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Scott, A

(2022)

*The Economics of Longevity – An Introduction.*

Journal of the Economics of Ageing.

ISSN 2212-828X

(In Press)

DOI: <https://doi.org/10.1016/j.jeoa.2022.100439>

Elsevier

[https://www.sciencedirect.com/science/article/pii/...](https://www.sciencedirect.com/science/article/pii/)

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# Journal Pre-proofs

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PII: S2212-828X(22)00071-8

DOI: <https://doi.org/10.1016/j.jeoa.2022.100439>

Reference: JEOA 100439

To appear in: *The Journal of the Economics of Ageing*

Received Date: 10 December 2022

Accepted Date: 12 December 2022



Please cite this article as: A. J.Scott, The Economics of Longevity – An Introduction, *The Journal of the Economics of Ageing* (2022), doi: <https://doi.org/10.1016/j.jeoa.2022.100439>

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## The Economics of Longevity – An Introduction<sup>1</sup>

Andrew J.Scott

One of the most remarkable achievements of the last 150 years has been a dramatic increase in life expectancy. As documented by Oeppen and Vaupel (2002) and Vaupel, Villavicencio and Bergeron-Boucher (2021), best practice life expectancy has increased since 1840 by around 2.5 years every decade. Life expectancy at birth in Sweden was 49 in 1871, 60 in 1921 and 83 in 2021. But as shown in Table 1, it is not just life expectancy at birth that has changed. Swedes of all ages can now look forward to more years ahead of them.

The issue of whether these life expectancy gains can and will continue is a controversial one. Clearly, these trends have been disrupted by Covid-19 and we do not yet know whether these short-run effects will turn into medium or even long-run ones. If historical trends continue, even at a more modest rate, then further gains to life expectancy will occur. But even absent further progress they represent a remarkable increase in the expected length of life at all ages.

Age	1871	1921	1971	2021
0	48.9	60.1	74.6	83.0
20	43.2	48.9	56.0	63.3
40	28.2	33.0	36.9	43.9
60	14.1	17.3	19.4	25.1
80	4.8	5.7	6.8	9.6

**Table 1 – Swedish Remaining Life Expectancy at Selected Ages**

Source : *Human Mortality Database*, accessed December 1<sup>st</sup> , 2022

This increase in life expectancy makes up one of the two component parts of a familiar narrative about a demographic transition. Along with falling fertility rates, the outcome is smaller young and larger old cohorts and a concomitant rise in the average age of society alongside a growing proportion of older people. In addition to a demographic transition the share of older people has also risen in many countries due to a post-WWII baby boom. The macroeconomic implications of this ‘ageing society’ have long been of interest (see Lee (2016) for an overview) and their potentially adverse consequences the subject of considerable scrutiny (see Goodhart and Prahan (2020) for a recent book length analysis).

Given the importance of factor endowments in economic analysis this focus on changes in the age structure of the population is understandable. For the first time ever the world’s population now has more people aged over 65 years than under 5. Such unprecedented shifts will have important economic and social consequences. In some countries, such as China, the shift will be particularly dramatic. In 1970 only 6% of the Chinese population were aged 60 and older, today it is 18% and by 2080 it will have risen to 48% - although

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Thanks to Julian Ashwin, David Bloom and Rainer Kotschy for comments as well as for funding from ESRC Grant T002204.

given long run uncertainty about both life expectancy and fertility rates these predictions are associated with large confidence intervals. However, even allowing for uncertainty it is clear that the world is set for a dramatic change in the age structure of its population.

The demographic transition is also bringing about another change in factor endowments that tends to get less focus. As life expectancy increases individuals can expect more time. Not only is this valuable in its own right (Murphy and Topel (2006)) but it should also lead to changes in behaviour at every age. A 60-year-old with a remaining life expectancy of 25 years should make different decisions compared to one with a life expectancy of 14. As well as changes in individual behaviour these increases in life expectancy can also be expected to trigger changes in policies and institutions which in turn will bring about further changes in behaviour.

This simple insight highlights two key economic features of increasing life expectancy. The first is that longevity is about additional time and an increase in remaining life expectancy (what is called ‘thanatological’ or ‘prospective’ age (Sanderson and Scherbov (2019)). The second is that in response to growing life expectancy we should expect changes in how we age. In other words, ageing is malleable. The malleability of age may be in terms of changes in behaviours at each age (see Kotschy (2021) and Scott (2021c) for evidence of important shifts in terms of life cycle decisions regarding education, fertility and work). Both in terms of underlying health and behaviours, the result is changes in how we age.

Viewed from this perspective the demographic transition will impact the economy through two different channels. The first is through an ageing society due to changes in the age structure of the population. The second is through a longevity society and changes in how we age in response to longer lives. The former tends to lead to negative conclusions as it is based on an adverse shift in the population mix towards more people using resources and fewer producing them. The latter in contrast has the potential to be a positive economic influence - a longevity dividend (Scott (2021a)).

The differences between an ageing and a longevity society are subtle but important. An ageing society tends to view chronological age as a reliable state variable so that economic decisions follow chronological age closely. From the viewpoint of longevity, this focus on chronological age misses two key aspects – the forward-looking nature of longer lives and the malleability of age. Chronological age is a backward-looking measure occurring at a fixed rate every year. By focusing on chronological age, the important channels through which longevity may influence the economy are neglected.

Better understanding the shifts in behaviour that result from longevity, disentangling these different concepts of ageing and identifying the best way to support longer lives in terms of welfare and the economy is an issue rising in importance. Due to longevity the probability of the young becoming the old has never been so high. In Sweden, the probability of a 20-year-old reaching age 80 has increased from 16% in 1871, to 44% in 1971, to a current level of 70% (assuming no further improvement in mortality rates). Further, the majority of life expectancy gains in high-income countries before Covid-19 were driven by mortality gains above the ages of 80 years (Eggleston and Fuchs (2012)). A rising proportion of older people also demands a better understanding of their incentives and behaviours. That is a problem

as partly because of their historically low numbers the behaviour of older individuals has been relatively understudied in economics. Adding to this is the fact that in traditional life cycle models, older ages have relatively few economic decisions to make once labour supply comes to an end. A richer model of longer lives and later life is needed as society ages.

This is not to imply that longevity has been ignored in the economic literature. A large number of papers exist covering a wide range of important issues (see, *inter alia*, Acemoglu and Johnson (2007), Cervellati and Sunde (2011), de La Croix (2017), de la Croix and Licandro (1999), Jayachanadan and Lleras-Muney (2009)). But as the demographic transition becomes increasingly a longevity transition the need for further work as well as establishing canonical approaches to modelling the various channels becomes more important. An analogy with technological change is useful. The impact of technology on growth and employment depends upon the type of technological progress and how this interacts with a wide mix of institutional structures and behavioural responses. That is reflected in a broad range of economic models and empirical studies (see Acemoglu (2009)). Developing the same around the impact of gains to life expectancy would help guide better understanding and hopefully better outcomes in response to major demographic change. It was for this reason that a conference was organised in London in April 2022 (hopefully to become an annual event) drawing together a range of researchers covering a broad range of topics related to longevity. This special issue contains the majority of the papers delivered at that conference.

### *The Importance of Biological Age*

A major concern with longer lives and an ageing society is the rising burden of disease. With global life expectancy in 2021 estimated by the United Nations to be 71 years, this disease burden is shifting towards age-related illnesses such as dementia, cancer, arthritis, etc. Whilst gains to life expectancy are valuable (Murphy and Topel (2006)) the fact that additional years of life are spent in declining health makes additional gains less so (Scott, Ellison and Sinclair (2021)) and places a premium on achieving a compression of morbidity (Fries (1980)). This rising importance of age-related diseases is reflected in a growing interest in the biology of ageing and geroscience (Campisi et al (2019)). If ageing is the main risk factor for multiple diseases, then geroscience holds out the prospect for treatments that can improve how we age in terms of our health.

Cox (2023) summarises recent research in this area and the different pathways through which ageing may be influenced by potential future therapeutics. In outlining these developments three key results for economists emerge – the malleability of age, the importance of biological measures of age and the value of preserving health rather than treating illness.

Current developments in geroscience point to how we age biologically being far more malleable than previously thought. The degree to which the speed and timing of ageing can be influenced in the laboratory is striking. Both the pace and extent of future progress in geroscience is unknown and current promise may lead to future disappointment. There is a huge transition to be made from the laboratory to therapeutics and from worms and mice to humans. However, the growing confidence within the field points to the importance of

recognising that how we age is malleable and capable of being changed. Whilst geroscience makes this claim in a dramatically new context this notion of age being malleable has long been known with extensive work around the social determinants of health and ageing (Marmot and Allen (2014), Hood et al (2016))).

The fact that age is malleable leads to the second implication – the importance of biological age as a state variable reflecting an individual's overall health and mortality. If ageing is malleable the relationship between health and chronological age will not be fixed. The issue of whether health at later ages is improving is subject to considerable debate although for evidence it is see Abeliansky and Strulik (2018), Levine and Crimmins (2018) and Abeliansky, Erel and Strulik (2020). Effectively chronological age is a 'nominal' measure of age and biological age a 'real' measure (Shoven and Goda (2011)), as reflected in everyday notions such as '60 being the new 50' or 'You look good for your age'. A focus on biological age has two modelling advantages over a simple reliance on chronological age. Firstly, it enables examining the possibility of ageing better and a potential positive impact from longevity. Secondly, it enables a greater modelling of inequalities and the considerable diversity in how people age (Hosseini, Kopecky and Zhao (2022)).

Cox (2023) also emphasises a third key result which is the value of spending money on drugs that promote and maintain health rather than treatments that help people suffering from chronic age-related diseases. As emphasised in Goldman et al (2013) and Scott et al (2022), the welfare gains from maintaining health in later life are enormous when quantified in economic terms regardless of any impact better ageing has on GDP. In particular, Scott et al. (2021) show that achieving a full compression of morbidity is more valuable than any further gains in life expectancy.

The implications of biological age for life cycle modelling are the theme of Strulik (2023). Using the frailty indices of Mitniski, Mogilner and Rockwood (2001) as a measure of biological age ("the intrinsic, cumulative, progressive, and deleterious loss of function") Strulik looks at the implications of ageing being malleable and in part endogenous. He does so by considering the implications of progress in medical technology on the economic decisions of households. The results show the existence of a potentially considerable longevity dividend. Living longer in better health leads to a significant increase in working life and lifetime production. Of course, it is well known that investments in health are positive for economic growth (Bloom and Canning (2000)) but relatively less emphasis has been placed on the possibility of this result at older ages. Using a calibrated life cycle model based on U.S data, Strulik finds that a 50 per cent improvement in medical technology leads to 23 percent fewer health deficits at age 65, adds 7 more years to live and 10 years to working life.

By encasing geroscience improvements in the context of a life cycle model, Strulik reveals a number of interesting results. The first is that individuals respond to improvements in medical technology with additional investments of their own in terms of how they age. This magnifies the impact of medical breakthroughs. That raises a second issue – how the malleability of ageing can lead to growing inequalities in how we age. By explicitly modelling changes in how we age, Strulik's model also provides insight into a host of frequently asked questions. Does ageing better (health investments) lead to overall lower expenditure on

health and especially health treatments? What about expenditure on non-healthy consumption?

This life cycle model can obviously be extended in numerous dimensions to reflect a range of ways individuals may respond to longevity. How does working for longer impact investments in human capital (Hazan (2009)) both in terms of the timing and quantity of education? How do longer careers and the need for more education impact fertility choices? By focusing on changes in the length of life and the malleability of age this life cycle perspective helps provide insights as to how behaviour changes at each chronological age. In doing so it helps frame the insights around major policy issues such as a) the dependency of the length of working career on health and life expectancy b) the shifting pattern between prevention and intervention in terms of health expenditure and c) the importance of identifying mechanisms to address inequalities.

### *How do we change with age?*

A focus on biological rather than chronological age taps into concepts of ageing based around the rising risk of frailty, poor health and mortality. But to restrict our concept of ageing to just health is limiting. There is also a broader concept of ageing connected with the passage of time independent of any impact on health. Those changes may be driven by experience, self-knowledge or wisdom and are reflected in shifting values, beliefs and knowledge. Effectively ageing is a fundamentally non-stationary process whereby individuals themselves change over time. Modelling such processes are complicated as they raise the risk of time inconsistency in decision-making. There is also unease in modelling changes in economic behaviour by assuming changes in preferences (Stigler and Becker (1977)). If preferences shift too much, there are subtle and important issues about the continuity of the ‘self’ (Parfit (1984)), which is especially relevant around issues of dementia (Chandra, Coile and Mommaerts (2023)).

The tendency in economics then is to model ageing in terms of underlying health. Absent a theory of ageing there is no other reason to expect older individuals to behave differently. The most extreme case here is of course the infinite horizon representative agent model whose ease of use is partly a result of the stationarity of decision making. Ignoring the not insignificant issue of whether infinite lives are biologically plausible (see de Grey and Rae (2007)) these models make the strong assumption that preferences do not change, and individuals make the same decisions every period irrespective of their age. There is no boredom, taste for variety or shifts in tastes over time. With an ageing society implying that the ‘representative agent’ is getting older this is not an innocuous assumption. For instance, Ferranna et al (2022) document substantial differences in time use between older and younger people but also across older people in different countries. Again, we are back to the need to understand better the incentives and behaviours of older people given their increasing number and the rising probability that the young will become the old. The need is to integrate a theory of ageing into life cycle models.

Moving beyond the extreme nature of infinite horizon models there are a number of papers which examine whether deep seated preference parameters that are core for life cycle decision making change with age (see Dohman, Huffman and Sunde (2023) for a survey).

Essentially these approaches make the issue of ageing stationary by conditioning upon chronological age as a state variable and using chronological age to track changes in preference parameters. However, once again the relevance of chronological age in a world of increasing life expectancy is questionable. Sanderson and Scherbov (2019) emphasise the importance of prospective age (remaining life expectancy) as a state variable, and this is a theme picked up on by both Sunde (2022) and Carstensen and Reynolds (2022).

Sunde (2022) examines empirically issues of trust and risk aversion and investigates the dual role of prospective and chronological age. He finds it important to allow for prospective age in modelling the rise of risk aversion with chronological age. The more life expectancy remaining for any given chronological age the less risk averse individuals are although he finds no impact on trust.

Carstensen and Reynolds (2022) focus on how intertemporal trade-offs and preferences change with the time horizon, outlining a number of implications of Socioemotional Selectivity theory (Carstensen (2006)). Effectively the theory says that the shorter the time horizon the more present focused individuals become. This insight has numerous implications including explaining the better mental health of older individuals compared to those in middle age and the reallocation of time with age towards emotionally meaningful goals.

Both these papers draw attention to the dual nature of ageing – the passage of time as reflected in chronological age and the sense of an ending as measured by prospective age. Longevity means that the relationship between these two concepts shifts and just focusing on chronological age fails to adequately capture both aspects. It also introduces another way over and above health in which longevity may lead to how we age being malleable. Understanding this bidirectional theory of ageing provides insight into a range of increasingly important economic policy issues such as the incentives of older workers to train and improve their skills, to invest in health and take actions that favour the future over the current, their appetite for risk and the investment portfolios they hold, their preference for consumption versus leisure and the marginal value of money at each age.

Both these papers focus on how shifts in the individual's time endowment lead to changes in how they assess risk and intertemporal decision making. There are of course other ways whereby longevity may affect individual preference parameters. For instance, Becker and Mulligan (1997) show how as life expectancy increases the value of being patient rises and model how the consumer can invest in actions that increase patience and examines how this impacts key consumption-savings decisions. Other ways longevity may impact key intertemporal preferences is via the intertemporal elasticity of substitution. Rosen (1988) shows how the value of life expectancy gains depends upon the intertemporal elasticity of substitution. The greater this elasticity the less an individual values gains to life expectancy as total lifetime consumption matters more rather than its distribution across individual years. It seems plausible that this parameter might itself depend on the time endowment. In other words, an infinitely lived consumer may have a higher intertemporal elasticity of substitution than someone with life expectancy of 40 years.

The most obvious area where an economic longevity dividend can be gained is through increasing the labour force participation of older workers. Across the Organization of Economic Co-operation and Development (OECD (2019)) governments are responding to longer lives and a rising proportion of older people by making numerous parametric changes to pension systems. As well as reducing their generosity, restricting access and raising contribution rates, governments have introduced and announced a series of increases in the state pension age. This has led to a reversal of a long-established decline in the employment rate of older workers. In 1880, around three-quarters of men aged 65 years and over worked in the United Kingdom and the United States. Over the next 100 years, this proportion declined continuously, reaching around one in six in the US and one in 12 for the UK by 1990. In France, it reached as low as one in 50 in 2000. Since then, the pendulum has swung the other way and now one in four are working in the US, one in seven in the UK and around one in 20 in France. Given both this increased likelihood of being employed and the large size of the babyboomer cohort the result has been older workers accounting for the majority of employment growth in recent decades (see Scott (2023) Table 18.1).

Given future demographic trends, understanding this increase and introducing policies to achieve further gains is an important policy issue. This is the subject of a number of papers in this issue. Wallenius (2022) focuses on the employment of older men and surveys a wide range of international evidence on the forces behind both the decline and more recent rise in their participation rate. Education, health and household circumstances all combine to influence the employment outcomes of older workers in conjunction with interactions with the tax and benefit systems. Three related conclusions emerge. The first is that labour supply decisions of older workers can clearly be influenced – how we age in terms of the labour market is malleable. The second is the considerable diversity in experience of older workers. That means that focusing only on age-based policies is unlikely to be effective given this substantial diversity amongst older workers. This links into the third and final implication. Whilst there are undoubtedly issues, especially around health, caring and age discrimination, that are more prominent among older workers the broad issues that influence labour market outcomes at older ages are similar to those at other ages. Supporting employment at older ages will involve applying existing labour market policies to these older age bands. Pure age-based policies in other words are too blunt.

Although Berkman and Truesdale (2023) have a different focus the conclusions they draw are similar. Their focus is on employment at older ages in the United States. On the surface this seems a success story, given the high level of US labour force participation at older ages compared to other countries. However, drawing from a range of papers in Berkman and Truesdale (2022) they reveal a far more complex and challenging situation. In particular, they stress that raising the state pension age as a way of boosting employment is likely to be of limited effectiveness. For a host of reasons including health, caring responsibilities, skills and ageism in the workplace, employment declines from age 50 onwards. If individuals are not in regular employment in the decade running up to the state pension age, then their probability of working after that point are much reduced.

As with the findings of Wallenius (2022) the results here point to : a) considerable diversity in the labour market behaviour of older workers b) purely age-based policies such as raising

the state pension age will be of limited effectiveness and c) dealing with this diversity requires applying a range of existing labour market policies to older ages. The results of Berkman and Truesdale (2022) also reveal another insight. If individuals are to extend their working lives a life course perspective needs to be considered. That is interventions when people are in their 50's are needed in if they are to be working in their 60's.

Singh and Aitken (2022) also focus on the dynamic implications of working for longer. One of the issues they focus on is the problem of job switching for older workers. Older workers are less likely than younger workers to change jobs but they are more likely to leave employment and exit the labour force. If working lives are to be extended, both these need to be tackled, especially given the widespread belief that technological change is set to increase labour market turnover. They propose a range of policies to support this. One proposal is for firms to focus on better age management policies including developing age diverse teams. Once again, the need here is to understand what makes older workers different from younger workers and then find ways to exploit these differences constructively within teams. As well as measures aimed at lengthening tenure Singh and Aitken (2022) also suggest active labour market policies that can help older workers transition into new occupations and roles. Once more this involves applying existing labour market policies to older age groups.

Another way of boosting employment at older ages is not to focus on changing older workers in terms of their health or education but changing the nature of work so that it becomes more 'age-friendly'. A number of studies (Maestas et al (2018), Ameriks et al (2021)) find that older workers value certain occupational characteristics – such as flexible work, greater autonomy, less physical demands – more than other age groups. Using these findings and O\*NET data and NLP methods Acemoglu, Mühlbach and Scott (2022) create an occupational index of age-friendliness and examine its role in supporting the growth in older employment. They find that there has been an increase in the age-friendliness of three-quarters of occupations and that between 1990 and 2020 there was an increase of 49 million in the number of above average age-friendly jobs. This has been a supportive environment for older workers who have benefited from this increase. However, not all of these age-friendly jobs went to older workers with large numbers also going to women and graduates. They also show diverse experiences amongst older workers with older graduate workers faring well in terms of age-friendliness compared with non-graduates especially male.

Across all four papers, some common themes emerge. The first is the bluntness of pure age-based policies – whether that be a focus on raising the state pension age or the provision of age-friendly jobs. Dealing with the diversity of older workers is crucial. This feeds into a second common theme - much of what is needed is targeting certain types of older workers with labour market policies that work at other ages, e.g skill provision and transition support. The third is the need for a more dynamic life cycle perspective. In particular, the need to determine what, if anything, it is that makes younger and older workers different from one another (Allen (2022)). Given the finding that age-friendly jobs are popular amongst young and old alike, rising employment at older ages will impact the wages and job opportunities available to the young. Finding ways to ensure younger and older workers are complements and how to construct longer working careers that support all ages will be an

important aspect to adjusting to longer lives and making them more productive and innovative.

### *Macro implications*

The negative implications of an ageing society for macroeconomics have long been heralded. More recently, there has been concern that a rising proportion of older people has placed downward pressure on long-term real interest rates (Summers (2014), Gagnon, Johannsen and Lopez-Salido (2016), Auclert et al (2021)). Two channels dominate this effect. The first is a classic growth channel. If there is a falling proportion of people of working age then the capital to labour ratio rises and the marginal product of capital falls. The other channel is through savings and wealth. As life expectancy increases the amount of wealth required at retirement also increases. This high stock of wealth increases global savings and pushes down rates of return. As Vlieghe (2022) points out demographics is not the only factor contributing to low real interest rates but it is an important one. The consequence is concern about the effectiveness of monetary policy given the existence of a zero lower bound. Removing this problem requires extending working careers so that individuals need to accumulate less wealth. A positive longevity channel has the potential to offset the negative impact of an ageing society.

Miles (2022) focus is on unpicking the two different strands of an ageing society – a falling fertility rate and rising life expectancy – rather than just considering their joint effect through a changing population age structure. On both counts he offers a more optimistic outlook than is traditionally the case. Declining fertility rates lead to declining populations which enables consumption levels to be maintained through reductions in the capital stock without lowering the capital-labour ratio. Rising life expectancy also can support economic growth if healthy and productive longer careers are supported.

What is striking about Vlieghe (2022) and Miles (2022) is how these demographic topics have gone from being a future macro issue to one policy makers are having to grapple with today. It is also clear that adapting to longer lives requires fundamental changes in working careers and the life course. That suggests that adapting to longevity is far more than just a responsibility for central bankers and Ministers of Finance and involves much more than parametric changes in our pension systems.

This broader agenda is the focus of Wong, Fried and Dzau (2022) who summarise the main findings of an international commission established by the National Academy of Medicine to create a Global Roadmap for healthy longevity. They frame the need to adapt to longer lives in terms of system thinking and point to a wide range of changes for the economy and society if we are to avoid the negativity of an ageing society and achieve the benefits of longer lives. In a nutshell these are about investing more resources in the second half of life to ensure that this time is both healthy and productive. That simple injunction sounds deceptively simple but involves a profound change in society, policies and institutions if it is to succeed.

### *Conclusion*

Global life expectancy now stands at 71 years compared with 30 years in 1870. This represents one of the greatest achievements of the past 150 years and means that the young can expect to become old for the first time in human history. That fact has two important implications for economics. It increases the need to understand how we age and how that impacts our economic decision making. It also raises the issue of how we should change our life cycle behaviours, policies and institutions to adapt to these longer lives. The combination of these two factors leads to a very different focus from the traditional interest of an ageing society and its focus on changes in the age distribution of society.

Given the importance of intertemporal decision making and the life cycle model in economics the implications of longevity for economic research offers rich pickings across a range of areas covering health, human capital, employment, financial decisions and macroeconomics. Understanding the changes in how we age in response to longer lives and identifying the channels to ensure that longer lives are welfare enhancing should be a fruitful and important area for research.

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