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Science Fiction, Legal Fiction, Political Fiction, and the 100-Year Life

Daniel J. Hemel

A child born in the West today has a more than 50 per cent chance of living to be over 105 . . . This is not science fiction.[1]

The claim by Lynda Gratton and Andrew Scott that "the 100-year life" will become the norm for cohorts born in the Western world today is startling. It also is, contrary to the authors' characterization, "science fiction." By "science fiction" I do not mean that it is necessarily wrong – science fiction sometimes proves prescient, as with Jules Verne's predictions of electric submarines and space travel. But the claim is "science fiction" within the dictionary definition: a "story featur[ing] hypothetical scientific or technological advances."[2] For Gratton and Scott's claim to come true, biomedicine will need to make advances against aging that – for now – remain hypothetical.

Imagining a 100-year life requires us to engage not only in science fiction but also in legal and political fiction. I do not mean "legal fiction" in Blackstone's sense – a fiction that litigants and judges use to rationalize particular jurisdictional results, such as the fiction that defendants before the King's Bench committed trespass in Middlesex county.[3] And by "political fiction," I do not mean that the 100-year life is a *House of Cards*-style thriller about officeholders in Westminster or Washington. Rather, the journey to a 100-year life will likely require new developments in law and politics that – as with their biomedical counterparts – remain hypothetical. Not only have we failed to achieve the biomedical advances that will allow 100-year lives to become the norm, but we have also failed to build the legal institutions and political coalitions that will foster those biomedical advances. As with Verne's submarines, today's fiction may become reality in the not-so-distant future. But the journey to a

[1] Lynda Gratton & Andrew Scott, The 100-Year Life: Living and Working in an Age of Longevity 2 (2016).

[2] *Science Fiction*, Oxford English Dictionary Online, https://www.oed.com/dictionary/science-fiction_n?tab=meaning_and_use#23960648 (accessed Nov. 27, 2023).

[3] William Blackstone, Commentaries on the Laws of England 28 (Thomas P. Gallanis ed., 2016).

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100-year life will require creative solutions in the realm of law and public policy, just as it will require ingenuity in the scientific realm.

While other chapters explore the implications of the 100-year life *for* law and public policy, this chapter explores the role *of* law and policy in achieving century-long lifespans. Section 16.1 argues that for 100-year lives to become the norm within the time frame that Gratton and Scott envision, we will need to make extraordinary progress in reducing old-age mortality. These advances will need to be qualitatively different from the disease-specific innovations that attract the bulk of biomedical investment today.

Section 16.2 considers the role of law and policy in efforts to delay aging and death. It argues that patent law – the most familiar tool in the innovation policy toolkit – is ill fitted for the goal of achieving century-long lives. Many of the most promising longevity-enhancing innovations fall outside the legal and practical limits of patent protection. Even for new pharmaceutical and biologic products that lie closer to patent law's core, the long time frame necessary to establish efficacy through clinical trials leaves few years for firms to monetize their innovations. Section 16.2 goes on to consider other legal mechanisms that can potentially sustain longevity-related research and development – specifically the private foundation and the for-profit corporation, which, unlike patents, can have infinite legal lives. Although nonprofit and corporate law have facilitated significant longevity-related investments in recent years, they have done so for reasons that are more idiosyncratic than systematic – and in ways that highlight the potential pitfalls of a private sector-driven quest for 100-year lifespans.

The chapter concludes by considering the political economy of public sector investment in longevity research. To achieve century-long lives, we will likely need governments – in particular, the US federal government – to commit to a moonshot investment in longevity akin to the Apollo project that brought Neil Armstrong and Buzz Aldrin to the lunar surface. But whereas the Apollo project commanded broad bipartisan support, a longevity moonshot is bound to encounter powerful political resistance. That wall of resistance may prove penetrable, but not easily so. Thus the path to a 100-year life will likely require major breakthroughs not only in the laboratory but also in the legislature.

16.1 A 100-YEAR LIFE EXPECTANCY IS STILL SCIENCE FICTION

Understanding the incredible optimism of Gratton and Scott's predictions requires a brief primer in demographic terminology. Life expectancies are conventionally stated in *period mean* terms. Life expectancy at birth in a given year reflects the average number of life-years remaining for a newborn if age-specific mortality rates remain at that year's levels. For example, life expectancy at birth in the US in 2021 was 76.4 years, meaning that if age-specific mortality rates remain at 2021 levels,

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the average age at death would be 76.4.[4] Most likely, babies born in the US in 2021 will on average live longer than 76.4 years because age-specific death rates will decline from 2021 levels. (The year 2021 was especially bad for period mean life expectancy because it coincided with the COVID-19 pandemic's peak.) But of course, we don't know how fast death rates will decline because we can't see into the future.

Gratton and Scott offer life expectancy estimates in *cohort median* terms. By their estimates, 50 percent of babies born in the US in 2007 will live to be at least 104, and half of babies born in Japan that year will celebrate their 107th birthdays. Cohort lifespan estimates are in some ways more useful than period life expectancies because cohort estimates, unlike period estimates, apply to identifiable individuals (individuals born in a given country and year). By contrast, period mean life expectancy at birth in a particular year is *not* an estimate of the mean lifespan of individuals born in that year – it is a calculation of the mean lifespan of individuals born in that year under the unrealistic assumption that all age-specific mortality rates remain at that year's levels. A downside of using cohort statistics, though, is that we can't measure the cohort median until half a cohort has died. Barring catastrophe, we won't know the cohort median lifespan for babies born in the US in 2007 until the late twenty-first or possibly early twenty-second century.

Gratton and Scott draw cohort lifespan projections from a 2009 paper in *The Lancet* by Kaare Christensen, Gabriele Doblhammer, Roland Rau, and James Vaupel ("CDRV").[5] CDRV observe that "best practice" period mean life expectancy – the highest period mean life expectancy in any country in any given year – increased almost linearly at an annual rate of 0.25 years from 1840 into the 2000s. (Sweden was the best practice country for much of that period; Hong Kong is now.) CDRV then translate this observation about best practice period mean life expectancy into projections of cohort median life expectancy for eight high-income countries: Canada, Denmark, France, Germany, Italy, Japan, the UK, and the US.

To arrive at these projections, CDRV assume that period mean life expectancy in high-income countries will increase linearly at an annual rate of 0.2 years into the twenty-second century. They also assume that age-specific mortality rates will follow a particular path that generates annual increases of 0.2 years in period mean life expectancy. Mortality rates from age zero to fifty and from 110 on up will remain

[4] Mortality rate and life expectancy data come from the Human Mortality Database, https://mortality.org (accessed July 17, 2023).

[5] Gratton and Scott cite the Human Mortality Database for their cohort median estimates, *see* Gratton & Scott, *supra* note 1, at 24 fig. 1.1, but that database does not include cohort median projections for post-1990 cohorts. Gratton and Scott's numbers align precisely with estimates in another paper – Kaare Christensen, Gabriele Doblhammer, Roland Rau & James W. Vaupel, *Ageing Populations: The Challenges Ahead*, 374 Lancet 1196, 1197 tbl.1 (2009) – and Gratton and Scott cite Vaupel's work elsewhere. *See* Gratton & Scott, *supra* note 1, at 377.

unchanged from 2006 levels, and mortality rates from age 50 to 110 will decline at a rate of 2.2 percent per year.[6]

To recap: When Gratton and Scott say that "a child born in the West today has a more than 50 per cent chance of living to be over 105," what they really mean is this: If cohort median lifespans in advanced economies grow as fast as CDRV project, then there is a 50 percent probability that a member of a high-income country cohort born in the first or second decade of the twenty-first century will reach age 105.

How plausible are CDRV's projections? As CDRV note, previous prognosticators have often underestimated future life expectancy growth. As recently as 1990, an article in *Science* stated that "it seems highly unlikely that life expectancy at birth will exceed the age of 85"[7] – a threshold that Hong Kong surpassed in 2018. But while past projections of life expectancy growth have been unduly pessimistic, the growth rate that CDRV project appears to be extraordinarily optimistic – for at least two reasons.

First, CDRV project that period mean life expectancy in high-income countries will increase at an annual rate of 0.20 years from 2006 onwards, but we already know that – even before COVID-19 – those countries were not keeping up with that pace. The average annual rate of life expectancy growth across the eight countries in CDRV's study from 2006 through 2019 was 0.15 years, and the rate for the US during that stretch was just 0.09 years. At a 0.15-year annual rate of life expectancy growth from 2006 onwards, none of the eight high-income countries in CDRV's study would reach century-long life expectancies by 2120. At a rate of 0.09 years, US life expectancy in 2120 will be 88.1 years. For US life expectancy to reach 100 within a century, we will need to pick up the pace substantially.

Second, not only are CDRV's period mean life expectancy projections quite optimistic relative to recent experience, but their projections for mortality rates are extraordinarily optimistic in light of historical experience. As noted earlier, CDRV project that mortality rates from age 50 to 110 will decline at a rate of 2.2 percent per year from 2006 to 2120. Yet over the entire period of the Human Mortality Database's coverage from 1933 through 2019, the mortality rate for fifty-year-old Americans has declined at an annual rate of only 1.3 percent, or about three-fifths as fast as CDRV project. And the mortality rate for 100-year-old Americans has declined at an annual rate of 0.2 percent – less than a tenth of the rate that CDRV project going forward.

One might ask: How do CDRV arrive at such optimistic predictions if their model simply projects outwards from pre-2006 life expectancy growth? The primary reason is that CDRV's model does not account for the different trajectories of mortality rates at different age levels. The US, like other high-income countries, made huge

[6] Author's correspondence with Roland Rau.

[7] S. Jay Olshansky, Bruce A. Carnes & Christine Cassel, *In Search of Methuselah: Estimating the Upper Limits to Human Longevity*, 250 SCIENCE 634, 634 (1990).

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progress in reducing childhood and midlife mortality over the course of the twentieth century, which fueled similarly large gains in period mean life expectancy. In recent years, progress in reducing childhood and midlife mortality has slowed (and midlife mortality rates have actually increased in the US since 2010), but even if those mortality rate reductions picked up pace, they would have a relatively small impact on overall life expectancy. Indeed, even if we eliminated *all* mortality before age fifty, life expectancy at birth in the US would increase by less than four years. For century-long lifespans to become the norm, the US and other high-income countries will need to make extraordinary improvements in mortality rates at older ages.

Reducing mortality rates at older ages is not necessarily impossible, but it will require interventions different from those that are effective at younger ages. Disease-specific interventions can lead to large reductions in mortality at younger ages because if a younger person does not die of a particular cause (e.g., breast cancer), she is relatively unlikely to die of a competing cause in the near future (e.g., heart disease). By contrast, disease-specific interventions hold less promise for reducing mortality at older ages because if an older person does not die of a particular cause, she remains highly vulnerable to other fatal risks. For example, the Centers for Disease Control and Prevention estimates that a complete cure for Alzheimer's disease – a top-five cause of death among Americans over age sixty-five – would extend overall US life expectancy by only about seven weeks.[8] To achieve the twenty-year life expectancy increase that CDRV project over a century, we will need to do more than play a game of disease-specific whack-a-mole.

This recognition raises two related questions. The first is whether any intervention – a lifestyle change, a miracle drug, a nonpharmacological therapy, or some other innovation, alone or in combination – can generate the all-cause mortality reductions at older ages that would be needed to realize CDRV's forecasts. The second is whether, if there is any such intervention out there, countries can identify it and disseminate it to their populations. The former is, at bottom, a bioscientific question that lies beyond this chapter's scope. The latter is a question of law, economics, and politics – and the question upon which the remainder of this chapter focuses.

16.2 THE LIMITS OF LAW

16.2.1 *Patents and Their Discontents*

Discussions of law and innovation often begin – and too often end – with intellectual property – in particular, patent law. The promise of patent protection can

[8] Elizabeth Arias, Melonie Heron & Betzaida Tejada-Vera, *United States Life Tables Eliminating Certain Causes of Death, 1999–2001*, 61 NAT'L VITAL STATISTICS REPORT, 1, 101–104 tbl. 22 (2013).

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encourage profit-seeking firms to undertake costly investments in the development of new technologies. But for most innovations with the potential to bring about century-long lifespans, the incentives generated by patent law are severely underpowered.

Consider, for example, intermittent fasting (fasting for one to two days per week), which – according to a recent article in the *New England Journal of Medicine* – appears to have "broad-spectrum benefits for many health conditions, such as obesity, diabetes mellitus, cardiovascular disease, cancers, and neurologic disorders."[9] While the strength of these findings is a subject of much debate among biomedical researchers, the example of intermittent fasting provides a helpful illustration of patent law's limits. A method for extending human lifespan through intermittent fasting would almost certainly lie outside the scope of patent eligibility under current law.[10] And even if Congress changed the law to permit patents on dietary innovations, it is hard to see how a patent on intermittent fasting could be enforced. A patent holder could not realistically determine whether individuals have gone twenty-four hours without eating and sue them if so. A firm that sponsored a clinical trial successfully showing that intermittent fasting extends lifespan would have little ability to monetize its investment.

Other promising longevity-enhancing interventions relate to drugs that have been off-patent for several years – and there, too, existing legal institutions generate weak incentives for research. Consider metformin – a drug that has been used to treat Type 2 diabetes for decades and that has been off-patent in its tablet formulation in the US since the beginning of the millennium. A 2014 study lifted hopes that daily metformin use might produce significant reductions in all-cause mortality even in nondiabetic patients.[11] But in the decade since that finding grabbed headlines, no pharmaceutical firm has conducted a clinical trial to see whether the results are robust. In 2015, the FDA green-lighted a proposal for a study to test whether metformin could reduce all-cause mortality in elderly patients, but the researchers who designed the trial have failed to attract the necessary funding – roughly $50 million.[12]

Why have for-profit firms proved unwilling to finance a clinical trial of metformin – notwithstanding the potentially massive demand for a drug that reduces the risk of death across the board? In theory, firms can apply for new-use patents

[9] Rafael de Cabo & Mark P. Mattson, *Effects of Intermittent Fasting on Health, Aging, and Disease*, 381 New Eng. J. Med. 2541, 2548 (2019).

[10] *See In re* Zunshine, 816 Fed. App'x 477 (Fed. Cir. 2020) (affirming Patent and Trademark Office's rejection of patent application for method of calorie restriction).

[11] C. A. Bannister et al., *Can People with Type 2 Diabetes Live Longer Than Those Without? A Comparison of Mortality in People Initiated with Metformin or Sulphonylurea Monotherapy and Matched, Non-Diabetic Controls*, 16 Diabetes, Obesity & Metabolism 1165 (2014).

[12] Megan Molteni, *As Billionaires Race to Fund Anti-Aging Projects, a Much-Discussed Trial Goes Overlooked*, STAT News (Aug. 9, 2022), https://www.statnews.com/2022/08/09/anti-aging-projects-funding-much-discussed-trial-overlooked.

covering the application of an existing drug to treat a different medical condition – for example, the use of metformin to reduce all-cause mortality in nondiabetic patients. However, enforcing a new-use drug patent is extraordinarily difficult in practice. Typically, a pharmacist who fills a metformin prescription will not know whether the prescribing physician ordered metformin as an antidiabetic medication or an antiaging drug. And in many states, the pharmacist has a legal obligation to fill the prescription with the cheapest medicine available.[13] Thus, even when physicians prescribe a drug for a new use, the revenues are likely to flow to a low-cost generic manufacturer rather than the new-use patentee.

Even for new longevity drugs that are legally eligible for patent protection, long commercialization lags are likely to remain a significant impediment to profit-seeking investment. An analogy from the cancer context sheds light on the scope of the challenge. Eric Budish, Benjamin Roin, and Heidi Williams have shown that private sector firms are less likely to initiate clinical trials for drugs that treat slow-acting cancers than for drugs that target fast-acting cancers.[14] An important reason is that trials for slow-acting cancers last longer, thus taking up a larger chunk of the twenty-year patent life. By the time a pharmaceutical firm can win approval from the Food and Drug Administration (FDA) for an early-stage cancer treatment, the firm has only a short period of exclusivity within which to monetize its investment before generics can enter.

Aging is the ultimate slow-acting disease. Each step of the research process is likely to take longer for antiaging agents than for therapies that target quick killers. The antiaging treatment may require years to show any effect, and even if the effect on aging is immediate, the effect on clinical outcomes – for example, all-cause mortality – may not be detectable until much later. By that point, the patent clock may have run out.

A possible policy solution is to extend the exclusivity period for treatments that slow the aging process. Congress has enacted several other provisions that provide fixed periods of market exclusivity for manufacturers of new drugs, irrespective of whether the patent term has expired. For example, under the Orphan Drug Act of 1983, the manufacturer of a drug that treats a "rare disease" – typically a disease affecting fewer than 200,000 people in the US – can qualify for seven years of market exclusivity starting from the date of FDA approval, even if patent protection has run out. Aging is the polar opposite of a rare disease – it affects us all – but Congress could seek to incentivize the development of antiaging drugs by offering a similar exclusivity period. Such a statute might, for example, make eligibility conditional

[13] Daniel J. Hemel & Lisa Larrimore Ouellette, *The Generic Drug Trilemma*, 2 Entrepreneurship & Innovation Policy & the Economy 41, 47–48 (2023).

[14] Eric Budish, Benjamin N. Roin & Heidi Williams, *Do Firms Underinvest in Long-Term Research? Evidence from Cancer Clinical Trials*, 105 Am. Econ. Rev. 2044 (2015).

upon the manufacturer demonstrating a statistically significant reduction in all-cause mortality among the general population.

Exclusivity, however, is a double-edged sword. Market exclusivity incentivizes investment because it allows firms to charge higher prices for their products. Those higher prices tend to place products out of the reach of some consumers. Exclusivity thus implicates a trade-off between innovation and access, potentially resulting in the development of more antiaging interventions but not necessarily ensuring that those interventions reach more patients.

Another way for policymakers to encourage pharmaceutical firms to invest in the development of antiaging drugs would be for the FDA to confirm that a drug that reduces all-cause mortality – even if it does not target any specific disease – could achieve agency approval. Traditionally, the FDA has oriented its approval process around a "one disease, one drug" model, raising doubts that a drug that extends lifespan but does not target a specific recognized disease could be approved for sale in the world's most lucrative pharmaceutical market. The FDA through regulatory guidance – or Congress through legislative action – could lay that concern to rest.

But even with the promise of market exclusivity beyond the end of the twenty-year patent life, and even with assurance that the FDA would approve an effective antiaging drug, large pharmaceutical companies still may balk at R&D efforts that won't affect quarterly earnings in the short to medium term. Likewise, biotech startups may steer away from projects that won't come to fruition before venture capital funding runs out. These concerns about short-termism motivate a search for institutions beyond the pharmaceutical and biotech sectors that might facilitate investment in longevity research.

16.2.2 *Nonprofits and Pet Projects*

The first stop on that search is an institution with a long history of financing ambitious public health investments: the philanthropic foundation. Millionaire and billionaire philanthropists who fund foundations would seem to have more of an incentive to invest in longevity research than in solving most other public health problems. After all, while many global public health challenges (e.g., malaria and tuberculosis) are unlikely to affect millionaires and billionaires, extreme wealth is no cure for aging. Foundations, moreover, can operate on a longer time frame than publicly traded corporations that must report quarterly earnings, or startups burning through their venture capital funding. Longevity research, with its high risks and long timelines, would seem to be exactly the sort of area in which foundations can play a productive role.

Some foundations have indeed emerged as major funders of longevity research. One of the most famous cases in the law of philanthropy – mentioned in almost every nonprofit law casebook – even has a longevity twist. *In re Estate of Buck*,

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described at the time as the "Super Bowl of probate,"[15] involved the will of Beryl Buck, a long-time resident of wealthy Marin County outside San Francisco. Buck's will established a charitable trust – a private foundation for tax purposes – that was to be used entirely for nonprofit activities in Marin. Buck funded the trust with oil company stock that traded for less than $10 million at the time of her death but ballooned in value to more than $250 million a few years later.

Reasoning that Buck's largesse exceeded Marin County's needs, the San Francisco Foundation – Buck's designated trustee – sought permission from a California probate court to distribute trust income across the Bay Area. The court rebuffed the foundation's request, ordering instead that funds be allocated to Marin-based projects with the potential to benefit "all of humankind." One of these, in northern Marin County, is now named the Buck Institute for Research on Aging and provides a home to a world-class faculty of academic scientists searching for cures to age-related diseases.

Yet foundations like the Buck Trust are unlikely to fill the void left by industry underinvestment in longevity research. Foundation funding is often contingent upon the whims of millionaires and billionaires whose moneymaking skills in one sector – or whose luck in the birth lottery – may not necessarily qualify them as biomedical grantmakers. While perpetual trusts like Buck's may provide sustained support, other foundations – especially those with living donors – can be more mercurial. A case in point is the Ellison Medical Foundation, financed by Oracle cofounder Larry Ellison, which spent more than $300 million on antiaging research before Ellison abruptly halted further funding in 2013.[16] Moreover, the aggregate amount of foundation funding for biomedical research remains just a drop in the bucket relative to industry and public sector sources – only around 1 percent of total US biomedical research spending, compared to 66 percent from industry and 25 percent from the federal government.[17]

In recent years, another private sector source has emerged as a much more significant funder of longevity research – at least in dollar terms – than any philanthropic foundation: Alphabet, the parent company of Google. Since 2014, Alphabet has committed $1.75 billion to Calico Life Sciences, an internal laboratory focused on longevity. This is a startling sum for a for-profit company to spend on R&D unrelated to its core business. Yet it represents less than 0.1 percent of Alphabet's market capitalization as of this writing.

[15] *In re* Estate of Buck, No. 23259 (Cal. Super. Ct. 1986), reprinted in 21 U.S.F. L. Rev. 691 (1987); *see* Douglas Bartholomew, *The Battle for the Buck*, L.A. Times (Dec. 21, 1986), https://www.latimes.com/archives/la-xpm-1986-12-21-tm-3738-story.html.

[16] Tad Friend, *Silicon Valley's Quest to Live Forever*, New Yorker (Mar. 27, 2017), https://www.newyorker.com/magazine/2017/04/03/silicon-valleys-quest-to-live-forever.

[17] Research! America, *U.S. Investments in Medical and Health Research and Development, 2016–2020* (2022), https://www.researchamerica.org/wp-content/uploads/2022/09/ResearchAmerica-Investment-Report.Final_.January-2022-1.pdf.

Alphabet has faced criticism for pursuing what seems like a distraction from its profit-generating activities.[18] But Alphabet's dual-class corporate structure shields the company from investor pressure. Cofounders Larry Page and Sergey Brin control more than 50 percent of Alphabet's voting power, even though they own only a little more than one-tenth of the corporation's stock by value. This dual-class structure would seem to encourage pet projects like Calico, because the cofounders who effectively decide whether to pursue the projects bear only a fraction of the cost.

Nevertheless, mega-corporations like Alphabet are no more likely than philanthropic foundations to bring about century-long lives. For one thing, laboratories inside mega-corporations are vulnerable to their own pathologies. Biomedical researchers outside Calico have described Alphabet's longevity lab as "hyper secretive" – a clandestinity consistent with the competitive corporate culture of Silicon Valley but at odds with the values of academic science.[19] For another, Alphabet's $1.75 billion commitment – though beyond the means of all but the wealthiest private foundations – still pales in comparison to the more than $100 billion that the biopharmaceutical industry spends on R&D each year. Alphabet no doubt has the resources to up its commitment, but at some point – notwithstanding the insulation provided by a dual-class share structure – forces inside and outside the corporation (e.g., independent directors and institutional shareholders) would likely push back if Alphabet allocated substantially more money to a research effort so far afield from the company's core competencies.

Thus, even in a "second Gilded Age" of billionaire philanthropy and trillion-dollar mega-corporations, we cannot rely exclusively on the private sector to lead us down the path to century-long lives. By far, the entity with the greatest ability to finance longevity research – perhaps the only hope for investment on the requisite scale – remains the US federal government. The prospects for the 100-year life thus depend, in large part, on the political economy of public sector investment in longevity. Encouragingly, the US has a history of financing large-scale R&D efforts – the Apollo project being the most famous example. But as this chapter's final section highlights, the political landscape for the 100-year life is far less inviting than it was for the original moonshot.

16.3 THE POLITICAL ECONOMY OF THE 100-YEAR LIFE

Each year Congress plows tens of billions of dollars into biomedical research – with $47.5 billion budgeted for the National Institutes of Health (NIH) in fiscal year 2023.

[18] *See* Leonid Bershidsky, *Google's Main Business Could Use Some Moonshots*, BLOOMBERG (May 8, 2021), https://www.bloomberg.com/opinion/articles/2021-05-08/google-s-other-bets-should-focus-on-its-main-business.

[19] Julia Belluz, *Google Is Super Secretive about Its Anti-Aging Research. No One Knows Why*, VOX (Apr. 28, 2017), https://www.vox.com/science-and-health/2017/4/27/15409672/google-calico-secretive-aging-mortality-research.

Yet only a tiny sliver of that sum – $405 million – goes toward the Division of Aging Biology (DAB), the unit within NIH's National Institute on Aging that studies interventions that might slow the aging process.[20] (The bulk of the National Institute on Aging budget goes toward Alzheimer's disease and related dementias.) To put the DAB figure in perspective, NIH now spends more each year on research related to brain cancer than the DAB's entire budget, even though brain cancer affects 0.1 percent of the population while aging ultimately affects everyone.[21]

In recent years, several scientists and public health advocates have argued for a dramatic increase in federal funding for longevity research – a "longevity moonshot."[22] They argue that sustained federal investment – on the order of $3 billion annually – will produce long-lasting health and economic gains that compensate for the cost many times over. As the DAB funding figures illustrate, this argument has yet to win over congressional appropriators. Why not?

A partial answer is that the push for a longevity moonshot defies the logic of collective action. As economist Mancur Olson famously observed, small groups with well-defined memberships enjoy political advantages vis-à-vis larger and more diffuse groups: they are better able to forge common identities and less vulnerable to free-riding.[23] The success of rare-disease patient groups in securing federal funding for orphan drug research is arguably an illustration of the Olsonian logic: Relatively small groups of rare-disease patients have large individual stakes in finding a treatment or cure – and often strong group identities borne out of a shared experience. By contrast, individuals experiencing the aging process are the ultimate large group: Everyone is included.

Beyond the large-group problem, proponents of a moonshot investment in delayed aging face a fiscal challenge. Although the $3 billion-per-year outlay proposed by moonshot advocates would have only a trivial effect on the federal government's fiscal position, the effort would – if successful in lengthening lifespans – lead to a significant increase in the number of people eligible for old-age entitlement programs such as Social Security and Medicare. Some of the corresponding fiscal burden could be offset by additional tax revenues from older workers who remain in the labor force for longer, as well as from a reduction in per-capita Medicare costs among healthier seniors. Yet economist Dana Goldman and coauthors have projected that even with those offsets, an increase in life expectancy of 2.2

[20] US Dep't Health and Human Services, Congressional Justification FY 2024 (2023), at 18–19, https://www.nia.nih.gov/sites/default/files/2023-03/nia_congressional-justification_fy2024.pdf.

[21] *Estimates of Funding for Various Research, Condition, and Disease Categories*, Nat'l Institutes Health (Mar. 31, 2023), https://report.nih.gov/funding/categorical-spending#.

[22] S. Jay Olshansky et al., *The Longevity Dividend*, The Scientist (Mar. 2006), https://www.the-scientist.com/uncategorized/the-longevity-dividend-47757; Bonnie Kavoussi, *The Case for a Longevity Moonshot*, Foundation for Am. Innovation (July 27, 2021), https://www.thefai.org/posts/the-case-for-a-longevity-moonshot.

[23] Mancur Olson, The Logic of Collective Action (1965).

years due to delayed aging would add nearly $420 billion to the federal entitlement deficit by 2060.[24] The life expectancy gains envisioned by CDRV – twenty years over the course of a century – would place an even greater burden on Social Security and Medicare.

Economically the US could very likely bear the additional fiscal weight of an older but healthier population. For example, Goldman and coauthors estimate that raising the Social Security normal retirement age and the Medicare eligibility age to sixty-eight would more than offset the additional entitlement program costs of delayed aging. But as demonstrated by the recent experience in France – where President Emmanuel Macron's increase in the retirement age from sixty-two to sixty-four sparked nationwide strikes – retirement age changes remain "the third rail" of politics across the high-income world. An alternative way to offset rising entitlement program costs would be to raise taxes, but both major political parties in the US have soured on broad-based tax hikes in recent years. Most Republican lawmakers have pledged not to vote for any net tax increase, while Democratic President Joe Biden has promised not to raise taxes on any household earning less than $400,000 annually – a promise that puts three-quarters of the income tax base beyond reach.

To be sure, the entitlement spending effects of longer lifespans will accrete slowly, with most of the expenditures lying decades down the road. By then, most of today's elected officials will have long since retired, died, or been ousted by voters. In that respect, political short-termism – unlike corporate short-termism – may be complementary to longer lifespans: Lawmakers can appropriate more funds to a longevity moonshot while externalizing the difficult fiscal choices to their successors.

But even if the extra entitlement spending triggered by longer lifespans won't come due for decades, government debt markets may transform those future liabilities into near-term costs. As the US proceeds down a fiscally unsustainable path, investors are likely to demand higher interest rates on Treasury bonds. For that reason, today's lawmakers may be reluctant to commit to a longevity moonshot that – without unpopular entitlement reforms or tax hikes – will force the federal government to face higher near-term debt service expenses.

This is where the science fiction and the political fiction of the 100-year life converge. The Olsonian logic of collective action is not an iron law: Advocates for programs with diffuse benefits sometimes prevail in the hurly burly of distributional politics. But to do so, proponents of a longevity moonshot will need to weave a narrative that motivates legislators to allocate funds toward longevity research. In other words, the biomedical advances needed to normalize century-long lifespans will likely depend on political developments that require storytelling and imagination.

This political-fiction framing flips Gratton and Scott's script. Gratton and Scott tell us that the 100-year life is coming, and they argue that policy needs to adapt to

[24] Dana P. Goldman et al., *Substantial Health and Economic Returns from Delayed Aging May Warrant a New Focus for Medical Research*, 32 Health Affs. 1698 (2013).

that reality. But whether the 100-year life becomes a reality depends in large part on whether longevity moonshot advocates can convince lawmakers and voters that century-long lifespans are worth pursuing. That persuasion effort involves many of the same elements as Gratton and Scott's adaptation effort: thinking about how different elements of law and society might respond to century-long lifespans and considering whether those responses would leave us better off or worse. But at the end of the day, whether we proceed down the path to a 100-year life remains a political choice, not a fait accompli.

The science fiction and political fiction aspects of the 100-year life merge in another respect: Mapping out the plausible biomedical pathways to century-long lifespans will help us understand what collateral benefits a longevity moonshot might bring. The original moonshot and other NASA space exploration efforts have generated a long list of spinoff technologies ranging from the programmable cardiac pacemaker to the modern cochlear implant. A longevity moonshot may likewise yield collateral biomedical benefits. For example, research on intermittent fasting may yield glycemic control benefits for Type 2 diabetes patients.[25] Senolytic therapies that delay or reverse aging may help address frailty among childhood cancer survivors.[26] By highlighting these and other potential payoffs, longevity moonshot proponents may be able to forge political alliances with advocates for disease-specific research, who – for Olsonian reasons – tend to be better organized and more easily mobilized.

In short, understanding the 100-year life as an aspiration rather than an inevitability may make the outcome more realistic. Our legal and political institutions can help to provide the support that makes scientific breakthroughs more likely, but first, advocates will need to convince lawmakers that a longevity moonshot justifies the financial and political costs. Thus, to say that the 100-year life is a work of science fiction, legal fiction, and political fiction is not to write off the possibility of century-long lifespans. Rather, it is to say that in order to achieve the 100-year life, we need to imagine it first. In that sense, the enterprise that Gratton and Scott ask us to engage in is worthwhile even though – indeed, precisely because – century-long lifespans cannot be taken for granted.

[25] Sharayah Carter, Peter M. Clifton & Jennifer B. Keogh, *Effect of Intermittent Compared with Continuous Energy Restricted Diet on Glycemic Control in Patients with Type 2 Diabetes: A Randomized Noninferiority Trial*, 1 JAMA Network Open e180756 (2018).

[26] J. L. Kirkland & T. Tchkonia, *Senolytic Drugs: From Discovery to Translation*, 288 J. Internal Med. 518 (2020).