Human Longevity and Savings: A U.S. Case Study

Benjamin S. Forman

Preface

The fundamental question of "How long will we live?" has been asked since the beginning of recorded human history. Still today, biologists, demographers, statisticians, geneticists and economists alike grapple with this basic inquiry of human longevity. Religion has even addressed the issue, stating in Genesis 6:3 that people could not live longer than 120 years – "And the Lord said, 'My spirit shall not strive with man forever, for he is indeed flesh; yet his days shall be one hundred and twenty years."

Amidst all hypotheses and beliefs regarding human longevity, the empirical evidence speaks for itself: humans are living to older ages than ever before. Over the past century, global life expectancy has increased from thirty-two years in 1900 to sixty-seven years today[1]. The number of centenarians, people living over the age of 100, has doubled each decade since 1950 in industrialized countries[2].

This trend does not appear to be a past phenomenon; in fact, mortality rates continue to decline unimpeded at old ages. Regardless of the breadth of aging research, no consensus has been reached as to the future trajectory of human life expectancy or to the limitations of human longevity. If anything, mankind has been left with more questions than answers.

The consequences of the global ageing trend have already penetrated social, political, and economic arenas. Socially, the family structure has been altered and there is an increased demand for geriatric services and products. In politics, elected officials have been forced to address issues stressed by the elderly population. From an economic standpoint, governments have readdressed public policies and long term pension plans. Individuals, as well, have had tougher decisions to make with regard to savings and retirement.

This paper is divided into two main parts. The first part outlines the three main scientific camps with regard to the controversial issue of the future of human longevity. The second part of the paper focuses on a single economic consequence of increasing longevity, namely the savings decisions of individuals. Finally, it provides a commentary on the confluence of longevity increases and decreasing savings rates in the United States.

Introduction

The modern era has brought with it an unprecedented rise in human longevity. After fluctuating between twenty and thirty-five years since the Neolithic Age, human life expectancy has experienced a dramatic increase over the past two centuries. Due to improvements in public health and welfare referred to as the "health transition", life expectancy stood at sixty-seven years at the turn of the 21st century. Certain developed countries have even achieved life expectancies above eighty years, with Japan ranked highest at eighty-two[3]. This striking increase in longevity has already produced a tangible demographic change – the number of people aged 60 years or over has increased from 200 million in 1950 to 700 million in 2006[4].

But to what extent will this trend continue? Is the dramatic increase in life expectancy indicative

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1 James C. Riley, "Estimates of Regional and Global Life Expectancy, 1800-2001" *Population and Development Review* 31 (2005), 538.

2 Kevin G. Kinsella, "Future Longevity–Demographic Concerns and Consequences," *American Geriatrics Society* 53 (2005), 301.

3 CIA Factbook, 2007, 24 Mar. 2008.

4 World Population Ageing, United Nations Department of Economics and Social Affairs, Population Division, (2007), xvii

of a long term trend or merely a past aberration? Some believe that linear extrapolations of mortality decreases are the best method of forecasting global life expectancy. Such approaches project people to live until 100 years or more within the close of the 21st century[5]. Others, however, take an even more bullish approach—predicting that human life expectancy will increase exponentially due to the reversing of aging in the wake of unprecedented scientific and genomic advances. Aubrey de Grey, the leader of Strategies for Engineered Negligible Senescence (SENS) at Oxford, has boldly stated that through reversing and curing the process of aging, "the first person to live to 1,000 might be 60 already"[6]. Many, however, dismiss these claims as speculative science. They claim that it is illogical to assume the future will be like the past, and even more nonsensical to project four-digit life expectancies. This contingency of scientists refers to themselves as "realists"—positing that the upper limit to mean human longevity is age eighty-five.

While the scientific community remains divided as to the rate of future increases in human longevity, they agree that the prior increases and potential further improvements will profoundly affect the economic sphere[7]. The extension of lifespan influences an individual's savings-consumption decision, investment in education, and retirement pensions. It poses serious issues to government health care plans, such as the U.S. Social Security System and Medicare. Many speculate that the aging phenomenon is inflationary since a larger portion of the population is not contributing to the economy but still demanding goods.[8] Also, as the average lifespan increases, so does the standard deviation, putting more pressure on the individual to make estimations regarding their own length of life.[9] While the economic effects of increasing longevity are broad, this paper intends to examine savings through the lens of increasing lifespan.

History

In order to conjecture about the future path of human life expectancy, it is necessary to understand its past. For most of human history, life expectancy remained fairly constant. It is believed that global life expectancy fluctuated between twenty and thirty-five years since the Neolithic Revolution, and at the turn of the 19th century, was likely below twenty-five years[10]. Many women died in childbirth and nearly half of children died before the age of ten.

However, at the turn of the 19th century, a steady rise in life expectancy began to take place in Northwestern Europe. University of Indiana's James C. Riley documents this dramatic change in his book "Rising Life Expectancy: A Global History", dubbing it the "health transition". The preliminary engines of longer life, according to Riley, were products of the increased standard of living brought about by the industrial revolution, such as better nutrition standards and improvements in housing and clothing. During the latter part of the 19th century, additional increases to life expectancy were achieved through sanitary projects. The drivers of increased longevity in the 20th century were economic development, public health, and biomedicine[11].

By 1850, the changes that were taking place in Northwestern Europe were also occurring in Australia, New Zealand, and Canada. By the turn of the 20th century, Japan, Eastern Europe, the United States, and some countries of Latin America joined in. In the past half century, other developing economies,

5 Jim Oeppen & James W. Vaupel, "Broken Limits to Life Expectancy," *Science* 296 (2002), 373.

6 Aubrey De Grey, "We Will Be Able to Live to 1,000," *BBC News,* 3 December 2004.

7 World Population Ageing Executive Summary 2007, xxvi.

8 Assumes that members of the elderly population contribute to the demand rather than supply of economic goods and services

9 This assumes that future gains to life expectancy are primarily due to reductions in senescent mortality rather than infant and background mortality.

10 James C. Riley, *Rising Life Expectancy: a Global History*, (Cambridge: Cambridge UP, 2001), 33.

11 Riley, 8.

such as those of India and China, began their health transitions.

The numbers are staggering. Despite the dearth of life expectancy data in early history, it is believed that global life expectancy has increased more than two-fold in the past two centuries. A study by a Dutch Demographer named John Bongaarts examined a cohort of 16 high income countries with life expectancy records traced back until 1850. The data showed a steady upward trend from 40-45 years of age up to 75-80[12]. The only interruptions to this trend were the global influenza pandemic and the two world wars.

High-income countries are not the only ones who have rode the longevity wave. In fact, every continent on the globe has experienced life expectancy increases since 1950[13]. According to a U.N. report, life expectancy in a cohort of "least developed" countries increased from roughly 35 in 1950 to around 53. In the same study, a broader-defined set of "lesser developed" countries experienced similar increases from 40 years to around 62[14]. An interesting observation generated by the report is that the gap in life expectancy between the first and last ranked country decreased from 31 years to 25 years over the past half century. However, on a broader level, studies have concluded that there is no overall convergence trend between low and high life expectancy countries.

In light of this finding, it is prudent to examine the leaders rather than the laggards when examining the future course of life expectancy. In other words, one can assume that a country such as Belize, with a slightly above average life expectancy, will eventually achieve the gains that the leading countries have already experienced. In assessing the future of global life expectancy, we draw our focus to the countries that have achieved remarkable advances in life expectancy, such as Japan, the United States, and the countries of Western Europe. The gains in life expectancy that these leading countries have garnered from advancements in economic development and public health will likely soon be realized by the less advantaged countries. This train of thought rests on the notion that all people of the world, regardless of ethnicity or gender, are endowed with an equal quantity of health capital. Therefore, if Singaporean women achieve a life expectancy of 90 years, then we can logically deduce it is possible, at a point in time, for global life expectancy to achieve that mark. The worldwide cohort with the highest life expectancy is deemed the "best practice life expectancy"—a metric commonplace in demographic analysis and a centerpiece in many studies regarding future life expectancy.

Three Schools of Thought on the Future of Global Life Expectancy

Projecting the future course of human longevity is no easy task. Economists, biologists, politicians, doctors, statisticians, and demographers have produced a magnitude of literature trying to answer the straightforward questions of: How long will humans live in the year 2100? What about the year 2300? Is there a maximum human life span? The answers to these questions have produced anything but a consensus. In fact, academics within the same discipline have come up with completely different answers.

To simplify things, the prevailing views of future human longevity can essentially be placed into three schools of thought: the realists, the optimists, and the futurists.

The Realist Camp: A Peak at 85

In a 1980 article in the *New England Journal of Medicine*, James Fries made the bold prediction that

12 John Bongaarts, "How Long Will We Live?" *Population and Development Review,* 32 (2006), 605.

13 World Population Prospects: the 1998 Revision, United Nations Secretariat, New York: Department of Economic and Social Affair, Population Division, (1988), 546-573.

14 World Population Prospects: the 2006 Revision, United Nations Secretariat, New York: Department of Economic and Social Affair, Population Division, (2007), 1-21.

human life expectancy had a natural limit at 85 years with a standard deviation of 7 years[15]. The Fries' Hypothesis, as it came to be known, is the fulcrum of what is now known as the Realist camp. Realists believe that, in the absence of medical interventions, average human life expectancy is unlikely to exceed 85 years. This theory is rooted in both biological and statistical underpinnings.

The origin of Fries work can be traced back to Aristotle. The Aristotelian view on human life span was incredibly simplistic, yet it was widely accepted for over two millennia and still has a following today. Aristotle believed that there were two forms of death—premature and senescent. Premature death was the equivalent of extinguishing a fire with a bucket of water; senescent death consisted of burning all the wood until it extinguished on its own. Aristotle maintained that each individual was born with a fixed amount of "fuel" or wood, and therefore had a finite limit to their lifespan.

Today, Dr. Carnes and Olshansky, two prominent realist colleagues, have produced copious amounts of literature to support the realist camp. As students of medicine, they take a scientific angle to aging—contending that a longevity gene is not naturally selected for because it falls beyond the reproductive ages[16]. As a result, harmful genes are able to operate at old ages without any Darwinian opposition[17]. In other words, realists believe that investing physiological capital into the body beyond the reproductive years and those years needed to nurture offspring is an unnecessary outlay[18]. According to this view, the longevity increases seen over the past century do not have evolutionary sources, but are due to exogenous causes such as improvements in public medicine. Likewise, any further increases in life expectancy beyond the age of 85 must be a result of further decreases in infant mortality and other premature deaths. Realists rest on the notion that past improvements in life expectancy were shocks, rather than engines, and are unrepeatable by nature. For instance, the reduction in mortality due to the creation of the polio vaccine was a one-time shock, rather than a continuous source of improvement.

Nevertheless, the Realists acknowledge that the modification of the human genome by artificial means or reversing the process of aging could provide a way to extend life expectancy beyond 85. They also recognize that advances in nanotechnology and other sciences could provide a breakthrough in longevity. However, given mankind's current ability and willingness to manipulate senescent genes, life expectancy's peak will not exceed 85 years.

Why the number 85? The study conducted by Olshanky and Carnes demonstrated that in order to reach this target life expectancy, death rates would have to be reduced by 55% from 1985 levels—a reduction equivalent to the elimination of cancer and heart disease. Furthermore, this study concluded that, with infant mortality constant at 5%, the elimination of all deaths before the age of 85 would be required in order for humans to achieve a life expectancy of 100 years. In other words, no deaths under the age of 85 could occur due to car accidents, homicides, cancer, obesity, HIV/AIDS, and other prominent mortality causes in order for humans to live to an average age of 100[19].

In addition to contemplating a maximum average human life span, realists also take a stance on the limit to human life. Olshanky and Carnes liken human longevity limits to world record times for the one-mile run. Times that were beat by several seconds in the past are now surpassed by only fractions of a second. They claim that "a naïve extrapolation model...leads to the prediction that eventually the race will be completed the very moment the starting gun fires"[20]. In other words, realists claim that there are practical constraints on how long humans can live. In their words, "while bodies are not designed to fail,

15 James F. Fries, "Aging, Natural Death, and the Compression of Morbidity." *New England Journal of Medicine*, 303 (1980), 130.

16 Bruce A. Carnes and S. Jay Olshansky, "A Realist View of Aging, Mortality, and Future Longevity," *Population and Development Review,* 33 (2007), 371.

17 John R. Wilmoth, "The Future of Human Longevity: a Demographer's Perspective," *Science*, 280 (1998), 396.

18 T.b.l. Kirkwood, and R. Holliday, "The Evolution of Ageing and Longevity," *Proceedings of the Royal Society of London,* 205 (1979), 535.

19 Kinsella, 300.

20 Olshanky and Carnes, 374.

neither are they designed for extended operation"[21]. Because bodies are not built for extended operation, life span is finite and subject to a warranty.

The Optimists' Take: 100 and Beyond

The optimist camp consists of those who believe that life expectancy will exceed the realist's peak at 85 years but will not experience an exponential rise, as the futurists claim. Optimists claim that life expectancy will continue to improve past the age of 85, and perhaps into the early or mid 100's towards the end of the century. This view is based on statistical approaches and sociological explanations.

One of the most prominent longevity optimists is demographer James Vaupel. He argues that a limit to human life expectancy either does not exist or is out of the realm of current conceivability based on past empirical data. He points out that many published historical estimates of life expectancy limits have been surpassed. In 1928, the statistician of the Metropolitan Life Insurance Company, Louis Dublin, predicted a limit of 64.75 years to human life expectancy. Unbeknownst to him, this barrier had already been broken by non-Maori New Zealand women. More recently, Olshanky's 1990 prediction of a life expectancy limit of 35 years at 50 years of age was broken six years later by Japanese females[22]. These are two of many instances of experts publishing life expectancy limits that later turn out to be broken. In fact, the U.N. Population Council has continuously made upward revisions to life expectancy limits from the 1950's through 1980, at which point they abandoned the practice of imposing limits[23]. Furthermore, the US National Research Council recently concluded that any limits to life expectancy are too far above the current level to impose ceilings in future projections.

In addition to scrutinizing past predictions, Vaupel's argument also draws upon linear extrapolations of historic life expectancy data. He uses a metric deemed "best-practice life expectancy"— a measure of the highest gender and country-defined cohort globally. For instance, in 2007, the best-practice life expectancy cohort was Andorran females at 86.62 years. Vaupel notices an astonishingly linear trend in best-practice life expectancy. The data shows that best-practice life expectancy has risen steadily for the past 160 years at a pace of approximately 3 months per year (r^2=.992). In 1840, Swedish women were the longest-living cohort at 45 years; in 2002, Japanese women were living to a global high of 85. The regression line shows a slope of .243, namely an increase of a quarter-year per year, or two and a half years per decade. The best-practice life expectancy line happens to be equivalent to the record-holding female life expectancy country line due to the gap between female and male life expectancies.[24] However, it is noteworthy that record life expectancy for men has also risen linearly, albeit at a slightly slower rate of .222 years per year.

The value of these findings is incredibly significant. According to Vaupel, it suggests that "reductions in mortality should not be seen as a disconnected sequence of unrepeatable revolutions but rather as a regular stream of continuous progress"[25]. This finding runs precisely counter to the realist claim. Moreover, the gap between a cohort's life expectancy and best-practice life expectancy provides "a measure of how much better a country might do at current states of knowledge and demonstrated practice"[26]. As mentioned earlier, there is no reason to assume that any nationality or gender is innately endowed with more health capital than another. As a result, the laggards should be able to experience the mortality decreases that come along with improvements in income, nutrition, education, medicine

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21 Olshanky and Carnes, 374.

22 Oeppen and Vaupel, 1031.

23 Bongaarts, 607.

24 Throughout history, females have had longer life expectancies than males

25 Oeppen and Vaupel, 1029.

26 Oeppen and Vaupel, 1029.

and the like. Extrapolations of the data produce a scenario in which record life expectancy would reach 100 years in six decades.

The realist and optimist camps often engage in dialogue on specific issues within the longevity debate. For instance, the realists claim that gains in global life expectancy have leveled off in recent decades relative to the first half of the 20th century. Wilmoth and other optimists acknowledge that life expectancy has leveled off in the past century, but that death rates have, in fact, declined at an accelerating rate. In other words, as Wilmoth points out, it is possible for life expectancy to increase at a decelerating rate, while decreases in mortality remain constant or even accelerate. Life expectancy is, by definition, "the average age at death for any group of individuals whose lifetime mortality experience mirrors that of the period in question"[27]. As a result, the decline in infant mortality at the beginning of the century had a greater impact on life expectancy than the decrease in old-age mortality is having today. This is for the simple reason that saving an infant, who may have lived to seventy-five, produces far greater gains in life expectancy than an elderly member surviving to eighty instead of seventy-five. In other words, diminishing gains in life expectancy doesn't mean that longevity increases are coming to a halt.

Vaupel and other scholars in the optimist camp point to the fact that age-specific death rates at the oldest ages have exhibited steady declines and show no signs of leveling off. This trend is undetectable in life expectancy data, but it has become apparent through several studies examining death rates of the elderly. These claims run counter to several primary realist tenets. One centerpiece of the realist camp is the Gompertz curve, which describes an exponential increase in death rates with age. However, recent studies have invalidated the Gompertz curve due to the dramatic increases in survival of the elderly. Another long standing realist claim made by Fries (1980) suggested that: "the number of very old persons will not increase". In spite of this, Kannisto looked at demographic data from 27 developed countries and discovered that the number of centenarians has roughly doubled every decade since 1950. Further, the population above age 80 has more than tripled in the forty years following 1950, growth disproportionate to that of the overall population.

Numerical analysis shows that average death rates in these 27 countries at ages above 80 have declined at a rate of 1 to 2 percent a year for females, and .5 to 1.5 percent for males since 1960. Kannisto points out that "if mortality among the oldest-old were approaching biological or practical limits, then countries that have the lowest death rates would be closer than other countries to such limits"[28] . However, rates of mortality improvement show only a weak correlation to levels of mortality. Since half of all female and a third of all male deaths in developed countries occur after the age of 80, a reduction in mortality at older ages is crucial in determining the future trajectory of life expectancy[29]. Another Vaupel study has shown that, at very old-ages, human mortality decelerates. According to a study of 287 million people, death rates seemed to follow a quadratic trajectory[30]. After age 80, death rates increase at a decelerating rate until the age 110 at which point their decline is accelerated.

Due to decreased old age mortality, the number of centenarians is growing rapidly. A study by Vaupel and one of his colleagues indicated that the number of centenarians has doubled globally each decade since 1950, and grew at a staggering 7% annual rate between 1950 and 1980[31]. According to the Census Bureau, centenarians constitute the fastest growing segment of the U.S. population. Also, it is

27 Wilmoth, 396.

28 Vaino Kannisto, Jens Lauritsen, Roger A. Thatcher, and James W. Vaupel, "Reducions in Mortality At Advanced Ages: Several Decades of Evidence From 27 Countries," *Population and Development Review,* 20 (1994), 802.

29 Kannisto et al, 793.

30 James W. Vaupel, James R. Carey, Kaare Christensen, Thomas E. Johnson, Anatoli I. Yashin, Niels V. Holm, Ivan A. Iachine, Vaino Kannisto, Aziz A. Khazaeli, Pablo Liedo, Valter D. Longo, Yi Zeng, Kenneth G. Manton, and James W. Curtsinger, "Biodemographic Trajectories of Longevity," *Science*, 280 (1998), 856.

31 Jim Oeppen and James Vaupel,,"Broken Limits to Life Expectancy," *Science* 296 (2002), 1029-1031.

predicted that the chances of becoming a centenarian for those born in the baby boomer generation between 1946 and 1964 is one in 26, an estimated increased from 1 in 20 million at the beginning of the 19th century[32].

Optimist scholars argue that if life expectancy in developed countries was approaching a maximum, then the pace of improvement in developed countries should be lower than that of lesser-developed countries. However, this is not the case. According to Riley, the gap between a cohort of "high life expectancy countries" and "lowest life expectancy countries" has remained virtually constant since 1900, barely increasing from 24.6 to 26.3 years[33]. Most statistical studies examining this trend cannot find any evidence of a convergence in life expectancies worldwide.

In sharp contrast from the statistical approaches of Vaupel, Wilmoth, Kannisto, and other optimists, Nobel Laureate Robert Fogel attempts to explain the dramatic rise in human longevity through his Theory of Technophysio Evolution. He attributes past mortality declines to the unprecedented level of control that humans have over their environment. Over the past 300 years, humans have been able to "increase [their] average body size by over 50 percent, to increase [their] average longevity by more than 100 percent, and to greatly improve the robustness and capacity of vital organ systems"[34]. Fogel attributes this increase to the synergies between technological and physiological improvement. Human physiological capital, he claims, is not fixed—in fact, it's mutable. He argues that health capital will continue to increase as humans gain further control over their environment.

Optimists also have a biological response to the realist claim that human longevity is not an evolutionarily stable strategy. Judge and Carey claim that grandparents providing monetary support across generations can help improve the survival prospects of their kin. They state: "Increased per capita investment in offspring decreases juvenile mortality, increases the health and well-being of offspring, and thus improves adult health and survival."[35] In other words, if intergenerational transfers from older to younger generations decrease mortality, the result is a natural selection for longevity. Transfers of resources, knowledge, and skills also flow from younger to older generations. For example, elderly moving back with their children has been a popular trend over the past couple decades. Overall, Judge and Carey suggest that a symbiotic relationship between generations may increase the survival prospects of all parties involved.

Up to this point, the studies discussed have taken a holistic approach to examining life expectancy. John Bongaarts, in his paper "How Long Will We Live?" seeks to decompose past trends in increasing life expectancy. He separates all causes of death into three categories: juvenile mortality, background mortality, and senescent mortality. Juvenile mortality, denoted as "J", includes all those causes of death under the age of 25. Background mortality, denoted as "B", includes all those causes of death that are independent of age (i.e. accidents, infectious diseases, etc.). Senescent mortality includes all the other causes of death that come along with the deterioration of biological processes at old ages (i.e. heart disease, cancer, etc.).

Bongaarts aims to isolate LE (life expectancy), LEj (life expectancy assuming no deaths before age 25), and LEs (life expectancy in which senescent mortality is the only cause of death). The effect of juvenile mortality (J) on life expectancy can be calculated as the difference between LEj and LE. Likewise, the effect of background mortality (B) can be derived by subtracting LEj from LEs. The resultant equation allows us to estimate LEs, life expectancy without any juvenile or background mortality.

32 The Future of Human Life Expectancy: Have We Reached the Ceiling or is the Sky the Limit?, The National Institute on Aging. Washington D.C.: Population Reference Bureau, (2006), 2.

33 James C. Riley, "Estimates of Regional and Global Life Expectancy, 1800-2001," *Population and Development Review*, 31 (2005), 541.

34 Robert W. Fogel, "Changes in the Process of Aging During the Twentieth Century: Findings and Procedures of the Early Indicators Project," *National Bureau of Economic Research*, (2003), 24.

35 James R. Carey and Debra S. Judge, "Life Span Extension in Humans is Self-Reinforcing: a General Theory of Longevity," *Population and Development Review*, 27 (2001), 417.

$J = LEj - LE$
$B = LEs - LEj$
$LE = LEs - B - J$

Through further algebraic manipulation, Bongaarts concludes that the change in life expectancy at birth is equal to the rise in senescent life expectancy, plus any decrease in background mortality or juvenile mortality.

$$\Delta LE = \Delta LEs + \Delta B + \Delta J$$

Bongaarts applies this statistical decomposition to five developed countries that have relatively up-to-date records of causes of death since 1850—Denmark, England and Wales, Norway, Sweden, and the Netherlands. This exercise reveals some significant findings. Data from both males and females exhibited similar trends, and for purposes of this summary, only female data will be analyzed. Life expectancy over this 150 year stretch increased from 45.7 years to 80.7 years. Life expectancy without juvenile mortality, LEj, over this same stretch increased from 63.9 years to 81.4 years, and senescent life expectancy, LEs, increased from 72.3 years to 81.7 years. In other words, senescent life expectancy, LEs, was already significantly high in 1850—26.6 years higher than normal life expectancy in that year. However, due to large reductions in juvenile mortality (J) and background mortality (B), senescent life expectancy (LEs) is now only 1 year higher than normal life expectancy.

In other words, most of the improvements in life expectancy prior to 1950 were reaped because of decreases in juvenile and background mortality. However, after 1950, the rise of life expectancy was primarily caused by a rise in senescent life expectancy. As Bongaarts points out, an increase in public medicine helped senescent life expectancy advance—"medical treatment became more effective around the middle of the twentieth century with the widespread use of antibiotics and the ability to treat cardiovascular and other chronic diseases."[36]

After accounting for the effect of smoking in senescent life expectancy, Bongaarts makes several assumptions to project a future course for human life expectancy. He assumes that there will be no further decreases in juvenile or background mortality, and that all future gains in life expectancy will come from advances in senescent life expectancy. He also assumes that smoking levels stay constant. Further, he supposes that over the next fifty years, senescent life expectancy will increase at the same rate it did from 1950 to 2000 in 16 developed countries.[37]

Over this stretch, senescent life expectancy increased on average .15 years per year or 7.5 years for the half century period. This projection rate is applied to a series of countries; for instance, life expectancy in the United States is projected to rise to 87.0 years in 2050. This linear trend in senescent life expectancy portrays strong evidence towards the optimist stance that there is no looming limit to human longevity. While this projection is slower than the .25 years per year estimated by Oeppen and Vaupel (2002), it is still significantly faster than the U.S. Social Security estimates of .11 years per year. Vaupel summarizes the optimist camp's views well in saying: "Given the extraordinary rise in best-practice life expectancy and the demonstrated near-sightedness of expert vision, the central forecast should be based on the long-term trend of sustained progress in reducing mortality."

The Futurists' Take: Immortality?

The futurist approach to human longevity is undoubtedly the most controversial of the three views. Rather than being founded on history, the futurist approach to life expectancy focuses on the projected progress of science. Futurists make a bold prediction—namely that we are on the brink of a scientific revolution in which humans born in the 21st century, and maybe even the 20th century, will experience an exponential increase to four-digit life expectancy. While this may seem farfetched, there is a large

36 Bongaarts, 614.

37 The sample of countries has expanded in this part of the study due to the increased availability of mortality data over the past half century

contingency of scientists who believe that these advances are not only possible, but inevitable. In fact, a recent survey of 60 demographers, gerontologists, and aging researchers asked to estimate the life expectancy of a baby born in the year 2100 responded with a mean estimate of 292 years, with 9 members responding with figures above 200 years.[38]

Futurists reject an extrapolation approach to estimating future life expectancy, as used by the optimists. Prominent futurist Aubrey De Grey uses an analogy of human progress to undermine the optimist's statistical approach to projecting future longevity—"In 1900, extrapolation of trends in the speed of ocean-going liners over the previous century or two would have predicted that the time taken to travel from London to Washington D.C. in 2004 would be at least a couple of weeks."[39] De Grey urges disbelievers to think of the human body as a machine, like a car, composed of a large number of parts working together. As we age, parts of our body may lose function—just as when a car gets older, its brakes may lose effectiveness or its overhead light may burn out. However, with the proper technology, any organ in the human body can be fixed or even replicated—similar to the way a technician installs a new break pad or rewires the lights in an automobile. If one agrees that an automobile can achieve immortality through temporary maintenance and replacement of its parts, it follows logically that a human body may do the same given the proper technology. De Grey points to buildings in Venice that have continued to exist over thousands of years due to periodic maintenance. Granted the human body is significantly more complex than an automobile or building—it still contains a finite number of parts whose malfunctions can be corrected by a finite amount of technology.[40]

This idea of constantly re-engineering our bodies calls for a paradigm shift in the way science views aging. Rather than being an inevitable breakdown of our system, the futurists claim that aging is a disease that can be prevented or even reversed.[41] By leveraging our understanding of nanotechnology, stem cell science, and the human genome, scientists will soon be able to overcome the aging process in the post-reproductive years. Nanotechnology could efficiently repair physical damage, Stem Cell Science could provide rejuvenation to our vital organs, and increasing knowledge of the Human Genome could allow us to identify and manipulate the genes that control longevity.[42] Futurists points to seven causes of aging from cell atrophy to mitochondrial mutations—addressing potential cures and progress made in each category.[43]

Many point to a hypothetical event known as Singularity as the launching point of an exponential increase in human longevity. Singularity refers to a period of extremely swift technological progress coupled with the advent of self-improving intelligence. It refers to the creation of artificial intelligence with greater capabilities than human intelligence. Begin with the idea that technology is the product of human intelligence. As a result, all technology is the result of human intelligence. However, if technology can, in turn, produce intelligence greater than the initial human intelligence, then the loop is closed—creating a positive feedback effect and a self-propelling cycle. The result is technology with the ability to self-improve and subsequently create new technology unforeseeable by mankind.[44]

Artificial intelligence offers faster and smarter intelligence than that of humans. Computer chips fire

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38 Theo Richel, "Will Life Expectancy Quadruple in the Next Hundred Years? Sixty Gerontologists Say Public Debate on Life Extension is Necessary," *Journal of Anti-Aging Medicine*, 6 (2003), 309.

39 Aubrey De Grey, *Extrapolaholics Anonymous: Why Demographers' Rejections of a Huge Rise in Cohort Life Expectancy in This Century are Overconfident,* Annals New York Academy of Science, (2006), 90.

40 *Do You Want to Live Forever?* Dir. Jason Pontin, Perf. Aubrey De Grey, (2007), Google Video, <http://video.google.com/videoplay?docid=-3329065877451441972&q=aubrey+de+grey+documentary&ei=vyYeSKmdJY6IrQKog7m2Ag, Accessed 2 Feb. 2008.

41 B. Anton, L Vitetta, F Cortizo, and A Sali, "Can We Delay Aging? the Biology and Science of Aging," *Annals New York Academy of Science,* (New York, 2005), 529.

42 Priya Shetty, "Never Say Die?" *The Lancet,* 369 (2007), 1422, www.thelancet.com, Accessed 13 Feb. 2008.

43 "Do You Want To Live Forever?" Documentary.

44 "What is the Singularity?" *The Singularity Institute for Artificial Intelligence,* www.singist.org, Accessed 3 March 2008.

at speeds ten million times faster than the 150 neurons per second rate of humans. Given the acceleration of speeds as witnessed by Moore's Law, a one-million fold increase is probable within the next couple decades. This kind of speed would produce the amount of thinking that normally takes place in a year to occur in 31 seconds. Better yet, the entire volume of human thought from Socrates to today would occur in a mere 22 hours.[45] Faster-than-human intelligence is one thing, but the core of singularity focuses on the creation of smarter-than-human intelligence. One mind, even slightly smarter than that of humans, could in turn create smarter minds. Considering the fact that all human technological advances have come from the threefold increase in human brain size over chimpanzees, the promise of self-improving technology is awe-inspiring. The creation of smarter-than-human intelligence could be "the first domino in a chain, [or] starting an avalanche with a pebble."[46]

This acceleration of technological advances describes a phase in which humans would possess an encyclopedic knowledge of the human body, cures to virtually every intrinsic cause of death, and the technology to create synthetic organs and effectively conduct large-scale surgeries. It is as hard for modern day scientists to conceive of a post singularity universe as it was for Benjamin Franklin to imagine all the uses of electricity and all the inventions that came about as a result of it.[47] At the very least, however, humans could expect an increased life span, perhaps immortality.

An important distinction to be made in the debate over increasing longevity is "quantity" versus "quality" of the added years. Are additional years of frailty and decay tacked onto the end of old age? Or is our life stretched proportionally so we may enjoy more of each phase? Futurists opt for a third scenario in which technology would allow humans to stay biologically equivalent to a twenty-five year old for eternity. A life expectancy of one thousand would result from an indefinite possession of a mortality rate seen in young teenagers in wealthy societies today.[48]

Part II: Longevity and Economic Savings

Determining which theory of human longevity will ultimately come to fruition is incredibly complicated, as the issue spans many disciplines and involves a multitude of variables. All three camps are supported by prestigious and intelligent personnel, and all three make a convincing argument. Perhaps humans will look back several centuries from now and remark at the transparency of the correct prediction, while scoff at the theories that were proven wrong. The concept of a "round world" several centuries ago was perhaps more unconventional than "four-digit life expectancies". Furthermore, one cannot neglect the possibility that none of the three theories is accurate in portraying human life expectancy. For instance, an incurable infectious disease, global warming, or nuclear conflict could reverse the trajectory of human life expectancy. Instead of weighing the veracity of each longevity theory and taking a clairvoyant approach, this paper will shift its tactic. It will assume that life expectancy will increase into the future and examine how it influences the human decision to save.

Imagining a world where humans live to 150, 200, or even 1000, is mind-boggling. Imagine staying in school until you're forty, graduating with an M.B.A., J.D., and PhD in Anthropology. Perhaps then you would spend thirty years as a lawyer, twenty as a businessman, and then set off to the third-world for a fifteen year sabbatical. Nine children and eighty years later, your first marriage ends. You go back to school for another ten years to get that M.D. You then work in medicine for fifty years before remarrying and settling into a forty-year retirement. Is this what a typical two-hundred year life would look like? Maybe, maybe not. Speculation is interesting in theory, but impossible to truly test. Instead of taking a holistic approach to how increased longevity will affect human life, this paper aims to approach the

45 "What is the Singularity?"

46 "What is the Singularity?"

47 "What is the Singularity?"

48 De Grey, 87.

consequences from an economic perspective.

Rising longevity has a host of macro and microeconomic consequences. Economists have teamed up with demographers and scientists to devise models to capture this ageing phenomenon. The studies have examined the impact of improvements in life expectancy on the fertility rate, schooling time, GDP growth, and retirement age, among many other variables. Methodologies include the construction of simple theoretical models, the regression analysis of macroeconomic data, and qualitative approaches to the subject. The broadest and most universal of the variables studied is savings—both on an aggregate level and the rates themselves. The remainder of this paper seeks to examine and understand the effects of increasing longevity on savings. The following section will review several of the current models reconciling life expectancy and savings, and the final section will look at how increased longevity has affected savings in the United States.

The most universal model of an individual's intertemporal saving and consumption was proposed by Albert Ando, Franco Modigliani, and Thomas Friedman in the 1950's. It is known as the Life-Cycle Model. The thrust of this model is utility smoothing—the notion that individual's consume a constant annuity of their lifetime income over each period of their life. In other words, individuals borrow against expected future income in childhood, save during their working years, and then consume the remainder of their wealth in retirement. In the absence of bequest motives or intergenerational transfers, the saving of the working aged population should perfectly offset the negative savings of children and elderly—assuming a uniform age distribution and no population growth.[49]

If life expectancy increases and retirement age stays constant, the Life-Cycle model predicts greater average savings rates as individuals increase accumulation of assets for their retirement. Consumption would decrease during working years, as individuals substitute labor for leisure in order to save more for later years. Furthermore, due to compounding returns, there is a greater incentive to save at younger ages with a longer time horizon.

Jonathan Skinner illustrates this increase in savings rates as a result of rising longevity. Assuming you enter the workforce without any positive or negative savings, you need to save 1 – (working years/ (working years + retirement years)) each year in order to smooth consumption over an expected life span. For example, if you are a 25 year old entering the work force, planning to retire at 65 and live until 74, you need to save 1-(40/49) or 18% of income per year in order to finance your retirement. Now let's assume life expectancy increases two years from 74 to 76. Keeping working years constant, the resulting savings rate is 1 – (40/51) or 21%.[50]

If this simple model is accurate, rising longevity should result in an increase in savings rates at all ages. However, empirical evidence supports the opposite behavior. The past half century has seen decreasing savings rates coupled with rising life expectancies in many regions of the world. Skinner attributes this enigma to the "bequest motive"—the anticipation of intergenerational transfers from deceased family members.

Regardless, this simple model fails to take into account the exact nature of the longevity increase. The model assumed that the extra two years of life were tacked on at the end of retirement, a far cry from the actual reality of increasing life expectancies. Is a proportional rescaling of the life cycle more appropriate? In other words, if life span doubles, then each period of life doubles — resulting in one's childhood, working years, and retirement to all become twice as long. Under this proportional restructuring, Lee and Goldstein suggest that savings rates would be unaffected. As humans live longer, they spend more time in school, reproduce later, work longer, and retire later. Because working years and retirement years grow by the same proportion, savings rates can stay constant according to the Life-

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49 David E. Bloom, David Canning, and Bryan Graham, "Longevity and Life-Cycle Savings," *Scandinavian Journal of Economics*, 105 (2003), 320.

50 Jonathan Skinner, "The Effect of Increased Longevity on Capital Accumulation," *The American Economic Review,* 75 (1985), 1143.

Cycle model.[51] Assume life expectancy doubles. Under proportional rescaling, working years double, lifetime earnings double, and savings for retirement doubles—funding a retirement that is twice as long. In other words, a longer life span doesn't necessarily need to affect savings rates if working lifetime extends proportionally.

Lee and Goldstein also discuss the difference between weak proportionality and strong proportionality. The former adjusts to increases in life expectancy by shifting the mean age of each phase proportionally, while holding the variance of each phase constant. The latter shifts both the mean and variance proportionally. Assuming a weak proportional increase, a doubling of life expectancy would facilitate the start of puberty at 26 years of age, instead of the normal 13. However, if puberty typically lasts 5 years (from age 13 to 18), then after the weak proportional increase it would still last 5 years and take place from 26 to 31. Strong proportionality, on the other hand, calls for an increase in both age and variance—resulting in a 10 year long adolescence from 26 to 36 years.

Empirical evidence, however, indicates that life span does not increase proportionally, in either a weak or strong manner. Lee and Goldstein examined the major transition points of life such as completion of college, first marriage, and birth of first child in Japan, Sweden, and the United States. They found that these transition points were increasing at a rate faster than that of life expectancy. Among American females, for instance, age of first birth was increasing at 4 times the rate of life expectancy and age of marriage was increasing at 9 times the rate. They also discover the trend of increasing educational enrollment at every age, including younger ages. Extending education into adulthood supports proportionality, but increased enrollment in preschool and day care is contradictory to the notion of a stretched lifespan. In other words, the prescribed behavior for parents under proportionality would be to wait longer before enrolling their children in school.[52] Other social evidence, however, supports the notion that the time it takes to reach adulthood is decreasing – demonstrated by younger voting ages worldwide, adult criminal penalties for minors, and the biological trend of reaching physical maturity at younger ages.[53]

Proportionality does not seem empirically evident at the later stages of life either. If proportionality held true, one would witness later retirement ages due to the extension of the working years. Kotlikoff makes two proposals about shifting retirement ages. First, he suggests that retirement age may rise proportionally to an increase in longevity. Second, he suggests that individuals may treat the number of retirement years as constant at the end of one's lifetime.[54] However, neither of these proposals is supported by statistics. In fact, the opposite seems to be the case. Costa proved that old-age labor force participation rates have dropped along with retirement ages in industrialized countries that have experienced increases in life expectancy.[55] According to the National Academy on an Aging Society, retirement ages have dropped among men in the United States from over 70 in 1900 to around age 63 today.[56] Perhaps, as Lee and Goldstein suggest, a rising real income rate over this stretch may have increased the demand for leisure, thus driving down the retirement age. The increase in life expectancy is only one of many economic and social trends that have taken place over the past century, and it is vital to recognize that data reflects the cumulative impact of all these trends.

Clearly, proportionality has inherent flaws as a theory of increasing lifespan. Nevertheless, it is a widely used metric in economic models examining longevity. In the words of Lee and Goldstein,

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51 Ronald Lee and Joshua R. Goldstein, "Rescaling the Life Cycle: Longevity and Proportionality," *Population and Development Review,* 29 (2003), 200.

52 Lee and Goldstein, 192.

53 Lee and Goldstein,192-3.

54 Lee and Goldstein, 198.

55 Lee and Goldstein, 198.

56 National Academy on Aging, 6.

"proportional rescaling provides a starting point, a simple framework, from which to view the largely unexplored consequences of increasing longevity for the timing of different segments of life. We do not suggest that all the changes we considered are directly or indirectly caused by increased longevity. In some cases there are plausible links, but in many cases the causes of change are not in any obvious way connected to mortality change."[57]

Three economists, Bloom, Canning, and Graham, show that an increase in life expectancy prompts the rational individual to increase savings at every stage of life. Operating under the assumptions that leisure and consumption are normal goods, they conclude that a rise in life expectancy increases the optimal length of one's working years. However, this increase is not enough to provide for consumption during retirement. Therefore, savings rates should increase at every stage of life.

However, while savings rates increase with increasing longevity, the effect on aggregate savings is more ambiguous. In a population with a stationary age structure, the savings of the young offsets the negative savings of the old. However, as Li, Li, and Zhang point out in their 2007 study, as the population ages, dissavers outnumber savers and aggregate savings is reduced. The old-age dependency ratio is a demographic metric that measures the number of old people in a population as a percent of the total working population. This factor needs to be considered when thinking about the influence that longevity has on savings.

There are two opposite effects taking place. One effect is that people save more at every age as they expect to live longer. A second is that as people live longer, older people increase in proportion to younger people, thus reducing aggregate savings. If these two forces cancel out, the net effect would be zero. Therefore, according to Li, Li, and Zhang, the prospect of increased longevity has a positive effect on aggregate savings due to increased savings at every age, but an increase in old-age dependency has a negative effect on aggregate savings as the number of dissavers increase relative to savers. Therefore, the effect of increased longevity on aggregate savings is ambiguous, depending on which factor is bigger.

D.E. Bloom et al. also points to several of the ways that increased longevity can affect savings. First, the individual must take into account old age morbidity and factor in the probability that their working life may be shortened. Secondly, effects of compounding interest and increasing wages produce extra incentive for savings. Thirdly, imperfect annuity markets may understate the actual value of savings. Fourthly, social security systems and other such government annuities discourage longer working lives. Their thesis is that the effect of life expectancy on national savings rates depends on the features of the social security system of that particular country. With no social security system in place, the optimal response to life expectancy improvement is the proportional lengthening of working life and no change in savings rates. However, in countries that have social security systems in place that create incentives to retire at a particular age, individuals treat retirement age as fixed and save more in order to fund a longer retirement.[58]

The Li, Zhang, and Zhang study mentioned earlier attempts to reconcile savings, growth in longevity, and population age structures. It uses data from the World Bank from over 200 countries from 1960 to 2004. The study regresses (aggregate savings / output) against life expectancy, old to working age population ratio, and fertility. The authors expect the coefficients for the variables to be positive, negative, and negative respectively based on the predictions of their theoretical model. After including an additional variable of log GDP per capita growth into the equation, they find statistical significance in all the variables to at least the 10% level. Life expectancy had a beta of .002, and the old-age dependency ratio had a beta of -.603.[59]

These results follow logically from the prediction that longevity has a positive impact on aggregate

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57 Lee and Goldstein, 202.

58 Bloom et al, 94.

59 Hongbin Li, Junsen Zhang, and Jie Zhang, "Effects of Longevity and Depedency Rates on Savings and Growth: Evidence From a Panel of Cross Countries," *Journal of Development Economics,* 84 (2007), 146.

savings, while old-age dependency has a negative impact. The meaning of the .002 coefficient is that a one-year increase in life expectancy produces a two-tenths of a percent increase in the aggregate savings rate. Likewise, a one percent increase in the old-age dependency ratio leads to a six-tenths percentage point decline in aggregate savings. This study further analyzes the results by doing a rudimentary analysis of the World Bank Data Set. They look at a set of countries with life expectancies below 50 years over the period 1993-1998, and another set of countries with life expectancies above 70 years over the same time frame. The mean life expectancy in the latter group was 74.7 years, and those countries had an average aggregate savings rate of 21.2%. In the low life expectancy group, the average life expectancy was 44.9 years with an average aggregate savings rate of 5.8%. Furthermore, the low life expectancy group had an old-age dependency ratio of 5.5% versus 15.4% in the higher group. The differences in life expectancy of 30 years account for a 6 percentage point difference in aggregate savings rates (.002*30), while the difference of 10 percent in old-age dependency ratios account for a 6 percentage point difference. In this example, these effects balance out.[60]

Case Study: Longevity and Savings in the United States

The United States is an interesting arena to examine the trend of increasing life expectancy and its economic impact. Life expectancy of Americans has increased at a rapid rate over the past century, much like other countries in the developing world. Furthermore, the old-age dependency ratio has increased, as the older segments of the population have expanded disproportionately. However, this longevity trend has coexisted with patterns in savings rates and retirement ages that are counterintuitive to the LZZ model. Retirement ages have, in fact, witnessed a fall over the past century in the United States. Furthermore, savings rates have turned negative in recent years. Are Americans underestimating their life expectancies when making decisions regarding consumption and savings?

A rudimentary examination of demographic data in the U.S. from the past fifty years reveals some interesting trends. Life expectancy has risen from 68.2 years in 1950 to 76.9 in 2000, an increase of nearly 13%.[61] Going back to 1900, life expectancy increased from 47.3 years, representing a precipitous 65% increase to 2000. Likewise, the percentage of the population 65 and over has experienced a ten-fold increase over the past century. At the time of the last census in 2000, the population aged 65 and over stood at 35 million, constituting 12.4% of the United States Population. This is a rise from 12.3 million in 1950. The old-age dependency ratio was 17.4% in 2000, up from 14% in 1950.[62]

According to the LZZ regressions, the rise in life expectancy from 1950 to 2000 should produce an increase in aggregate savings rates of .002*8.7, or nearly 1.7%. On the other hand, the increase in old-age dependency of 3 percentage points over this same stretch of time should result in -.603*3, or approximately a negative 1.8%. In other words, based on trends in life expectancy and old age dependency ratios in the United States, one would expect that these effects would cancel out and aggregate savings per capita would stay constant.

However, the contrary has occurred. Savings in the United States has shown a downward trend since 1950, even dipping into negative figures in recent years. In the 1980s, aggregate savings averaged nine percent; in the 1990s, they averaged five and a half percent; and from 2000 to 2005, the after-tax savings rate has averaged a measly one point nine percent.[63] The ratio of personal consumption expenditures to GDP has reached an all-time high of nearly 70%. To accompany this low rate of savings, U.S. households are carrying a large amount of debt. Recently, the household debt to personal disposable

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60 Li, Zhang, and Zhang, 148.

61 National Healthy Survey Report, 175; U.S. Census Bureau.

62 U.S. Census Bureau.

63 Kevin J. Lansing, Federal Reserve Bank of San Francisco, Spendthrift Nation, (2005), 2.

income ratio reached an all-time high of 118%.[64] Furthermore, the average retirement age across the country has declined from just over 68 in 1950 to around 63 today for both genders.[65]

How can people live longer, retire earlier, and save less? Is this behavior rational and, if not, why are Americans making irrational economic decisions? A large contingency of economists agree upon the fact that this behavior is irrational. Kevin J. Lansing, Senior Economist at the Federal Bank of San Francisco, states that "The decline in the U.S. personal saving rate and the dearth of internal saving raise concerns for the future. In coming decades, a growing fraction of U.S. workers will pass their peak earning years and approach retirement. In preparation, aging workers should be building their nest eggs and paying down debt. Instead, many of today's workers are saving almost nothing and taking on large amounts of adjustable-rate debt with payments programmed to rise with the level of interest rates. Failure to boost saving in the years ahead may lead to some painful adjustments in the future when many of today's workers could face difficulties maintaining their desired lifestyle in retirement."[66]

One rationale for earlier retirement ages and lower savings is that individuals seek to obtain their Social Security benefits earlier. Retirement income has often been considered a three-legged stool: personal savings, employee benefits, and social security.[67] However, the apparent trend is increasing reliance on the latter two sources. According to the Social Security Administration, social security and employee benefits account for 53.6% of retirement income for those aged sixty-five and over. In fact, one-third of the country has no income personal savings—essentially rendering this leg of the stool futile.[68] As labor force participation rates have taken a drastic dip over the course of the century, retirees have increasingly relied on social security to fund their later years of life. This behavior is not rational. Seniors are carrying huge burdens of debt and going into bankruptcy faster than ever. A recent CBS article stated that credit card debt among seniors age 65 and over has increased 89 percent to $4,041 between 1992 and 2001.[69]

Another plausible explanation for this irrational savings behavior is increased health care costs. In other words, decreased mortality does not necessarily mean decreased morbidity. Health care costs have skyrocketed for seniors in recent years. Hospital bills are becoming hard to swallow. Nursing homes are charging record enrollment fees. Anticipating these costs is incredibly hard from an economic perspective, and people generally tend to err on the short side.

Economic theory can only go so far to explain the way people behave. Perhaps it is people's own faulty estimations of their personal longevity that is the root of the problem. In the life cycle model, the rational economic agent estimates their expected lifespan so that savings at the end of life is zero. In theory, this model sounds fine; however, in practice, the probability of ending up with exactly zero dollars at your time of death is negligible. It is reasonable to believe that if people act according to the life cycle hypothesis, then half of the population overestimates their longevity and half underestimates it. If half of the population plans to die earlier than they actually do, one can only imagine the economic hardship this would cause.

Richard Pollock and Jack Suyderhoud of the University of Hawaii conducted a study in 1992 which tested subjects' ability to make rational expectations regarding their own lifespan. The question they asked was simple: do subject's perceived life spans take into account further improvements in life expectancy over the course of their lifetime or are they aligned with current life expectancy tables? In other words, if a twenty year-old subject expects to live until eighty-two because the current life

64 Lansing, 3.

65 Murray Gendell and Jacob S. Siegel, "Trends in Retirement Age by Sex, 1950-2005," *Monthly Labor Review,* 115 (1992), 23.

66 Lansing, 3.

67 William J. Wiatrowski, "Changing Retirement Age: Ups and Downs," *Monthly Labor Review,* (2001), 4.

68 Wiatrowski, 4.

69 CBS News.

expectancy tables indicate that the life expectancy for a twenty year-old is sixty-two years, then that is an irrational judgment. It fails to take into account further improvements in life expectancy that will occur over a subject's lifespan.[70]

They polled a large sample of Hawaiians at a variety of ages and asked them how long they expected to live. The study found that Hawaiians of both genders and of all ages underestimated their lifespan based on conservative forward extrapolations of U.S. life expectancy. More surprisingly, in every single age and gender cohort except for one, life expectancy expectations were below the current life expectancy tables. The cohort of 131 Hawaiian females between the ages of 35-39 expected their life spans to be over seven years shorter than current life expectancies, and ten and half years shorter than the conservative extrapolation estimate. In short, subjects grossly underestimated their survival prospects at highly significant levels.[71]

This study sheds a very peculiar light on the situation in the United States. If people believe that their current life span lies below current life expectancy tables, let alone taking into account further improvements in mortality, this poses a dramatic problem for the economy. In a prior study conducted by Economist Daniel Hamermesh, it was discovered that people judge their future life spans at least partially on those of their relatives.[72] If people expect to live as long as their parents or grandparents, they are making irrational judgments that can have serious repercussions. From an evolutionary standpoint, it seems rational to err on the side of overestimating lifespan. That way, if one dies earlier than expected, their extra resources can be bequeathed to their offspring, thus helping their survival. Underestimation results in a reliance upon one's offspring—draining their resources and detracting from their survival prospects. Also, given the fact that the standard deviation of life expectancy has increased as well as the mean, additional incentive is provided for erring on the longer side because the risk of underestimation is greater.

Even if the most conservative longevity estimates of the realist camp transpire and humans live until eighty-five years of age, this will still result in an increase in life expectancy well beyond today's levels. In order to anticipate this, and perhaps greater increases, it is imperative that people are aware of the current increases in longevity taking place. As savings rates and retirement ages continue to drop, more and more elderly members of our population are going into serious debt towards the end of their lifetime. Perhaps it is time for the Social Security Administration to raise the retirement eligibility age in a way that reflects the increase in life expectancy. When Social Security commenced in the 1930's, life expectancy in the United States was around sixty years of age and twelve years at sixty years old.[73] Furthermore, the system still did not pay out benefits until age sixty-five. As a result, the majority of Americans never received a Social Security check and the system was self-sufficient. Now the situation is drastically different with the vast majority of the population living past sixty-five.

Until the government acknowledges the phenomenon of increasing longevity and gives it proper emphasis in public policy, the longevity miracle of the past century will turn into the longevity problem. People make retirement decisions based off ages set by the Social Security Administration, and it is therefore up to the government to guide people's judgments. In this case, good politics are needed to guide economics. As in many societal problems encompassing the economic and political spheres, it is to the benefit of government and its people to err on the side of caution. The existence of global warming, for instance, is still disputed by many. If society doesn't take any action to remedy the environmental problem, it may be alright and it may not be. On the other hand, if society is proactive about the issue,

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70 Richard L. Pollock and Jack P. Suyderhoud, "An Empirical Window on Rational Expectations Formation," The Review of Economics and Statistics, 74 (1992), 320-324.

71 Pollock and Suyderhoud, 320-324.

72 Daniel S. Hamermesh, "Expectations, Life Expectancy, and Economic Behavior," The Quarterly Journal of Economics, 100 (1985), 390.

73 Wiatrowski, 4.

we either become more efficient as a society or we avoid a complete collapse. In other words, acting on global warming is a win-win situation, whereas standing idle puts us at the mercy of our circumstance. The longevity phenomenon is no different. Government can choose to act on this issue and raise awareness about longevity; or, on the contrary, it can sit idle and risk entering a national economic crisis.

Humans have been blessed with unfathomable increases in longevity over the past couple centuries and will likely experience further improvements into the future. It is the responsibility of both our government and the citizens of our world to study the aging phenomenon and raise awareness worldwide. This way, long life will be a blessing rather than a curse.