Health Technology, Health Care Cost, Longevity and Retirement Security: A Dynamic Upward Spiral and Challenge to Future Policy

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Abstract

The squaring of the life curve and the resulting aging of the population have profound ramifications for health care and its increasing overall and per capita cost. Moreover, health security and financial security are integrally related: As people live longer, they need to provide economically for more post-retirement years, including health care costs during this telescoping period; the one intensifies the other. This study will discuss the general global effects of longevity on health care costs, primarily focusing on the system for the finance and delivery of health care in the United States.

Introduction

According to the U.S. Census Bureau, average life expectancy at birth in the United States in 1900 was 47 years; for those who survived to 65 years of age, 12 more years of life could be expected on average. By 1965, when Medicare began in the United States, life expectancy at birth was 70, and at age 65, 15 additional years of life could be typically expected. Hence, during the year 1965, those born in 1900 had already beaten the odds by 18 years beyond the expected, just by surviving to age 65. By the year 2000, these two life expectancies were 77 and 18 years; both had increased approximately 50 percent in the 20th century. I am simplifying here by rounding to integers and approximating, but the point is clear: People are living longer than ever before.

But what does "living longer" mean? In essence, it has meant that fewer people were dying young. From 1900 to 2000, infants and children especially, but also young and middle-aged adults, were no longer dying at the alarming rates they had been from illnesses and infectious diseases, such as diphtheria, typhoid, meningitis, and scarlet fever. These illnesses ravaged the United States in the 1800s and before. In the late 1800s, diphtheria was still known as "membranous croup." Children who contracted it then in New York City had a mortality rate of 40 percent. People simply did not understand the causes of these infectious diseases, and many ineffective remedies were attempted. We are the beneficiaries of those failed experiments and eventual scientific advancements. Far fewer people die prematurely today than did 100 or 200 years ago.

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The elderly are living longer, too. Like the mitigation and eradication of infectious diseases that killed prematurely, the medical outcomes of the elderly have similarly benefited from medical progress, which allows older people to live beyond afflictions that formerly would have been a death sentence. Upon reaching 65 years of age, people nowadays can expect more nonworking (retirement) years than ever before, which puts additional pressure on the financial security of those in this age bracket. Meanwhile, the overall per capita cost of health care rises inexorably worldwide for two reasons: First, the cost of living increases, and second and as important, people receive more care and more sophisticated care. New medical technology, which includes pharmaceuticals, drives the overall per capita cost of health care higher and higher each year. If we think of the seventh generation, as in the Native American adage, we need to plan for the challenges ahead. The transition of nations into the future has always been difficult for governments to manage. If popular opinion is a credible reference point in early 2016 in the United States, the government's ability to manage the present is not held in high confidence by the public. Like a Greek drama, we will begin in medias res.

One could establish a flow chart of various ways to describe the reciprocating relationship between longevity and health cost over time, but basically, here is what is happening in this self-intensifying process:

1. The cost of living rises, and health care delivery further evolves with the benefit of new medical technology.
2. These changes lead to higher per capita health cost and increased longevity.
3. Consequences include increased national health expenditure (since increased health care cost affects individuals and families during all years of their lives) and more retirement years of life for which to provide, during which medical cost is greater than in younger years.

Individuals are living longer with more accumulated chronic conditions, and the median age is increasing. In the 20th century, the United States experienced an unprecedented longevity boost that reflected the effectiveness of the infectious-disease model. The 20th century was the peak period of that model, and similar gains in longevity cost more today than previously. Continuing on this trajectory, we can expect smaller longevity gains at greater cost per life-year gained.

Health spending and longevity intensify one another. They constitute an autocatalytic process. This is not a statistical or actuarial process, like the compound negative binomial process that some actuaries may have learned about in exam training. This is a social sciences term for two or more forces that drive one another higher.

As a result of all this, we, as individuals and as a nation, face increased pressure to plan for the future. Hence, individuals must either accumulate more savings before retiring or postpone retirement, or both, all the while devoting an increased portion of income to current health needs. This situation places continual stress on financial and health security systems, which is the subject of this paper. Little attention has been paid to this subject in the media. As the national focus intensifies on the problems of the present, the problems of the future seem more and more remote, and our options to resolve them may become more limited.

There are multiple variations on this theme of self-perpetuating increase in per capita health cost. Events may occur, randomly, and situations arise that change things up a bit. Those who retired in 2007 and 2008, for example, and who had market-connected savings when the economy contracted significantly, saw a

substantial decrease in their net wealth, all while facing the usual ongoing difficulty of escalating health cost and longevity. Disease, contagion, pandemics, and one-time events complicate the situation and rearrange it somewhat. A medical breakthrough, such as a new wonder drug, may accelerate the upward spiral temporarily; similarly, a fluctuation in underlying population, such as the baby-boom generation, may affect some of the underlying demographics and economics. Nonetheless, the underlying situation of the upward-spiraling per capita cost unavoidably remains.

Demographers refer to this ongoing phenomenon of increasing longevity as the squaring of the survival curve. We actuaries have studied the survival curve as it applies to humans. The survival curve for animals in the wild is a negative exponential function; many die young.

The graph of the survival curve shows the number of people, all born in the same year, who remain alive in each succeeding year. If we express the population in each year after the original birth year as a percentage of the birth year, we can predict the approximate shape of the same curve for some future birth year by taking the square root of each of the percentages. Eventually, the survival curve looks like an inverted L: everyone born in the same year remains alive until some limiting age, called omega, and then dies. The term "squaring" describes this visual squaring, not to be confused with the mathematical square root. For people in the United States today, the survival curve is more a concave-down parabola than a negative exponential, but then we humans are further along in the squaring process than the rest of the phylogenetic chart, thanks to cultural evolution.

Figure 1 shows multiple survival curves for those in the United States who are eligible for Social Security. Each curve represents the number or percentage of people remaining alive at age *x*, and it begins with a large cohort of people all born in the same year—call it time 0. (The lowest curve represents those born in 1900.) Life scientists track how many remain alive at age 1, age 2, et cetera. Assume we begin with a contemporary cohort of 100,000 people born in the same year. As the years pass, the number of people surviving decreases; eventually, none of the original cohort remains. Except for infant mortality, which accounts for a relatively large number of childhood deaths, the mortality rate at this point in history is generally lower for the young and roughly increases with age. The survival curves in Figure 1 were developed by the U.S. Social Security Administration; the graph shows the survival curves at 1900, 1950, 2000, 2050, and 2100. By observing the progression of curves, we see the "squaring" from one cohort to the next one, 50 years later.

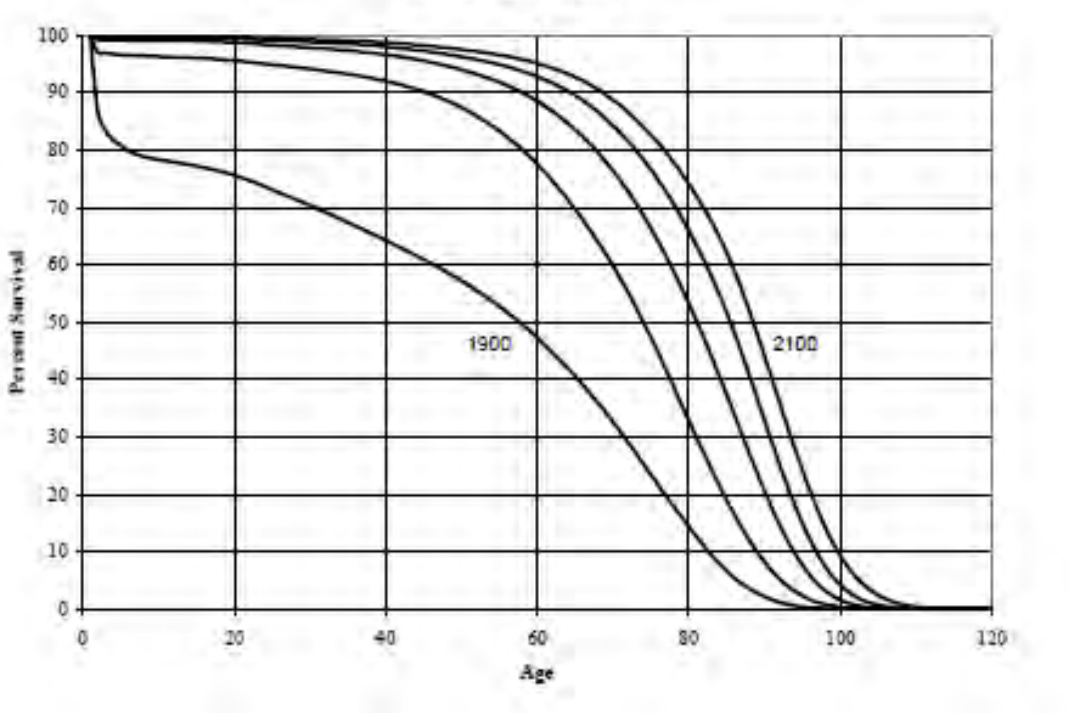

Fig. 1. Survival Function for SSA Population for Selected Calendar Years (1900, 1950, 2000, 2050, 2100), Based on Period Tables
Source: Bell and Miller (2005), Figure 5, p. 16.

Ultimately, when the survival curve is "square" or fully "rectangularized," it looks like the inverted L in Figure 2. In that diagram, everyone remains alive until omega and then dies. To avoid complication, we will avoid any discussion of terminal age omega or the change in omega.

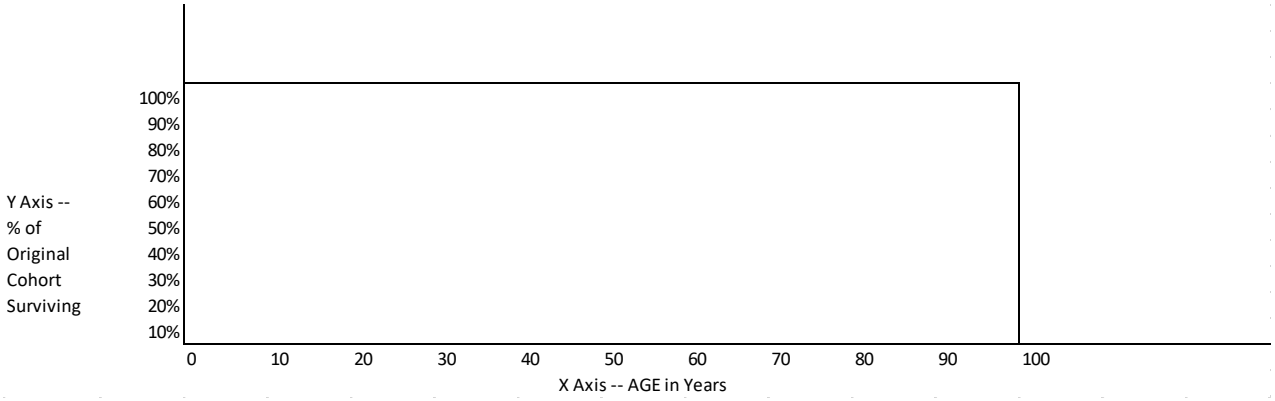

Fig. 2. Inverted-L Shape of "Square" Survival Curve

Obviously, however, if 1,000 or 2,000 years from today, "physicians" are routinely 3D-printing various replacement body parts and organs and some people are living to 200, then that will be another force with which to reckon. This is certainly consistent with the objectives of the emerging transhumanism movement. And perhaps the SOA will then be touting bicentenarians as the fastest-growing age bracket. It seems likely that humanity will cross that bridge then; however, there is no guarantee the planet will

even exist. Who knows what the future holds? Waxing Marcus Aurelian here, all we know is that at some point in time, it will not hold us.

It is the nature of existence to move forward onto uncharted waters. And one of the roles of effective governments is to help manage safe passage on that voyage and perhaps regulate, if necessary, the rate at which certain policy change occurs. Like weather, markets have become more volatile. Life circumstances have become more complicated. And markets and government continue in the endless cat-and-mouse game of regulation with its telescoping actions and reactions. All this affects the system for the finance and delivery of health care, as well as retirement security.

This upward spiral of increasing longevity and per capita health cost is the fundamental metaphor of this paper. Like compatible exercise partners, the one drives the other. Virtually all of us believe longevity is a blessing, especially healthy longevity. Living itself is priceless, but living longer is generally perceived as even better. We have much for which to be grateful. The issue here, however, is proper and responsible planning for a world in which we live longer. Such planning is easier said than done. Working longer is a great solution, but it is not a given; ageism in the workplace is at odds with working past 65. This is a world in which financial security in old age is becoming an increasingly difficult responsibility.

In the United States, the politics around financial security and retirement planning are relatively laissez-faire in comparison with European examples. Twenty-five years ago, we spoke of the three-legged stool for retirement security: Social Security, defined-benefit pension, and savings. Then two of the legs became one, as defined-contribution plans superseded defined-benefit pension plans. And personal savings got wrapped into the defined-contribution retirement plan—401(k) or 403(b) or whatever. One thing is clear: More retirement years and higher per capita health cost in those years can only exacerbate the problem and challenge of retirement security.

Health Technology

For the sake of discussion, let us assume the per capita cost of health care increases due to two fundamental forces: first, the ongoing annual increase in the cost of living for a fixed market basket of medical goods and services, and second, all else, much of which is driven by the evolution of health technology and includes more and better items to add to the basket—new goods and services, and improved ones, or the same ones delivered more frequently. Let us further assume that both forces are approximately equal over time. Some years, one may be more or less, and overall, the two might not be of exactly equal force, but let us assume that is approximately the case. It has, in fact, been the case—approximately—for the past several decades.

There are likely other forces at work that drive up the per capita cost of health care. Some of these may even be a function of our culture and its changes—forces that cultural anthropologists might yet one day reveal and explain to us. These may come as a revelation to us, not unlike that of the microscopic world of germs (bacteria and viruses) that were discovered to cause infectious diseases. Be that as it may, there has long been a residual force that drives up the overall per capita cost of health care above and beyond inflation and the cost of living. In fact, it *has* been approximately as strong a force as inflation.

Meanwhile, inexorable technological evolution and expansion continue. More and "better" medical goods and services come into being, and the existing methods and clinical pathways are superseded by newer ones. Improvements in public health are most evident in developing nations, where relatively low-cost

measures to produce clean water and improve sanitation produce enormous gains. Relatively speaking, such improvements are usually less evident in the developed nations of the Organisation for Economic Co-operation and Development (OECD), such as the United States, where the cost of even simple goals to improve public health is higher, and where enormous gains in public health are less frequently witnessed, unless it is something like a breakthrough drug or drugs enabling people with a death-sentence disease to stay alive when no such drugs previously existed. This was the case with HIV not so long ago.

For better or worse, this force I call health technology acts on the per capita cost of comprehensive medical coverage and increases it over the long run. There might even be years in which annual per capita cost stays the same or even decreases, but by and large, over decades and scores of years, the growth has been intractably upward.

There are myriad examples of technological innovation in medicine from the time of Galen to today. The relatively recent invention of penicillin is an oft-touted one. Years ago, my family and I walked around on the grounds of the first hospital at the Asklepion in Pergamum, Turkey. The practice of medicine inside those halls then, the halls where Galen practiced, was quite different from the goings-on in the typical hospitals, clinics, and medical offices of 2016. Great is this tool we call the scientific method. It is instrumental in our quest to improve our quality and length of life—but it is both a blessing and a curse. Galen was the great physician of his time and place, but it would be thousands of years before antiseptics or general anesthesia were discovered. And who back then would have guessed that sulfa drugs and antibiotics would one day kill bacteria that cause disease, or that antibiotic wonder drugs would eventually alter the evolution of germs and help produce resistant superbugs that may eventually stymie us, for a time.

Speaking of medical progress and the onward march of technology, which leaves a lot of outmoded and superseded equipment and approaches littered along the path, I recall seeing a book in Heidelberg in 1986 during the 600th anniversary of that venerable educational institution. I was peering into a glass museum exhibition case at the *Handbook of Surgery*, a German medical text written in 1529. (Just 40-some years before that exhibition, some of the university's books had been burned on the square during Nazi rule. It is shocking to realize how quickly the wheel of civilization can roll back and undo several eons of social progress.) In that *Handbook of Surgery*, a picture of a trepanation was depicted, and the blood drops spattered on the page gave mute testimony to the history it encapsulated. The state of the art and standards of care in medicine evolve with the culture. Yesterday's panacea can become tomorrow's poison—or more likely, a forgotten temporary detour in the grand scheme of medical progress. Although we no longer attribute what we do not understand to demons, gremlins, and witches, some of our current knowledge of physical and mental health is yet incomplete and has a long way to go before the ideal or optimal clinical pathways are developed, if such a thing exists. In another hundred years, we may look on some of today's medicine as we now look upon leeching, bloodletting, mind cures, mercury as a miracle ointment and syphilis remedy, and pervasive use of lobotomy. Moreover, to some extent, future medical solutions will vary by person based on individual genetics. The advances in genetics and molecular biology have launched a whole new era in medicine. And if you think things are complicated now, just wait a few decades!

Health Cost

Although we have demographic data from the U.S. Census going back to 1900, we do not have similarly reliable data on annual per capita cost in the United States extending back that far in time. The Centers for Medicare and Medicaid Services and its Office of the Actuary provide national health expenditure (NHE) data from 1960 to today. These data are used throughout this paper, which focuses on one aspect in particular: the per capita average annual cost of health care for U.S. residents of all ages.

There is one confusing detail to sort out first, and that is the difference between total NHE and per capita cost. Journalists are often ambiguous on this point—their reader does not know the one to which they refer. Total NHE depends on the number of people in the U.S. population, as well as the underlying cost per person. The U.S. population has been growing, and it also drives NHE even if per capita cost were flat. It is important to distinguish between the two. As actuaries, we more often study per capita cost increases.

According to the Census Bureau, the U.S. population has grown as shown in Table 1. The population for 2015 is estimated, since the U.S. Census occurs once every 10 years. From 1965 to 2015, the U.S. population grew from 194 million to 320 million—about 1 percent per year. From 1900 to 1965, it grew more quickly, at closer to 1.5 percent per year—and that includes the "baby boom" after World War II. The highest fertility rates occurred from 1947 to the mid-1960s. From 1940 to 1960, the population increased about 1.6 percent per year on average.

Table 1. Growth of U.S. Population

Year	Population (Millions)
1900	76
1960	181
1970	205
1980	227
1990	250
2000	282
2010	308
2015*	320

*Estimate.
Source: U.S. Census Bureau (2010).

For those inclined to business-speak, let us say that some of population growth is internal, and the rest is net acquisitions—that is, immigration less emigration. The internal growth involves fertility and mortality rates, which fluctuate over time, as does net immigration. When looking at NHE or Medicare cost over time, it is important to consider the confounding variable of population growth. The media do not always do a good job of separating the simple difference in the growth of health cost for all in the United States from cost per capita. The growth in per capita health cost is the focus of this paper.

For present purposes, health care cost is the annual per capita average cost for all U.S. residents combined. The Office of the Actuary provides the NHE data sliced many different ways, so one can view it at a much more granular level than in aggregate only. Average health cost per person per year has risen much faster than population growth. Suffice it to say, the annual per capita cost for those over age 65 is

greater than it is for those younger than 65. Studies show that health cost is typically greatest in the final year of life, which of course can only be known ex post facto.

According to NHE data, health care cost rose 8.4 percent on average per year from 1960 to 2010. Table 2 shows some of the NHE data, based on annual cost data and population data from the Census Bureau. The average annual growth rates over the last 10, 20 and 50 years were calculated as in this example for the last 50 years: 8.4% = ($8,400/$146)$^{1/50}$ – 1. The trend in the health cost has mitigated somewhat from about 1990 forward.

Table 2. Growth in Per Capita Annual Health Care Cost

Year	National Health Expenditure per Capita	Annual Growth Rate, Last *X* Years			U.S. Population[1] (Millions)
		Last 10 Years	Last 20 Years	Last 50 Years	
1960	$146				186
1970	$355	9.3%			210
1980	$1,110	12.1%	10.7%		230
1990	$2,840	9.9%	11.0%		254
2000	$4,857	5.5%	7.7%		282
2010	$8,400	5.6%	5.6%	**8.4%**	309

[1]U.S. Bureau of the Census, resident-based population less armed forces overseas and population of outlying areas.
Source: NHE OACT data 2016.

Note that the population data in Table 2, which comes from the Office of the Actuary's NHE data, differs slightly from the population figures in Table 1. Since the NHE data begins in 1960, this same population data has been used here to establish the annual average per capita cost calculations in this paper.

Next, Table 3 presents the increase in the cost of living in the United States over the same 50-year period, from 1960 to 2010. As in Table 2, the annual trend calculations are the author's.

Table 3. Cost of Living in the United States

Year	Index	Annual Growth, Last *X* Years		
		Last 10 Years	Last 20 Years	Last 50 Years
1913	$31.03			
1960	$100.00			
1970	$131.03	2.7%		
1980	$282.76	8.0%	5.3%	
1990	$448.28	4.7%	6.3%	
2000	$593.10	2.8%	3.8%	
2010	$751.72	2.4%	2.6%	**4.1%**

Source: U.S. Bureau of Labor Statistics.

During some decades, the cost of living increased more quickly than in others. The 1970s had the highest inflation of the five decades, which then slowed in the 1980s. Over the entire 50-year period of 1960 to 2010, the U.S. cost of living increased on average by 4.1 percent per year. That is roughly half of the growth rate for per capita health cost.

Now let us calculate the residual and see how much of health cost growth is unexplained by the cost of living. To calculate the percentages in Table 4, I back-solved for the difference between Tables 2 and 3. The residual is 4.2 percent.

Table 4. Residual Health Cost Growth

	Per Capita Cost Growth/Cost of Living Increase		
	Annual Trend, Last *X* Years		
Year	**Last 10 Years**	**Last 20 Years**	**Last 50 Years**
1913			
1960			
1970	6.4%		
1980	3.8%	5.1%	
1990	4.9%	4.3%	
2000	2.6%	3.7%	
2010	3.2%	2.9%	4.2%

There is more going on in the 4.2 percent residual than just health technology. As stated previously, this could include a whole matrix of causes, perhaps even cultural forces. It does include the aging of the population, for example. As people live longer, the average age gets older. According to the Census Bureau, the median age was 28.1 in 1970 and 37.2 in 2010. Actuaries understand that health cost increases with age; hence, when average age increases, we expect the average per capita cost to increase as well. This is an important point: Today, the per capita health cost of a male over 65 years of age is about seven times that of a male aged 23. (This does not include the cost of maternity, which follows the female in the claims data.) And the health cost of a male age 65-plus is about three times that of a male aged 45. Other researchers have teased out the cost of the aging of the population from the other forces of health cost increase, and they make it clear that this is another factor contributing to the increase in per capita health cost. Fundamentally, there is something like a circular reference in this formula: The more we spend on health care, the longer we live, and the more our average health cost increases as average age increases. And more retirement security is required to provide for those extra life-years.

A large portion of the 4.2 percent residual cost growth in Table 4 is health technology—new medical goods and services. It drives up the per capita cost of health care because it increases with respect to (1) the intensity of service performed or the complexity of each good received, and (2) the number of medical goods and services provided per person per year.

This is not meant to be a profound trend analysis. The basic point is that per capita health cost increases at a rate about twice that of the consumer price index (CPI). This 2X factor is easy to remember, but it is easily overlooked when planning for the future. Retirement planning involves consideration of the future increase in CPI during one's nonworking years, but it is only more recently that planners have begun to consider the fact that health cost rises faster than CPI. Because Medicare is an indexed benefit,

beneficiaries have not had to worry as much about its cost growth. Any change in Medicare as a defined benefit would have significant implications for retirement security. For example, switching to a fixed-contribution approach using "premium support" could eventually shift cost to the Medicare beneficiary and thereby increase the risk borne by the individual.

In Medicare Part D, despite the indexing of the pharmacy benefit combined with the closing of the coverage gap, we have seen significant cost increases nonetheless, and that has occurred despite the high level of managed competition that Part D involves. Here, too, the availability of coverage and presence of insurance may contribute to the overall increase in pharmacy cost for seniors. Medicare Part D did not exist prior to 2006.

It would be simplistic to attribute all the growth in health cost (outside of CPI) to technology. Other factors include the increase in median age and the fact that people are living with more accumulated medical conditions. We saw an unprecedented improvement in longevity in the 20th century as the infectious-disease paradigm enjoyed its best and most effective years. Continued improvements in fighting disease will cost more and more. An increasing percentage of the population will live long enough to be diagnosed with cancer and Alzheimer's disease. Anti-senescence treatments currently in development will further increase the median age of those already living with accumulated conditions and thereby increase per capita health cost.

National Health Expenditure as Percent of GDP

As an inevitable consequence of per capita health care cost increasing faster than CPI, health care cost constitutes an increasing percentage of gross domestic product (GDP) as time moves forward. This subject raises far more questions than can be addressed in this paper. The question of primary interest that arises here is this: Is there an optimal number for health cost as a percentage of GDP at any given point in time? To extend that question, does health spending crowd out potential spending on other items of national importance, such as education and defense? If so, to what extent?

The rise of health cost as percentage of GDP is often discussed, and the critical bias seems to be that more is not better. But is that necessarily true? In the same way that countries' economies evolve and service industries become a greater percentage of GDP, the rise of health cost seems similarly inevitable. Is this really a guns-or-butter type of allocation question? Many ancillary issues come into play, such as optimal allocation of economic resources, increase in national debt, and intergenerational equity, to name a few. Before we rush to judgment, let us put aside any critical bias for or against a change in NHE as percent of GDP. The crux of the matter is whether economic productivity can increase faster than health cost and thereby absorb it. In recent decades, the United States has spent more of its GDP on defense than other OECD nations. This is yet another confounding variable that further complicates the discussion concerning percent of GDP.

The fact that per capita health cost increases faster than the cost of living at the same time that people live longer contributes to the ongoing rise in NHE as a percent of GDP. The other consideration is that the percentage of nonworking elderly increases. In a nation with a declining birth rate, this places an increasing burden on the PAYGO system, because the ratio of nonworking elderly to working young people increases. Changing demographics and fluctuating fertility rates come into play. In a stationary population, this is less problematic.

If per capita economic productivity could grow at the same rate as or more quickly than per capita health care cost, the rise in NHE as percent of GDP would not be an issue. But the opposite has occurred over the past 50 years, and thus the dilemma.

How Did We Get to This Level of Health Care Spending?

With respect to longevity and quality of life, humanity is in a more privileged place today. With the passage of time and benefits of science, we have moved past the medieval paradigm that ascribed magic to much of the unknown and miasma to the spread of disease because it was beyond the human ken then to envision life at the microscopic scale—bacteria, germs. The same holds true for the macroscopic realm. An early Renaissance man, Giordano Bruno, was burned at the stake for his hard-earned scientific theory of a post-Copernican universe with multiple solar systems consisting of planets rotating around stars. Science was at cross-purposes with religion and could be perceived as heresy. The first amendment to the U.S. Constitution was still centuries away, and there were some serious psychological barriers to challenging the status quo back then, given the torture and individual annihilation that could result.

It was not until the mid-1800s that germ theory even began to be more widely understood. Anesthesia began to be used for surgery in the late 1800s. Roentgen's discovery of the X-ray around 1895 was the beginning of a revolutionary era of medical imaging that continues to this day. The first medical wonder drug was a sulfa drug; it killed bacteria inside the body and came into use in the 1930s. It was later superseded by penicillin, which first came into use in the late 1920s. (And not long after began the era of the mutating and evolving superbugs, unknown to us until many decades later.) Vaccination, beginning with smallpox, has been a called a medical miracle. Vaccines alone are responsible for eliminating untold tribulation in preventing many of the childhood diseases that previously decimated so many families. Tuberculosis treatment is another, as is the polio vaccine.

These are all major breakthroughs that we can readily recognize. But what about the more recent medical triumphs of the past approximately 50 years that helped put us where we are today in terms of medical cost? Here is a list of some of them:

- Complex imaging—PET and CT scans, MRI; even ultrasound is a relatively recent advancement
- Continued development of vaccines against childhood diseases and improvement of existing vaccines
- Minimally invasive surgical techniques, such as laparoscopy, and laser and robotic surgery
- Organ transplantation
- Dialysis
- Improved diagnostics of many varieties, such as non-invasive kidney; other exponentially improved diagnostic tools, such as blood analysis; advancements in pathology
- Cardiac therapies—angioplasty, bypass surgery, valve replacements, pacemakers, beta-blockers, statins; ACE inhibitors for hypertension
- Considerable development in prostheses and artificial limbs, as well as medical equipment

- Diabetes testing and treatment
- Advances in preventing and treating infectious disease, including recent antiretroviral therapies for HIV
- Exponential development in prescription drugs and biopharmaceuticals; the general explosion in new pharmaceuticals—amazingly, in the same way that a dose of vaccine can prevent something that could formerly kill or debilitate, a pill regimen can now treat and cure diseases or reduce symptoms to a remarkable degree
- Psychotropic drugs for the treatment of mental illness, depression, anxiety, and the myriad of psychiatric and psychological conditions that beset people in this increasing technical and complicated world
- Oncological advances, not just Gleevec and Tamoxifen, but also targeted treatments, better oncology drugs, and advancements such as the Cancer Genome Atlas
- Genomics, targeted gene therapy
- In vitro fertilization (IVF) and infertility treatment
- Rheumatology—targeted biopharmaceuticals, such as tumor necrosis factor (TNF) inhibitors
- Stem cell therapy
- Recognition of medical conditions, such as the autism spectrum disorders, that previously did not exist, or new infectious conditions such as Zika virus and Lyme disease
- Recent interferon-free hepatitis C treatments
- The rise of primary care

This is not an exhaustive list, and I apologize in advance if I have omitted anything or anyone important. These items share two things in common. First, they generally help people live longer lives with higher life quality. Second, they add to per capita medical spending, regardless of whether they are covered by insurance, the individual, employer, government, charitable individuals or institutions, or some combination thereof.

A Case Study for a State: The List of Covered Medical Services Grows

Many health policy experts have the sense that comprehensive medical benefits are specific and bounded. This is not the case—they expand over time, and that expansion is inevitable as technology develops new solutions to unsolved medical problems. It is usually slower than most naked eyes can detect, but sometimes it occurs more quickly. Moreover, it is not free. Additional comprehensive medical benefits generally mean higher average per capita health cost. Higher mathematics aside, we can think of essential health benefits as a pie slowly expanding in diameter and height over time.

A multiyear study I led and authored as an outside actuarial consultant for a state analyzed the cost of state-mandated medical treatments. These were treatments the state had legally required health insurers to cover in health insurance policies and treatments the state was considering for future mandate(s). Prior

to the Affordable Care Act, these mandates helped determine the "essential medical benefits" for insured health coverage in each state. Health insurers often resisted coverage of new treatments, conditions, or providers. There is a period of uncertainty between the discovery of a new treatment and its universal recognition as a new standard of care. It is fraught with the difficulty of change, because there will be winners and losers, and some of the current winners who stand to lose are willing to invest forcefully in the protection of their status quo. For the payers of health care, it adds further uncertainty to projections of future cost.

That study examined the cost of the mandates and the downstream ramifications on the system for finance and delivery of health care and the availability of care. The financial burden of the insured person's portion of cost was examined for various economic strata as it related to access to care. Interestingly, most of the specific mandated items were not all that costly as a percentage of the total per capita cost of care. (But the panoply of diverse medical discoveries is more the story of death by a thousand paper cuts when it comes to the cumulative cost of care.) And many of these items, at least in terms of our current cultural values, were very much non-elective, such as treatment for cancer and leukemia, although that was, relatively speaking, one of the more costly of the 48 mandates on the books in 2010. It is not that insurers are unwilling to pay for cancer treatment or other necessary treatments, but on rare occasions, there may be one that takes a shortcut in coverage to mitigate its own liability. That is when the law may have to step in and become the final say on who pays how much for what.

In some cases, such as blood lead screening for children and lead risk assessment, the mandate provided coverage through private insurance for services that might be established through a public health agency in another nation. The boundary between public and private is occasionally subject to debate.

Two of the more relatively expensive mandates involved (1) diagnosis and treatment of mental and nervous conditions and (2) the availability of psychotropic drugs in health plans. These two medical treatments involve a complex history in which mental and nervous conditions moved from ignorance and stigma to a more comprehensive understanding of these conditions and scientific knowledge concerning their causes and treatment. I suspect that improved mental health improves productivity, but that is a different study.

One of the recent medical developments that proved salient (and expensive) during the mandate study was the increasing frequency of utilization and high unit cost of complex imaging—MRI, PET and CT scans. It seemed to aptly reflect the recent evolution in health care. The intent of one mandate was to help relieve some of the insured person's cost sharing for these services. Complex imaging could be a study in itself, since there was significant variability in the unit cost of care; many aspects of optimal use and efficiency play a role in this discussion.

Some new medical tools are used to help medical providers better screen for diseases—not only cancer, but also heart disease and lower respiratory problems—three major killers. Mammography for breast cancer screening and colonoscopic screening for colon cancer—these are examples of medical tools that increase longevity and life quality through early detection followed by early treatment. None will refute that these tools have proven beneficial for some. But some clinicians have argued that inappropriate use may lead to adverse consequences for the patient.

Coverage of newborns was another costly mandate. No one opposes covering newborns in health insurance, but the cost of doing so has been increasingly rapidly. The advances in neonatal treatment in

the past one to three decades have been remarkable. Today, premature infants of low birth weight can survive, where only 30 years ago, their survival would have been thought entirely impossible. This, too, however, comes at a nontrivial cost to the average person's commercial health insurance policy.

The role of the government in mandating coverage of specific treatments can be fraught with peril. Somewhere between the moment of discovery and the establishment of a new standard of care, there may be an ambiguous zone of uncertainty. One classic example is bone marrow transplants for those with breast cancer. Some states required insurers to pay for these treatments before their inefficacy was declared. Another is hormone replacement treatment for disease prevention in menopausal and post-menopausal women.

Which services health insurance should cover is a contentious area. It touches the deepest nerve of all, and that involves the questions of who pays, for what, and how much. Suffice it to say, over the past 50 years or so, outside of the time-value-of-money issue, humanity has discovered and created a great deal of new medical technology that propels us into an era of living longer at a far greater cost—a cost that has consumed an increasing portion of the GDP.

In reviewing the previous list of bullet points, certain things stand out:

- More than 25 years ago, pharmacy spending was about 6 percent of the total medical and drug cost combined for commercial group health coverage. Today, it is far higher, as the fast-increasing cost of medical care has been outstripped by the even faster-increasing cost of prescription drugs. Add to that the cost of in-office drug treatments, such as injectables. Add to that the recent introduction and increased use of specialty drugs, which are, by definition, high-cost. The even more recent release of interferon-free hepatitis C agents, such as Sovaldi and Harvoni, have also added to pharmacy cost.
- The more frequent use of complex imaging is another area that comes with a significant increase in per capita cost, and the per member per month cost for commercial (under-65) group health insurance coverage is likely in the teens or more for many insurers.
- The evolution of diagnostic and screening tools, especially for cancer, is another costly area with breakthrough impact on longevity and quality of life. The results have been remarkable, but the cost is nontrivial.
- Diabetes testing and treatment is an increasingly costly first-world problem. And type 2 diabetes is occurring more frequently in non-OECD and developing nations as well, as a result of changing diet and lifestyle.

Other conclusions could be drawn from the mandate study. IVF and fertility treatments may add approximately 1 percent to overall health cost, depending on what exactly the mandate covers and how much cost sharing is required of the insured. The more generous the benefit, the more frequently it is utilized, and the more it costs in total. States with richer infertility benefits have higher utilization and overall cost. The infertility benefit is used by relatively few, but it adds to the average cost of the many.

The same is true for other mandates that are not the same kind of life-and-death decisions that a person with cancer or leukemia must make. (In a true life-or-death situation, the laws of economics may change, and the supply-and-demand rules that typically apply to the commodity pricing of gallons of milk in a robust market no longer apply to the middle-aged person whose oncology treatment is tantamount to what biologists describe as the survival of the organism.) Some mandates affect convenience and reduce

the insured's cost of care without a direct link to life or death. These are more subject to normal economic rules, but given the current employer-based system of coverage in the United States, it is hard to argue that we have a system that resembles a free market for health care. Given the unconscionable skyrocketing cost of certain critical medicines in the media recently, we need to ask, "Do we want a perfectly free market for all health goods and services?" Some of these mandates cover medical situations, such as treatments for orphan diseases, whose proper handling is better left for expert medical ethicists to speak to.

All this expansion of health benefits from mandates occurs in parallel with the general expansion of coverage for self-funded health plans. And this implicit expansion of benefits comes at a cost. It certainly has a positive benefit to humankind, but it is part of the underlying force driving up per capita health cost at a rate faster than CPI.

The concept of "essential benefits" came into being with the Affordable Care Act. It is the smallest set of medical benefits that must be covered in a comprehensive health insurance plan for it to meet the minimum criteria of coverage, regardless of the plan's actuarial value and how much cost sharing the member must pay. Over time, that list of benefits has lengthened as new medical technologies and treatments come into being for medical conditions we did not understand or label as medical problems until relatively recently. The point of this section is that the set of covered goods and services is growing. No one can draw the line between what is essential and what is not. We want it all, as soon as possible, without personal expense. The distinction between basic and essential services versus supplemental ones has been difficult to make.

Implications for the System of Finance and Delivery of Health Care in the United States

As a leader in the global economy, the United States pays for a larger than usual share of the cost of research and development for new drugs and medical treatments. Patients treated in the United States, however, have access to the latest and greatest modalities of care. Something similar can be said for other OECD nations as well.

The American Medical Association recently came out against the widespread advertising of drugs in the United States, which is generally not permitted in other nations except for New Zealand. The role of the marketing of medical services in the United States is unlike that of most other OECD nations. U.S. hospitals in the same city may all have the same cutting-edge equipment, and they advertise aggressively on television, radio, billboards, etc. for the limited supply of patients. This has been referred to as the medical arms race. Obviously, if all the utilization is appropriate, it is better for public health to have more than one digital tomosynthesis machine in one urban location, but how many is too many? How far should we expect the patient to travel? At some point, individual convenience plays a role.

As medicine evolves, it creates more specialized treatments for care. This is not a complaint about overuse of medical care. It is a recognition that new forms of care improve individual and population health but come with increasing cost. Some examples of services that have emerged in the past 50 years are the rise of physical therapy, occupational and speech therapy and home health care agencies, none of which insurers wanted to pay for early on, and all of which contribute to better population health. The number of psychotherapists also has likely increased with an increase in funding, either private or public,

that such providers receive for their services, as well as the general recognition of the positive value of this service. Applied behavioral therapy for autism spectrum disorder is a more recent example. Moreover, the cost-benefit of these services may have indirect advantages that have not yet been determined and proven, such as increased productivity.

The United States has far more care delivered by specialists than other nations, and commensurately less by primary-care physicians (PCPs). As new treatments develop, capital investment flows in the direction of those breakthroughs that are most likely to succeed and be financially rewarding. Medical waste is increasingly prevalent, as is graft and corruption. This is not just a for-profit problem. Some not-for-profit organizations base their livelihoods on the rise of new areas of care. And when the government is paying for medical services, a certain kind of fraudster inevitably arises to find the chink in the system's armor. At this moment, it is possible there are cybercriminals in other nations working on their entry point to the Medicare and Medicaid systems.

But the vast majority of cost is perfectly legitimate medical treatment, and thus the urgency, for the past 20 years. These new treatments (and regulations to treat) create new industries of health care providers, wheelchair and other medical-device manufacturers, etc. And the forces that impel businesses to grow and prosper affect these organizations, too, as they all compete for a larger slice of the growing health care pie.

Other related social problems arise, such as the percentage of U.S. residents who frequently use or are addicted to opioids. Many contemporary social issues exist on a battleground of who pays—the public versus the private sector, the individual or society. The mean-spiritedness of humans knows no limits in some of these contests, so that care providers and payers become disconnected from those whom they affect and otherwise removed from the will of Hippocrates.

Moreover, not all developments are a straight add-on to overall cost. Some are more complicated, such as the rise of primary care, which may help decrease cost as health care dollars are invested in upstream care, wellness and prevention, and ultimately diverted from more expensive downstream cures. Some of these interventions involve investment today to produce tomorrow's better population health. The scientific acknowledgment that smoking is linked with cancer, especially lung, mouth and throat cancer, has helped diminish tobacco use in the United States, especially its primary culprit, cigarette smoking. Despite the deep-pocketed lobbying and virulent opposition by the tobacco industry, after decades of struggle, progress has been made in the United States on this front.

There is also increased use of palliative care, hospice and other alternatives to the more demanding end-of-life medical measures that buy a few more (perhaps miserable) months, weeks or days at great cost to the patient's well-being. The often-taboo topic of how we leave this life on earth is giving way to the realization that we have choices. A death in the ICU setting might not be preferable to exiting life at home surrounded by loved ones.

The role of technology cannot be avoided in any discussion about health care cost in the United States, but there is more. We do not yet fully understand how our health care dollars are allocated in comparison with those OECD nations with high quality but lower per capita cost. There are clearly areas where the United States spends inefficiently, and this contributes to the overall inefficiency of the U.S. system relative to other nations. By efficiency, we mean the relationship between inputs cost and the outcomes of the health system. We know the United States lags behind in certain respects, but it is no easy matter

to tease out those areas in which other nations are able to achieve equal or better health outcomes at lower per capita cost, or the reason why. Clearly, those nations are healthier whose public planning has traditionally included more walking and biking, pedestrian and bike zones, and more balanced lifestyles. Diet is a factor as well. What works here and is right for this culture might not be the answer elsewhere, and vice versa. It is beyond the scope of this paper to address the difference in medical outcomes in different nations versus their respective per capita costs. For all nations, however, developments in medical technology relentlessly drive up per capita health cost.

The manner in which new technology comes into popular use can play out in a number of ways. Downstream implications may include an increase in the supply of providers who perform the service or provide the new or updated medical good. The question of who pays how much undergoes a process of development. Any business that develops from the new technology will be subject to the same laws of business survival affecting other types of business—manufacturers, distributors, and retailers of cars, tires, sporting goods, hot-water heaters, lawn mowers, food, clothes—the list is long but not endless. Regardless of whether the business model is for-profit or not, circumstances compel the new business to grow, to pay people more and bring in more revenue for all such purposes. It is difficult to predict the myriad ways in which it may pan out. Needless to say, these forces drive increased utilization of newer medical goods and services, and they underlie an inexorable increase in unit cost. Each player or business entity in the system seeks to improve or optimize its position—some players more altruistically, others more rapaciously than the rest. In the midst of it all, some may have what they think is a bright idea to charge 10, 20, 50 times more for an important drug than previously because "the market will bear it." In 2016, we saw this come to public light more than once. (Here is where the regulatory structure better be fully functional.) The multifactorial actions and reactions that occur are more a subject for complexity theory than a simple linear flow chart. Obviously, a great deal of branching may occur.

The new hepatitis C drugs exemplify the high retail prices that a drug manufacturer may command for a new, much better drug for a serious disease. Harvoni is not a highly complex molecule, like some new drugs that require more research and development cost because of the size of the new molecule under development and testing. The price of the new hepatitis C drugs is a function of market dynamics and the forces of supply and demand. This is not a condemnation of the way the U.S. drug market works. It is an observation that the forces of supply and demand seem to operate in a relatively unrestrained manner in this case involving a serious disease. Just imagine how much a single-dose immortality tablet could cost?

An International Perspective

Up to this point in the paper, I have looked at evolving technology, increasing longevity and increasing per capita health cost primarily in the United States as stressors on the system for the delivery and finance of health care and the system for retirement security. Although NHE as a percent of GDP varies widely in developed nations, all OECD nations recognize that per capita health expenditure and NHE as a percent of GDP are both increasing at a worrisome rate. The sustainability of that rate of increase is called into question. The implications and ramifications of this exponential increase appear to lead to a Malthusian conclusion. Granted, Malthus was a bit ahead of his time, and the eventual doom of famine that he gloomily depicted in his 1798 essay, "The Principle of Population," was generally perceived as fantastically incredible futurism by 1900, at which point it seemed it could never come true. In the same way that Malthus recognized the limitations of the biomass of England more than 200 years ago, however, today

we can see the limitations of the entire planet. The population of the United States was 79 million in 1900, 282 million in 2000, and 320 million in 2015—a fourfold increase in 115 years. Is there a tipping point? Similarly, the cost of health care in the United States is of substantial and increasing concern, both in terms of its magnitude in per capita dollars and NHE as a percent of GDP. Even the rate of growth in NHE as a percent of GDP is concerning. Intergenerational equity issues surface. Will the increasing cost of the living become an unfair and disproportionate burden on those yet unborn?

To put the U.S. experience into broader perspective, I enlisted the assistance of another actuary, Michael Ankrah, and we used the World Bank data to examine longevity and health cost in other nations. In particular, we studied NHE as a percent of GDP in other nations outside the United States and OECD nations, especially in developing nations. In the data, we observed that NHE is a significantly lower percent of GDP in developing nations than in the United States or other OECD nations. Moreover, the rate of increase is also slower for developing nations. In particular, we focused on and examined sub-Saharan Africa. The same rate of growth in NHE as percent of GDP is not observed in sub-Saharan Africa as in the United States or OECD nations. In general, over the past 20 years, NHE as a percent of GDP has grown more slowly in developing nations. The availability of health insurance, health care financing, and health care services in the developed nations is associated with their rise in NHE as a percent of GDP. The same cannot be said for the sub-Saharan developing nations that do not have similar health care resources and financing systems in place.

Over the past 20 years, NHE as a percent of GDP has largely been flat in sub-Saharan Africa, at approximately 6.0 percent. When we look at the experience of each individual nation in sub-Saharan Africa, each country may have its own reasons explaining the change in its NHE as percent of GDP over the past two or three decades. For example, during the 1990s in Ghana, there was no social health insurance. Medical care was strictly based on one's ability to pay. In 2003, Ghana passed the National Health Insurance Act. It provided basic health insurance for most of the population. In keeping with our earlier observation about NHE increasing with the availability of and funding for care, Ghana's increase in NHE as a percent of GDP in the years soon after 2003 is consistent with the increase in the availability and financing of health care. In 2011, eight years later, there was a sudden dip in NHE as a percent of GDP. This could be partly attributable to the unusually high GDP growth of 14 percent in Ghana's economy in 2011. The nations of sub-Saharan Africa are non-homogeneous, and their results may move in different directions at different times. The volatility of national results observed in sub-Saharan Africa, however, would be atypical in the United States or other large OECD nations, whose year-over-year changes tend to be more stable.

The AIDS deaths associated with the HIV epidemic in sub-Saharan Africa have had a significant impact on longevity there. HIV incidence rates were highest in the 1990s. Within each nation, longevity has been bimodal (those with HIV and all others), and the greater the prevalence of HIV and AIDS, the lower the total average national longevity. The effect of AIDS was not uniform across sub-Saharan African nations. Some nations were affected more than others with higher prevalence and incidence rates, as well as differing mortality rates, which erased recent longevity gains and reversed the trend in increasing longevity, at least temporarily. (A similar phenomenon of lesser magnitude is seen in the United States, where gun homicides among young males have been a downward force on the increase in longevity. It

was not as powerful as the HIV epidemic and AIDS in Africa, but the epidemiological concept is similar: The increase in longevity over time is not without certain stressors that may reverse the trend.)

Relatively speaking, the public-health issues of developing nations are more elemental and fundamental than those in the United States. In general, the treatment of communicable diseases is by far the largest part of the health expenditure for most countries in sub-Saharan Africa. Some diseases and medical conditions that are largely eradicated or controlled in OECD nations are still problematic in developing nations. However, as in many developing nations or regions, increasing life expectancy coupled with a more Western lifestyle could be driving the observed increase in certain chronic diseases, such as diabetes, stroke and cancer, in sub-Saharan Africa. Although these lifestyle diseases are more problematic in the United States and OECD nations, they, like new medicines and medical treatments, find their way to developing nations.

All nations face the threat of contagion and pandemic. With economic resources come the means to fight pandemics, such as the latest threat—the Zika virus. The tiny, short-lived mosquito may be the most dangerous creature in the world.

Figure 3 shows NHE as a percent of GDP over time for the United States and several selected regions. The dots on the curves indicate the magnitude in each year. The lighter dotted lines show the slope of the trend line. The groups of nations are the least-developed nations (a UN classification), the OECD nations, sub-Saharan Africa (developing nations only), and the world (all nations).

According to the World Bank database notes (World Bank n.d.), longevity is defined as life expectancy at birth, and it indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life." Figure 4 depicts longevity, measured as average life expectancy at birth. It includes the same groups of nations as in Figure 3, as well as Ghana, which has higher longevity than the other African nations shown.

The national health expenditure (NHE) as a percent of GDP varies from one nation to another but is observably greater in the United States and OECD nations. Longevity also varies, and it too is observably greater in the United States and OECD nations. From each line’s slope, we can infer the trend over time.

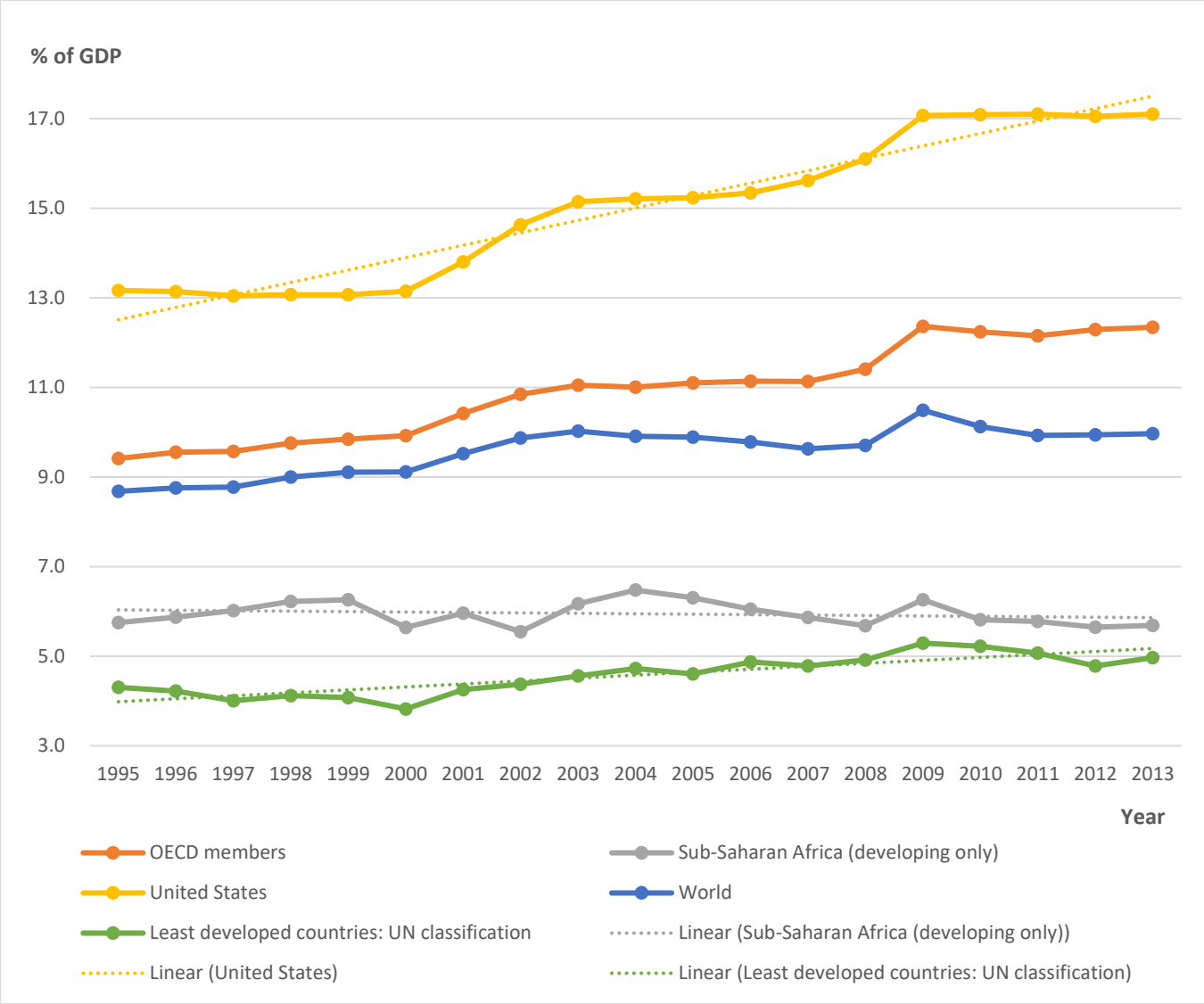

Fig. 3. National Health Expenditure as a Percent of GDP, 1995–2013
Source: World Bank.

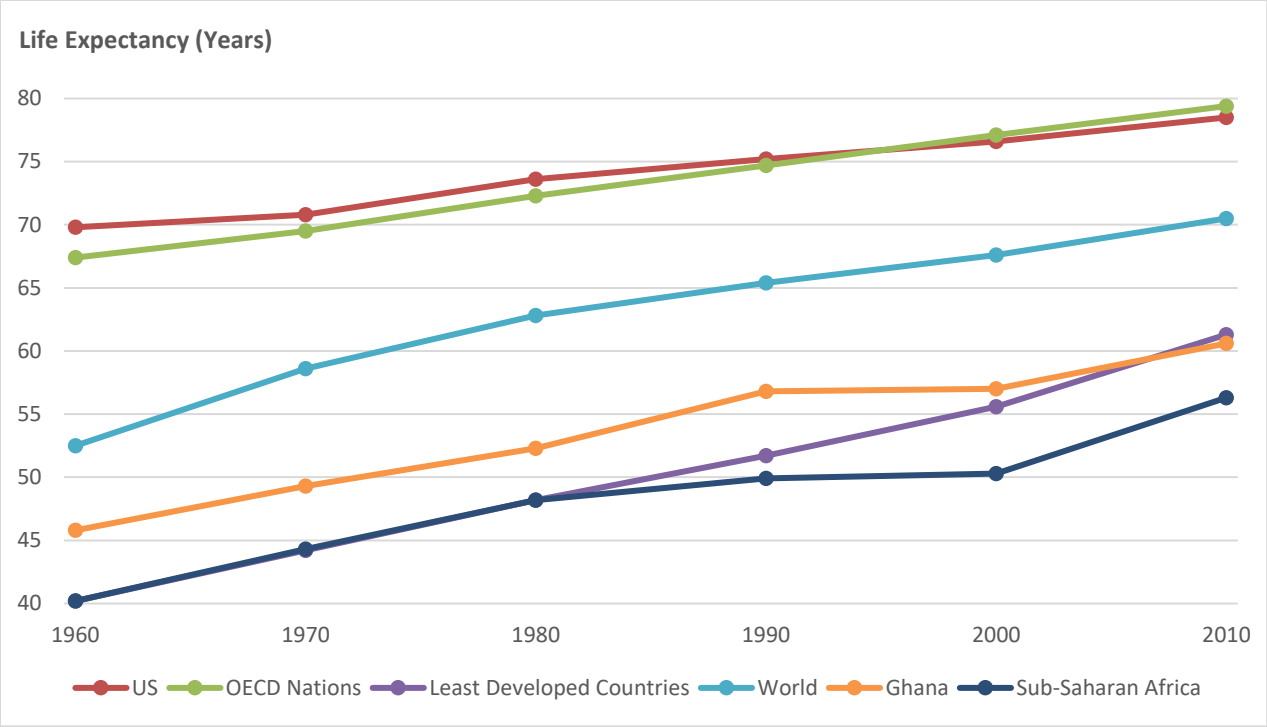

Fig. 4. Longevity: Life Expectancy at Birth, 1960–2010
Source: World Bank

We observe interesting patterns when comparing the data of other nations:

- NHE as a percent of GDP is highest in the United States and OECD nations. It is lower in the developing nations.
- Longevity also tends to be greater in the United States and OECD nations than in developing nations.
- NHE as a percent of GDP has been spiraling upward faster in the United States and OECD nations over the past 20 years. That is, the trend line is steepest for the United States—a greater slope than for OECD nations, the world, etc.

Most interesting is the last bullet. It appears that the OECD nations and especially the United States have greater difficulty controlling the rise in per capita health cost. Moreover, the rise in NHE as a percent of GDP is also increasing faster than in less-developed nations and regions. The increase in health spending in the United States and OECD nations does not buy as large an increase in life-years. We must ask what this suggests about the potential productivity gains in the most developed nations and whether these gains can keep pace with the increase in per capita health cost.

Health spending and longevity intensify one another in an autocatalytic process. The United States (and other OECD nations that spend the most for per capita health cost and as a percent of GDP) receive less and less longevity gain for their health care dollars. Over the past 50 years, the sub-Saharan African nations and those classified by the United Nations as least developed have spent less per capita and less

as a percent of GDP, but they have experienced greater longevity improvements than the United States and other nations.

In terms of measuring the success of individual health systems, longevity is often a primary metric. There are other ways in which the effectiveness of health systems can be rated both individually and collectively. Infant and maternal mortality are useful measures everywhere and especially in developing nations. Similarly, GDP has been criticized for not appropriately reflecting all the economic activity that benefits the common good, such as the investments we make in environmental improvement. Health expenditure is similarly difficult to compare. Our personal health is not a widget in the classical economic sense; however, our collective health and well-being is closely connected to our national productivity, which drives per capita GDP growth. Employers know this well, and hence the historical tax break for companies' fully insured and self-funded health coverage in the United States. This is not a simple situation in which there is only one thing wrong that can be fixed to solve the problem of escalating cost. It is actually highly complex, and as soon as we create better and more hygienic living conditions, conquer certain diseases, and devise cures for formerly incurable ones, new sets of complicating factors emerge, such as the chronic diseases that affect developed nations whose expedient modern-world lifestyles involve more and continual work stress, poor diets of processed foods, more sedentary time, less walking and fresh air, and less personal attention to health. Over time, not all the steps we take are forward.

These observations about different nations and regions cannot yet be easily packaged into neat scientific conclusions, but they do raise questions that future research could address. For the United States and developed nations, the sustainability of increasing health cost is a formidable challenge. For the developing nations, each step forward in improving public health involves substantial expenditure of scarce resources and is also a daunting task. For all nations, the goal is to improve productivity such that increases in per capita health can be paid out of those productivity gains. The data suggests this is more difficult to achieve in the United States and developed nations, in which per capita health cost is higher and substantial longevity gains have already been achieved. Moreover, as seen in Figure 4, the OECD nations overtook the United States with respect to longevity (life expectancy at birth) approximately 20 years ago.

Conclusion

As a result of increasing longevity and health cost increasing faster than the cost of living, several socioeconomic challenges face us. As a nation, we are already required to make hard decisions about the allocation of GDP to NHE, and this will be increasingly necessary and apparent 10, 50, 100, 500 and 1,000 years from today. Currently, an array of market and non-market forces act to change health cost up or down, and many winners and losers are created in that business process of *meum versus tuum*, and not always for the right reasons. Politicians invariably find it easier to give away benefits in the present and saddle present and future generations with that cost. As nations, we create wealth and enduring institutions as part of our legacy. Our responsibility is to build on that. Without the necessary policy, it will be increasingly difficult to help the growing portion of the population who live to 100. We will have greater need for financial and health security in old age and nonworking years. How do we address this?

The rising per capita cost of health care during retirement presents additional difficulty for retirement security in general. Up to this point, this paper has focused on the cost of comprehensive medical cost apart from the cost of custodial care. Health actuaries typically distinguish the difference between (a) medical costs and (b) costs of custodial care or long-term care services and supports. Health insurance does not pay for custodial care, not does Medicare, except for a limited period in a skilled nursing facility following an inpatient admission. Private long-term care insurance pays for private assisted living. And Medicaid pays for the long-term services and supports for the elderly and disabled whose financial means do not permit them to purchase it for themselves on the private market. As the population ages and fewer elderly have the support of their extended families, more assisted living is and will be required, as well as more long-term services and supports.

People of advanced years will live longer in a state that is, though not disabled, at least compromised with respect to some activities of daily living (ADLs) or instrumental ADLs. This is already a significant social problem, and it will increase in decades to come. We already see states trying to provide more of these long-term services and supports in the community to delay the Medicaid-covered individual's permanent assignment to custodial care in an institutional setting, such as a nursing home, which is considerably more costly. The increasing national cost of this custodial care for individuals covered by Title XIX is of significant importance for social and economic policy. Custodial care and medical care are two separate things, but there is some synergy between them for the disabled and elderly, as well as advantages to coordinating medical and custodial care to achieve better outcomes for each, at reduced per capita cost. The aging of the population causes a similar increase in national spending for custodial care, especially public spending for long-term services and supports.

In a distant future world in which health care spending hypothetically consumes twice the GDP it does today, all other economic activity will need to be far more efficient in order to simply maintain the current quality of life. It is not a foregone conclusion that society and the economy can rise above these hurdles. Similarly, spending on custodial care in the final years beyond active employment will also constitute a larger portion of GDP. The average number of months during which an elderly person requires custodial care will likely increase over time also; medical science will find new and better ways to keep people alive longer despite disease and infirmity. This, too, will test retirement security and the efficiency of the economy to meet society's needs as well as the productivity of all employment.

The U.S. Census Bureau estimates the U.S. population will reach 439 million in 2050. CMS estimates that NHE as a percent of GDP will rise by 1.3 percent per year from 2014 to 2025. CMS estimates that 2025 NHE will be 20.1 percent of GDP. Using the same linear trajectory until 2050, we can calculate NHE as 27.8 percent of GDP in 2050. Though approximate, that percentage seems daunting. We have our work cut out for us. Yes, it is better to begin saving for retirement at age 25 than 40 or 55. Analogously, it behooves nations to think and plan ahead.

The intent of this paper is to explain and draw attention to the ongoing process of increasing per capita comprehensive medical cost and the difficulty it poses to public health, financial security, and retirement security, especially in the United States, but in all other nations as well. There is still a great deal of work that needs to be done, not only to break down and understand the various components and forces of health cost increase, but also to better manage them and achieve higher systemic efficiency. This is especially true in the United States, but all developed nations are feeling the pressure of upward-spiraling health costs. Although this relentless increase in spending has many benefits in terms of improved quality

and length of life, it also presents long-term challenges. Human nature can be quick to take for granted these benefits and gains, and quick to blame someone else for the cost increase. One can buy a car or boat for about the same cost as an annual family health insurance premium, and for some, the latter goods may seem to do considerably more for one's personal pursuit of happiness and immediate gratification. These issues reflect human nature and cultural values and are not easily changed or resolved.

The sometimes-heated national discussion continues over cost of, access to and quality of health care. In the meanwhile, the upward spiral continues, and the usual debate over who pays, what for and how much takes center stage. We the living are fortunate to be living longer and more comfortably than our ancestors. How quickly we become accustomed to it and then expect no less. We hope the nation can improve average productivity such that we can leave the world a better place for our descendants. Clearly, we could potentially slow down the growth of health spending as a percent of GDP by increasing productivity, which will drive up the denominator. In discussing this issue with health economists from other nations, the distinction is made between efficiency gains in health care versus similar gains in the general economy. Apparently, they have not been far apart in recent decades.

Focusing more on future planning is no easy task. Most would rather forget their immediate problems, let alone plan for future ones. Our future retirement and health security challenges will require a paradigm shift back to a longer-term view, away from a preoccupation with gain in the present. The United States and OECD nations will be forced by necessity to place more focus and emphasis on the direct and indirect costs of future financial and retirement security. Intergenerational equity issues will result otherwise.

Upon examination of the economic and employment data since the economic downturn that began around 2008, economists have noted that the gains in employment over the past seven years have been predominantly in lower-paying service sector employment that has not benefited GDP significantly. This productivity problem exacerbates the rise in NHE as a percent of GDP.

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