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[Scott, A](#)

(2021)

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Nature Aging, 1 (6). pp. 500-505. ISSN 2662-8465

DOI: <https://doi.org/10.1038/s43587-021-00074-y>

Nature Publishing Group

<https://www.nature.com/articles/s43587-021-00074-y>

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Title : *Achieving a Three Dimensional Longevity Dividend*

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Abstract : Improvements in life expectancy amongst high income countries are increasingly occurring in later years. Preserving a positive trend between life expectancy, health and GDP requires a longevity dividend delivering healthy and productive aging. Achieving this means exploiting the malleability of age and the additional time longevity brings. Change is already underway but significant roadblocks remain. Focusing on treatments that target delayed aging, supporting employment beyond 50 years of age and tackling ageism are key priorities. Investing in a longevity dividend is needed to offset the economic challenges of an aging society but requires deep seated changes in individual behaviour and corporate and government policies.

Main Text

Introduction

The twentieth century saw best practice life expectancy [52] increase from 55.1 to 83.9 years. As shown in Figure 1, these gains have continued [65], reaching 87.8 years by 2017. The benefits of this in terms of health, education, GDP and welfare have been extensively detailed (see, *inter alia*, [11], [25]).

However, a shift is underway. In the early 20th century less than 20% percent of US life expectancy gains were realised after age 65 but that proportion is now above 75% and “approaching 100 percent asymptotically” [29]. As these later years are characterised by poorer health and lower economic activity, the fear is of divergent trends between life expectancy, health and the economy.

Avoiding this requires a longevity dividend [53] (see Box 1 for a glossary of key terms) which creates a positive connection between these three dimensions. That in turn requires achieving “healthy aging” (improving the connection between health and age) and “productive aging” (ensuring longer lives can remain active and productive for longer). Healthy and productive aging reinforce one another. Without healthy aging it is not possible to increase lifetime productivity and without productive aging it is not possible to produce the resources longer lives require.

Towards a Longevity Transition

Figure 2 shows the challenges increased longevity brings. It plots U.S survival rates for the years 1933, 1975 and 2018. The survival rate measures the probability of a new-born

reaching different ages based on the mortality rates of a particular year. The area under the survival curve equals life expectancy at birth.

Between 1933 and 1975 the survival curve shifted up due to improvements in infant and midlife mortality. Further improvements were achieved between 1975 and 2018 but driven by gains at older ages, as will any future gains that may occur.

Figure 2 shows an index of ill-health (DALYs lost per year from all diseases on a per capita basis) as well as how employment varies with age. Life expectancy gains between 1933 and 1975 were concentrated at ages where health and employment are above average. As a result, these went hand in hand with gains in health and GDP. However, gains since 1975 are occurring during ages where health is worse and employment low. These long term trends are typical amongst high income countries. With life expectancy at birth showing broad signs of convergence they also appear to be the likely future trajectory for many emerging markets, leading to concerns that countries will become 'old before they are rich'.

These problems are exacerbated by a substantial decline in global fertility (United Nations 2020). If longevity gains lead to a rising number of years in poor health and economic inactivity at the individual level, demographic forces are leading to an analogous shift in terms of the population mix (an 'aging society').

An aging society means fewer people of working age [20] and so lower levels of GDP [3]. Fewer workers reduces the need for firms to invest in capital, lowering interest rates [16]. An older population also increases expenditure on health care and pensions leading to expectations of deteriorating public finances. According to [10] non-communicable diseases are the equivalent of a 3.6% annual tax on OECD economies.

These negative implications of an aging society derive from a focus on GDP. Underlying an aging society is the fact that fewer infants are now mourned, less adults die in midlife and the vast majority of children born in high income countries will now live beyond 70 years. There is much to be celebrated about an aging society.

However, the case remains that, despite these social gains, the shift in the age structure of the population and the growing proportion of life afflicted by noncommunicable diseases raises new challenges. Maximising the gains from longevity and minimising the economic costs of an aging society requires focusing on healthy and productive aging.

At the heart of both healthy and productive aging is the notion that how we age is malleable. If the narrative of an aging society focuses on changes in the population structure, a longevity agenda focuses on changes in how we age. Given that according to UN projections every country around the world will see its population aged over 65 increase by 2050, delivering a longevity agenda is crucial if the full benefits of more people living longer are to be realised.

Healthy aging involves reducing the disease burden at each age and improves the quality of life. It also serves as a support for productive aging. Productive aging refers to enhancing

the ability to create resources into older ages. Without productive aging, longer lives mean resources spread more thinly over time leading to a decline in the standard of living.

Productive aging refers to all uses of time, including non-paid activities such as caring, social entrepreneurship and volunteering - estimated as equivalent to around 3% of European GDP [13] as well as subsistence based activities. The fact these non-paid activities play a larger role in the lives of older individuals points to the need to broaden focus away from GDP when measuring the impact of an aging society. A focus on healthy aging would also suggest emphasising measures of healthy life expectancy.

However, whilst GDP is limited and incomplete in its ability to assess progress in adapting to an aging society it still has a role to play in measuring a longevity dividend. If lives are longer and healthier then they should generate more resources and that should manifest itself as a positive contribution to GDP. Whilst the gains of a longevity dividend undoubtedly extend beyond GDP they should also be reflected in measures of economic growth.

Healthy Aging

Trends in healthy aging are less clear than those for life expectancy but in general the evidence suggests improvements over time (see [46] and [1]). However, if health has improved it has not kept pace with life expectancy. The Global Burden of Disease [34] dataset suggests that on average the proportion of life in good health has remained broadly constant, implying an increase in the number of years lived in poor health.

This suggests substantial welfare gains from achieving a 'compression of morbidity' [32]. Supporting this [59] estimate the value of an additional year of life expectancy as worth \$118k to the average American compared to \$242k for an extra year of healthy life expectancy. Their results also show that a focus on boosting health rather than life expectancy is optimal until a full compression of morbidity is achieved, consistent with public attitudes [30].

Achieving healthy aging requires exploiting four forms of age malleability – behavioural, environmental, socioeconomic and biological. The fact aging is malleable also means that positive trend improvements cannot be relied upon to continue. For instance, behavioural shifts in diet are producing rising levels of obesity and diabetes that need to be addressed through public health campaigns and economic incentives such as sugar taxes. Environmental factors, such as clean air and urban planning that encourages movement and social interaction, also influence how we age.

Socioeconomic factors are behind widening health inequalities. Life expectancy between US males at the top and bottom of the income distribution differs by 14 years [18]. Addressing this requires tackling a range of factors concerning employment, families, housing and community [49] and [17]. That will require major public health campaigns on the part of government, echoing similar policies that were implemented to achieve widespread improvements in infant mortality during the twentieth century.

Achieving substantial progress in healthy aging at older ages will require significant contributions from the biology of aging [24]. This is a topic that is growing rapidly, both in terms of published findings [15] and popular interest [7], [61].

The potential gains from delaying aging are enormous. [36] estimate the value to Americans over the age of 50 of an extra 2.2 years of healthy life as worth \$7.1 trillion. [59] calculate that delaying aging in the U.S to achieve a one year increase in life expectancy and a compression of morbidity is worth \$38 trillion, and a ten year increase \$367 trillion.

Currently in the U.S the National Institute on Aging has a budget of \$2.6bn (including dementia research), the National Cancer Institute \$6.4bn, the National Institute of Health \$42bn and total US healthcare expenditure is \$4trn annually. The magnitude of these prospective gains points to the need to redirect more funds to understanding age related diseases, their trajectories and causes of widening disparities.

Underpinning this argument is a distinctive feature of aging [59]. A virtuous circle for aging exists such that improvements in how we age increases the value of *further* improvements. This is an unusual dynamic as usually once progress is made in tackling a disease the research agenda shifts elsewhere. This virtuous circle suggests increasing resources will be directed towards healthy aging.

Three features of this increased willingness to pay for healthy aging are notable. The first is that the increase is about delaying aging and not just increased expenditure on a frail older population (the 'evergreen' rather than 'silver' economy). The second is healthy aging implies identifying key life stages where interventions have the greatest impact. That doesn't necessarily imply a greater focus on old age but could involve more resources allocated to early childhood ([35], [42], [33] and [37]).

The third feature is that much of this growth will occur outside the traditional health sector and be driven by new providers and new products [23]. Google, Apple, Amazon and Microsoft are all making investments in the health sector and big data and AI [66] can be expected to play a major role in a preventative health agenda. Similarly, major food manufacturers and distributors will seek to enter this rapidly growing health market through supplements and new products. This will also need to be aligned with a population based public health system to deliver the basics of health creation.

Combining these three features emphasises the need for policies tackling inequities in aging if this virtuous circle isn't to turn into a vicious circle. If the gains to healthy aging are increasing depending on your life expectancy then income inequalities will create different life paths and considerable diversity in aging.

Productive Aging

Whilst an aging society is usually framed as a negative for the economy, longer lives spent in better health should be a positive [58]. Not only is extra time valuable in its own right [50], longer lives make education more attractive [[9], [62], increases the incentive to save [55],

[44] and invest in future health [28]. All of these should support a positive connection between longevity and GDP.

While it may seem obvious that longer lives should also require longer working careers the opposite occurred in high income countries during the 20th century. In the late 19th century around 3 out of 4 U.S men aged over 65 were in the labor force [22]. As pension provision increased this reached a low of 1 in 6 by 1993. Since then it has risen continuously and is projected to reach 1 in 3 in 2029 (US Bureau of Labor Statistics).

These shifting trends are consistent with economic theory [12]. As life expectancy rises, individuals have more time and want to benefit from more leisure. However, they also want to consume more over their lifetime and so need to work for longer. The net effect is retirement age should rise but by less than life expectancy. However, if wages are increasing rapidly extra consumption can be financed even if retirement age is lowered. This is what happened in high income countries during the 20th century and more recently in many emerging markets.

However, if wage growth is weak and life expectancy increasing mainly at later ages, retirement age has to rise to preserve financial solvency. This is the current situation in high income countries. As a result, the state pension age has been increasing (see OECD Pensions at a Glance (2019)) and in some cases becoming indexed to life expectancy. Young entrants to the labour market today can expect to have to work into at least their late 60s before claiming a full pension, even higher in some countries (74 in Denmark).

However, concerns over health inequality, the differing physical demands across occupations and the tendency to pre-announce pension age all mean that increases in the state pension age lag behind increases in average healthy life expectancy. This has created the capacity for increased employment beyond the state pension age]. The result is a rising number of people working after 'retirement' and the growing phenomena of 'unretiring'. Retirement as a mass phenomena, where work comes to an abrupt end at a specific age for everyone, is disappearing in the 21st century.

This may help explain the trends shown in Figure 3. Between 2008 and 2018 those aged over 55 accounted for 79 percent of employment growth across the OECD and 103 percent amongst G7 nations. The longevity dividend is already in operation.

Roadblocks to Productive Aging

Whilst employment at older ages has been increasing, maximising a longevity dividend requires tackling a number of roadblocks. One major issue, shown in Figure 2, is that employment starts to fall from age 50. The reasons for this decline are several but the biggest challenge is reducing the risk of becoming unemployed at older ages and improving the rehiring rate of older workers. Older workers are often seen as less productive and more expensive [4] and suffer from ageism in recruitment [51].

Why hire older workers?

Despite widely held pre-conceptions the evidence concerning the link between age and productivity is far from clear. Aside from considerable within group heterogeneity, young and older workers possess different skills and characteristics. For instance, younger workers tend to have stronger more up to date general skills, whilst older workers have more firm- and job-specific knowledge. This has two implications. The first is that the relative attractiveness of young and older workers will vary across sectors, potentially explaining why the average age of a Google employee is 30 but in a manufacturing firm is 44 (although these facts are also consistent with more pronounced ageism in tech companies). The second is that age diverse teams are likely to be more productive than age segregated ones [37].

However, innovation is required to exploit these synergies and find out the working practices that unlock them [19]. As with so much of the longevity agenda this will require substantial social experimentation but incorporating age more firmly into corporate diversity agendas is an important first step.

This is because whilst the evidence suggests older ages may not be less productive, firms may mistakenly perceive this to be the case. The advocacy group AARP estimates [63] ageism towards older workers cost the US economy \$850bn in 2018. Governments need to incorporate age more fully into discrimination legislation in order to tackle these challenges.

As demographic trends unfold and firms recognise their dependence on older workers there are signs of change occurring. Technology can reduce the physical burden of work and help support employment for longer. For instance, Japanese and South Korean manufacturing firms have invested more heavily in robotics to preserve the productivity of an older workforce [2]. Similarly [14] notes how relatively small changes in the production process e.g slowing down mechanical processes etc, can help maintain productivity. Recruitment and apprenticeship schemes are also being opened up to a variety of ages rather than restricted to young entrants.

Achieving a longevity dividend requires not just firms being willing to employ older workers but older workers wanting the jobs that are available. Older workers place a higher weight [48] on non-wage aspects of jobs (i.e flexible working, autonomy and independence, paid leave, etc). The result, according to [5], is they are prepared to accept significantly lower wages in return for these features. As well as supporting part time work, governments can also offer tax incentives to older workers to continue in employment [45]

Whilst progress is occurring, corporate practice lags behind what is needed to fully support productive aging. As a consequence, there is increasing involvement at older ages in the contingent workforce e.g the gig economy, independent contractors, on-call workers, etc. Older ages are also increasingly likely to become entrepreneurs, with the evidence suggesting they feature disproportionately amongst the most successful [6].

Lifelong learning

Longer careers makes the need to invest in skills an important component of productive aging. Whilst longer working careers require more years of education [41] what is less obvious is when this education should occur. Longer lives lead to a longer period over which investment can pay off but also over which obsolescence can occur. This points to shifting more education into later life. The implications for higher education are substantial and in the U.S is leading to the development of a “60 year curriculum” [26].

The challenge will be who will provide this education. Corporates may provide some and higher income individuals will have resources to invest in their own future. However, the challenge will be in achieving widespread access to education. Lower priced online courses and government vouchers for education (as in Singapore’s National Silver Academy) will all be needed.

A Diverse Agenda

What rapidly becomes apparent when discussing productive aging is that there isn’t a single shared agenda among older individuals. Some are working because they enjoy their work and find it fulfilling, others are working out of financial desperation. Some are in good health whilst others struggle with illness and caring obligations. Many have the resources and time to upgrade their skills and are supported by their employer, others do not.

This is a similar range of issues that occur across all ages in the labour market. This is an important insight for policymakers and corporates. Much of the longevity agenda is not about creating distinctive policies for older age groups. The real implication of age malleability is that chronological age defines the needs of people less than previously. This creates a dilemma for governments and corporates. The fact employment starts to decline at around age 50 suggests the need for a common set of policies across that age group looking at the factors why – ageism, health, skills, caring demands, lack of suitable jobs, etc. However, the considerable diversity that is being revealed as more people live into older ages also points to the need for policies that are much more nuanced around individual circumstances than a blanket policy covering a whole age range.

A New Life Course

Twentieth century increases in life expectancy led to the creation of teenagers [54], [57] and retirement [40], [22], [47], shaping a three stage life of education, work and retirement. However, in response to additional time the milestones of a three stage life are being stretched out. As life expectancy increases options become more valuable [27] and commitments are made later. The age of graduation, getting married, childbirth and retirement have all increased.

However, in response to longer lives it may not be optimal to simply stretch out a three-stage life. As working careers lengthen they are likely to be characterised by more job

transitions, more intervals between roles (gap years, time for studying, caring roles) and so will involve multiple stages each with potentially different motivations and priorities [38]. The consequence is that whilst past gains to life expectancy have led to an increase in leisure *after* retirement future gains are likely to see more leisure taken *before* retirement. A shift to a multi-stage life will require substantial changes in corporate practice [39] – reframing retirement, focusing on recruitment at multiple ages, creating flexible career paths and supporting life-long learning. As with the emergence of teenagers and retirees, a multi-stage life requires considerable social experimentation to discover how best to manage these transitions.

Tackling Inequality

If healthy and productive aging are good for the individual and the economy then failing to tackle inequality will significantly reduce the size of any longevity dividend. The risk though is that as life lengthens there is a longer time for inequality to compound. This isn't just a concern over expensive medical treatments being the preserve of the rich but also the ability to support a multi-stage life and invest in the longer term.

Similar concerns would also have been relevant with the initial emergence of teenagers and pensioners, with both options only available to those with resources. Over time social norms and government legislation helped reduce these inequalities through the introduction of compulsory free schooling for all children, statutory unemployment benefit and pensions as well as (in most countries) maternity (and increasingly paternity) benefit. Extending existing social insurance systems to include support for caring and educational breaks would be a natural extension of these measures. These additional social security costs represent an investment in achieving a longevity dividend and avoiding the economic costs of an aging society. Just as with initiatives that supported the creation of a three stage life such policies would help reduce inequality as well as deliver a larger longevity dividend. However, it also requires a focus on productive aging in order to produce the resources necessary to support longer multi-stage lives. Longevity, health and productivity are all required to support one another in order to deliver a longevity dividend.

Rethinking Age

In the 18th century, in response to growing numeracy and literacy, government bureaucracy began to focus on chronological measures of age [64]. It is this which leads to the problem of 'age stickiness' – deeply held cultural beliefs about old age and aging that form a major barrier to achieving a longevity dividend.

Chronological measures of age by construction abstract from two key aspects of the longevity dividend – age malleability and the presence of a longer future. The malleability of age points to the importance of biological [43] age and the need to deal with 'age inflation' (e.g 70 becoming the new 60, [60]). Chronological age also fails to capture the increase in remaining life expectancy that is occurring, especially in later years. Measuring this using 'prospective age' [56] leads to radically different results as to whether society really is aging. Chronological age also fails to deal with the diversity that characterises aging.

The more successfully healthy aging is achieved the less informative the measure of an individual's age is in pinning down their needs. That in turn requires a better understanding of the other determinants of decision making at older ages. Better understanding the incentives of older individuals will require disentangling the different impacts of age, time and health. Just as medical research has historically tended not to focus on the biology of aging, so economics has tended not to consider later years of life as an important time for economic decisions. Designing policies to support a longevity dividend will require a shift in research focus to better understand how individual preferences shift over time.

Conclusion

As global life expectancy increases a new stage of the demographic transition is emerging. In high income countries, life expectancy gains are increasingly concentrated at ages after 65 years rather than at birth. With so many now living longer lives an emerging priority is to age well across the life course. Longer healthier lives should be good for individual welfare as well as positive for the economy. However, concern exists because an aging society is producing substantial shifts in the population structure and longevity gains are increasingly occurring in years of below average health and economic activity.

This requires investing in healthy and productive aging in order to achieve a longevity dividend. This in turn involves exploiting the malleability of age and the additional time that longer lives bring. For countries, such as China and Japan, where projected shifts in the age distribution are pronounced, investing in a longevity dividend is of critical importance. Whilst a longevity dividend should manifest itself through higher GDP a focus on broader measures and especially healthy life expectancy will be important for monitoring how countries are adapting to aging and longevity.

Exploiting the malleability of age is a broad agenda extending well beyond the health sector to include behaviour and socioeconomic factors. Healthy aging provides a platform for productive aging as longer lives will require longer working careers. Increased employment amongst older workers has already been a significant source of growth but a number of barriers to productive aging need to be tackled. Focusing on continued employment for those aged over 50, more flexible career paths and a substantial growth in adult education are key priorities.

Of particular concern is the risk of longer lives magnifying existing inequalities. Fully maximising a longevity agenda will require addressing these inequalities and the creation of social institutions to support healthy long and productive lives for all.

Acknowledgements :

Funding from ESRC Research Grant T002204 is gratefully acknowledged as well as comments from J.Coughlin, M. Ellison, G. Mellior, D. Miles, the editor and an anonymous referee.

Competing Interests :

A.J.S is a co-founder of The Longevity Forum, an advisor to Genflow BioSciences , has acted as a consultant for GSK and the U.N on issues of longevity and is a member of the World Economic Forum’s Healthy Ageing and Longevity Global Future Council.

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Figure Legends :

Figure 1 – Best Practice Life Expectancy 1870-2017

Source :

Based on data from *Human Mortality Database*. University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). Available at www.mortality.org or www.humanmortality.de (data downloaded on 10th December 2020)

Figure 2 – U.S Survival, Health and Employment by Age

Source :

Employment data - BLS (<https://www.bls.gov/cps/cpsaat03.pdf>). Survival Rates calculated based on mortality rates from Human Mortality Database (www.mortality.org). Burden of disease index calculated from Global Burden of Disease (2020) <http://www.healthdata.org/gbd/2019> and shown as DALY lost per year across all diseases on a per capita basis.

Figure 3 - Percentage of Total Employment Increase (2008-18) Accounted for by Over 55s

Source : OECD dataset <https://www.oecd.org/employment/labour-stats/onlineoecdemploymentdatabase.htm>

BOX 1 : Glossary of Key Terms

Aging Society – *a country experiencing an increase in its median age and/or the proportion of its population aged over 65/80 years*

Compression of Morbidity – *a reduction in the length of the period at the end of life spent in poor health and disability*

Demographic Transition – *the shift over time in a country from high to low fertility and mortality rates*

Employment – *engaging in paid work*

Gross Domestic Product (GDP) – *a measure (in monetary terms) of the value added created in a country during a certain period through the production of goods and services. Is is both a measure of output produced, income earned and expenditure.*

Healthy Aging – *maintaining and improving health at each age so as to reduce the disease burden and improve functional ability*

Healthy Life Expectancy – *average number of years an individual spends in good health*

Longevity Dividend – *in this article a positive correlation between life expectancy, healthy life expectancy and GDP achieving an increase in welfare*

Productive Aging – *maintaining, enabling and improving the ability of the individual to remain active and create resources at all ages*

Productivity – *In relation to government data productivity is defined as GDP/Employment or GDP/Total Hours worked. More generally the amount of resources created by an individual over a certain period whether they are sold or for non-market use.*

Unemployment – *Someone who wishes to work but is not in employed.*