aging and health was substantially increased to somewhere around €350 million. Under the Health theme, funding was allocated under the header *Research on the brain and brain-related diseases, human development and ageing*. In addition, aging was one of several overarching health issues for which additional funds were allocated. And recently**,** aging and health was singled out as a top priority topic.

The *Second Program of Community Action in the Field of Health* of the *Public Health Program* also provides funds for actions in three key areas: improving citizens' health security; promoting health and reducing health inequalities; and generating and disseminating health information and knowledge. For example, the program supports actions to stimulate healthier ways of life for older people.

In addition to funding for biomedical health research, ICT and health have become research topics to receive increasing attention over the years.[59] Under FP7, aging and ICT-related projects were stepped up. Since 2007, around €91m became available within the theme *ICT for Health, Ageing Well, Inclusion and Governance*. Cross-border research initiatives like the EU's 'Capacities' program are an important driver of research and innovation partnerships. Including funding streams such as 'Science in Society', they provide a direct incentive to existing research institutes and willing enterprises to undertake valuable research into the effects of demographic aging on society. The subprogram *ICT for Ageing and*

59 European Communities, 'Capacities FP7 Funding Programme,' n.d., http://ec.europa.eu/research/fp7/index_en.cfm?pg=capacities.

Wellbeing focuses on developing service and social robotics and highly intelligent environments in support of an aging population. Under its *Digital Agenda* of 2010, the European Commission stressed e-inclusion, i.e. ICT-participation of European citizens. In this, the elderly are emphasized in 2 out of 7 focus areas:

- The *enhancing digital literacy, skills and inclusion* program tries to promote the take-up of digital technologies by potentially disadvantaged groups such as older people.
- *ICT-enabled benefits for EU society* formed the basis for the *Ambient Assisted Living (AAL) Joint Program*. The latter was set up by member states, targets elderly and people with disabilities and provides funds for projects that do research on living independently and actively. Total funding amounts to around €700 million for the period from 2008 to 2013. Half of the money comes from the European Commission and EU member states, the other half is provided by industry. Funding goes to projects that aim to enhance the quality of life of older people and to strengthen the industrial base in Europe by supporting the development of new ICT.

Finally, aging-related pilots were initiated under the *Competitiveness and Innovation Program* (CIP). The CIP is a policy support program that aims to stimulate the uptake of innovative ICT based services and products. Currently over €60 million has been spent on several pilots.

From 2014, the sucessor to FP7, *Horizon2020* (H2020), will concentrate previous research efforts and encompass the CIP. One of the social challenges outlined in H2020 is *Health, demographic change and wellbeing*, for which a total of €8.6 billion will become available from 2014 to 2020. Additional funds will be available for more social topics, under *Europe in a Changing World*[60]*, which is classified under part 2 of Horizon 2020 (i.e. 'Industrial Leadership'). Horizon2020 will also provide over Ð250 million for setting up a Knowledge and Innovation Community (KIC)* in healthy living and active aging. This 'community' will combine education, research and innovation into one overarching European organization.

60 Inclusive, Innovative and Reflective Societies and ICT-applications for ageing, human-machine interaction.

Other research areas under FP7

Here we give some examples of aging research projects within the Seventh Framework Programme that relate to the impacts discussed in the previous chapter. We provide a snapshot based on a quick scan of FP7 projects. It should be noted that there may be some overlap between these numbers and the budgets given for ICT and health-related research provided earlier. Research in mobility, for example, often focuses on ICT solutions, and other projects target the reduction of injuries for elderly, a typical health issue.

RESEARCH AREA	BUDGET	DESCRIPTION
Mobility	€36 million (10 projects)	Preventing and coping with injuries, increasing the mobility of the elderly. For example, improving infrastructure, such as transport systems, by increasing accessibility.
Housing	€24 million (9 projects)	Focus on the need for smart homes and technology-based home-care.
Education	€10 million (7 projects)	Education projects chiefly target professionals, both researchers and care-workers, that deal with the elderly. Focus is on cognitive and physical exercises, as well as studying the process of learning with the goal of preventing accidents. Interestingly, no lifelong learning programs came up in the search.
Social security	€5 million (4 projects)	Focus is mainly on long-term care and pension systems. One project tries to build databases for forecasting developments in social security expenditure.

In addition to the framework programs and theme-specific programs such as AAL, the European Union has launched several initiatives to better coordinate research efforts. One interesting intitiative is the *Joint Programming Initiative (JPI) 'More Years, Better Lives'*. The JPI was launched in 2010 and identifies 5 research areas that merit further and more concentrated efforts: Health & Performance; Welfare & Social Systems; Work & Productivity; Education & Learning; Housing, Urban-Rural Development & Mobility. It seeks to discover, analyze and offer research-based solutions 'for the upcoming social and political problems, make use of the economic potentials and establish a positive, holistic vision for *'Ageing in Europe'.* The JPI is driven by member states, pools its resources with other existing initiatives and tries to coordinate these activities.

Another coordinating platform was created in 2012. The *European Innovation Partnership on Active and Healthy Ageing* aims to better coordinate current projects and programs and strive towards a more coherent research agenda. The final objective is to add, by 2020, two healthy life years to the average life span of European citizens.

These projects show that aging has moved to the forefront of EU research programs. Both within the Framework programs and in other initiatives, funding for aging research has steadily increased. This increase is partly explained by the rise in EU collaborative research and corresponding budgets: projects that were funded by national research budgets may now be simply paid for via EU-funds. Within EU research budgets themselves, aging has received more and more attention. This is further underlined by the fact that, in Horizon2020, 'demographic change' is singled out as a component of the largest research theme. The research focus remains very much on two fields: ICT and health. Other research areas receive only a small fraction of its funding. At the same time, the coordinating frameworks which were recently set up so show an increasing awareness of the need to integrate research into the multidimensional nature of aging. Although the JPI lists several other research priority areas, this has yet to be translated into funding schemes. It remains to be seen to what extent this will be followed up on in Horizon 2020.

Another problem with regards to aging research relates to implementation. Lots of investment may be made into research programs aimed at developing new technologies – however, translating this into products and services that will be sold remains difficult. As one recent report on the AAL-program notes, despite the clear indications of market opportunities the gap between research and putting new technologies into practice looms large.[61]

61 Dr. Katrin Gaßner and Michael Conrad, *ICT Enabled Independent Living for Elderly: A Status-quo Analysis on Products and the Research Landscape in the Field of Ambient Assisted Living (AAL) in EU-27* (Institute for Innovation and Technology, March 2010), http://www.ifap.ru/library/book467.pdf.

2.3 CENTERS OF EXCELLENCE

In this section, we look at the worldwide centers of excellence in academic research on aging, both at the level of countries and institutions. As an indicator of excellence, we use citation scores as listed by Thomson Reuters. Although such rankings have their limitations, they serve as a 'good but crude' indicator of research excellence. We look at *total number of citations* of aging articles and their *impact* (by dividing aging citations by aging articles). In addition, we tried to measure the *relative research focus* (RRF) by quantifying the number of aging-related articles over the total articles produced (aging articles/total articles).[62]

At a **country-level,** the US is most dominant in aging research with regards to total citations, which is more than six times higher than the country below it, the UK (see figure 3).[63] This is the result of a clear head start by the US, which has progressively focused on research on aging since the early 70s. Seven European countries figure in the top-10 producers of aging-related citations. However, in Europe, large differences remain. Whereas some countries seem to punch above their weight, such as Sweden, Italy, the UK, Greece and, especially, the Netherlands and Norway (as is confirmed by the high scores in the 'efficiency column'), others seem to do less well, most notably France and Germany. Another remarkable result is the low scores of Japan and South-Korea on aging research citations, especially if one considers the impact aging has and will have on these countries in the future, as noted in paragraph 1.2.

62 The total number of ageing-related articles is the sum of all articles appearing between 1999 and 2010 in 'aging research journals'. The total number of all articles published over this period was obtained from the World Banks (http://data.worldbank.org/indicator/IP.JRN.ARTC.SC).

63 Neumann, R., Ageing Research (Publication Analysis 1999-2010), Lab Times, 4/2012, p.33. Available at: http://www.labtimes.org/labtimes/issues/lt2012/lt04/lt_2012_04_32_34.pdf.

COUNTRY	TOTAL CITATIONS	TOTAL ARTICLES	IMPACT (CIT./ART.)	RELATIVE RESEARCH FOCUS (RRF: (ART./TOTAL ART.) X100)
USA	**322,402**	**44,556**	7.2	**1.84**
UK	**50,654**	**6,215**	**24.9**	1.05
Italy	**37,665**	**3,593**	10.5	1.23
Canada	**36,347**	**4,190**	8.7	1.38
Germany	**30,915**	**3,456**	9.0	0.66
Netherlands	26,239	2,318	**11.3**	1.23
Australia	24,251	2,813	8.6	**1.44**
Sweden	19,587	1,849	10.6	**1.57**
Japan	18,790	2,856	6.6	0.44
France	18,461	1,753	10.5	0.47
Spain	11,836	1,200	9.9	0.55
Switzerland	9,679	1,003	9.7	0.96
Finland	8,541	847	10.1	**1.43**
Israel	8,118	1,095	7.4	**1.43**
Belgium	8,094	695	**11.7**	0.88
Denmark	7,816	588	**13.3**	0.97
China	6,550	1,117	5.9	0.22
Austria	5,339	536	10.0	0.97
South Korea	5,225	886	5.9	1.12
Ireland	5,015	496	10.1	**1.98**
Norway	4,757	385	**12.4**	0.24
Poland	2,471	391	6.3	0.89
Greece	2,195	289	7.6	0.59
Turkey	2,191	370	5.9	0.47

TABLE 3: RANKING OF ACADEMIC EXCELLENCE IN AGING RESEARCH BASED ON COUNTRY ORIGIN OF PUBLICATION (TOP-5 PER COLUMN IN BOLD)

The UK has the highest score in quality of research, way ahead of any other country, and does so through moderate levels of expenditure. The recent push in trying to improve networking in aging research aimed at improving the quality of research might have contributed to this.[64]

The table further shows that US research is heavily focused on aging, just like in Ireland, Finland and Sweden. However, although the US ranks highest on total number of citations, on impact it only achieves an average score, with the UK and other European countries such as Denmark, Norway and the Netherlands placed above it. Most countries with a high production of research in aging, such as the US, Canada and Australia are among the lowest ranges of impact. Finally, China has consistently low scores in all four columns, which in part indicates the relative lack of state-of-the-art research infrastructure, but may also reflect skewed results due to language barriers. This may be a factor contributing to the underestimation of the aging research efforts of other non-English-speaking countries too, such as in Germany, France and Japan.

When looking at world-leading **institutions** in aging research, the firm grip of US universities on aging research becomes apparent. Top ranking research institutes are mostly American (see table 4).[65] In the first column, which lists total citations, the Free University of Amsterdam is the only EU university to make it into the top-25. But when we look at the second column, we see that many European institutes appear with high impact scores. Italian universities rank especially highly, with two in the top-10. In addition, two UK institutes, another Dutch university and the University of Gothenburg (Sweden) made it into the top-25.

64 *A Strategy for Collaborative Ageing Research in the UK* (Medical Research Council, 2010), http://www.bbsrc.ac.uk/web/FILES/Strategies/ageing_strategy_report.pdf; 'Dundee Professor Appointed Chair of Research Network for Ageing' (University of Dundee External Relations Press Office, January 20, 2009), http://www.dundee.ac.uk/pressreleases/2009/prjan09/researchnetwork.htm; 'All Our Futures: Planning for a Scotland with an Ageing Population,' *The Scottish Government* 2, no. Part 5 Improving and Maintaining the Health and Wellbeing of Older People in Scotland (March 8, 2007), http://www.scotland.gov.uk/Publications/2007/03/08143924/5.

65 Data was taken from the Thomson Reuters Web of Science database, available at http://archive.sciencewatch.com/ana/fea/10julaugFea/.

INSTITUTION (COUNTRY)	TOTAL CIT.	IMPACT (CIT./ART.)
National Institute on Aging (US)	**13,228**	**15.38**
University of Bologna (Italy)	No data	**13.48**
Wake Forest University (US)	5,331	**12.81**
Univ. Texas, San Antonio (US)	4,117	**12.55**
Beth Israel Deaconness Med. Ctr. (US)	No data	**12.53**
Italian Natl. Res. Ctr. on Aging (Italy)	No data	12.35
Univ. of Southern California (US)	4,178	11.77
Univ. Calif., San Francisco (US)	7,040	10.93
Harvard University (US)	**8,359**	10.88
University of Minnesota (US)	3,667	10.66
Newcastle University (UK)	No data	10.54
Boston University (US)	3,894	10.27
University of Colorado (US)	No data	10.18
University College London (UK)	3,751	10.17
Brown University (US)	3,292	10.16
Veterans Admin. Med. Ctrs. (US)	5,261	10.16
University of Maryland (US)	3,854	9.93
Vrije University Amsterdam (Netherlands)	4,868	9.93
Gothenburg University (Sweden)	No data	9.79
University of Maastricht (Netherlands)	No data	9.67
Stanford University (US)	No data	9.60
Johns Hopkins University (US)	**8,794**	9.49
University of Washington (US)	6,106	9.47
Univ. Calif., Los Angeles (US)	**9,365**	9.46
University of Pittsburgh (US)	**8,955**	9.29
Duke University (US)	5,893	No data
McGill University (Canada)	3,209	No data
Saint Louis University (US)	3,154	No data
Univ. Calif., San Diego (US)	3,368	No data
University of Michigan (US)	5,550	No data
University of Pennsylvania (US)	4,203	No data
University of Toronto (Canada)	3,088	No data
Yale University (US)	3,457	No data

TABLE 4: RANKING OF ACADEMIC EXCELLENCE IN AGING RESEARCH BASED ON INSTITUTION (TOP-5 PER COLUMN IN BOLD)

2.4 PRIVATE R&D

The private sector plays a crucial role in aging research. Because aggregated data on private research is hard to find, we will present by way of illustration, some examples from the most dominant sectors. We will look at private for profit, not-for-profit, and public-private partnerships.

FOR-PROFIT RESEARCH

Companies that invest in aging research are predominantly from three sectors: health, ICT and insurance. Below we provide some examples:

- **Health companies** are increasingly allocating larger budgets to aging related research. For example, pharmaceutical companies like the Swiss company Roche Holding have started to trial a new experimental Alzheimer's drug, in this case 'Crenezumab', which is administered to people in the early stages of dementia. It is the first such trial to assess whether early spotting and intervention can help prevent or mitigate the disease.[66] In addition, the administration of drugs remains a big issue with regards to the elderly. Both under- and overuse are frequent. One of the limitations is that older people are often not included in drug trials, since they are considered too frail to participate. In addition, research is being undertaken to understand the effects of polypharmy – administering multiple drugs at the same time, something that is common among the elderly.[67]
- **Insurance companies** such as the Japanese Nippon Life Insurance also constitute important sources of funding. The latter invests in R&D through five foundations. The Nissay Seirei Health & Welfare Foundation devotes research to aging from a health perspective. It produces agingrelated surveys, research and services and support for the education of qualified nursing care workers. In addition, the Nippon Life

66 Julie Steenhuysen, 'Alzheimer's Drug Crenezumab Picked for Major Test,' *Heath News*, May 15, 2012, http://www.healthnews.com/en/news/Alzheimers-drug-crenezumab-picked-for-major-test/1C4TJyigX9qum_O_oW6iRg/.

67 See the somewhat outdated but comprehensive article by Marjolein Willemen, Dr. P.A.F. Jansen, and Prof. Dr. H.G.M Leufkens, 'Priority Medicines for Europe and the World 'A Public Health Approach to Innovation',' October 7, 2004, http://www.pharmaceuticalpolicy.nl/Publications/Reports/7.2%20Pharmaceuticals%20and%20elderly.pdf.

Foundation funds non-profit organizations and universities that perform basic and applied R&D on aging. It also holds symposiums and workshops on aging-related issues.[68]

- **ICT** companies (especially in the field of medical technologies) are investing in aging-related research on a large scale. The development of assisted-living technologies, such as household robots and eHealth devices could help older people with diminishing physical opportunities.[69] Siemens for example is involved in joint research projects such as 'Smart Senior' aiming to develop technologies that help older people live more safely and easily in their own homes.[70] In addition, the company is working with partners to develop robots that can assist in providing health care to the elderly.[71] One report suggests that this could furthermore indirectly contribute to the sustainability of health-care systems, by easing the impact of aging demographics, increasing individual productivity levels, and mitigating health-care costs.[72] Such technologies could reduce the need for caregivers' assistance, working lives could be extended, or patients could be kept at home independently rather than in costly health-care facilities.[73]
- **Public-private partnerships:** The demarcation of 'public' and 'private' research is less and less strict. The previously mentioned *Ambient Assisted Living (AAL) Joint Program* is for example half funded by industry, half by member states and the European Commission. Other examples of public-private cooperation abound. One example is the

68 *2010 Nissay Annual Report* (Nippon Life Insurance Company, 2010), http://www.nissay.co.jp/english/annual/pdf/ar2010.pdf.

69 *Health and Innovation*, OECD Science, Technology and Industry Scoreboard 2011 (OECD, n.d.), http://dx.doi.org/10.1787/sti_scoreboard-2011-35-en.

70 'Siemens - Demographic Change: Custom-Implants,' accessed April 25, 2013, http://www.siemens.com/innovation/apps/pof_microsite/_pof-fall-2010/_html_en/custom-implants.html.

71 'Demographic Change and Robotics: I, Butler,' *Siemens, Pictures of the Future*, Fall 2010, http://www.siemens.com/innovation/apps/pof_microsite/_pof-fall-2010/_html_en/i-butler.html.

72 *Spurring the Market for High-tech Home Health Care* (Mc Kinsey Quarterly, September 2011), http://www.mckinseyquarterly.com/Health_Care/Strategy_Analysis/Spurring_the_market_for_high-tech_home_health_care_2856.

73 See also our report by Chivot, Gehem, and Stephanie, *Taking Care of Our Health - Research Tackling Europe's Grand Challenge of Future Health Issues*.

Netherlands Consortium for Healthy Ageing (NCHA). It consists of a four-year collaboration (2009-2013)[74] between six universities and six corporations (among which Unilever, Philips, Pfizer, and DSM). The budget of the project is €28 million, approximately 14% of which is provided by private partners.[75]

NON-PROFIT RESEARCH

In some countries, the United States in particular, non-profit research enterprises contribute significantly to aging research. Charity-funded research in universities is common in the UK and Germany too, although research in the latter tends to rely more often on public funds. We will provide some illustrations of non-profit provisions in these countries in turn.

UNITED STATES

The Ellison Medical Foundation invested over €32m in 2011 into aging-related research.[76] The main research lines are health-related: genetics, maintenance and repair of proteins and organelles, neurodegenerative diseases and cancer, as well as aging of the nervous, immune, cardiovascular, musculoskeletal, reproductive and visual systems. The foundation is accountable only to the philanthropist who founded it, and can therefore afford to fund highly risky projects, or ones which may only yield results in the long term.

The Glenn Foundation devotes an annual €8m to aging research, and has four research clusters at Stanford, Harvard, MIT and the Salk Institute for Biological Studies in La Jolla, Calif.[77] They focus on the biological mechanisms of aging and gerontology.

74 'Netherlands Consortium for Healthy Ageing,' n.d., http://www.healthy-ageing.nl/.

75 1, Adding Healthy Years to the Human Lifespan, and The Netherlands Consortium for Healthy Ageing, 'Adding Healthy Years to the Human Lifespan,' n.d., http://www.healthy-ageing.nl/UserFiles/file/NCHA_stuk_voor_Topsector_Lifesciences.pdf.

76 The Ellison Medical Foundation, 'Aging of the Nervous System,' n.d., http://www.ellisonfoundation.org/research/aging-of-the-nervous-system.

77 Stanford School of Medicine, 'Inaugural Event for New Research Center Probes How to Slow the Aging Process,' February 2, 2012, http://med.stanford.edu/ism/2012/february/aging-0202.html.

GERMANY

- The renowned *Max Planck Institute for Demographic Research* and the *Max Planck Institute for Biology of Ageing* conduct non-profit research on new innovative areas of key aging research. The former studys biodemography, generations and gender, as well as transnationality and family formation. The latter looks into mitochondrial biology, biological mechanisms of aging and molecular genetics of aging. The Max Planck institutes play a major role in research, complement ongoing research and perform service functions (provision of equipment and facilities) for university research.
- In addition to the Max Planck institutes, *the Robert-Bosch Foundation* in Germany is worth mentioning for its research into geriatric medicine and elderly life, awarding aging research a total of over €3.6m per year.

UK

- *The Joseph Rowntree Foundation* focuses on the social aspects of aging, which range from the regulations entailed by elderly care and support services to urban planning (solitude and dementia-friendly cities).[78]
- Another not-for-profit institute that funds research on elderly is *Help the Aged*. Although aging has never been a concrete focus for grants, it has a research line focused on developing treatments for dementia, strokes and Alzheimer's disease with a view to reducing age-related ill-health and disability. It is one of the 5 research challenges that they have set until 2020.[79] For the 2009/11 grants, over €400m was allocated.[80]

2.5 CONCLUSIONS

In Chapter 1 we pointed out that as countries age, some economic sectors, health and ICT in particular, are likely to see business opportunities arise. It

78 'Ageing Society | Joseph Rowntree Foundation,' accessed April 25, 2013, http://www.jrf.org.uk/work/ageing-society.

79 Help the Aged, 'Wellcome Trust Strategic Plan 2010–20: Two-year Update,' February 2012, http://www.wellcome.ac.uk/stellent/groups/corporatesite/@policy_communications/documents/web_document/wtvm054497.pdf.

80 Approximation provided in the 2011 Financial Statement (http://www.wellcome.ac.uk/stellent/groups/corporatesite/@policy_communications/documents/web_document/wtvm054497.pdf). The Trust does not allocate a set proportion of its budget by challenge – spending allocation is determined primarily by the quality of applications that are received.

comes therefore as no surprise that precisely these two feature high on the research agendas of public and private actors. The funding for aging research in general has increased tremendously. Below we highlight the most important conclusions of this chapter:

- Funding for aging research is predominantly geared towards the area of natural sciences. In terms of grants, studies into the social aspects of aging receive much less attention.
- Within European research programs, attention on aging research has steadily increased. The focus is predominantly on ICT and health. These high levels of funding seem logical, considering the resource intensity of such research and the expected benefits of these investments in terms of prevention of diseases and improving the independence of older people. This also reflects an increasing awareness of aging as a (business) opportunity.
- Some research focuses on socio-economic issues, although this field receives proportionally less funding. This holds even more for research on aging and housing, mobility, education and social security. At the same time, there seems to be evidence of an awareness of the importance of and a push towards strengthening interdisciplinary research, reflected in the emergence of new coordinating initiatives at EU-level.
- Other dimensions of aging, most notably the impact of socio-economic factors on the total years lived in good health, and research on the sustainability of social welfare state, receive some attention, but remain much behind ICT and health research in terms of funding.
- One key issue that remains is the translation of research into practice.
- Aggregate figures on private sector research are hard to come by. Most activity seems to come from ICT companies, the pharmaceutical industry and insurance companies. Increasingly, PPPs are the preferred form of conducting research. Furthermore, the not-for-profit sector, such as charities and NGO research, seems to focus more on the socio-economic issues of aging.
- Looking at academic centers of excellence, the data presented in this section clearly indicates a strong geographical concentration of aging research in the US. At the same time, the US does far worse with regards to impact-scores than many European countries. On average, publications from the UK, Denmark, Norway, the Netherlands, and Belgium have more impact.

3 REJUVENATING AGING RESEARCH

This section lists key areas and directions of research that can help to deal with the graying of European societies. In the paragraphs below, we focus specifically on ways in which applied sciences can make our societies better adapted to aging. This chapter should be read as an overview of guidelines and frameworks for science, technology and innovation activities targeted at aging. The information comes from three sources. First, as was written at the end of Chapter 2, we identified a number of gaps between current research focus and possible future problems related to aging. These gaps suggest that it could be beneficial to further focus on these underrepresented research areas. Second, we looked at foresight literature and research roadmaps on the future of aging research. Third, we consulted several experts from academia and applied research organizations dealing with aging research. This yielded four focus areas for future research agendas: the positive effects of aging; a more intergenerational and interdisciplinary research agenda; sustainability of the welfare state; and healthy aging.

1.3 THE UPSIDE OF AGING

Looking at the literature and research projects on aging, the predominant focus seems to be on problems related to aging.[81] In more recent years, the focus has shifted from a negative definition to a more positive view, with emphasis on active and healthy aging. This shows for example in the phrasing of EU research programs on independent living and active and healthy aging. But overall, there still is little recognition of the possible positive effects aging may have, both on individuals and society at large.

81 Peter Martin et al., *Defining Successful Aging: A Tangible or Elusive Concept?* (UGA Institute of Gerontology, November 2012), http://healthyandsuccessfulaging.wordpress.com/2012/11/12/paper-1-defining-successful-aging-a-tangible-or-elusive-concept/.

As Leopoldina, the National Academy of Sciences in Germany, writes: 'gains in life years represent a potential for progress that has not yet been fully exploited.'[82]

Traditionally, aging has been viewed through the prism of diminishing possibilities and health.[83] Recently, other definitions have been developed that focus more on capabilities. Huber and others for example, see aging well as increasing the 'ability to adapt and to self-manage'.[84] Here health is defined as a more 'dynamic' process that results from the interaction of people with their environment. The extent to which individuals are resilient and respond adaptively and independently determines their level of good health. Even a person with a disease may still be considered healthy as long as the person is able to adapt and live a normal life.

As we mentioned at the start of this report, in many respects aging can be viewed as offering opportunities. Graying may boost markets for innovative products and services, thus creating new opportunities for businesses.[85] Especially since, as our monitor in Chapter 1 shows, aging is a global phenomenon that will affect many societies worldwide (though in different degrees and over a varying time span), there is a possible 'first mover advantage'. The quicker countries and businesses capitalize on the emergence of new demands for aging-related technologies, products and

82 *More Years, More Life: Recommendations of the Joint Academy Initiative on Aging* (Leopoldina (Nationale Akademie der Wissenschaften), 2010), 15, http://websrv.leopoldina.org/uploads/tx_leopublication/NAL372Text_01.pdf.. Also see Louise Bazalgette et al., *Coming of Age* (DEMOS, 2011), http://www.demos.co.uk/files/Coming_of_Age_-_web.pdf?1302099024.

83 JW Rowe and RL Kahn, 'Human Aging: Usual and Successful,' Science 237, no. 4811 (July 10, 1987): 143–149, doi:10.1126/science.3299702.

84 Machteld Huber et al., 'How Should We Define Health?,' *Brittish Medical Journal* no. 343 (July 2011), doi:10.1136/bmj.d4163; Machteld Huber et al., *Invitational Conference 'Is Health a State or an Ability? Towards a Dynamic Concept of Health,'* Report of the meeting December 10-11, 2009 (Netherlands Organisation for Health Re search and Development, May 2010), http://www.gezondheidsraad.nl/sites/default/files/bijlage%20A1004_1.pdf.

85 'Competitiveness and Innovation Framework Programme (CIP): ICT Policy Support Programme, ICT PSP Work Programme 2012' (European Union, 2012), http://ec.europa.eu/information_society/activities/ict_psp/documents/cip_ict_psp_wp2012_adopted_01022012.pdf.

services, the larger the business potential. In this respect, business would also benefit from more concerted action in mapping the global markets and products that can expect such growth in demand.

At the same time, there is no such thing as 'the' older consumer. As Sinclair and others have pointed out, the elderly are a very heterogeneous group.[86] For companies to capitalize on the business opportunities that aging may present they need to develop an understanding of the heterogenality of elderly populations. Their preferences are a result of a myriad of factors, such as wealth, education, and the like. Another point in case is the translation of research into practice.[87] As noted in the previous chapter, research funding often does not amount to new and innovative products and services that respond to existing gaps in the market. With regards to the EU's Ambient Assisted Living program, one report argues that what is lacking is 'a clear evidence-based business strategy for implementing the proposed systems, a general understanding of how they will work in practice and an effective way of communicating benefits to potential customers.'[88]

Alongside capitalizing on the business opportunities that aging offers, science can help to improve our understanding of the value of the elderly in society. Currently, most studies on the impact of aging focus on economic measures, like income and use of social provisions, that may be ill-equipped to present an overview of the real value of the elderly for our societies. For example, many elderly people perform voluntary work, which

86 David Sinclair, *The Golden Economy – The Consumer Marketplace in an Ageing Society* (International Longevity Centre - UK and Age UK, September 2010), http://www.ilcuk.org.uk/record.jsp?type=publication&ID=80; Rebecca Taylor, *Ageing, Health and Innovation: Policy Reforms to Facilitate Healthy and Active Ageing in OECD Countries* (International Longevity Centre - UK, June 2011), http://www.globalcoalitiononaging.com/v2/data/uploads/documents/ilc-uk-ihp.pdf.

87 Claude M.D. Lenfant, 'Clinical Research to Clinical Practice - Lost in Translation?,' *The New England Journal of Medicine* 349, no. 9 (August 2003).

88 Ambient assisted living ops: *The Business of Ageing - Commercial Challenges and Opportunities in Ambient Assisted Living* (Netcarity Consortium, November 2010), http://www.netcarity.org/White_paper_The_Business_of.909.0.html.

has positive benefits for our societies but is difficult to quantify.[89] The same holds for a large share of informal care provided by older people themselves.[90] Though a rough estimation at most, one organization from New Zealand expects the value of voluntary and caring work done by older people to amout to around $5-6 billion.[91] In addition, the value of the elderly population may be largely non- or only indirectly economic. For example, older generations may add to the collective social capital of societies.[92]

Finally, some possible positive impacts of aging remain ill-studied. Research in some areas, most notably security and strategic implications of aging, and environmental aspects of graying societies, remains limited. Data is scarce, interpretations differs widely. A more concerted research effort could yield more interesting and objective results.

3.2 INTERDISCIPLINARY AND INTERGENERATIONAL

R&D efforts would benefit greatly from a more interdisciplinary and encompassing approach. As many authors have noted, current research activities are often fragmented and isolated from each other, with a split between research into mental degeneration, physical ailments, and social aspects of health.[93] However, issues related to aging do not naturally fall

89 Marjolein Broese van Groenou and Theo van Tilburg, 'Six-year Follow-up on Volunteering in Later Life: A Cohort Comparison in the Netherlands,' *European Sociological Review* 28, no. 1 (n.d.): 1–11, doi:10.1093/esr/jcq04.

90 See for examples in Australia: *Older Australia at a Glance - 4th Edition* (Canberra: Australian Institute of Health and Welfare, 2007), http://www.aihw.gov.au/WorkArea/DownloadAsset.aspx?id=6442454209; and in Canada: Kelly Cranswick and Donna Dosman, *Eldercare: What We Know Today*, Canadian Social Trends (Statistics Canada, October 21, 2008), http://www.statcan.gc.ca/pub/11-008-x/2008002/article/10689-eng.pdf.

91 ''The Business of Ageing' | Age Concern New Zealand,' accessed April 25, 2013, http://www.ageconcern.org.nz/money/working/business-ageing.

92 Simon Biggs, Laura Carstensen, and Paul Hogan, 'Social Capital, Lifelong Learning and Social Innovation,' in *Global Population Ageing: Peril or Promise?* (World Economic Forum, 2012), 39–41, http://www.hsph.harvard.edu/pgda/WorkingPapers/2012/PGDA_WP_89.pdf.

93 One such article discusses the situation in the UK: Sabine Koch, 'Healthy Ageing Supported by Technology--a Cross-disciplinary Research Challenge,' *Informatics for Health and Social Care* 35, no. 3–4 (December 2010): 81–91, doi:10.3109/17538157.2010.528646.

into such neatly-defined research disciplines. Certainly, some research, for example into the relationship between socio-economic situation and healthy aging, does take a more holistic approach. Also, as pointed out in Chapter 2, there seems to be a push at the EU-level towards a more integrated approach to aging research. But although some do recognize the need for an interdisciplinary aging research, in practice more can be done.[94]

Aging research should also take the whole life-process into account. Graying is a continuous process that doesn't just start at 65, but concerns all of us. We all age from the moment we are conceived, with health-patterns genetically and epigenetically established for life. In this sense, aging is something we are subject to throughout our lives. Furthermore, the positive and negative effects of aging concern the whole of society. It is an intergenerational process that involves all citizens of society: an inclusive approach to devising aging strategies. This means moving away from the dominant view of aging as the final stage of life, associated with inactivity. Instead it is important to take a more holistic approach, taking into account all life stages and the whole of society. For example, labor markets in aging societies could benefit from more flexible forms of education that take lifelong learning as a departing point. Such an approach departs from the idea that education is primarily for young people. Similarly, other traditional ideas concerning life cycles and productivity seem outdated: work is not just for the middle-aged, and elderly people are not necessarily less and less economically active. Younger and older workers are not necessarily competing for work, and opportunities for cross-generational learning should be embraced.[95]

The advantage of such a holistic approach can be observed when looking at questions of social inequality. As one author notes, social inequalities and aging can be examined from at least three perspectives: looking at the

94 For more on systemic approach to health research, see chapter 3 of our report by Grand Challenges Health report: Chivot, Gehem, and Stephanie, *Taking Care of Our Health - Research Tackling Europe's Grand Challenge of Future Health Issues*.

95 Baroness Sally Greengross and Michael Hodin, *Ageing, Health and Innovation: Policy Reforms to Enable Healthy and Active Ageing in OECD Countries* (Global Coalition on Aging, June 22, 2011), http://www.oecd.org/els/health-systems/48245594.pdf.

risks of social inequality for age-related issues; looking at the resources available for dealing with such issues; and looking at how aging affects social inequalities themselves.[96] However, intergenerational issues are rarely taken into account in such studies. Social inequalities among caregivers and the inequality in access to caregivers are often not part of research, let alone policies. As one author notes, 'empirical research and available data are scarce. [Thus a] bi-directional and bi-generational approach in research as well as in policy planning needs to be developed.'[97]

3.3 SUSTAINABILITY OF THE SOCIAL WELFARE STATE

As we have seen, research on aging is mostly connected to health issues (especially from a biomedical point of view) and ICT. One of the larger concerns, however, is the effect that aging will have on our public finances. The question arises over whether our current conception of a welfare state, where the elderly have a right to social benefits (pensions, health care), is sustainable in light of demographic challenges ahead. Providing an answer to this question will require having a picture of the effects of aging and the possible role of policy measures on the mitigation of costs. For some issues, policy measures may be best suited to target the problem at hand. For example, a recent report points out that for the Netherlands, raising the pension age may indeed be a very effective measure for sustaining an increasingly pension-dependent society.[98] Here, research will have a limited role to play at most, for example through developing new ideas on pension systems.

But in other areas, most notably those surrounding the adaptability and productivity of our labor force, the role for research will be much larger. Innovation can help to develop adaptive and compensatory technologies that for example change the work situation so that productivity of older people improves. Studying alternative wage developments may be one idea, with wages not incrementally increasing with age, but decreasing at

96 Saraceno, 'Social Inequalities in Facing Old-age Dependency: a Bi-generational Perspective.'

97 Ibid.

98 Willem Auping et al., *Aging: Uncertainties and Solutions*, Strategy & Change (The Hague Centre for Strategic Studies, TNO and Delft University of Technology, 2012), http://www.hcss.nl/reports/aging-uncertainties-and-solutions/109/.

some stage so that companies may find it more attractive to hire older workers.[99] Technological developments too may help in creating a better understanding of cognitive developments and the onset of impairments and ways to keep the elderly mentally fit.[100] More research on how to provide education to different age groups, and on what education could mean for graying societies, is needed as well.[101]

To keep our welfare state sustainable, some argue for a more participatory approach of older people themselves towards covering the costs of aging.[102] One part of how a society deals with aging depends on policies or public expenditure, however much is also determined by the personal wealth of citizens. To what extent governments can tap into the wealth of the elderly to cover the costs of aging depends largely on cultural factors. One report suggests that the attitudes of people vary between countries, from more willingness to contribute in the US, Germany and the UK, to being less inclined to do so in France, Hungary, Poland and Spain.[103] A more active involvement of the elderly in paying and providing for their health care and pensions could greatly improve the sustainability of social

99 It has sometomes been suggested that such an 'invese U-shape' of wage-age developments is already the case. However, there seems to be little evidence to back up this claim. See for example Michal Myck, *Wages and Ageing: Is There Evidence for the 'Inverse-U' Profile?*, Discussion Papers 724 (Berlin: German Institute for Economic Research, September 2007), http://www.diw.de/documents/publikationen/73/diw_01.c.63414.de/dp724.pdf; and Maria Casanova, *Revisiting the Hump-Shaped Wage Pro_Le: Implications for Structural Labor Supply Estimation* (University of California, Los Angeles, February 2013), http://www.econ.ucla.edu/casanova/Files/Casanova_wage_older_workers.pdf.

100 Soar, Jeffrey, and Youngjoon Seo. 'Health and aged care enabled by information technology.' *Annals of the New York Academy of Sciences* 1114, no. 1 (2007): 154-161.

101 Tarja Tikkanen, *The Learning Society as a Greying Society: Perspectives to Older Workers and Lifelong Learning*, Fourth report on vocational education and training research in Europe: background report vol 2 (Luxembourg: Cedefop, 2008), http://www.cedefop.europa.eu/EN/Files/04-Tikkanen.pdf.

102 See for example *Biotechnology and Healthy Ageing: Policy Implications of New Research* (OECD, 2002), http://www.oecd.org/science/biotech/2487386.pdf; Heikki Oksanen, *A Case for Partial Funding of Pensions with an Application to the EU Candidate Countries*, Economic Papers (European Commission, March 2001), http://ec.europa.eu/economy_finance/publications/publication11052_en.pdf.

103 http://www.aegon.com/en/Home/Insight/Aegon-Retirement-Readiness-Survey/

provisions. A larger role for the elderly in bearing the brunt of aging should be supplemented by greater contributions from all sections of society including both public and private sectors.[104] For example, it makes sense to look more carefully at the potential for public-private research partnerships. Similarly, such PPPs may be well-suited to deliver long-term care provision to elderly.

The economic pressure that aging places on public finances also invites new ethical questions. Research should address such concerns, for example end-of-life issues. Does it benefit both the elderly and our societies as a whole to continue medical treatment *ad infinitum*? And is there a limit to how much money we should spend treating elderly people suffering from chronic diseases and their consequences (in part due to unhealthy lifestyles)? Answering such questions seems to involve a trade-off between the benefits for society at large (i.e. economic sustainability) and personal welfare (i.e. receiving quality of life improving treatments). However, as some reports have pointed out, in many cases older people themselves do not seem to benefit from the dominant paradigm of continuous treatment.[105] Graying societies will be confronted with such ethical questions, the answers will differ from country to country and may largely reflect cultural sensitivities. Research is needed to further thinking on what a fair expenditure of public funds looks like and how to balance societal and individual welfare.

Finally, it should be noted that R&D efforts may have both positive and negative effects on our ability to make our government budgets sustainable. In some ways, it is part of the problem: as we noted before, health-care costs have expanded due to the availability of and rising

104 This was noted for example in 'Ensuring a Society for All Ages: Promoting Quality of Life and Active Ageing,' in *Ministerial Conference on Ageing* (Vienna, Austria, 2012), http://www.unece.org/pau/ageing/ministerial_conference_2012.html. Synthesis report on the implementation of the Madrid International Plan of Action on Ageing in the UNECE region. Available at http://www.unece.org/fileadmin/DAM/pau/age/Ministerial_Conference_Vienna/Documents/Synthesis_report_complete_final.pdf

105 See for example 'End of Life Care: An Ethical Overview' (Center for Bioethics University of Minnesota, 2005), http://www.ahc.umn.edu/img/assets/26104/End_of_Life.pdf.

demand for more (expensive) health-care technologies. This has put pressure on the sustainability of public finances. Furthermore and paradoxically: improving the health of the elderly with new innovative technologies may actually strain public finances even more. The longer people live, the more they make use of social security provisions and other services. In other ways, science, technology and innovation are all important parts of the solution. New innovations can drive down costs due to efficiency gains, by preventing people from getting ill and allowing older people to live independently for longer. They can also make lives both safer and more comfortable while opening up new markets for economic growth. Still, research is at most *part* of the solution. Much of how we will be able to deal with aging depends on policy measures. This seems to hold especially for certain issues, such as workforce shortages in long-term care, or the sustainability of pension systems. Furthermore, for research projects to be effective, they need to be embedded in policy frameworks that have a long-term focus and stimulate investment.

3.4 HEALTHY AGING

As the idiom goes: preventing is better than curing. Healthy aging will depend, to a large extent, on the effectiveness of preventive measures. Even if the macro-economic effects were neutral or negative, there still may be very good moral grounds for focusing more on prevention. And what is more, effective preventive approaches may help to limit the costs of aging, for example by increasing productivity levels. Simply said: someone who is healthy is more productive than someone who is not. Here, too, the role of informal health-care provision should be taken into account. As pointed out earlier, unpaid care workers perform 'invisible' labor that may, on the one hand, be of enormous value to people in need of help, and on the other limit the possibilities of the people providing such care to access the labor market. Such effects are currently rarely studied, and there seems to be an argument for broadening the focus of economic studies into the benefits of prevention. However, as mentioned earlier: there may indeed be *negative* economic effects of prevention: people may indeed live longer but paradoxically cost societies more, because the years in which someone needs access to healthcare facilities increases too.[106]

106 More on this can be found in our report by Chivot, Gehem, and Stephanie, *Taking Care of Our Health - Research Tackling Europe's Grand Challenge of Future Health Issues*.

There is already a shift visible in R&D funding towards prevention of the onset of certain diseases. Such a focus is at the heart of many research programs in Europe that aim to increase the independent living of the elderly. A preventive approach is particularly strong for some diseases such as dementia, where research is increasingly geared towards the links between genetics and external components (such as physiological mechanisms) which both influence the aging process. Environmental and lifestyle factors are increasingly taken into account in research on the development of such diseases. Progress is also expected in the early diagnosis of neurodegenerative illnesses.[107] Similar efforts for other diseases could greatly help in the compression of morbidity, that is: extending the period of a persons healthy life years and delaying the onset of certain diseases. Again, here it is key to shy away from viewing the elderly as one mololithic cohort. Effective preventive measures are often those tailored specifically towards the situation of individuals. [108]

Connected to this, research should try to better understand the drivers of ill-health and unhealthy lifestyles related to aging. A case in point is chronic stress and social isolation. For example, an elderly person who lives alone is much more prone to chronic disease and mental illness than if they lived with a partner.[109] Although both chronic stress and social isolation are widely considered to have a negative impact on the health situation of older people, both seem to occupy a modest role in current preventive programs. That has at least partly to do with the limited understanding of the exact causal mechanisms of how, say, a lonely life may lead to a quicker emergence and development of dementia. However the complexity of addressing such drivers of ill-health also limits their inclusion in preventive

107 'Researching: Health' (Alliance of Scientific Organizations, July 2011), 19, http://www.dfg.de/download/pdf/dfg_im_profil/geschaeftsstelle/publikationen/alliance_researching_health.pdf.

108 See Prevention from perspective of elderly. What works? Not a 1-size fits all. Vb bloeddruk Jacobijn Gusseklo (Leiden) en Rudi Westerdorp (NRC)

109 See for example Carla M. Perissinotto, Irena Stijacic Cenzer, and Kenneth E. Covinsky, 'Loneliness in Older Persons - A Predictor of Functional Decline and Death,' *JAMA International Medicine* 172, no. 14 (July 23, 2012): 1078–1084; Alfred Dean et al., 'The Influence of Living Alone on Depression in Elderly Persons,' *Journal of Aging and Health* 4, no. 1 (February 1992): 3–18, doi:10.1177/089826439200400101.

programs, as it is easier to identify ways to get someone to stop smoking, than it is to have someone live a more sociable and less stressful life. Research plays an important role in creating a better understanding of such processes.

Finally, the role of technological innovation in increasing the health of the elderly is important.[110] Technological solutions such as tailor-made software programs could assist in providing better education programs, both for elderly people and their caregivers. Furthermore, technology can assist the elderly in living independently for longer, by for example improving mobility and communication. Finally, new innovations may help in the early detection of symptoms of diseases and thus provide a basis for prevention.

3.5 MAIN CONCLUSIONS

For Europe, the grand challenge of aging is two-faced. On the one hand, it is a sign of the success of our societies. It indicates our wealth and overall health status. It also provides opportunities for businesses and may yield other valuable (not nescessarily economic) benefits as well. But to continue this success story, we have to look at the shadow side of aging too. Government expenditure on health care and pensions will rapidly increase, some sectors will see demand for their products and services shrink, and intergenerational issues may come to the fore.

If we want to capitalize on the opportunities that aging offers and cope with the challenges that it presents, investing in R&D is key. Research funds have rapidly increased in recent years. Currently, the focus of most research strategies at the EU-level are on health and ICT. Though there is a push towards a more integrated approach that includes other, socio-economic aspects of aging, this has yet to be translated into practice. This report listed some suggestions to take a step in that direction.

There is no silver bullet for coping with aging. What we can do is outline several guidelines that help in making research strategies better targeted

110 Misha et al. Pavel, 'Technologies for an Aging Population,' *The Bridge - National Academy of Engineering* 39, no. 1 (Spring 2009), http://www.nae.edu/File.aspx?id=12500.

at the opportunities and challenges aging poses to European societies. We list the following key points.

- We note the need for research that has an eye for the **positive effects of aging**. The value of older people is huge, both in financial and non-financial terms. They make companies more profitable, posess large 'reservoirs' of social capital, etc. Making these assets visible is a task for research. Other possible positive effects of aging, for example on the environment and international security, merit further study.
- Furthermore, aging offers **economic opportunities**. Graying is big business. The rising share of elderly citizens worldwide should be viewed as a growth market. Capitalizing on such opportunities now may offer a first mover advantage. To make the most of this, we need to think of new and innovative products that target this growing group, while keeping in mind that the elderly are not a homogenous population.
- Aging is a multifaceted phenomenon that requires **interdisciplinary and intergenerational study**. Intergenerational questions and issues related to social inequality should form a cornerstone of research strategies.
- Ensuring the **sustainability of our social welfare state** will require more targeted innovation, especially in the field of social studies. One of the key questions is how to improve labor productivity. A solution could be to ask the elderly to pay more for their health care and other benefits. Such a 'participatory' approach could be combined with increasing the involvement of the private sector. In addition, ethical question over the limits to medical treatment of the elderly need to be addressed.
- **Prevention**, research on drivers of aging and ill-health, and targeted technological research are key in any effective aging research strategy.

There are many shades of gray: some bright, others dark. This report has offered suggestions on how research can take full advantage of the opportunities aging offers, while making our societies more resilient.

APPENDIX: GEORISQ MONITOR METHODOLOGY

This monitor consists of two parts. A first set of maps shows worldwide data on Old-Age Dependency Ratios (OADR, the percentage of people over 65 over those between 14 and 65). A second set of maps looks at projected developments of aging-related public expenditure. Below we will describe the methods used in creating the monitor.

OLD-AGE DEPENDENCY RATIO (OADR)

Aging equals a relative increase of older people in a society. The most commonly used indicator for measuring aging is the Old-age Dependency Ratio (OADR): the number of old people at an age of economic inactivity (i.e. 65 years and over) compared to those aged 15-64 (typically the working age population).[111] OADR figures and projections are available for almost all countries in the world. This indicator thus allows us to visualize the development of aging worldwide.

We looked at the most recent projections up to 2050 from the United Nations. Although a 40-year time span is somewhat large, demographic changes are relatively inert: they develop slowly and over long periods of time. Fertility rates or life expectancy may change somewhat, but even if they do, the effect will be gradual and only felt in the long run. It should be noted though that this measure has some limitations. According to the definition of OADR, people 65 and older are 'economically dependent'. However in some countries the retirement age is higher or lower than 65, whereas in others the lowest age at which people are allowed to work differs. Furthermore, this may be influenced by changes in labor laws or the pension age. However, we can read OADR plainly as a measure of the share

111 United Nations, Department of Economic and Social Affairs, Population Division (2011). World Population Prospects: The 2010 Revision. Available at: http://esa.un.org/wpp/Documentation/glossary.htm.

of older people (65 and over) in a country over population in younger age cohorts (14-65). Furthermore, since OADR is a widely used measure, it allows us to compare projections between countries worldwide.

In a first map, we show worldwide OADR predictions from 2010 to 2050, using 5-year intervals.[112] Countries scoring 20% or lower considered 'green' populations with a relatively small share of elderly people. Countries with scores over 20% are colored progressively more gray. A second map shows absolute change in % points of OADR, with 2010 as the base year. If a country scores 10% in 2050, that means its OADR has increased with 10% from 2010 onwards. Negative scores are marked green and indicate a decreasing share of people 65 and over in relation to those between 14-65.

AGE-RELATED PUBLIC EXPENDITURE

This monitor shows how aging affects government budgets. A first group of maps looks at two expenditure items that are most closely associated with graying: long-term care and pension spending. A second set of maps zooms in on Europe and shows the aging-induced projected change in three additional expenditure items.

WORLDWIDE (PENSIONS AND LONG-TERM CARE)

The negative effects of aging will be especially severe on pensions and long-term care. Based on data availability, a first set of maps shows scores for several countries worldwide on these two items. Pension and long-term care spending are generally reflective of the economic situation of a country. Developed countries are more likely to spend a relatively large share of their budgets on these two items. Thus we show projections for a group of developed and developing countries worldwide. This allows us to view the future situation in Europe in a global perspective. In addition to other high-income countries, we included a group of developing countries that are likely to experience economic development and aging to varying degrees (the BRICS, Mexico and Indonesia).

112 United Nations, Department of Economic and Social Affairs, Population Division (2011). World Population Prospects: The 2010 Revision. Available at: http://esa.un.org/wpp/Excel-Data/population.htm.

Developments in long-term care and pension expenditure are more difficult to predict than population aging rates. Governments may decide to increase the pension age or privatise long-term care, thereby altering the size of the 'dependent' part of the population and/or government spending. For the purposes of this monitor, we look at developments from a 'no policy change' perspective. Obviously, this does *not* mean we assume governments will not act – simply that it is impossible to predict such actions. Furthermore, projections of developments in aging-related expenditure will give us a measure of the efforts countries will need to make to cope with aging.

A first map shows aggregate scores for selected countries on long-term care and pension spending as a percentage of GDP. We also include a map indicating the absolute change in percentage points of GDP with 2010 as a base line, in 5 year intervals. If a country scores 5% by 2030 and 10% by 2050, this means public expenditure on the 2 scored items is projected to increase by 5% of GDP in the 20 years following 2010, and by 10% in 40 years. Finally, we include two maps on the separate expenditure items. Pension expenditure refers to 'public pension spending before taxes and social security contributions paid out to the beneficiaries.'[113] With long-term care spending we refer to 'a range of services required by persons with a reduced degree of functional capacity, physical or cognitive, and who are dependent for an extended period of time on help with basic activities of daily living.'[114] Whereas pension projections were available for all countries for 2050, this was not the case for the intermediate 5-year intervals. Where we lacked such projections, we linearly extrapolated the scores.

113 Salomäki, A., Public pension expenditure in the EPC and the European Commission projections: an analysis of the projection results, Economic Papers N° 268, Directorate-General for Economic and Financial Affairs, European Commission, December 2006. Available at: http://ec.europa.eu/economy_finance/publications/publication825_en.pdf.

114 Help Wanted? Providing and Paying for Long-Term Care, OECD, 2011. p. 2. Available at: http://www.healthyageing.eu/sites/www.healthyageing.eu/files/resources/47836116.pdf.

EU-27 (ALL AGING-RELATED BUDGET ITEMS)

Alongside pensions and long-term care expenditure, aging is likely to influence other budget items too. General health-care spending is likely to go up due to aging. Conversely, education and unemployment benefits are expected to be positively influenced. Having less young people generally means having a smaller education demand. A decreasing labor market also usually translates into lower unemployment benefits.

These three budget items are influenced by a whole range of factors, of which aging is only one. A report from the European Commission tries to isolate the effect aging will have on these expenditure items. In the last set of maps we include these scores for all 27 countries within the European Union. A first map shows the aging-induced change in public expenditure on these 5 budget items combined (pensions, long-term care, health care, education expenditure and unemployment benefits). Per country, we show the cumulative change in percentage points from 2010 onwards. The Netherlands scores 8.2% in 2050, meaning that in the 40 years following 2010, aging is projected to drive up public expenditure by 8.2% of GDP. In five consecutive maps, we detail the cumulative change for each of the 5 budget items.

SUMMARY OF INDICATORS

CATEGORY	INDICATOR	DEFINITION	SOURCE	YEAR
Rate of Population Aging	Old-age Dependency Ratio	The ratio of the population aged 65 years or over, compared to the population aged 15-64.[115]	United Nations, 2011[116]	2010-2050
Public Aging-related Expenditure (Worldwide)	Public expenditure on pensions	Public pension spending before taxes and social security contributions paid out to the beneficiaries.[117]	**EU-27 + Norway:** European Commission 2012[118] **Other countries:** OECD, 2011[119]	2010-2050
	Public expenditure on long-term care	Public spending on 'a range of services required by persons with a reduced degree of functional capacity, physical or cognitive, and who are dependent for an extended period of time on help with basic activities of daily living. This personal care component is frequently provided with basic medical services, nursing care, prevention, rehabilitation or palliative care.'[120]	**EU-27 + Norway:** European Commission, 2012[121] **Other countries:** OECD, 2012[122]	2010-2050
Public Aging-related Expenditure (EU-27)	Public expenditure on five aging-related budget items	Aging-induced cumulative change in public expenditure, in % of GDP, from 2010 onwards. Specified for five public expenditure items: Long-term care, Pensions, Health Care, Education and Unemployment Benefits.	European Commission, 2012[123]	2010-2050

115 United Nations, Department of Economic and Social Affairs, Population Division (2011). World Population Prospects: The 2010 Revision. Available at: http://esa.un.org/wpp/Documentation/glossary.htm.

116 Ibid.

117 Salomäki, A., Public pension expenditure in the EPC and the European Commission projections: an analysis of the projection results, Economic Papers N° 268, Directorate-General for Economic and Financial Affairs, European Commission, December 2006. Available at: http://ec.europa.eu/economy_finance/publications/publication825_en.pdf.

118 *The 2012 Ageing Report: Economic and Budgetary Projections for the 27 EU Member States (2010-2060)*, European Economy (European Commission (DG ECFIN) and the Economic Policy Committee (AWG), 2012), http://ec.europa.eu/ economy_finance/publications/european_economy/2012/pdf/ee-2012-2_en.pdf.

119 Pensions at a Glance 2011: Retirement-income Systems in OECD and G20 Countries, OECD 2011. Available at: http://www.oecd-ilibrary.org/docserver/download/8111011e.pdf?expires=1375450488&id=id&accname=guest&checksum=6A2BFD44221B0E903EBDFF64E7B1ED51.

120 Help Wanted? Providing and Paying for Long-Term Care, OECD, 2011. p. 2. Available at: http://www.healthyageing.eu/sites/www.healthyageing.eu/files/resources/47836116.pdf.

121 *The 2012 Ageing Report: Economic and Budgetary Projections for the 27 EU Member States (2010-2060)*, European Economy (European Commission (DG ECFIN) and the Economic Policy Committee (AWG), 2012), http://ec.europa.eu/ economy_finance/publications/european_economy/2012/pdf/ee-2012-2_en.pdf.

122 Public Spending on Health and Long-term Care: A New Set of Projections, OECD Economics Department, 2012, p 27. Available at: http://www.oecd.org/els/health-systems/OECD%20HC%20and%20LTC%20proj%2021nov12.pdf.

123 *The 2012 Ageing Report: Economic and Budgetary Projections for the 27 EU Member States (2010-2060)*, European Economy (European Commission (DG ECFIN) and the Economic Policy Committee (AWG), 2012), http://ec.europa.eu/ economy_finance/publications/european_economy/2012/pdf/ee-2012-2_en.pdf.

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