IEPS
Instituto de Estudos para Políticas de Saúde

WORKING PAPER SERIES

IEPS WP No. 13

American Delusion: Life Expectancy and Welfare in the US from an International Perspective

Rodrigo R. Soares
Rudi Rocha
Michel Szklo

August, 2021

Instituto de Estudos para Políticas de Saúde
Texto para Discussão nº 13
Agosto de 2021

Rua Itapeva 286 | 81-84
Bela Vista, São Paulo – SP
01332-000 - Brasil

www.ieps.org.br
+55 11 4550-2556
contato@ieps.org.br

American Delusion: Life Expectancy and Welfare in the US from an International Perspective

Rodrigo R. Soares* Rudi Rocha† Michel Szklo‡

Abstract

Recent increases in mortality are at the forefront of the public health debate in the US. This paper takes a comparative international perspective and documents the poor relative performance of life expectancy in the US. We characterize its age and cause of death profiles over time and estimate its welfare implications. We show that this poor performance is not recent, not restricted to very particular causes of death, but mostly driven by adults and older ages. We calculate that recent welfare gains could have been 19%-28% higher had the US been able to reproduce the OECD life expectancy performance.

*Insper and Columbia University, r.soares@insper.edu.br.
†FGV - São Paulo School of Business Administration and IEPS, rudi.rocha@fgv.br.
‡FGV - São Paulo School of Business Administration, mszklo@gmail.com.

1 Introduction

The five-year interval between 2013 and 2018 represents the first episode in almost one hundred years when life expectancy at birth in the US experienced a sustained decline. In 2020, according to UN population projections made prior to the Covid-19 pandemic, US life expectancy was anticipated to return roughly to the level observed seven years before, in 2013. This would have marked a seven-year interval, without any major exogenous event, with null gains in life expectancy, an unprecedented case worldwide in modern times. With the arrival of the Covid-19, the picture is obviously much bleaker and large reductions in life expectancy are now expected in 2020 (Andrasfay and Goldman, 2020).[1]

The recent increases in mortality have brought life expectancy back to the forefront of the US public health debate. Though unprecedented, these reductions in life expectancy come after an equally surprising but, within economics and the broader public debate, largely overlooked phenomenon: a decades long deterioration in the country's relative performance in life expectancy, after which the US has fallen considerably behind the rest of the developed world. Today, life expectancy in the US is substantially lower than in every single Western European country, including those with income per capita below half of its own, such as Greece and Portugal, both of which have life expectancy numbers more than 2.5 years above that of the US. In fact, life expectancy at birth in the US is now slightly below that of Chile and only slightly above that of Uruguay, two of Latin America's top performers (2016 data from the World Bank's World Development Indicators).

Figure 1 presents the evolution of life expectancy at birth in the US and various regions of the world over the last few decades. Figure 1A organizes the international data by region of the world, while Figure 1B does it by development level. In 1960, the US had

[1]One would have to go back to the 1910s and to World War I and the Spanish Flu to find such long-lived reductions in life expectancy at birth in the US. But, even at that time, the increase in mortality was a short-term transitory shock: life expectancy still grew by over 4 years between 1910 and 1920, despite the flu (data from the National Center for Health Statistics). Without major global pandemics and wars, it is simply impossible to find episodes similar to the one observed between 2013 and 2018 unless one goes way back into previous centuries. None of the countries considered later on in our analysis has experienced, in modern times and under "usual" circumstances, periods of several years without significant improvements in life expectancy. One would have to look for exceptional times—such as the arrival of HIV/AIDS in Sub-Saharan Africa, the collapse of the communist block in Eastern Europe, the Great Famine in China, or major civil conflicts—to find repeated reductions in life expectancy year after year.

a small advantage over the average for developed countries, with approximately one more year in terms of life expectancy at birth, and was on par with Europe and the Western Offshoots (Australia, Canada, and New Zealand). Though there was already some deterioration in its relative position in the 1960s, up to the 1980s the country was able to remain reasonably close to the life expectancy levels observed in the average developed country. But then, during the 1980s, the US started lagging most of the developed world, reaching the late 2010s with a gap of 3 years from the European average. This difference is roughly equivalent to that separating the US from the average upper middle-income country (this difference was 12 years in 1960). In concrete terms, it means that health outcomes in the US today are roughly midway between those observed in Western Europe and Latin America.

The figure also shows that the poor US performance in terms of mortality is not a mechanical result of the high life expectancy levels reached by the wealthiest countries in the world. It is certainly true that, as life expectancy grows to very high levels, additional reductions in mortality become increasingly more difficult to achieve. It is also true that countries at the top of the life expectancy distribution sometimes experience minor temporary reductions in life expectancy, typically lasting no more than a year and of exceedingly small magnitude. But Figure 1 shows that high income countries performed systematically better than the US during the last 40 years, even though they were at very similar levels in 1980 and, if anything, in a worse relative position before that. And upper middle income countries did catch up to developed countries in general as well, but at a much slower pace than they caught up to the US: for example, while the 1960 gap from Latin America to Europe had been closed by 53% in the late 2010s, that in relation to the US fell by 75% over this interval. This is even more surprising because health expenditures in the US during this same period increased to levels never before seen. Health expenditures as a percentage of GDP in the US are approximately double the OECD average, while in 1975 these numbers were not too far apart.

How is it possible that the US has performed so much worse than various countries with similar initial mortality profiles, but much lower income per capita and even lower health expenditures? Where does this increasing difference in life expectancy come from in terms of mortality over the life cycle and causes of death? Are there differences in health expenditures, inputs, and systems that could help explain this apparent paradox? These are the questions that motivate the first part of this paper. We deepen the discussion inspired by Figure 1 and consider in detail the specific timing and nature of the gap in life expectancy that has emerged in recent decades between the US and other developed nations. We analyze closely the relative performance of the US over time and its position in the distribution of mortality outcomes across countries. The goal of this analysis is to understand when this gap first appeared and whether there were any major changes in the American health system during the time. We also analyze how this gap has changed across age groups and causes of death, and discuss what this profile tells us about its potential explanations. Finally, we consider some descriptive evidence on lifestyle and individual behaviors that could help explain the observed mortality patterns. In short, we document that this phenomenon goes back at least to the 1960s, that it has not been restricted to very particular causes of death, but that it is driven mostly by adult and old age mortality.

We then consider explicitly the social cost of the US disadvantage in life expectancy gains. We borrow from the methodology developed by Becker et al. (2005) and apply it to various counterfactuals, considering different combinations of life expectancy and health expenditure levels observed in OECD countries. In some counterfactual scenarios, we also incorporate, under extreme assumptions, the potential changes in labor supply that could arise from a major restructuring of the US health system. We calculate that overall welfare gains in the US over the last 40 years would have been larger by 7% if the US had been able to reproduce the life expectancy outcome observed in the average OECD country during this period. If, in addition, the US had access to the same public health technology used by the typical OECD country—in the sense that it could reproduce its life expectancy outcome at its health expenditure level—this gain in welfare would have been higher by 28%. The total welfare loss from the relatively poor life expectancy performance and high health expenditure adds up to a net present value of $188,483 for the hypothetical life-cycle individual considered by Becker et al. (2005). When we consider an extreme version of the potential labor market distortions that could be generated by this change, the additional gain in welfare is reduced from 28% to 19%, remaining therefore still sizeable.

There is a recurring debate in health economics on whether health expenditures in the US are too high, or whether they are simply the result of a higher marginal willingness to pay for improvements in health due to higher income (Baltagi et al., 2017; Hall and Jones, 2007). The aggregate evidence typically finds that the willingness to pay for improvements in health seems to behave like a luxury good, though some well-identified micro studies suggest otherwise (Acemoglu et al., 2013). This debate is also closely related to the applied micro literature on the efficiency of health expenditures. In general, this literature explores natural experiments and focuses on specific medical interventions. Not surprisingly, it finds mixed evidence, with some studies indicating that marginal expenditures in health are cost-effective, and others that they are not (e.g., Almond et al., 2010; Doyle Jr et al., 2015; Duggan et al., 2018). These conclusions are not too distant from the opinion typically seen in popular media, where the US health system is portrayed as unequal and somewhat inefficient, but overall effective in delivering high quality care for a significant fraction of the population (see, for example, Atlas, 2018, or the critical discussion in Kristof, 2009).

A comparative international perspective sheds fresh light on this debate and allows for a more systemic view. The discussion in the literature revolves partly around the idea that the higher expenditures in the US, motivated by higher willingness to pay, may be efficient because they actually lead to better outcomes. This may be true for marginal increases in expenditures in certain procedures, as documented by the empirical micro studies. But, from a comparative and systemic perspective, such possibility would be puzzling. Almost all the developed world reaches health outcomes, on average, substantially better than those observed in the US at only a fraction of its cost in terms of health expenditures. Differences in individual habits and lifestyle may explain some of this difference, but we present evidence in the paper that they are unlikely to account for a major part of it. The evidence, though only descriptive, seems to challenge the notion that the US health system broadly understood—including its curative and preventive medical services, but also its educational and regulatory roles—is indeed effective in delivering good care for most of the population. Our calculations indicate that the loss in welfare due to the combination of lower life expectancy and higher health expenditures can indeed be sizeable.

We cannot hope to answer in this paper why the health performance of the US over the last decades has been so poor. Our goal here, instead, is to document this fact from various perspectives and to highlight its potential welfare implications. Along the way, based partly on our own data and partly on the literature, we raise some candidate explanations. But a lot of further research is needed to fully address this question. What seems clear is that an inward-looking analysis of the US health system, considering only marginal changes in expenditures in specific procedures, though obviously valuable, is unlikely to be able to address systemic problems, which may be an important source of inefficiency. In addition, we believe this broader long-term perspective brings relevant information to the debate on the 2013-2018 reduction in life expectancy. Explanations based solely on exceptional circumstances associated with this episode are unlikely to be fully satisfying, given the long-term trend of deterioration in relative health performance that predates it.

We are obviously not the first ones to consider the performance of health in the US from an international lens. A large body of research, such as Crimmins et al. (2010), Palloni and Yonker (2016), Ho and Hendi (2018), and Woolf and Schoomaker (2019), among others, has analyzed some of the aspects that we emphasize here. We save the detailed discussion of this literature to the next sections, but highlight that our paper adds to the existing body of work by adopting a broader perspective in various dimensions—including comparison sample, age groups, and causes of death—and by conducting an explicit analysis of the welfare costs of the recent US performance.

The remainder of the paper is structured as follows. Section 2 looks at historical data and the literature and discusses the timing of the reversal in the relative US life expectancy performance. Section 3 looks at the evolution of mortality by age groups and causes of death, and at differences in lifestyle, to better characterize the changes in mortality and to shed light on their potential underlying determinants. Section 4 looks at health expenditure data with a similar objective. Section 5 calculates the welfare loss from the limited improvements in life expectancy in the US considering various counterfactual scenarios. Finally, section 6 concludes the paper.

2 US Life Expectancy from a Long-Term Perspective

A growing body of research has analyzed and characterized historical life expectancy and mortality trajectories in the US. This includes comparisons over time, to peer countries, for different age groups, and by cause of death. An encompassing assessment of this literature suggests a remarkable contrast between an increasingly consolidated map of stylized facts, and a puzzling lack of conclusive explanations for what this map shows.

On the one hand, extensive analyses and literature reviews have pointed out to an emerging consensus (Crimmins et al., 2010; Woolf and Aron, 2013; Woolf and Schoomaker, 2019). First, life expectancy in the US has improved substantially throughout the past century, but the country has long experienced a consistent health disadvantage relative to other high-income countries. Second, with some exceptions and many nuances, the US health disadvantage and higher mortality rates are generally pervasive across age, racial, and ethnic groups, states and counties, and socioeconomic strata, and it is observed for multiple health conditions and diseases. Third, the gap has increased and has become more salient as the long-term upward trend in life expectancy has recently reversed, following an increase in all-cause mortality by the turn of the 2010s. The reversal is pervasive as well. The singular US old-age mortality advantage once documented and widely publicized has now been delayed and diminished. Many cause-specific mortality rates, in fact, started to increase already earlier on, during the 2000s, particularly for midlife age groups (Palloni and Yonker, 2016; Woolf and Schoomaker, 2019).

On the other hand, the literature is inconclusive when it comes to understanding the determinants of this US disadvantage. No single factor is able to fully explain why the country is outperformed by its peers in general, and what accounts for the recent reversal in life expectancy in particular (Woolf and Schoomaker, 2019).[2] The US disadvantage in life expectancy is not only a pervasive phenomenon but also dynamic, in the sense that it is likely to reflect a contrived compositional effect and the lagged timing of exposure to its

[2] As documented by Woolf and Schoomaker (2019), midlife mortality rates have increased for 35 causes of death, across all racial groups, primarily led by drug overdoses, alcohol abuse, suicides, and a diverse list of organ system diseases. In particular, the authors point out that a major cause of increasing midlife mortality has been a large increase in fatal drug overdoses.

underlying determinants.

This complexity perhaps helps explain why most research has focused on specific demographic groups, health conditions or periods of time, usually in an attempt to come closer to isolating immediate causes. In fact, few studies take a broader view, in which the US performance is put into long-run perspective and compared to a large set of countries. Ho and Preston (2010), for example, look at the US performance in international rankings throughout the 1960-2005 period, but focus on age groups beginning at 40 and restrict the comparison to high-income countries. Thakrar et al. (2018) examine the US health performance over the 1960-2010 period in comparison to 19 OECD countries, but restrict the analysis to child mortality. Palloni and Yonker (2016) also compare the US to its high-income peers and cover a longer period, 1955-2010, but focus specifically on the changes in the US old-age advantage. Woolf and Schoomaker (2019) provide a comprehensive analysis of life expectancy and mortality rates in the US throughout the 1959-2017 period, but do not compare it to other countries.

In what follows, we contribute to the effort of characterizing the US life expectancy disadvantage by extending the analysis to a broader set of countries and by systematically assessing the inflections in the US relative historical performance dating back to 1960. We rely on data on life expectancy at birth throughout the 1960-2016 period from the World Bank's World Development Indicators. For the sake of conciseness, we focus our discussion in this section on the US and averages for geographic groups of countries. Our comparison sample includes a total of 107 countries of various development levels (refer to Appendix F for a list of the countries included in this sample). In some exercises, we also normalize life expectancy numbers to 100 in 1960 and analyze relative changes, or compare cross-country rankings over time. This analysis is complemented in the next section, where we decompose changes in life expectancy into the underlying contributions of age groups and causes of death.

The broader perspective taken here allows us to uncover certain patterns of evolution in life expectancy that call into question some common interpretations of the exact timing of emergence of the US disadvantage. We start by presenting, in different ways, the performance of life expectancy in the US in comparison to that observed in different groups of countries. Figure 2 introduces our first pieces of evidence. For reference, Figure 2A reproduces one of the figures from the introduction and shows overall trends in life expectancy for the US and for various groups of countries. Figure 2B plots these same trends converted into indices set to 100 in 1960. Two patterns immediately standout. First, in Figure 2A, one can see that the average slope of the trajectory of life expectancy in the US is the smallest among all country groups. In particular, the average slope is also small when compared to Europe and the Western Offshoots, which started in 1960 at a similar level. Second, Figure 2B restates this fact by showing that the US performance in life expectancy was also the weakest when considered in relative terms.

To shed a little more light on these changes, Figure 2C zooms in on the comparison between the US and other high-income countries, while Figure 2D presents the position of the US in the life expectancy ranking of all countries. Both Figures 2C and 2D reinforce that the US performance has long been inferior to that of other countries and that the US disadvantage has long been increasing, except for the exceptional period between the late 1960s and the late 1970s. Figure 2C shows that the US, despite starting from a marginally better position, was already having a relatively worse trajectory than the average high-income country in the 1960s. This trend reversed in the early 1970s, when the US experienced a relatively better performance that lasted for roughly 10 years. After 1980, the US returned to a relatively worse trajectory that was maintained up to the late 2010s. The ranking positions depicted in Figure 2D tell precisely the same story: the US was already loosing ground in the 1960s, then it experienced a short-lived recovery in the 1970s, and finally it returned to its poor performance after 1980. Perhaps the most striking information from Figure 2D is the fact that, while the US ranked 12th in life expectancy among our sample of 107 countries in 1960, its rank had fallen to 31st by 2016, outside of the top tercile of the distribution.

The patterns depicted in Figure 2 allow us to analyze exactly when the US disadvantage begins. Many studies document that the gap between the US and its high-income peers started to increase in the early 1980s, an inflection that is clearly seen in the bottom two graphs of Figure 2. This may in fact explain why some of the most comprehensive analyses focus exclusively on the period starting in 1980 (eg: Crimmins et al., 2010; Woolf and Aron, 2013). We do observe a clear inflection point in the US disadvantage during the early 1980s, when the distance in life expectancy with respect to European countries and the Western Offshoots starts to increase, and it is also clear that the gap had in fact declined during the previous decade. But, going further back in time, we observe another inflection point between the late 1960s and the early 1970s, when a previous divergent trend was temporarily reversed and the gap started closing. Woolf and Schoomaker (2019) formally test for inflection points in the life expectancy series for the US over the 1959-2017 period and confirm that there are significant changes in the slope of the series in 1969 and 1979, and then again in 2011 and 2014, when the reversal in levels begins.

We extend Woolf and Schoomaker (2019)'s analysis and formally test for inflection points in the life expectancy series between 1960 and 2017 for the US, for the high-income countries' average , and for the difference between these two series. We formally assess inflection points by using segmented linear regressions to pinpoint changes in the slope of life expectancy series. The regressions were estimated using the method developed by Kim et al. (2000).[3] The authors propose a permutation test to identify the number of significant inflection points (or joinpoints) in time series data. The method fits segmented regression models using the grid search method of Lerman (1980) and estimates the p-value of each permutation test using Monte Carlo simulations. The overall asymptotic significance is adjusted through Bonferroni corrections.

The estimated joinpoints and slopes between each joinpoint are presented in Figure 3. Figure 3A plots the results for life expectancy in high-income countries and in the US, and Figure 3B presents the results for the difference between the two series. These results are complemented by Table 1, which presents the slope estimates and its standard errors (Panel A), and the difference between each segment slope and its standard errors (Panel B). For the group of high-income countries, we find that slopes between joinpoints are stable for most years, approximately in the range between 0.20 and 0.27, decreasing to 0.12

[3] Regressions were implemented using the Joinpoint Regression Program

from 2013 onward. For the US series the slopes vary considerably, remaining generally below the point estimates for the high-income series, except for the period between 1969 and 1979. In particular, we observe statistically significant inflection points in the late 1960s and late 1970s, when the slope of the difference between the two series becomes negative (-0.068). The inflections found in 1969 and in 1979 mark the decade of 1970 as an exceptional period for the US amidst an otherwise poor relative performance dating back to 1960. This long-term relative deterioration is noted in Ho and Preston (2010) as well, who look at the rankings of US age-specific death rates for females and males in ten-year intervals since 1965.[4] This statistical tests confirm our previous qualitative discussion.

Figure 4 incorporates differences in income directly into this discussion. Figure 4A displays the US relative position in comparison to Preston Curves estimated for different decades and across all countries in the sample. Preston Curves give the average relationship between income per capita and life expectancy at birth. They can therefore be interpreted as representing the predicted life expectancy at birth given observed income per capita levels.

Figure 4B plots the difference between the observed life expectancy in the US and its expected level as predicted by the Preston Curves for each year in the 1960-2016 interval. The patterns arising from Figure 4 are similar to those discussed before. The US appears systematically below the Preston Curves and, except again for the period between the late 1960s and the late 1970s—and now for a reduction in the mid-2000s—the gap increases throughout the period. In particular, we observe sharp increases in the US disadvantage in the beginning of the decades of 1960, 1980 and 2010. The average gap for the entire period hovers around a deficit of 4 years in terms of life expectancy at birth. So, as should already be clear from the previous comparison with high-income countries, the overall patterns discussed before hold irrespective of changes in income per capita over time.[5]

[4] We acknowledge that our analysis would allow more definitive conclusions if additional data for the period before 1960 was available for international comparison.

[5] It is important to note that, as the US remains an outlier in income per capita over the entire period, the distance between its life expectancy and the estimated Preston curve is particularly sensitive to out of sample projections of the curve to higher income levels, which depend a lot on functional form and vary substantially over time. The resulting time series is marked by a large number of joinpoints. Yet, the overall patterns are qualitatively consistent with the main findings in Figure 3 throughout the 1960-1990 period.

The long-term relative trajectory of life expectancy in the US thus suggests that its disadvantage begins much earlier on and may have deeper roots. This timing indicates that these roots were laid much before many of the plagues whose prevalence has increased more recently—such as obesity and substance abuse—became the dominant public health concerns. So the role of these factors during the more recent changes in mortality has to be understood within the context of a health system where relative health performance had already been deteriorating for a considerably long period of time. In the next section, we further investigate these issues by considering the contribution of mortality by age groups and causes of death to the recent life expectancy dynamics, and by discussing the underlying determinants of the relative US performance.

3 Explaining the US Life Expectancy Divergence

In this section, we focus on the role of age groups and causes of death in determining the relative performance of life expectancy observed in the US between 1960 and 2016. We also consider some potential determinants of the US relative performance by discussing, based on the literature and available descriptive evidence, the extent to which differences in mortality seem to reflect factors related to health system characteristics or individual behavior and lifestyle.

3.1 The Role of Age Groups and Causes of Death

We now restrict the comparison group to the US peer countries belonging to the OECD for which we have data on mortality by age group and cause of death. This leaves us with a sample of 20 developed countries, listed in Appendix F. Our main data sources for this analysis are the Human Mortality Database for period life tables, and the World Health Organization for cause- and age-specific mortality and lifestyle data. In order to maximize our sample coverage, we use the mortality data averaged by decade: 1960s corresponds to the average for the period 1960-1969 (or years available in this interval), 1970s corresponds to the average for the period 1970-1979 (or years available in this interval), and so on, up to the

2010s (which end with our last observation, 2016).

We classify mortality by the following broad groups of causes of death: (i) infectious diseases, abortion and obstetric, congenital and perinatal conditions; (ii) neoplasms; (iii) endocrine, metabolic, and blood diseases, nutritional deficiencies; (iv) heart and circulatory diseases; (v) respiratory and digestive diseases; (vi) accidents, suicides and homicides; and (vii) others.[6]

We decompose the difference in life expectancy at birth between the US and the sample of OECD countries into its age groups and causes of death contributions following Arriaga (1984, 1989). The decomposition of differences in life expectancy between two countries into the contribution of each age group can be obtained directly by using life table parameters. If one assumes additionally that the distribution of cause-specific deaths is constant within each age group, this method can also be applied for the decomposition by cause of death (by using the life table parameters and the proportion of deaths from each cause between ages x and $x + n$; for details, see Arriaga, 1989). We first decompose the differences in life expectancy at birth between the US and each country in our sample by age group and cause of death. Following, the contribution of each age group and cause of death is averaged across the sample of comparison countries, so that we are able to estimate their contribution to the difference in life expectancy between the US and the average for the OECD sample.

Figure 5 presents the contributions of, respectively, age groups and causes of death to the difference in life expectancy at birth observed between the US and our sample of OECD countries between the 1960s and 2010s.[7] In both figures, the dashed line indicates the total difference in life expectancy between the US and the the OECD sample, while the various symbols indicate the part of this difference that is attributable to each cause of death or age group. In line with the discussion from the previous section, Figure 5 shows that the difference in life expectancy at birth between the US and its peers started at close to 1 year in the 1960s, declined to roughly 0.5 year in following decade, and then increased

[6]See Appendix G for a description of the grouping of the mortality codes from ICD-7, ICD-8, ICD-9, and ICD-10 into the broad categories (i)-(vii) identified in the text.

[7]See Appendix A for trends on specific combinations of age groups and causes of death.

monotonically to reach close to 3 years in the 2010s. So the more restricted sample of OECD countries considered in this section does not change the story outlined previously.

The distribution of the total difference in life expectancy across age groups is very heterogeneous, both in terms of level and dynamics. Differences in mortality between ages 0 and 4 played no role in the 1960s, but became positive, though still small in magnitude (below 0.5 year) by the 2010s. Mortality rates between ages 5 and 14 played virtually no role in explaining differences in life expectancy at birth throughout the period. These results do not contradict the fact that the US has long had poorer child health outcomes than other high-income countries, as documented by Thakrar et al. (2018), but rather that child mortality does not contribute much quantitatively to the differences observed in life expectancy at birth. This is due to the overall small mortality rates for younger ages.

Adult mortality, on the other hand, appears as extremely important to explain the changes in the difference in life expectancy at birth. As documented in Ho and Preston (2010), the US has long occupied low positions in developed countries rankings of age-specific mortality rates before age 59, both for males and females. In Figure 5A, we observe that differences in life expectancy explained by mortality during prime ages, between 15 and 59, were already large, reaching over 1 year, in the 1960s. These differences were reduced a little bit until the 1980s, falling slightly below 1 year, but then started increasing again reaching close to 2 years in 2015. This pattern echoes the evidence presented by Vierboom and Preston (2017), who show that the US disadvantage in mortality rates for ages below 60 was more pronounced in the period 2001-2014 than in 1986-2001 (in comparison to 12 OECD countries). This is particularly relevant as it helps distinguish the case of the recent decline in life expectancy in the US from what has happened in other high-income countries. As documented in Ho and Hendi (2018), while most high-income countries in their sample experienced declines in life expectancy in 2014-15, predominantly driven by ages above 65, in the US the reversal already appeared clearly at younger ages.

Yet, the case of mortality above 60 years-of-age is the most salient evidence from Figure 5A. As first documented by Manton and Vaupel (1995), the US once had an advantage over other developed countries when old age mortality was considered. This was clear in the comparison of survival rates of American cohorts born in the late 19th century with populations from Japan, Sweden, France, and England (including Wales). Figure 5A shows that, before the 1990s, this old age mortality advantage still existed. Up to the 1980s, mortality above 60 contributed to reduce the difference in life expectancy at birth in relation to the OECD sample. In the 1970s, for example, the American advantage for this age group reached roughly 0.5 year. In the 1980s, this advantage decreased back to the levels observed in the 1960s, and then disappeared in the 1990s, after when the US started falling behind as well on mortality above age 60. By 2015, differences in mortality above 60 contributed in almost 1 year to the life expectancy disadvantage of the US in relation to the OECD. As noted by Ho and Preston (2010) and Palloni and Yonker (2016), the old-age mortality advantage of the US when compared to other developed nations has been moving monotonically into older and older ages.

It is clear from Figure 5A that mortality above age 15 accounts for the bulk of the movement in the life expectancy disadvantage between the 1960s and the 2010s. Mortality rates between 15 and 59 and above 60 contributed to different extents to the reduction in the gap observed in the 1970s, and to the increase observed thereafter, but both display similar patterns in terms of dynamic behavior, though with slightly different timings for the reversal. This immediately raises the question of what causes of death within these age groups account for the observed changes in the relative performance of life expectancy.

Figure 5B presents the same decomposition exercise from Figure 5A, but for causes of death. Before the 1980s, the US had some advantage in mortality by respiratory and digestive diseases and other causes of death, which explained the initially lower mortality observed above age 60. This advantage continuously decreased since the 1960s, and was lost and turned into a small disadvantage from the 1980s onward. For heart and circulatory diseases, the US had a large disadvantage in the 1960s, of roughly 1.5 years, enough to explain more than the total difference in life expectancy at birth at that point. This difference was reduced to close to zero in the 1980s, and then started opening up again to reach close to 1 year in the 2010s. For homicides, accidents, and suicides, the US always had some disadvantage. This disadvantage increased almost monotonically from below

0.5 year in the 1960s to close to 1 year in the 2010s. For the groups that include infectious diseases and endocrine conditions, there was no difference between the US and its peer countries in the 1960s, but a difference of slightly below 0.5 year appeared by the 2010s. Finally, neoplasms seem to play no significant role in explaining the differences in life expectancy at birth at any point during this period.

One striking feature of Figure 5 is that the US has experienced relative losses in life expectancy since the 1960s (when compared to peer countries) across virtually all age groups and causes of death, with few exceptions. The first exceptions are ages between 5 and 14 and causes of death related to neoplasms, for which there was no noticeable relative change throughout the period. The second set of exceptions are for ages 15-59 and causes of death related to heart and circulatory diseases, which contributed to a substantial reduction in the US disadvantage from the 1960s to the 1970s, followed by a rebound and an increasingly positive contribution from the 1980s onward (see Appendix A).

The exceptional period from the late 1960s until the late 1970s and early 1980s marks the arrival of both institutional and technological innovations that could help explain the relatively positive performance of health outcomes and the decline of the US disadvantage during this time. First, the timing of the narrowing of the gap between the US and its peer countries coincided with the introduction of Medicare and Medicaid in 1965. However, improvements in the gap were transitory and contrast with the results in Finkelstein and McKnight (2008). For instance, while we do observe that mortality for ages above 60 substantially contributed to relative improvements in life expectancy throughout the 1970s and early 1980s, the authors did not find any discernible impact on elderly mortality in the first 10 years of exposure to Medicare. More generally, the gap in life expectancy for those over age 60 grew continuously during recent years, despite the fact that most of these individuals are eligible for Medicare.

On the other hand, the fact that the positive patterns are concentrated on ages above 15, and on causes of death related to heart and circulatory diseases, is consistent with the timing of the introduction of relevant innovations in medical treatment. As mentioned in Goldman and Cook (1984), "in 1968 a surprising epidemiologic phenomenon appeared:

after decades of increase, mortality rates from ischemic heart disease in the United States began to decline" (p.825). As the authors document, this decline coincided with many medical innovations, including some designed for patients with symptomatic ischemic heart disease. According to their estimates, about 40% of the decline in ischemic heart disease mortality observed between 1968 and 1974 could be attributed to these specific medical interventions.[8]

The extent to which these innovations contributed to a transitory reduction in the US disadvantage in comparison to other countries depends on whether access to new treatments and information was disseminated more rapidly in the US. Higgins and Thom (1989) show that the declines in coronary heart disease death rates in the US from the mid-1960s onward were greater for acute myocardial infarction, for younger age groups, for the white population, and for higher socioeconomic groups. They also document that the number of coronary care units increased and the in-hospital fatality rate decreased. This suggests that favorable access to new treatments played a relevant role within the US. More generally, however, it is difficult to trace out precisely the international diffusion of medical innovations across countries (Heidenreich and McClellan, 2003). Yet, the existing evidence suggests that the adoption of high-tech procedures—such as cardiac catheterization, bypass surgery, and angioplasty—increased more rapidly in the US in comparison to many other high-income countries (McClellan and Kessler, 2002).[9] Rapid adoption of new treatments may have driven the US's initial advantage in heart and circulatory diseases during the first stages of the diffusion of the technological innovations mentioned here.

Figure 5 generally indicates that health advantages turned into disadvantages, while previous disadvantages increased over time. We test the robustness of these descriptive patterns by using segmented linear regressions to identify slopes and inflection points,

[8] These include the development of coronary care units, cardiopulmonary resuscitation, coronary artery bypass surgery, medical treatment of ischemic heart disease and drug treatment of hypertension. For example, Weisfeldt and Zieman (2007) presents a timeline showing relevant device and drug innovations in coronary artery disease dating back to the publication of clinical trials in 1970 (vein bypass surgery and drugs for hypertension) and 1978 (angioplasty). For an overview of the various explanations for the decline in cardiovascular disease mortality, including preventive care and behavioral changes, see Cutler and Kadiyala (2003).

[9] The authors attribute this pattern to differences in the financial and regulatory incentives for innovations in high-tech medical practices.

and formally assess on econometric grounds the role of age groups and causes of death in determining the relative performance of life expectancy observed in the US. We rely on a sub-sample of 13 countries for which we have yearly data for the entire period, so that we have enough observation to perform the time-series tests (Appendix F lists the countries included in this sample). Results are presented in Appendix B (decomposition by age group) and in Appendix C (decomposition by cause of death). We observe that slopes are generally positive and statistically significant for a number of age groups and causes of death throughout the early 1960s, except for small (and mostly non-significant) point estimates for ages 5-14 and above 60, and for heart and circulatory diseases, and the group of endocrine, metabolic and blood diseases. Slopes become markedly negative throughout the 1970s for heart and circulatory diseases and ages above 15, until a new inflection is identified in the early 1980s. A similar but smoother pattern is also observed for accidents, suicides and homicides (slope becomes mildly negative between 1968-1983), as well as for infectious, abortion, obstetric, congenital and perinatal conditions (between 1967-1976). Slopes remain either positive or statistically insignificant across all age groups from the mid-1970s and the early 1980s onward; the same occurring with most causes of death, except for specific segments related to endocrine conditions (1995-1999), neoplasms (2000-2011), and infectious, and infant/maternal-related causes (1988-1996 and 2000 onward). Again, these statistical results reinforce the interpretation from our previous qualitative discussion.

Overall, the magnitude of the contribution of the various age groups and causes of death to the dynamics of the life expectancy gap has been heterogeneous. But it remains true that the trend towards deterioration in the relative performance of life expectancy at birth is more general than usually assumed. This simple fact casts doubts on rationalizations of the poor relative performance of life expectancy at birth in the US that rely on specific causes of death or age groups. If anything, as recently documented by Woolf and Schoomaker (2019), this has been a general phenomenon. It is also remarkable that the deterioration of the US's relative position has been increasingly apparent since as far as 1960, except for the period between the late 1960s and the late 1970s, and for a few particular causes of death and age groups.

3.2 Health System Performance and the Role of Behavior and Lifestyle

Woolf and Aron (2013) conjecture that deep-rooted underlying individual and social preferences in the US, by shaping political and policy choices, may have contributed to a weaker societal commitment to the health and welfare of a large portion of the population. Within this broader context, however, are there specific factors that can account for the relatively poor mortality performance across different age groups and causes of death? There is a long-lasting and still inconclusive debate on whether the US performance reflects health policy choices and inefficiencies in the health care system, or behavioral and lifestyle factors that would increase the incidence of diseases irrespective of the functioning of the health care system.

International comparative studies take two different approaches to evaluate the efficiency of the US health system. The first approach considers trends in health indicators and in health spending, often concluding that the US health care system is inefficient as spending in the US is higher than in its OECD peers, while health indicators are often worse (Anderson and Frogner, 2008; Schoen et al., 2006). This stream of studies suggests that increasing coverage and reducing the inequality in access to health care and to quality of care would likely increase the value per dollar spent. Health coverage has indeed lagged in the US. We rely on data from Lozano et al. (2020) to estimate an index of universal health coverage (UHC) for several countries in the 1990-2019 period. Appendix Table E.1 replicates the UHC index estimated by the authors for the US and for our sample of OECD countries. In 1990, the US ranked 6th according to the coverage index, above the averages for high-income countries and the OECD. By 2019, the US had the lowest coverage. The results therefore indicate that health care coverage in the US has lagged in comparison to its peer countries throughout the last decades. Yet, evidence on whether lack of access to health care explains the differences in outcomes between the US and its peer countries is not conclusive. As previously mentioned, the distance between the US and other countries narrowed throughout the 1970s because of the introduction of Medicare and Medicaid in 1965. By contrast, Finkelstein and McKnight (2008) investigated the introduction of Medicare and concluded that there was not much effect on mortality for people around age 65. More generally, the gap in life expectancy for those over age 60 grew during recent years, despite the fact that most of these individuals are eligible for Medicare.

The second approach focuses on trends of major adulthood diseases, such as cancer and cardiovascular conditions, and the effectiveness of the health system in avoiding death through prevention, diagnosis or effective treatment. Preston and Ho (2009), for instance, show that reductions in mortality from prostate and breast cancer declined especially fast in the US relative to a group of peer countries, and suggest that these declines are attributable to wider availability of screening and more intensive treatment. These would be signs of efficiency in the health care system.[10] Yet, the authors also note that this performance relates to what happens after a disease has developed. If one considers the higher prevalence of major adult diseases in the US, it is possible that the US health care system performs poorly in preventing disease.[11] Maternal deaths, for example, although mostly preventable, have been increasing in the US and recently reached the highest rate among developed countries. This may reflect the fact that the US experiences a relative under-supply of maternity care providers, in particular midwives, and lack comprehensive postpartum support (Tikkanen et al., 2020). It also denotes little attention being paid to primary care needs.

Indicators of population health, such as life expectancy and mortality rates by age groups and causes, however, might reflect not only the efficiency and coverage of the health care system, but also individuals' lifestyles and behavior. Such behavior can include smoking, drinking, diet patterns, other forms of substance abuse, and physical exercise. In fact, studies on life expectancy decomposition often assess the role of potentially relevant lifestyle factors, such as smoking and obesity.[12] Preston et al. (2011) suggest that, in a ranking of life expectancy at age 50 among 20 OECD countries, after putting aside deaths attributable to smoking, the US position would improve from 14th to 9th for men, and from

[10]The authors argue that these types of cancers are not typically preventable and are not influenced by behavioral risk factors. In that case, mortality from these cancers is an indicator of health system performance. But, precisely for this reason, this argument only applies to the curative dimension of a health system.

[11]See Thorpe et al. (2007) and Avendano et al. (2009) for evidence on disease prevalence from an international comparative perspective.

[12]Smoking and obesity are the most studied lifestyle factors. This occurs not only for their relevance, but also because of the availability of data and methods to assess their impact on mortality and longevity.

18th to 7th for women. Cutler et al. (2003) show that recent trends in obesity in the US are worse than in developed countries, while Preston et al. (2018) suggest that between 1988 and 2011 the increase in the Body Mass Index (BMI) in the US reduced life expectancy at age 40 by roughly one year.

We further examine comparative patterns of behavior and lifestyle factors by gathering the available data on proxies for lifestyle for our sample of 20 OECD countries (over the longest period available). Data on BMI, overweight and obesity prevalence, physical inactivity, and alcohol consumption were collected from the WHO Global Database (World Health Organization, 2020). Data on tobacco consumption and smoking prevalence were collected from IHME (2014). Table 2 presents descriptive statistics for the US and the OECD sample average. Trends in BMI, overweight and, especially, obesity are relatively more adverse in the US, with obesity prevalence reaching almost 40% of the population in 2015. Data on physical inactivity prevalence, only available for 2016, also depict an adverse scenario for the US. When it comes to smoking, the reduction in prevalence between 1980 and 2012 was more pronounced in the US, but the average consumption in 1980 was considerably higher in the US, with similar prevalence levels. Data on alcohol consumption suggest lower levels of consumption for the US in 1970, but a slower reduction over time.

Quantifying how much of the historical mortality differences between the US and other OECD countries might be attributed to differences in lifestyle factors is often limited by the availability of cross-country data on lifestyle proxies and by our understanding of their association with mortality patterns by age-groups. Preston et al. (2011) propose a methodology to estimate the share of overall mortality attributable to smoking. We assess the contribution of smoking to the differences in life expectancy between the US and OECD by relying on their methodology and applying their estimates to our data.The methodology and the way we use their estimates in our context are described in detail in Appendix D. The results from this exercise are presented in Appendix Figure D.1. The figure shows that mortality attributable to smoking contributed positively to the differences in life expectancy, with the difference ranging from 0.03 year in the 1960s to 0.32 year in the

1990s. So, as expected, smoking indeed was associated with overall higher mortality in the US when compared to the OECD, but these differences had a minor impact on final life expectancy numbers. Particularly important for our discussion, this difference tended to shrink over the last decades, when differences in life expectancy between the US and OECD started to become more stark. Smoking, therefore, is unlikely to be a major contributing factor to the trends discussed in previous sections.

Overall, multiple factors are likely to underlie the relatively poor performance of life expectancy in the US. While the deterioration of the US's relative position has been increasingly apparent since as far as 1960, including in some causes from preventable conditions, disentangling its specific determinants has proven difficult in light of the potential confounding role of individual behavior and lifestyle. Yet, this implicit dichotomy between health system and individual behavior should be taken with a grain of salt if one thinks that health care systems should have more than a curative role. If health policy should also be responsible for preventing disease—through medical means, such as access to primary care, but also through educational campaigns and regulation of food and drugs—, then even some of the lifestyle aspects discussed above would still partly fall under a health system's attributions. In this sense, the extent to which prevention has more or less to do with private behavior *versus* health policy and regulation is open to debate. This adds another layer of complexity to the discussion on whether the relatively poor performance of the US in international rankings is determined by the under-performance of its healthcare system or by factors exogenous to the system.

4 Historical Changes in the Pattern of Health Spending

The trends discussed in the previous two sections are all the more puzzling because health expenditures in the US have grown at an accelerating rate in recent decades. In this section, we look at the changes in health spending in the US and its peer countries to shed further light on this phenomenon.

Figure 6A shows trends in health spending per capita (measured in 2011 PPP US$) and

Figure 6B presents the same data measured as percentage of the GDP (for the US and the OECD average). We rely on data from OECD Health Data for health spending and from the Penn World Table for GDP and population. The sample used in the figure is the same from Section 3 and the values are again presented as averages per decade (see Appendix F for the list of countries included in this sample).

From the 1970s to the 2010s, health spending as a percentage of the GDP in the US increased from around 7% to 17%, while health spending per capita increased from $1,466 to $9,462, roughly twice the OECD average health spending. As a percentage of the GDP, the difference in health spending between the US and the OECD corresponded to roughly 1.5 p.p. in the 1970s, but increased to over 7 p.p. in the 2010s.

Since the seminal work by Newhouse (1977) identifying income as the most relevant factor explaining cross-country differences in the level and growth of health expenditure, the level of health expenditures in the US has become a recurring topic of debate in the health economics literature. This debate revolves around understanding the determinants of health expenditures and whether health expenditure levels reflect a higher marginal willingness to pay for life extensions, due to higher income, or to some extent inefficiencies in the functioning of the US health system.

Early research typically focused on estimating the income elasticity of expenditures on health. While cross-country studies looking at developed countries usually reported elasticities of 1.0 and higher, suggesting that health care is a luxury good, individual level studies often found contradicting evidence, pointing to health care as a necessity good. Getzen (2000) and Gerdtham and Jönsson (2000) provide detailed surveys of this literature, covering the last decades of the 20^{th} century. The vast majority of these early studies relied on simple correlation analysis, with results covering a wide range of estimates.

More recently, Murphy and Topel (2006) provide an expression for the income elasticity of the value of a life-year, and argue that demand for health is likely to be income elastic. In particular, richer societies would invest proportionally more in health because life itself is more valuable. Hall and Jones (2007) emphatically argued that health spending seems to behave like a luxury good. Their model suggests that as income rises and the marginal utility of consumption falls, purchasing additional years of life is the most valuable type of expenditure. In part motivated by this macro literature with strong predictions of income elasticities above 1, Acemoglu et al. (2013) provided one of the first studies with a plausible identification strategy to estimate the general equilibrium income elasticity of health spending. Their estimates suggest that income is unlikely to be a main driver of the growth in health spending observed between 1960 and 2005. Baltagi et al. (2017), in turn, offer a global perspective on the income elasticity and its heterogeneity for different levels of income. With a panel of 167 countries from 1995 to 2012, their estimates suggest that, at the global level, health care behaves mostly as a necessity good and that as income decreases, the elasticity tends to increase.

A few non-income determinants of health spending have also received attention in the literature, including demographics, structure of health care financing, and access to and types of health insurance, among others. In an accounting exercise for the US, for example, Newhouse (1992) argues that the income and non-income factors typically considered, even when taken together, are not enough to account for the increase in health expenditure observed in the last decades. Several studies attribute the unexplained residual growth to technology (Newhouse, 1992; Peden and Freeland, 1998; Smith et al., 2009), with a number of papers looking at the impact of technology on expenditures also supporting this view (Holahan et al., 1990; Cutler and McClellan, 1996; Okunade and Murthy, 2002). Institutional aspects as well seem important. Finkelstein (2007), for example, suggests that the spread of insurance resulting from the introduction of Medicare in the 1960s accounts for half of the increase in spending from 1950 to 1990, and that it is associated with increases in the use of medical resources, in particular hospital entry and the adoption of cardiac technologies. Smith et al. (2009) argue that technological innovation is influenced by the size of the market, that in turn is influenced by the penetration of insurance coverage and income. They suggest therefore that the contribution of technology is smaller than estimated by Newhouse (1992), but attribute an important role to the interactions between income, insurance, and technology.

Another body of research takes an international comparative perspective and analyzes the diverging health expenditure trends portrayed in Figure 6. These papers shed light on several candidate explanations for the difference in health spending across the US and the OECD. Anderson et al. (2003) show that, though the US spends more on health than any other country, in most aggregate measures of utilization of health care the US is below the OECD median, suggesting that the observed spending discrepancy is caused mainly by higher prices for health care. While analyzing recent trends in expenditure growth, Lorenzoni et al. (2014) also points to prices as explaining a major part of this difference, and highlights that this could become even more relevant in the future, as the US faces health coverage challenges. In addition, research has shown that health care administrative costs are far greater in the US than in Canada (Aaron, 2003; Woolhandler et al., 2003) and explain 39% of their difference in hospital spending (Pozen and Cutler, 2010).

Another relevant aspect is that several costly chronic conditions, such as heart disease, cancer, and diabetes, have higher prevalence and treatment rates in the US, reflecting differences in underlying health status and medical practices, and resulting in higher per capita expenditures (Thorpe et al., 2007). Other papers look at population aging as a source of increasing expenditures, but often find that, from a comparative perspective, it has modest differential impacts (Newhouse, 1992; Meara et al., 2004; White, 2007).

To provide a more detailed picture of the recent historical trends, we further restrict our sample to the 16 OECD countries that allow us to work with yearly data (instead of by decade; see Appendix F for a list of the countries included in this sample). Figure 7A plots an index of total health spending as a percentage of the GDP, while Figure 7B portrays the percent growth in spending as percentage of GDP for each decade. Figure 7C and Figure 7D display the same plots for health spending per capita, also for the restricted sample. During the 1970s, the US presented a lower growth in spending as percentage of GDP, reversing this trend in the 1980s, when the growth rate became considerably higher. In the following decades, the US growth was roughly in line with the OECD average. These figures suggest that the trend observed in the most recent data has been in place at least since the end of the 1980s. When we look at the index for health spending per capita, the US growth pattern is overall very similar to the OECD average. From 1970 to 2016, the last year for which we have data, the US and the OECD present almost the same accumulated relative growth in spending per capita, with the US beating the OECD growth only during the the 1980s. White (2007) decomposes real health spending growth into growth in GDP per capita, population aging, and excess growth and argue that the US, in contrast to Figure 7, has an unusual long-term health spending growth. While during the period between 1970 and 1985 US excess growth (2.0%) was marginally higher than the OECD (1.7%), from 1985 onward the rate of excessive growth was notably higher (2.0% vs 0.6%).

The level of health spending by itself would not be an issue if it provided reasonable value. But, from a comparative perspective, the previous sections indicate that this does not seem to be the case in the US. Even in the 1970s, the US and the OECD had roughly the same life expectancy at birth, but health expenditures were already higher in the US. Several recent studies attempt to quantify the value of medical spending in the US. These studies focus mostly on the cost effectiveness of specific medical interventions and usually conclude that medical treatments seem to provide reasonable value (Cutler and McClellan, 2001; Skinner et al., 2006; Eggleston et al., 2009, 2011). An exception to this approach is Cutler et al. (2006), who provides estimates of the value of the US medical system as a whole. Their estimates suggest that, with the exception of spending in the elderly, the increase in medical spending from 1960 through 2000 provided some reasonable value in terms of health outcomes. This literature contrasts somewhat with the applied micro literature on efficiency of health expenditures, which explores natural experiments and also focuses on specific medical interventions. In general, these studies find mixed evidence, with some suggesting that marginal expenditures in health care are cost effective and others suggesting otherwise (see, for example, Almond et al., 2010; Doyle Jr et al., 2015; Duggan et al., 2018).[13]

Virtually all the developed world spends less on health and reaches considerably better health outcomes than the US. From a comparative and systemic perspective, the evidence seems to challenges the notion that the US health system, broadly understood, has been

[13]Ehrlich and Yin (2013) provide theoretical and numerical support to the idea that spending of a curative nature has more to do with demand than with increases in survival, so that it may be misleading to look at overall health spending as an indicator of system effectiveness in improving outcomes.

cost-effective. This is particularly true if one considers that the function of a health system is not simply curative, but also includes prevention in its various forms (e.g., access to primary care, educational campaigns, and regulation of food and drugs). The next section considers explicitly the potential welfare losses implied by this recent performance.

5 Life Expectancy Gains and Welfare in the US

5.1 Methodology

In this section, we apply the methodology proposed by Becker et al. (2005) to assess the relative welfare losses from the limited gains in life expectancy observed in the US in the last decades. To do so, we consider various alternative scenarios combining counterfactual life expectancy and health expenditures based on OECD numbers. The objective of these exercises is to assess how welfare would have evolved if the US were able to reproduce the performance observed in other developed countries. In principle, this should have been an achievable goal, so it seems to be an appealing counterfactual.

Consider a simplified version of the methodology proposed by Becker et al. (2005), where individuals live for a deterministic lifetime T and earn in every period of life a constant yearly income y. Define lifetime income Y and the indirect utility function $V(Y,T)$ as:

$$V(Y,T) \equiv \max_{\{c(t)\}} \int_0^T e^{-\rho t} u(c(t))dt \quad s.t. \quad Y \equiv \int_0^T e^{-rt} y dt = \int_0^T e^{-rt} c(t) dt, \tag{1}$$

where $c(t)$ is consumption at age t, r is the interest rate, and ρ is the subjective discount factor (and where the budget constraint assumes perfect capital markets).

The metric we use for welfare evaluation is based on how this hypothetical individual would compare two alternative scenarios, one with lifetime income and life expectancy Y and T, respectively, and another with Y' and T'. Define the infra-marginal income $W(T,T')$ as the compensation that would give this individual the welfare observed under Y' and T', but with life expectancy T:

$$V(Y' + W(T, T'), T) = V(Y', T'). \quad (2)$$

The compensation $W(T, T')$ represents the monetary value, in terms of lifetime income, of the gain in life expectancy $\Delta T = T' - T$. Assume that ρ, the subjective discount rate, is equal to the interest rate r. In this case, optimal consumption is constant throughout life and equal to the constant flow of income y, so that the indirect utility can be written as a function of yearly income y:

$$V(y, T) = u(y)A(T) \quad (3)$$

with $A(T) = \frac{1-exp(-rT)}{r}$. We can define $w(T, T')$ as the yearly analogue to the lifetime compensation $W(T, T')$:

$$u(y' + w(T, T'))A(T) = u(y')A(T') \quad (4)$$

So, with the simplifying assumptions discussed above, the monetary value of the total welfare gains—including improvements in health and income—observed between the two periods, when expressed as a flow of annual income, can be written as $(y' - y) + w$. Similarly, the contribution of health to the total welfare gain in the period is defined as $w/[(y' - y) + w]$.

In principle, one can write w explicitly by inverting the instantaneous utility function $u(.)$:

$$w = u^{-1}[\frac{u(y')A(T')}{A(T)}] - y'. \quad (5)$$

Again, w can be interpreted as the value that an individual earning y' in every period of life and living to life expectancy T' attributes to the gain in life expectancy $\Delta T = T' - T$. By definition, w measures this value as a flow of annual income, and W is the analogue measure in terms of lifetime income.

We are used to looking at the growth in income per capita as an indicator of the improvements in living conditions experienced by a country. This notion brings implicitly the idea that income per capita captures the typical living standards experienced by the population of a given country. The methodology proposed by Becker et al. (2005) extends this same view to life expectancy and considers the hypothetical individual living to the life expectancy observed at a point in time in that country and earning its income per capita throughout life. Welfare considerations are then made from the perspective of this individual at birth. This approach can be further motivated by the idea of an individual before birth, under the veil of ignorance, considering average welfare conditions prevalent in different societies and attributing monetary values to certain improvements in health observed in the past. It allows for welfare comparisons, with some economic content, based simply on aggregate data that are typically available for a large number of countries.

In our setting, differently from Becker et al. (2005), we net out health expenditures per capita from the income per capita numbers. Health is partly endogenous to expenditures and this helps to deal with this potential limitation. It is particularly important to take this dimension into account in our case, given the trajectories of expenditures on health observed across the US and other OECD countries in the last few decades. In addition, since we are focusing this exercise on developed countries, we are able to obtain health expenditure data for a relevant sample. Becker et al. (2005) did not do the same because they were looking at a larger sample of countries and did not have data on health expenditures for a considerable share of the sample.

We use the same functional form and calibrated parameters adopted before in this literature. The instantaneous utility function is assumed to take the form

$$u(c) = \frac{c^{1-1/\gamma}}{1-1/\gamma} + \alpha, \tag{6}$$

where α arises from the normalization of utility in the "death" state to zero, and γ is the intertemporal elasticity of substitution. Under this functional form and using equation 5, there is a closed form expression for w and, therefore, also for W.

Calibration of the parameters α and γ in the literature relies on the fact that $\alpha = c^{1-1/\gamma}(\frac{1}{\varepsilon} - \frac{1}{1-1/\gamma})$, where $\varepsilon = \frac{u'(c)c}{u(c)}$ is the elasticity of the instantaneous utility function. This elasticity can be calculated based on estimates of the value of a statistical life from empirical studies of compensating differentials (for a detailed discussion, see Murphy and Topel, 2003). We follow Becker et al. (2005) and use $\gamma = 1.25$, $\alpha = -16.2$, and $r = 0.03$.

5.2 Results

We use the methodology described in the previous subsection to assess the value of the life expectancy gains observed in the US and other OECD countries in the forty-year interval between the 1970s and 2010s. In addition, we consider some counterfactual scenarios analyzing how welfare gains in the US would have evolved during this period if the country had been able to perform like the average developed country. Finally, we also consider some scenarios that account for extreme versions of the potential economic distortions that could accompany this improved health performance. The analysis is restricted to OECD countries for which we have data on health expenditures in both periods, corresponding to the same sample from Section 3.1, consisting of 20 OECD countries (listed in the Appendix).

Table 3 presents the value of life expectancy and overall welfare gains between the 1970s and the 2010s, according to the methodology proposed by Becker et al. (2005), for the US and the OECD. The table also shows numbers for life expectancy at birth and income per capita net of health expenditures for the two reference years. In this specific period, life expectancy at birth increased by 6.5 years in the US and by 8.8 in the OECD, with a non-trivial difference of 2.3 years between the two. The welfare value of these gains in health were substantial, reaching around $100,000 in terms of present discounted value in both cases. Despite the fact that the US had income per capita above the OECD average, and therefore higher willingness to pay for improvements in health, the value of life expectancy improvements was 24.5% higher for the OECD because of the higher life expectancy gains: $118,832 as compared to $95,434. The value of overall gains in welfare, including increases in net income, reached $678,212 for the US and $852,226 for the OECD. The absolute difference is much higher than that associated with life expectancy alone because increases in income net of health expenditures were also higher for the OECD. From the perspective of our hypothetical individual at birth, overall gains in welfare are estimated to have been 26% higher in the OECD when compared to the US.

For illustration purposes, we also break down the OECD results according to the classification of health systems: Bismark, Beveridge, and National Health Insurance models.[14] The health performance is homogeneously superior to the American one across the different types of health systems. When considering the value of improvements in health, countries in the Beveridge model have a performance only 9.4% above the American, due mainly to the lower income per capita values in the 2010s. The best performance in terms of the value of life expectancy and overall welfare gains is found in countries belonging to the Bismark model, due to a combination of a high income per capita in 2015 with a superior performance in terms of improvements in health and income (net of health expenditures): our calculations indicate that these countries experienced overall improvements in welfare close to 40% above those experienced by the US.

In the second part of the table, we consider five counterfactual scenarios for the US: (i) reaching the life expectancy observed in the OECD in the 2010s and keeping everything else constant; (ii) keeping the US life expectancy in the 2010s, but at the health expenditures as a share of GDP observed in the OECD in the 2010s; (iii) keeping the US life expectancy in the 2010s, but at the level of health expenditures per capita observed in the OECD in the 2010s; (iv) reaching the life expectancy observed in the OECD in the 2010s at the health expenditures as a share of GDP observed in the OECD in the 2010s; and (v) reaching the life expectancy observed in the OECD in the 2010s at the level of health expenditures per capita observed in the OECD in the 2010s.

The first counterfactual indicates that, had the US reached the life expectancy at birth observed in the OECD in the 2010s (81.6 years), gains in welfare would have been higher by $43,665 in present value, corresponding to an improvement of 42% in terms of welfare gains from life expectancy and to an improvement of 6.7% in terms of overall welfare gains. Under this scenario, the contribution of health to overall improvements in welfare would have increased from 14.1% to 18.7%.

[14] Appendix H describes the classification of OECD countries within these groups.

Once one brings health expenditures into the analysis, the picture becomes more extreme. Keeping life expectancy at the 2010s US level, but reducing health expenditures to the levels typically observed in the OECD would increase the total gains in welfare observed during the period by between 17.5% and 20.3%, depending on the choice of health expenditure reference point (in per capita terms or as a percentage of GDP). Combining both life expectancy and health expenditures observed in the OECD would lead to improvements in total welfare gains between 24.9% and 27.8%. These improvements represent lifetime welfare gains of over $168,000. Under these scenarios, health would have contributed with approximately 17.5% of the total gains in welfare experienced between 1975 and 2015. In the best-case scenario—had the US been able to reach the OECD's life expectancy at birth at its level of health expenditure per capita—life expectancy would have been 81.6 instead of 78.7, and net GDP per capita would have been $47,882 instead of $43,665.

A concern sometimes expressed in these types of comparisons between the US and other developed countries is that the structural changes that would be needed to move US health outcomes and expenditures closer to the OECD average would bring about other, indirect, economic costs. Changes in the mode of delivery and financing of the health system might, for example, affect incentives to work through changes in taxation and access to benefits. Or improvements in health might require changes in lifestyle that would involve a reduction in hours of work and an increase in time spent on healthy behaviors. In fact, the evidence presented in Ehrlich and Yin (2005) supports the idea that individuals' life protective behaviors play a small but relevant role in explaining differences in mortality. On the other hand, health status is positively related to hours of work and labor force participation (Bartel and Taubman, 1979; Pelkowski and Berger, 2004; Cai, 2010; Cai et al., 2014), so that improved health could instead bring about increased income. It is therefore impossible, based solely on theoretical arguments, to figure out unequivocally the direction of the bias arising from ignoring these secondary effects.

The data, in fact, shows that average working hours for those employed—or labor supply at the intensive margin—tend to be higher in the US, while labor force participation and employment rates—or labor supply at the extensive margin—tend to he higher in the

OECD.[15] It is obviously unlikely that these differences in labor supply patterns are due entirely to differences in the modes of health financing and provision and to health related behaviors. Differences in other types of taxation, welfare-state design, and culture certainly account for an important part of them. Nevertheless, in order to assess the potential effects of ignoring the indirect economic costs in our previous calculations, we make the extreme assumption that all differences in hours of work and labor force participation across the US and the OECD are due to factors associated with the differences in health systems and health behaviors. In other words, we consider additional scenarios assuming that the counterfactual US improvement in health discussed before would be inevitably associated with changes in labor supply corresponding to the differences observed across the US and the OECD. Based on this idea, we consider three additional counterfactual scenarios, building upon scenario (v) in Table 3: scenario (vi) considers scenario (v) adjusting the US average working hours in the 2010s to the OECD average; scenario (vii) instead adjusts the US labor force participation in the 2010s to the OECD average; and scenario (viii) adjusts both the US average working hours and labor force participation to the OECD averages. In order to estimate the US net GDP in the 2010s considering the counterfactual working hours and labor force participation, we maintain US labor productivity constant (GDP by total hours worked in the data) and adjust the total amount of hours worked using average working hours and participation numbers to calculate the new counterfactual net GDP (the numbers for working hours and participation are presented in Appendix E). This new counterfactual net GDP is then divided by the population to generate the GDP per capita numbers used in the exercises. The results from these additional counterfactual exercises are presented in the third panel of Table 3.

Relative to the scenario (v), once working hours are taken into account (scenario (vi)), US net GDP per capita in the 2010s decreases from \$47,882 to \$42,887. Improvements in total welfare gains are reduced considerably, from 27.8% to only 2.8%, and the health contribution to total welfare gains increases from 17.4% to 19.1%. Adjusting instead the labor force participation and employment rates (scenario (vii)) leads to an increase in US

[15] Data from the the Penn World Tables 9.1 (Feenstra et al., 2015) and the World Population Prospects (United Nations, 2019).

net GDP per capita in the 2010s from \$47,882 to \$51,405 and, therefore, to a considerably higher improvement in total welfare gains, 45.4% vs 27.8%, and a slightly lower health contribution to total welfare gains. When both working hours and participation are combined, the net GDP per capita in the 2010s decreases by about 4%, to \$46,074, the improvements in total welfare gains are reduced from 27.8% to 18.7%, and the health contribution to total welfare gains experiences a minor increase of 0.5p.p. Incorporating in an extreme fashion the income effects of improving the US health status indeed reduces the total estimated potential gain in welfare. Still, overall gains remain close to 20% under our final counterfactual scenario, being, therefore, sizable.

One remaining issue in this welfare analysis, already discussed in previous sections, is to what extent these changes in life expectancy, and therefore in estimated welfare, are endogenous to individual behavior and reflect differences in lifestyle. In order to shed some light on this, we consider four additional counterfactual scenarios that try to minimize the role of lifestyle factors in our welfare calculations.

The four additional counterfactuals presented in the bottom panel of Table 3 consider the following alternative scenarios: (ix) US 2010s life expectancy using the US 1970s mortality attributable to smoking, based on the estimates from Preston et al. (2011) and our own calculations; (x) US 2010s life expectancy using the OECD's mortality attributable to smoking in the 2010s, also based on the estimates from Preston et al. (2011) and our own calculations; (xi) US 2010s life expectancy using the OECD's mortality attributable to obesity in the 2010s, based on estimates from Preston and Stokes (2011); (xii) a combination of the two previous scenarios ((x) and (xi)). Appendix D provides a detailed description of the methodology used to estimate these counterfactual scenarios. Scenario (ix) aims at analyzing to what extent smoking was a main driver of the changes in life expectancy in the US between the 1970s and the 2010s. The construction of this scenario relies on the estimates from Preston et al. (2011) and, therefore, a similar exercise unfortunately cannot be performed for the OECD or for mortality attributable to obesity. Scenarios (x) to (xii) aim at clarifying whether current differences in the levels of mortality due to smoking and obesity across the US and OECD can explain the divergence in gains in life expectancy over the forty-year interval considered here. So they generate 2010s counterfactual life expectancy numbers for the US replacing mortality profiles attributable to these two causes of death by those observed in the OECD at that same moment. These four new counterfactual scenarios should be compared directly to the baseline US scenario from the first row.

The last panel in the table shows that the new counterfactual scenarios change very little the 2010s life expectancy numbers and, consequently, also have only minor implications to the welfare calculations. Scenario (ix) is almost identical to the baseline US scenario. Though maybe surprising, this comes from the fact that the impact of smoking on final life expectancy numbers is roughly similar in the 1970s and in the 2010s. This impact actually peaked in between these two decades, and the 2010s numbers represent a substantial improvement in relation to the peak, but an improvement that simply brought the US back to roughly 1970s levels (see Appendix Figure D.2). For a similar reason, the counterfactual scenarios considering OECD's smoking and obesity numbers have little implications for our welfare calculations. At the final reference point used in our welfare calculations, there are only minor differences in the impact of mortality due to these two causes of death on life expectancy across the US and OECD. The profile of mortality due to smoking in the 2010s is almost identical across the two, though only slightly higher for the OECD sample. For obesity, the counterfactual scenario (xi) generates an improvement of 0.4 year in life expectancy for the US, which, despite non-trivial, does not change our previous conclusions in any substantial way. The final counterfactual scenario (xii), which abstracts entirely from differences in mortality due to smoking and obesity across the US and OECD, still indicates a gap of 2.5 years in life expectancy at birth. So lifestyle factors, as captured by mortality due to these two causes of death, are unlikely to be main drivers of the differences in welfare documented in this section.

All the welfare comparisons here are made from the Rawlsian veil of ignorance perspective, implicit in the conception of the hypothetical life-cycle individual proposed by Becker et al. (2005). There are various simplifying assumptions in this framework, which abstracts, for example, from inequality, lifetime income and mortality profiles, and age-composition of the population. It is not clear, though, that incorporating these dimensions into some measure of average gains in survival, potentially sensitive to population composition along different dimensions, would alter our main conclusions. Consider, for example, inequality and age composition. Latin America has inequality levels much higher than those observed in the OECD and, still, the life expectancy gap between the two groups of countries closed by more than 50% in the last decades, while that between the US and OECD increased substantially. Since we are focusing on changes in life expectancy over time, higher initial inequality should make further gains in life expectancy relatively easier, not more difficult. Regarding age distribution, the OECD countries considered in our sample have typically older populations than the US. So, also along this dimension, further gains in life expectancy should have been more difficult in the OECD than in the US. A deeper analysis would nevertheless be needed to fully explore how changes in population composition along different dimensions might alter the conclusions highlighted in this section.

Nevertheless, it remains true that, by any measure, from the Rawlsian veil of ignorance perspective of the hypothetical life-cycle individual proposed by Becker et al. (2005), the loss in welfare from the poor life expectancy performance and high cost of the American health system during these recent decades has been substantial. Given its simplicity and intuitive appeal, this framework allows for broad comparisons that would otherwise have been impossible. The previous sections of this paper showed that, along various margins, the US life expectancy performance falls considerably short of what would be expected given its income level, and even more so given its health expenditures. The goal of this section is simply to illustrate that, under a somewhat standard framework, the welfare losses from this poor overall performance can be quite large.

6 Concluding Remarks

The US performance in health, as measured by the standardized mortality reductions summarized in life expectancy numbers, has long been poor in comparison to other peer countries. The more recent period is particularly striking, as the US has experienced several years without significant improvements in life expectancy. This is even more surprising given the observed level and trajectory of health expenditures.

In this paper, we took a comparative approach and examined the relative performance of life expectancy in the US from an international perspective since 1960. We characterized the changes in this relative performance over time and its age and cause of death profiles. We documented that this phenomenon is not recent and is pervasive across various causes of death. Previous health advantages in old-age have also been converted into disadvantages. It is remarkable that the deterioration of the US relative performance has been increasingly apparent since as far as 1960, except for the short period between the 1960s and the 1970s. These patterns cast doubt on rationalizations of the poor relative performance of life expectancy at birth in the US that rely on specific causes of death or age groups.

Almost all the developed world reaches health outcomes, on average, substantially better than those observed in the US at only a fraction of its cost. Our calculations suggest that the loss in welfare due to the combination of lower life expectancy and higher health expenditures can be substantial. We estimate that welfare gains in the US over the last few decades could have been between 19% and 28% higher had the US been able to reproduce the average health performance from OECD countries at their typical health expenditure level. Our estimates indicate that, in comparative terms, it is difficult to argue that the US health system—broadly understood as including preventive, curative, educational, and regulatory roles—has been cost-effective. Much more research is needed to uncover the specific sources of these patterns and to propose policy solutions to address potential underlying problems.

Appendix

A Decomposition of Differences in Life Expectancy

Figure A.1 presents the decomposition of difference in life expectancy between the US and an OECD for cause-specific mortality by age groups.

Figure A.2 presents the decomposition of difference in life expectancy between the US and an OECD sample for which yearly data is available in the 1960-2016 period.

B Contribution of Age-Specific Mortality Long-term Inflections

Figure B.1 and Table B.1 present the results of the jointpoint regressions for the contribution of age-specific mortality.

C Contribution of Cause-Specific Mortality Long-term Inflections

Figure C.1 and Table C.1 presents the results of the jointpoint regressions for the contribution of cause-specific mortality.

D Contribution of Smoking and Obesity to Differences in Life Expectancy

D.1 Contribution of Smoking

The method used to estimate the impact of smoking on mortality proposed by Preston et al. (2011) assumes that, after adjusting for sex and age, lung cancer mortality is a good proxy for estimating the impact of smoking on all other cause mortality. This assumption is based on the evidence that variation in lung cancer rates is mainly related to changes in smoking behavior (Brennan and Bray, 2002; Haldorsen and Grimsrud, 1999; Lopez, 1995; Preston and Wang, 2006). Mortality from other causes than lung cancer is estimated as a function of lung cancer mortality at ages 50 and above using a negative binomial regression in a sample composed by 21 OECD countries from 1950 to 2003.

The procedure proposed to estimate the share of total deaths attributable to smoking is fairly simple and is composed by the fraction of lung cancers attributable to smoking (A_L) and the share of other cause mortality attributable to smoking (A_O) for each country, age group and sex:

$$A_L = \frac{M_L - \lambda_L^N}{M_L}$$

where M_L is the lung cancer death rate and λ_L^N is the expected death rate among nonsmokers[16]. When $M_L - \lambda_L^N$ is negative, A_L is set to 0. To estimate the share of mortality from all other causes attributable to smoking the number of deaths predicted by the negative binomial regression is used:

$$A_O = 1 - e^{-\beta'_L(M_L - \lambda_L^N)}$$

where β'_L is a expression that contains the main coefficient of the negative binomial regression of mortality from other causes on lung cancer mortality. When $M_L - \lambda_L^N$ is negative, $M_L - \lambda_L^N$ is set to 0 before computing A_O. The overall fraction of deaths from all causes attributable to smoking is then calculated as following:

$$A = \frac{A_L D_L + A_O D_O}{D}$$

where D_L is the number of deaths from lung cancer, D_O the number of deaths from all other causes, and D the overall mortality. To estimate the impact of smoking on life expectancy, we follow Preston et al. (2011) negative binomial regression coefficient (β'_L) and expected lung cancer death rate among nonsmokers (λ_L^N) and apply the methodology described above on our sample of OECD countries. We first estimate A for all countries, age groups above 50 years old, and sex, using data from World Health Mortality Database. Then, we adjust mortality rates in the period life tables from Human Mortality Database by subtracting the share of deaths attributable to smoking (A) and recalculate the life tables to find what Life Expectancy would be in the absence of mortality attributable to smoking.

We also use the share of deaths attributable to smoking (A) to estimate the contribution of deaths attributable to smoking to differences in life expectancy between the US and OECD using the same decomposition methods used to estimate the contribution of age-specific and cause-specific mortality. The results are presented in Figure D.1.

To estimate the counterfactual life expectancies (ix) and (x) presented in Table 3, we recalculate the US life table after adjusting the mortality rates by $A_{US_{2015}} - A_{US_{1975}}$ and $A_{US_{2015}} - A_{OECD_{2015}}$, respectively.

Finally, based on the same estimates, in Figure D.2 we are able to plot the years of life expectancy lost due to mortality attributable to smoking for the US and OECD separately.

[16] Preston et al. (2011) assumes that the lung cancer death rate by sex and age group in the absence of smoking match thes rates observed in the Cancer Prevention Studies II (CPS-II) presented in Thun et al. (1982)

D.2 Contribution of Obesity

The Body Mass Index (BMI) is often used as an indicator of obesity. However, estimating the impact of BMI on life expectancy is rather difficult due to the lack of data on BMI by different age groups and sex, and the mortality risks associated with these different levels of BMI. Preston and Stokes (2011) consolidates a database of BMIs by sex and age group above 50 for a sample of 14 OECD countries in 2006 and assumes that the mortality risk for different BMI categories recorded in a study by the Prospective Studies Collaboration (Whitlock et al., 2009) are applicable for all countries in the sample. The authors then estimate the proportion of deaths attributable to obesity by redistributing the population in BMI categories above the optimal to the optimal category and calculating the decrease in mortality that would occur after this redistribution, for each country, age, and sex. This methodology is known as population attributable fraction (PAF).

We only have available data on BMI, overweight and obesity aggregated by sex, which does not allow us to employ similar methodology to estimated the impact of obesity on life expectancy for our sample. To estimate the counterfactual life expectancy (xi) presented in Table 3, we recalculate US life tables after adjusting mortality rates using the difference in the share of deaths attributable to obesity in the US and average of comparison countries presented in Preston and Stokes (2011). Thought our counterfactual life expectancy is relative to the year of 2015 and Preston and Stokes (2011) estimates are relative to the year of 2006, data show that the increase in BMI, overweight and obesity for the US and OECD where fairly similar in this period (Table D.1). Thus, we assume that the differences in the share of deaths attributable to obesity in the US and comparison countries in Preston and Stokes (2011) still holds in 2015.

E Additional Tables

F Samples

Figures 1, 2, 3, 4, and Table 1, are based on a sample including 107 countries: Argentina, Australia, Austria, Burundi, Belgium, Benin, Burkina Faso, Bangladesh, Bolivia, Brazil, Barbados, Botswana, Central African Republic, Canada, Switzerland, Chile, China, Côte d'Ivoire, Cameroon, Congo, Colombia, Comoros, Cabo Verde, Costa Rica, Cyprus, Germany, Denmark, Dominican Republic, Algeria, Ecuador, Egypt, Spain, Ethiopia, Finland, Fiji, France, Gabon, United Kingdom, Ghana, Guinea, Gambia, Guinea-Bissau, Equatorial Guinea, Greece, Guatemala, China, Hong Kong SAR, Honduras, Haiti, Indonesia, India, Ireland, Iran, Iceland, Italy, Jamaica, Jordan, Japan, Kenya, Republic of Korea, Sri Lanka, Lesotho, Luxembourg, Morocco, Madagascar, Mexico, Mali, Malta, Mozambique, Mauritania, Mauritius, Malawi, Malaysia, Namibia, Niger, Nigeria, Nicaragua, Netherlands, Norway, Nepal, New Zealand, Pakistan, Panama, Peru, Philippines, Portugal, Paraguay, Romania, Rwanda, Senegal, Singapore, El Salvador, Sweden, Syrian Arab Republic, Chad, Togo, Thailand, Trinidad and Tobago, Tunisia, Turkey, U.R. of Tanzania: Mainland, Uganda, Uruguay, United States, Venezuela, South Africa, Zambia, and Zimbabwe.

Figures 5, 6, Tables 2 and 3, and Figure A.1 are based on a sample of 20 OECD countries: Australia, Austria, Belgium, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, United Kingdom, Ireland, Iceland, Japan, Luxembourg, Netherlands, Norway, Portugal, Sweden, and United States

Figure 7 is based on a sample of 16 OECD countries: Austria, Belgium, Canada, Switzerland, Spain, Finland, United Kingdom, Ireland, Iceland, Japan, Republic of Korea, Norway, Portugal, Sweden, and United States.

Figures A.2, B.1, C.1, and Tables B.1 and C.1 are based on a sample of 13 OECD countries: Austria, Belgium, Canada, Switzerland, Germany, Spain, France, United Kingdom, Italy, Japan, Netherlands, Sweden and United States.

G ICD Grouping

H Classification of Health Systems

Beveridge system countries: Denmark, Spain, Finland, United Kingdom, Ireland, Iceland, Norway, New Zealand, Portugal, Sweden.

Bismark system countries: Austria, Belgium, Switzerland, Germany, France, Japan, Luxembourg, Netherlands.

National Health Insurance countries: Australia and Canada

References

Aaron, H. J. (2003). The Costs of Health Care Administration in the United States and Canada — Questionable Answers to a Questionable Question. *New England Journal of Medicine*, 349(8):801–803.

Acemoglu, D., Finkelstein, A., and Notowidigdo, M. J. (2013). Income and health spending: Evidence from oil price shocks. *Review of Economics and Statistics*, 95(4):1079–1095.

Almond, D., Doyle Jr, J. J., Kowalski, A. E., and Williams, H. (2010). Estimating marginal returns to medical care: Evidence from at-risk newborns. *The quarterly journal of economics*, 125(2):591–634.

Anderson, G. F. and Frogner, B. K. (2008). Health spending in OECD countries: Obtaining value per dollar. *Health Affairs*, 27(6):1718–1727.

Anderson, G. F., Reinhardt, U. E., Hussey, P. S., and Petrosyan, V. (2003). It's The Prices, Stupid: Why The United States Is So Different From Other Countries. *Health Affairs*, 22(3):89–105.

Andrasfay, T. and Goldman, N. (2020). Impact of COVID-19 on 2020 US life expectancy for the Black and Latino populations. *medRxiv*.

Arriaga, E. (1989). Changing trends in mortality decline during the last decades. *Differential mortality: Methodological issues and biosocial factors*, pages 105–29.

Arriaga, E. E. (1984). Measuring and explaining the change in life expectancies. *Demography*, 21(1):83–96.

Atlas, S. (Nov 12 2018). The false promise of 'medicare for all'. *Wall Street Journal*.

Avendano, M., Glymour, M. M., Banks, J., and Mackenbach, J. P. (2009). Health disadvantage in us adults aged 50 to 74 years: a comparison of the health of rich and poor americans with that of europeans. *American journal of public health*, 99(3):540–548.

Baltagi, B. H., Lagravinese, R., Moscone, F., and Tosetti, E. (2017). Health Care Expenditure and Income: A Global Perspective. *Health Economics*, 26(7):863–874.

Bartel, A. and Taubman, P. (1979). Health and Labor Market Success: The Role of Various Diseases. *The Review of Economics and Statistics*, 61(1):1.

Becker, G. S., Philipson, T. J., and Soares, R. R. (2005). The Quantity and Quality of Life and the Evolution of World Inequality. *American Economic Review*, 95(1):277–291.

Brennan, P. and Bray, I. (2002). Recent trends and future directions for lung cancer mortality in europe. *British journal of cancer*, 87(1):43–48.

Cai, L. (2010). The relationship between health and labour force participation: Evidence from a panel data simultaneous equation model. *Labour Economics*, 17(1):77–90.

Cai, L., Mavromaras, K., and Oguzoglu, U. (2014). The Effects of Health Status and Health Shocks on Hours Worked. *Health economics*, 18(May 2013):S37–S54.

Crimmins, E., Preston, S., Cohen, B., on Understanding Divergent Trends in Longevity in High-Income Countries, N. R. C. U. P., et al. (2010). *International Differences in Mortality at Older Ages: Dimensions and Sources*. National Academies Press (US).

Cutler, D. M., Glaeser, E. L., and Shapiro, J. M. (2003). Why have americans become more obese? *Journal of Economic perspectives*, 17(3):93–118.

Cutler, D. M. and Kadiyala, S. (2003). The Return to Biomedical Research: Treatment and Behavioral Effects. *Measuring the gains from medical research: An economic approach*.

Cutler, D. M. and McClellan, M. (1996). The Determinants of Technological Change in Heart Attack Treatment. *National Bureau of Economic Research Working Paper Series*, No. 5751:0.

Cutler, D. M. and McClellan, M. (2001). Is technological change in medicine worth it? *Health Affairs*, 20(5):11–29.

Cutler, D. M., Rosen, A. B., and Vijan, S. (2006). The Value of Medical Spending in the United States, 1960–2000. *New England Journal of Medicine*, 355(9):920–927.

Doyle Jr, J. J., Graves, J. A., Gruber, J., and Kleiner, S. A. (2015). Measuring returns to hospital care: Evidence from ambulance referral patterns. *Journal of Political Economy*, 123(1):170–214.

Duggan, M., Gruber, J., and Vabson, B. (2018). The consequences of health care privatization: evidence from medicare advantage exits. *American Economic Journal: Economic Policy*, 10(1):153–86.

Eggleston, K. N., Shah, N. D., Smith, S. A., Berndt, E. R., and Newhouse, J. P. (2011). Quality adjustment for health care spending on chronic disease: Evidence from diabetes treatment, 1999-2009. *American Economic Review*, 101(3):206–211.

Eggleston, K. N., Shah, N. D., Smith, S. A., Wagie, A. E., Williams, A. R., Grossman, J. H., Berndt, E. R., Long, K. H., Banerjee, R., and Newhouse, J. P. (2009). The net value of health care for patients with type 2 diabetes, 1997 to 2005. *Annals of Internal Medicine*, 151(6):386–393.

Ehrlich, I. and Yin, Y. (2005). Explaining diversities in age-specific life expectancies and values of life saving: a numerical analysis. *Journal of Risk and Uncertainty*, 31(2):129–162.

Ehrlich, I. and Yin, Y. (2013). Equilibrium Health Spending and Population Aging in a Model of Endogenous Growth: Will the GDP Share of Health Spending Keep Rising? *Journal of Human Capital*, 7(4):411–447.

Feenstra, R. C., Inklaar, R., and Timmer, M. P. (2015). The next generation of the penn world table. *American Economic Review*, 105(10):3150–3182.

Finkelstein, A. (2007). The Aggregate Effects of Health Insurance: Evidence from the Introduction of Medicare. *The Quarterly Journal of Economics*, 122(1):1–37.

Finkelstein, A. and McKnight, R. (2008). What did medicare do? the initial impact of medicare on mortality and out of pocket medical spending. *Journal of Public Economics*, 92(7):1644–1668.

Gerdtham, U. G. and Jönsson, B. (2000). Chapter 1 International comparisons of health expenditure: Theory, data and econometric analysis. *Handbook of Health Economics*, 1(PART A):11–53.

Getzen, T. E. (2000). Health care is an individual necessity and a national luxury: Applying multilevel decision models to the analysis of health care expenditures. *Journal of Health Economics*, 19(2):259–270.

Goldman, L. and Cook, E. F. (1984). The Decline in Ischemic Heart Disease Mortality Rates: An Analysis of the Comparative Effects of Medical Interventions and Changes in Lifestyle. *Annals of Internal Medicine*, 101(6):825–836.

Haldorsen, T. and Grimsrud, T. K. (1999). Cohort analysis of cigarette smoking and lung cancer incidence among norwegian women. *International journal of epidemiology*, 28(6):1032–1036.

Hall, R. E. and Jones, C. I. (2007). The value of life and the rise in health spending. *Quarterly Journal of Economics*, 122(1):39–72.

Heidenreich, P. and McClellan, M. (2003). Biomedical Research and Then Some: The Causes of Technological Change in Heart Attack Treatment. *Measuring the Gains from medical research: An economic approach*.

Higgins, M. and Thom, T. (1989). Trends in CHD in the United States. *International Journal of Epidemiology*, 18(3_Supplement_1):S58–S66.

Ho, J. Y. and Hendi, A. S. (2018). Recent trends in life expectancy across high income countries: Retrospective observational study. *BMJ (Online)*, 362.

Ho, J. Y. and Preston, S. H. (2010). US mortality in an international context: Age variations. *Population and Development Review*, 36(4):749–773.

Holahan, J., Dor, A., and Zuckerman, S. (1990). Understanding the Recent Growth in Medicare Physician Expenditures. *JAMA: The Journal of the American Medical Association*, 263(12):1658–1661.

Human Mortality Database (2020). University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). Available at: https://http://www.mortality.org/ or http://www.humanmortality.de/ (data downloaded on 03/17/2020).

IHME (2014). Global Smoking Prevalence and Cigarette Consumption 1980-2012. Available at: http://ghdx.healthdata.org/record/ihme-data/global-smoking-prevalence-and-cigarette-consumption-1980-2012 (data downloaded on 01/20/2021).

Joinpoint Regression Program (Version 4.8.0.1, 2020). Statistical Methodology and Applications Branch, Surveillance Research Program, National Cancer Institute.

Kim, H.-J., Fay, M. P., Feuer, E. J., and Midthune, D. N. (2000). Permutation tests for joinpoint regression with applications to cancer rates. *Statistics in medicine*, 19(3):335–351.

Kristof, N. (Nov 04 2009). Best health care in the world? *The New York Times*.

Lerman, P. (1980). Fitting segmented regression models by grid search. *Journal of the Royal Statistical Society: Series C (Applied Statistics)*, 29(1):77–84.

Lopez, A. D. (1995). The lung cancer epidemic in developed countries. *Adult mortality in developed countries: From description to explanation*, pages 111–134.

Lorenzoni, L., Belloni, A., and Sassi, F. (2014). Health-care expenditure and health policy in the USA versus other high-spending OECD countries. *The Lancet*, 384(9937):83–92.

Lozano, R., Fullman, N., Mumford, J. E., Knight, M., Barthelemy, C. M., Abbafati, C., Abbastabar, H., Abd-Allah, F., Abdollahi, M., Abedi, A., et al. (2020). Measuring universal health coverage based on an index of effective coverage of health services in 204 countries and territories, 1990–2019: a systematic analysis for the global burden of disease study 2019. *The Lancet*, 396(10258):1250–1284.

Manton, K. G. and Vaupel, J. W. (1995). Survival After the Age of 80 in the United States, Sweden, France, England, and Japan. *New England Journal of Medicine*, 333(18):1232–1235.

McClellan, M. B. and Kessler, D. P. (2002). *Technological Change in Health Care: A Global Analysis of Heart Attack*. University of Michigan Press.

Meara, E., White, C., and Cutler, D. M. (2004). Trends in medical spending by age, 1963-2000. *Health Affairs*, 23(4):176–183.

Murphy, K. and Topel, R. (2003). Measuring the gains from medical research: An economic approach. *Bibliovault OAI Repository, the University of Chicago Press*.

Murphy, K. M. and Topel, R. H. (2006). The value of health and longevity. *Journal of Political Economy*, 114(5):871–904.

Newhouse, J. P. (1977). Medical-Care Expenditure: A Cross-National Survey. *The Journal of Human Resources*, 12(1):115.

Newhouse, J. P. (1992). Medical care costs: how much welfare loss? *The journal of economic perspectives : a journal of the American Economic Association*, 6(3):3–21.

OECD (2020). Health Data. Available at: https://stats.oecd.org/Index.aspx?ThemeTreeId=9 (data downloaded on 03/17/2020).

Okunade, A. A. and Murthy, V. N. (2002). Technology as a 'major driver' of health care costs: A cointegration analysis of the Newhouse conjecture. *Journal of Health Economics*, 21(1):147–159.

Palloni, A. and Yonker, J. A. (2016). Is the US Old-Age Mortality Advantage Vanishing? *Population and Development Review*, 42(3):465–489.

Peden, E. A. and Freeland, M. S. (1998). Insurance effects on US medical spending (1960-1993). *Health Economics*, 7(8):671–687.

Pelkowski, J. M. and Berger, M. C. (2004). The impact of health on employment, wages, and hours worked over the life cycle. *Quarterly Review of Economics and Finance*, 44(1):102–121.

Pozen, A. and Cutler, D. M. (2010). Medical spending differences in the United States and Canada: The role of prices, procedures, and administrative expenses. *Inquiry*, 47(2):124–134.

Preston, S. and Ho, J. (2009). Low Life Expectancy in the United States: Is the Health Care System at Fault? *NBER Working Paper*.

Preston, S. H., Glei, D. A., and Wilmoth, J. R. (2011). Contribution of smoking to international differences in life expectancy. *International differences in mortality at older ages: Dimensions and sources*, pages 105–31.

Preston, S. H. and Stokes, A. (2011). Contribution of obesity to international differences in life expectancy. *American Journal of Public Health*, 101(11):2137–2143.

Preston, S. H., Vierboom, Y. C., and Stokes, A. (2018). The role of obesity in exceptionally slow US mortality improvement. *Proceedings of the National Academy of Sciences of the United States of America*, 115(5):957–961.

Preston, S. H. and Wang, H. (2006). Sex mortality differences in the united states: The role of cohort smoking patterns. *Demography*, 43(4):631–646.

Schoen, C., Davis, K., How, S. K., and Schoenbaum, S. C. (2006). U.S. health system performance: A national scorecard. *Health Affairs*, 25(6).

Skinner, J. S., Staiger, D. O., and Fisher, E. S. (2006). Is technological change in medicine always worth it? The case of acute myocardial infarction. *Health Affairs*, 25(2):34–47.

Smith, S., Newhouse, J. P., and Freeland, M. S. (2009). Income, insurance, and technology: Why does health spending outpace economic growth? *Health Affairs*, 28(5):1276–1284.

Thakrar, A. P., Forrest, A. D., Maltenfort, M. G., and Forrest, C. B. (2018). Child Mortality In The US And 19 OECD Comparator Nations: A 50-Year Time-Trend Analysis. *Health Affairs*, 37(1):140–149.

Thorpe, K. E., Howard, D. H., and Galactionova, K. (2007). Differences in disease prevalence as a source of the U.S.-European health care spending gap. *Health Affairs*, 26(6).

Thun, M. J., Day-Lally, C., Myers, D. G., Calle, E. E., Flanders, W., Zhu, B., Namboodiri, M. M., and Heath, C. (1982). Trends in tobacco smoking and mortality from cigarette use in cancer prevention studies i (1959 through 1965) and ii (1982 through 1988). *Changes in cigarette-related disease risks and their implication for prevention and control: smoking and tobacco control monograph*, 8.

Tikkanen, R., Gunja, M., FitzGerald, M., and Zephyrin, L. (2020). Maternal Mortality and Maternity Care in the United States Compared to 10 Other Developed Countries. *Commonwealth Fund*.

United Nations (2019). World Population Prospects 2019, Online Edition. Rev. 1, Department of Economic and Social Affairs, Population Division. Available at: https://population.un.org/wpp/Download/Standard/CSV/ (data downloaded on 03/17/2020).

Vierboom, Y. and Preston, S. (2017). Recent Changes in US Mortality : Continued Deterioration Relative to Peers. *Population Center Working Papers*.

Weisfeldt, M. L. and Zieman, S. J. (2007). Advances in the Prevention and Treatment of Cardiovascular Disease. *Health Affairs*, 26(1):25–37.

White, C. (2007). Health care spending growth: How different is the United States from the rest of the OECD? *Health Affairs*, 26(1):154–161.

Whitlock, G., Lewington, S., Sherliker, P., Clarke, R., Emberson, J., Halsey, J., Qizilbash, N., Collins, R., and Peto, R. (2009). Prospective studies collaboration body-mass index and cause-specific mortality in 900 000 adults: collaborative analyses of 57 prospective studies. *Lancet*, 373(9669):1083–1096.

Woolf, S. and Aron, L. (2013). *US Health in International Perspective: Shorter Lives, Poorer Health*. National Academies Press (US).

Woolf, S. H. and Schoomaker, H. (2019). Life Expectancy and Mortality Rates in the United States, 1959-2017. *Jama*, 322(20):1996.

Woolhandler, S., Sekhon, J. S., Reinhardt, U. E., Cheng, T. M., Navarro, V., Tuckson, R., Campbell, T., Himmelstein, D. U., and Aaron, H. J. (2003). Costs of Health Care Administration in the United States and Canada. *New England Journal of Medicine*, 349(25):2461–2464.

World Bank (2020). Life expectancy at birth. Data retrieved from the World Development Indicators. https://data.worldbank.org/indicator/SH.XPD.CHEX.PP.CD (data downloaded on 03/17/2020).

World Health Organization (2020). Mortality Database. Available at: https://www.who.int/healthinfo/statistics/mortality_rawdata/en/ (data downloaded on 03/17/2020).

Tables

Table 1: Joinpoint Segmented Regressions: Life Expectancy in the US vs High-Income Countries

	High Income		US		Difference (High Income - US)	
Panel A: Life Expectancy Slopes						
Segment	Period	Slope	Period	Slope	Period	Slope
1	1960-1971	0.202 (0.005)***	1960-1969	0.040 (0.021)*	1960-1968	0.178 (0.023)***
2	1971-1984	0.274 (0.004)***	1969-1979	0.345 (0.021)***	1968-1979	-0.068 (0.016)***
3	1984-1998	0.221 (0.004)***	1979-1995	0.127 (0.01)***	1979-1988	0.129 (0.023)***
4	1998-2013	0.249 (0.003)***	1995-2012	0.176 (0.009)***	1988-2012	0.073 (0.005)***
5	2013-2017	0.120 (0.024)***	2012-2017	-0.052 (0.052)	2012-2017	0.201 (0.045)***
Panel B: Differences in Slopes						
Segment		Slope difference		Slope difference		Slope difference
2 - 1		0.072 (0.006)***		0.304 (0.03)***		-0.246 (0.028)***
3 - 2		-0.053 (0.005)***		-0.218 (0.024)***		0.197 (0.028)***
4 - 3		0.028 (0.005)***		0.049 (0.014)***		-0.056 (0.023)**
5 - 4		-0.128 (0.024)***		-0.228 (0.053)***		0.128 (0.045)***

Notes: Joinpoints, slopes and slopes differences were estimated using the Joinpoint Regression Program. The grid search method was used to fit segmented regressions into the time series. P-values were calculated using Montecarlo simulations and the standard errors are in parenthesis. ***p<0.01, **p<0.05, *p<0.1.

Table 2: Health, Behavior and Lifestyle Statistics: US vs OECD Countries

	USA			**High Income Countries**		
	1975	2015	% change	1975	2015	% change
Body Mass Index	24.90	29.00	16%	24.05	26.58	10%
Overweight prevalence	0.41	0.70	71%	35.38	59.05	67%
Obesity prevalence	0.12	0.37	214%	0.08	0.23	191%
	2016					
Physical inactivity prevalence	-	0.40	-	-	0.33	-
	1980	2012	% change	1980	2012	% change
Smoking prevalence	0.31	0.16	-48%	0.31	0.22	-29%
Average tobacco consumption per smoker	31.90	22.50	-29%	22.30	20.32	-9%
	1970	2015	% change	1970	2015	% change
Average alcohol consumption	9.54	8.78	-8%	10.26	8.59	-16%

Sources: Data on BMI, overweight and obesity prevalence, physical inactivity, and alcohol consumption are from World Health Organization (2020) Global Database and data on smoking prevalence and consumption from IHME (2014).

Table 3: Value of Life Expectancy Gains, USA vs OECD, 1970s - 2010s

	1975		2015		Life Exp Gains	Net Income Gains	Value of Life Expectancy Gains		Value of Total Welfare Gains		% Health in Total Welfare Gains
	Life Exp	GDP pc Net of Health Expenditures	Life Exp	GDP pc Net of Health Expenditures			Discounted PV in $	Comparison with US	Discounted PV in $	Comparison with US	
USA	72.23	24,359	78.68	43,665	6.5	19,306	95,434	0.0%	678,212	0.0%	14.1%
OECD	72.84	17,749	81.60	41,834	8.8	24,085	118,832	24.5%	852,226	25.7%	13.9%
Bismark model	72.67	19,555	81.74	46,036	9.1	26,480	137,644	44.2%	944,324	39.2%	14.6%
Beveridge model	72.96	15,662	81.39	38,599	8.4	22,937	104,417	9.4%	802,454	18.3%	13.0%
National Health Insurance model	73.02	19,919	81.92	39,587	8.9	19,667	112,801	18.2%	712,234	5.0%	15.8%
Counterfactual Scenarios:											
i: USA with OECD's 2015 life exp.	72.23	24,359	***81.60***	43,665	9.4	19,306	135,556	42.0%	723,426	6.7%	18.7%
ii: USA with OECD's 2015 health expenditures (% GDP)	72.23	24,359	78.68	***47,304***	6.5	22,945	104,430	9.4%	797,074	17.5%	13.1%
iii: USA with OECD's 2015 health expenditures (per capita)	72.23	24,359	78.68	***47,882***	6.5	23,523	105,865	10.9%	815,964	20.3%	13.0%
iv: USA with OECD's 2015 life exp. + health expenditure (% GDP)	72.23	24,359	***81.60***	***47,304***	9.4	22,945	148,350	55.4%	847,047	24.9%	17.5%
v: USA with OECD's 2015 life exp. & health expenditure (per capita)	72.23	24,359	***81.60***	***47,882***	9.4	23,523	150,392	57.6%	866,695	27.8%	17.4%
Counterfactual Scenarios with economic costs :											
vi: Counterfactual Scenario (v) with OECD's average working hours	72.23	24,359	***81.60***	***42,887***	9.4	18,529	132,837	39.2%	697,045	2.8%	19.1%
vii: Counterfactual Scenario (v) with OECD's labour force participation	72.23	24,359	***81.60***	***51,405***	9.4	27,046	162,873	70.7%	986,447	45.4%	16.5%
viii: Counterfactual Scenario (v) with OECD's average working hours + labour force participation	72.23	24,359	***81.60***	***46,074***	9.4	21,715	144,015	50.9%	805,250	18.7%	17.9%
Life Style Counterfactual Scenarios :											
ix: USA with 1975 mortality rates attributable to smoking	72.23	24,359	***78.76***	43,665	6.5	19,306	96,563	1.2%	679,487	0.2%	14.2%
x: USA with OECD's 2015 death rate attributable to smoking	72.23	24,359	***78.61***	43,665	6.4	19,306	94,506	-1.0%	677,164	-0.2%	14.0%
xi: USA with OECD's 2015 death rate attributable to obesity	72.23	24,359	***79.08***	43,665	6.9	19,306	101,113	6.0%	684,624	0.9%	14.8%
xii: USA with OECD's 2005 death rate attributable to obesity and smoking	72.23	24,359	***79.02***	43,665	6.8	19,306	100,191	5.0%	683,584	0.8%	14.7%

Notes: GDP per capita is GDP per capita at chained PPPs in 2011US$ (Penn World Table 9.1); Life Expectancy is life expectancy at birth (World Development Indicators, World Bank); value of life expectancy gains in annual income and yearly growth rate of full income is calculated following Becker et al. (2005) using the same calibrated values for interest rates ($r = 0.3$), inter-temporal elasticity substitution ($\gamma = 1.25$), value of being alive relative to being dead ($\alpha = -16.16$). To estimate what would be the US net GDP in the 2010s considering the OECD's average working hours, labor force participation and both taken together we maintain US productivity constant (GDP by total hours worked), and adjust the total amount of hours worked to calculate the new counterfactual net GDP. The values for working hours and labor force participation are presented in Appendix E.

Table B.1: Joinpoint segmented regressions: Contribution of Age-Specific Mortality

	Ages 0 - 4		Ages 5 - 14		Ages 15 - 59		Ages 60+	
PANEL A: Contribution of age-specific mortality Slopes								
Segment	Period	Slope	Period	Slope	Period	Slope	Period	Slope
1	1960-1965	0.082 (0.007)***	1960-1968	0.002 (0.001)***	1960-1968	0.069 (0.011)***	1960-1973	-0.006 (0.007)
2	1965-2007	0.004 (0.000)***	1968-1983	0.000 (0.000)	1968-1982	-0.052 (0.005)***	1973-1976	-0.156 (0.113)
3	2007-2016	-0.005 (0.003)	1983-1987	0.005 (0.004)	1982-1995	0.035 (0.006)***	1976-1992	0.043 (0.006)***
4			1987-2016	0.000 (0.000)*	1995-1998	-0.064 (0.056)	1991-2001	0.082 (0.014)***
5					1998-2013	0.035 (0.005)***	2001-2016	0.008 (0.006)
6					2013-2016	0.139 (0.035)***		
PANEL B: Differences in Slopes								
Segment		Slope difference		Slope difference		Slope difference		Slope difference
2 - 1		-0.078 (0.007)***		-0.002 (0.001)**		-0.121 (0.008)***		-0.151 (0.114)
3 - 2		-0.009 (0.003)***		0.005 (0.004)		0.087 (0.056)***		0.199 (0.113)*
4 - 3				-0.006 (0.004)		0.087 (0.056)*		0.039 (0.015)**
5 - 4						0.099 (0.035)*		-0.074 (0.015)***
6 - 5						0.104 (1.622)***		

Notes: Joinpoints, slopes and slopes differences were estimated using the Joinpoint Regression Program. The grid search method was used to fit segmented regressions into the time series. P-values were calculated using Montecarlo simulations and the standard errors are in parenthesis. ***p<0.01, **p<0.05, *p<0.1.

Table C.1: Joinpoint segmented regressions: Contribution of Cause-Specific Mortality

	Accidents, Suicides and Homicides		**Endocrine, metabolic and blood diseases, nutritional deficiencies**		**Heart and circulatory diseases**		**Infectious, abortion & obstetric, congenital & perinatal**	
PANEL A: Contribution of cause-specific mortality Slopes								
Segment	Period	Slope	Period	Slope	Period	Slope	Period	Slope
1	1960-1968	0.035 (0.006)***	1960-1985	0.000 (0.000)	1960-1967	0.008 (0.020)	1960-1967	0.046 (0.004)***
2	1968-1983	-0.013 (0.003)***	1985-1989	0.063 (0.012)***	1967-1979	-0.113 (0.010)***	1967-1976	-0.007 (0.003)**
3	1983-1999	0.009 (0.003)***	1989-1995	0.030 (0.005)***	1979-2016	0.013 (0.002)***	1976-1988	0.017 (0.002)***
4	1999-2014	0.025 (0.003)***	1995-1999	-0.061 (0.012)***			1988-1996	-0.010 (0.004)***
5	2014-2016	0.148 (0.041)***	1999-2008	-0.002 (0.003)			1996-2000	0.054 (0.014)***
6			2008-2016	0.011 (0.003)***			2000-2016	-0.003 (0.001)***
PANEL B: Differences in Slopes								
Segment		Slope difference		Slope difference		Slope difference		Slope difference
2 - 1		-0.048 (0.007)***		0.063 (0.012)***		-0.121 (0.022)***		-0.054 (0.005)***
3 - 2		0.022 (0.004)***		-0.033 (0.013)**		0.126 (0.010)***		0.024 (0.003)***
4 - 3		0.016 (0.004)***		-0.090 (0.013)***				-0.027 (0.004)***
5 - 4		0.123 (0.041)***		0.059 (0.012)***				0.064 (0.014)***
6 - 5				0.012 (0.004)***				-0.057 (0.014)***

	Neoplasm		**Respiratory and digestive diseases**		**Other causes**	
PANEL A: Contribution of cause-specific mortality Slopes						
Segment	Period	Slope	Period	Slope	Period	Slope
1	1960-1968	0.004 (0.002)**	1960-1966	0.047 (0.016)***	1960-1968	0.020 (0.006)***
2	1968-1977	-0.003 (0.002)	1966-1979	-0.008 (0.005)	1968-1972	0.104 (0.027)***
3	1977-2001	0.007 (0.000)***	1979-1987	0.033 (0.012)**	1972-1998	0.007 (0.001)***
4	2000-2011	-0.018 (0.002)***	1987-2016	0.010 (0.001)***	1998-2007	0.032 (0.006)***
5	2011-2016	0.002 (0.004)			2007-2016	-0.010 (0.005)*
6						
PANEL B: Differences in Slopes						
Segment		Slope difference		Slope difference		Slope difference
2 - 1		-0.007 (0.003)**		-0.055 (0.017)***		0.084 (0.027)***
3 - 2		0.010 (0.002)***		0.041 (0.013)***		-0.097 (0.027)***
4 - 3		-0.025 (0.002)***		-0.023 (0.012)*		0.025 (0.006)***
5 - 4		0.021 (0.005)***				-0.042 (0.008)***
6 - 5						

Notes: Joinpoints, slopes and slopes differences were estimated using the Joinpoint Regression Program. The grid search method was used to fit segmented regressions into the time series. P-values were calculated using Montecarlo simulations and the standard errors are in parenthesis. ***p<0.01, **p<0.05, *p<0.1.

Table D.1: BMI, Overweight and Obesity: US vs OECD Countries

	USA			**OECD Countries**		
	2006	2015	% change	2006	2015	% change
Body Mass Index	28.40	29.00	2.1%	25.99	26.29	1.2%
Overweight prevalence	64.40	69.60	8.1%	55.51	60.02	8.1%
Obesity prevalence	30.60	36.70	19.9%	18.71	22.83	22.0%

Sources: Data on BMI, overweight and obesity prevalenceare from World Health Organization (2020).

Table E.1: Universal Health Coverage Index

	UHC effective coverage index			Rate of change		
	1990	2010	2019	1990-2019	1990-2010	2010-2019
USA	**73.4**	**81.2**	**82.2**	**12.0%**	**10.6%**	**1.2%**
OECD sample	**70.4**	**86.9**	**89.8**	**27.6%**	**23.4%**	**3.4%**
High Income	**70.1**	**84.1**	**86.1**	**22.8%**	**20.0%**	**2.4%**
Australia	72.2	88.3	89.5	24.0%	22.3%	1.4%
Austria	71.2	82.3	86.5	21.5%	15.6%	5.1%
Belgium	67.6	83.4	87.5	29.4%	23.4%	4.9%
Canada	79.8	88.1	90.4	13.3%	10.4%	2.6%
Denmark	65.3	80.8	84.3	29.1%	23.7%	4.3%
Finland	71.4	88.5	91.4	28.0%	23.9%	3.3%
France	66.2	88.0	91.0	37.5%	32.9%	3.4%
Germany	66.5	83.5	86.5	30.1%	25.6%	3.6%
Iceland	78.2	93.8	95.3	21.9%	19.9%	1.6%
Ireland	63.2	86.3	90.6	43.4%	36.6%	5.0%
Japan	80.9	93.6	96.4	19.2%	15.7%	3.0%
Luxembourg	66.2	87.5	91.5	38.2%	32.2%	4.6%
Netherlands	69.8	87.6	89.9	28.8%	25.5%	2.6%
Portugal	60.8	79.2	83.8	37.8%	30.3%	5.8%
Spain	65.0	88.4	90.3	38.9%	36.0%	2.1%
Sweden	78.8	88.3	90.4	14.7%	12.1%	2.4%
Switzerland	77.2	90.7	93.7	21.4%	17.5%	3.3%
UK	67.2	86.0	88.0	31.0%	28.0%	2.3%

Notes: Elaboration by the authors based on Lozano et al. (2020).

Table E.2: Average working hours and labor force participation in the 2010s: US vs OECD Average

	Number of person engaged (millions)	Average annual hours worked by person engaged	Total population (millions)	Working age population (15-64, millions)	Labor force participation
US	150.28	1765.18	315.48	212.21	67.26%
OECD Average	13.64	1596.62	27.99	18.04	64.47%

Data sources: Penn World Table 9.1 (Feenstra et al., 2015) and United Nations's World Population Prospects.

Table G.1: Grouping of ICD codes

Causes of Death	Codes			
	ICD-7	ICD-8	ICD-9	ICD-10
(i) Infectious diseases, abortion and obstetric, congenital and perinatal	a001-a043, a115-a120, a127-a135; b001-b017, b040, b041-b044	a001-a044, a112 - a118, a126 - a135; b001 - b018, b040 - b041, b042 - b044	b01-b07, b38-b41, b44-b45	A, B, O, P, Q
(ii) neoplasms	a044-a060; b018-b019	a045-a061; b019-b020	b08-17	C, D01-D49
(iii) endocrine, metabolic and blood diseases, nutritional deficiencies	a061-a066; b020- b021	a062-a068; b021-b023	b18-b20	D50 a D89, E
(iv) heart and circulatory diseases	a079-a086; b024-b029	a080-a088; b025-b030	b25-b30	I
(v) respiratory and digestive diseases	a087-a107; b030- b037	a089-a104, b031-b037	b31-b34	J, K
(vi) accidents, suicides and homicides	a138-a150; b047-b050	a138-a150; b047-b050	b47-b56	S, T
(vii) others	a067-a078, a108-a114, a121-a126, a136-a137; b022-b023, b038- b039, b045- b046	a069-a079, a105-a111, a119-a125, a136-a137; b024, b038-b039, b045-b046	b21-b24, b35-b37, b46	F, G, N, L, M, R

Figures

Figure 1: Evolution of Life Expectancy in the World. Panel A: US vs World Regions. Panel B: US vs Income Groups. Source: World Development Indicators (World Bank)

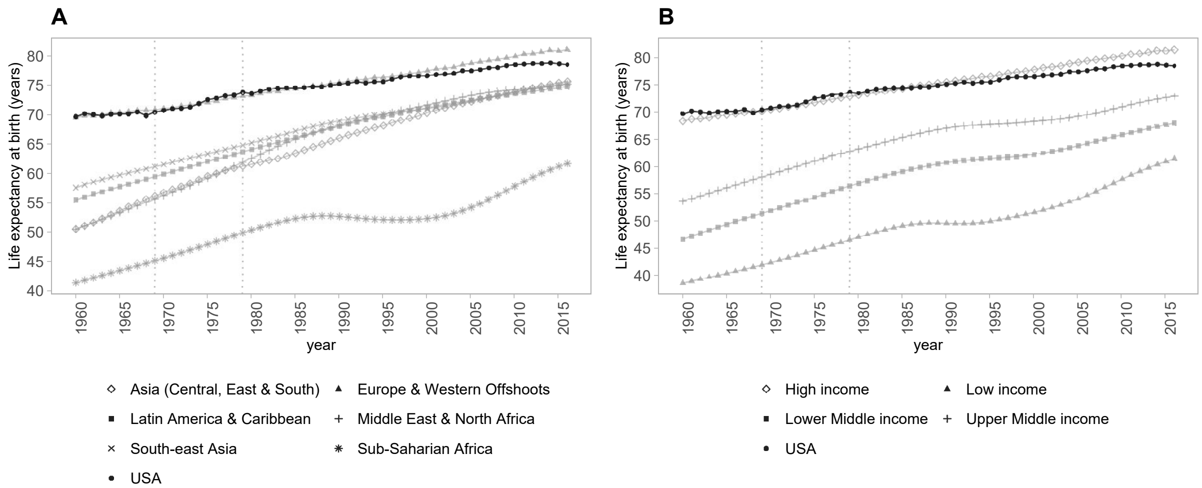

Figure 2: Life expectancy performance in the US. Panel A: Life expectancy - US vs World Regions. Panel B: Life expectancy index (1960 = 100) - US vs world regions. Panel C: Life expectancy - US vs High Income Countries. Panel D: Life expectancy rank - US vs All Countries. Source: World Development Indicators (World Bank)

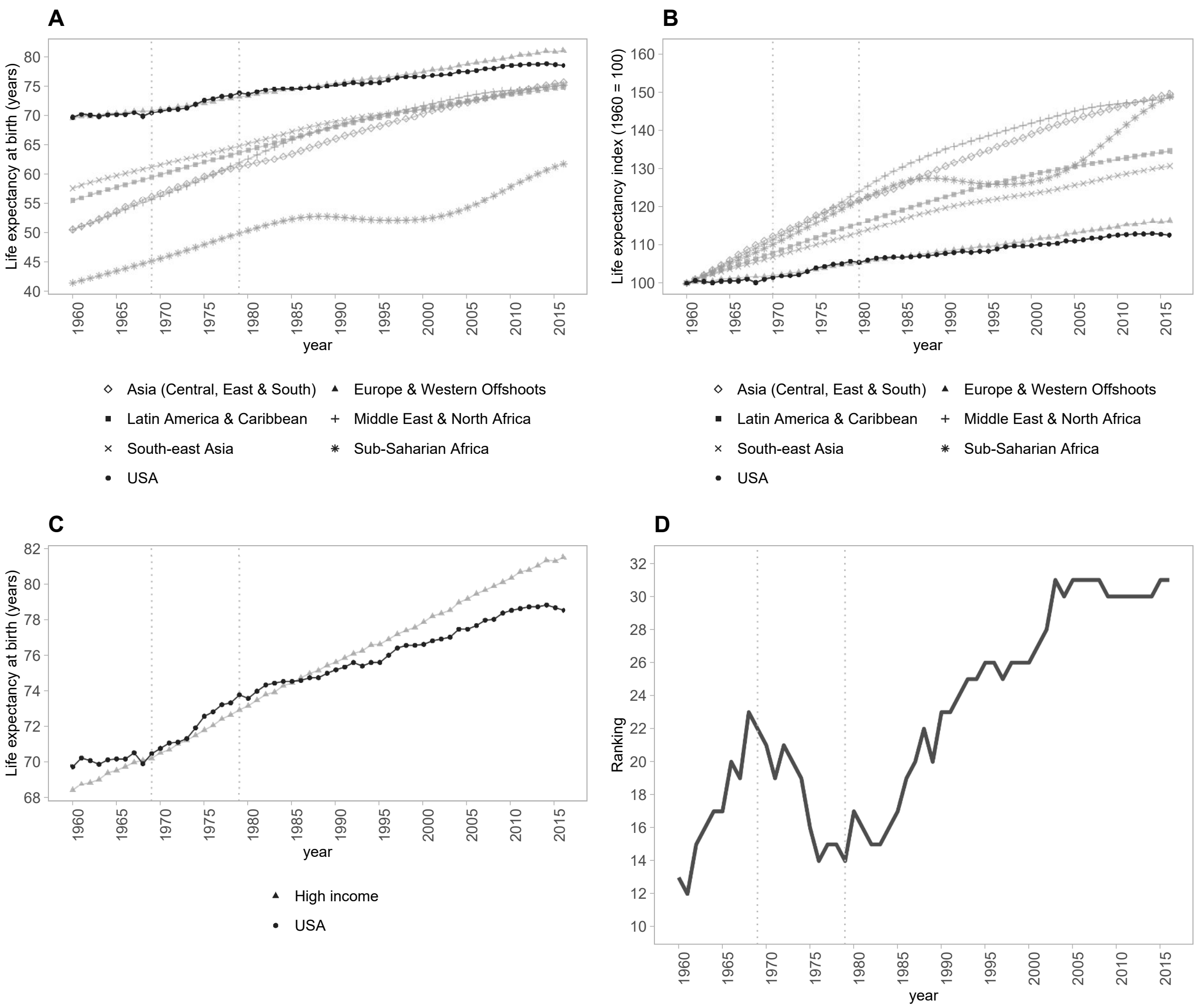

Figure 3: Life Expectancy Segmented Regression Slopes. Dots represent life expectancy for High Income countries and the US (A) and differences in life expectancy between them (B) for each year. Lines represent slopes estimated in the joinpoint regressions. Slopes' values and standard errors are presented in detail in Table 1. Source: World Development Indicators (World Bank)

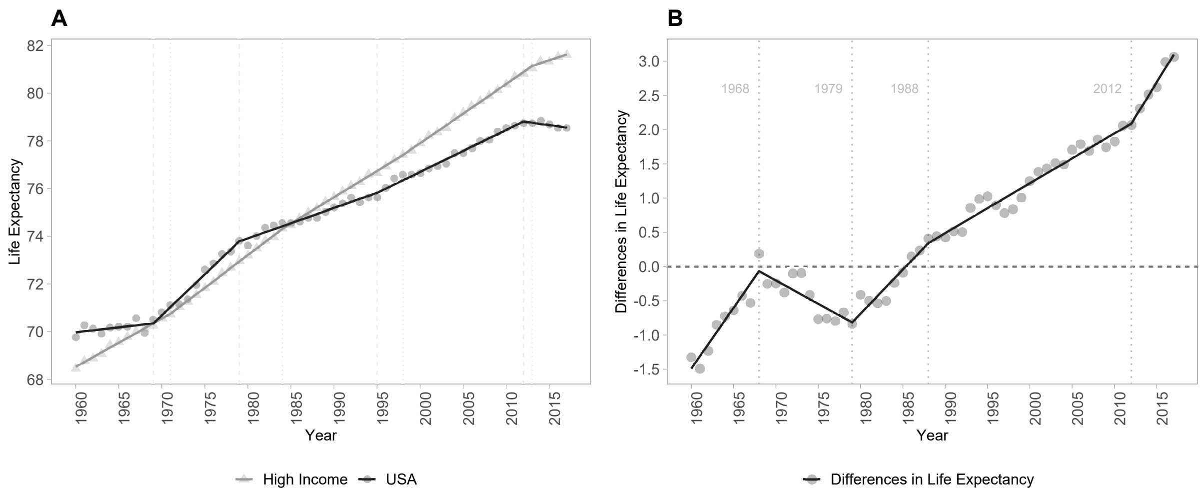

Figure 4: The Changing Relationship Between Income and Life Expectancy. The points in Panel A represent a country's life expectancy and income per capita in a given year. The Preston Curves were estimated using log regressions. The line in Panel B represents the y-axis distance of the US to the estimated log curve for every year in the 1960-2017 period. Sources: Penn World Table and World Development Indicators (World Bank).

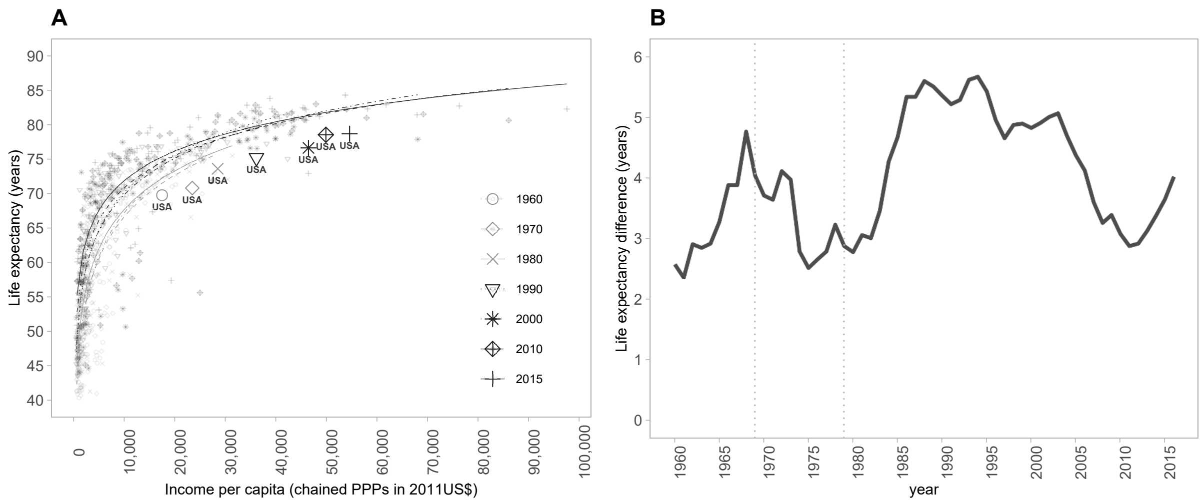

Figure 5: Decomposition of Differences in Life Expectancy. Panel A: Contribution of age-specific mortality. Panel B: Contribution of cause-specific mortality. Notes: The dashed line plots the difference in life expectancy between the OECD sample and the US. The dots represent the contribution of age-specific and cause-specific mortality to this difference. Source: Human Mortality Database and WHO Mortality Database

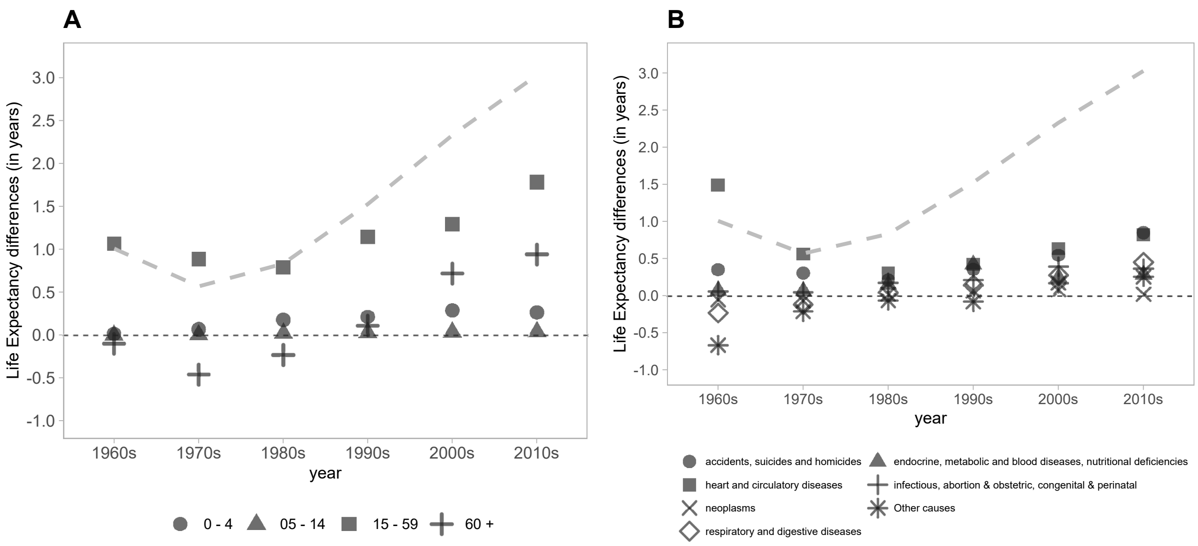

Figure 6: Evolution of Health Spending - US vs OECD by decade. Panel A: Health Spending (% of GDP). Panel B: Health Spending Per Capita. Source: OECD Health Data

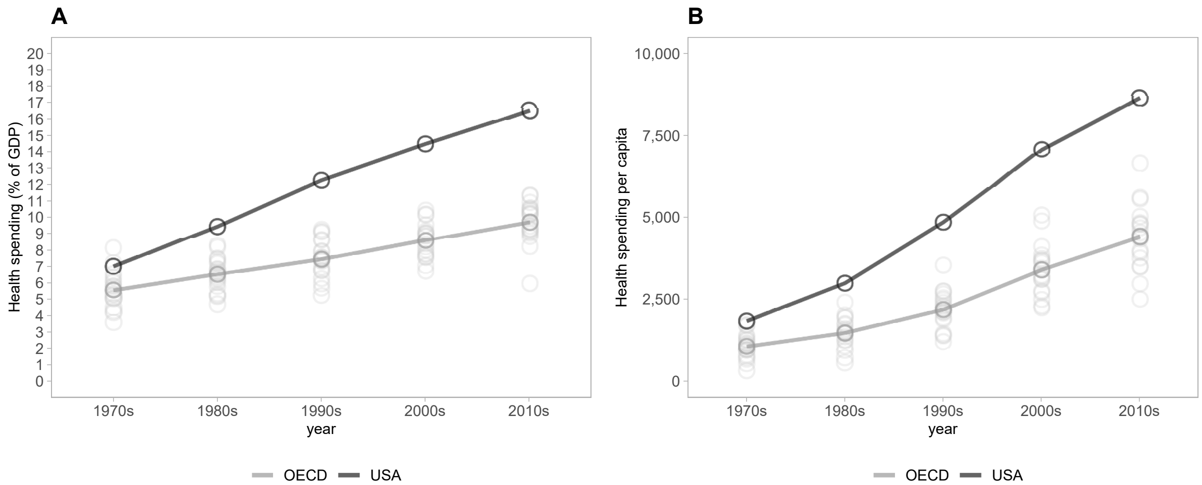

Figure 7: Evolution of Health Spending Growth - US vs OECD. Panel A: Index (1970=100) for Health Spending (% of GDP). Panel B: Health Spending (% of GDP) Percent Growth by Decade. Panel C: Index (1970=100) for Health Spending Per Capita. Panel D: Health Spending Per Capita Percent Growth by Decade. Source: OECD Health Data

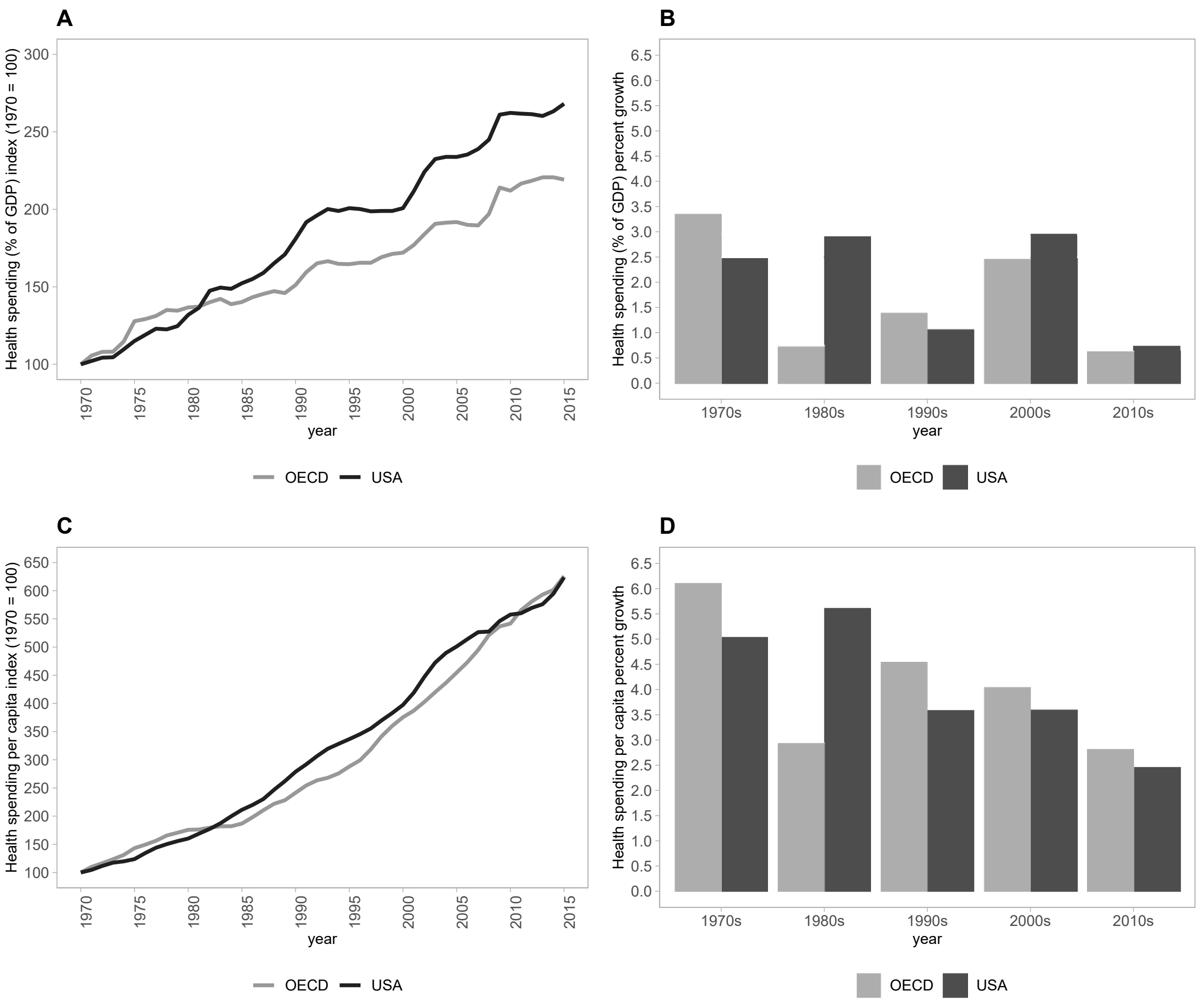

Figure A.1 Decomposition of differences in life expectancy for cause-specific mortality by age-group. Panel A: 0-4 years old. Panel B: 05-14 years old. Panel C: 15-59 years old. Panel D: 60+ years old. The dashed line plots the contribution of each group to the difference in life expectancy between the OECD sample and the US. The dots represent the contribution of age-specific and cause-specific mortality to these differences. Source: Human Mortality Database and WHO Mortality Database.

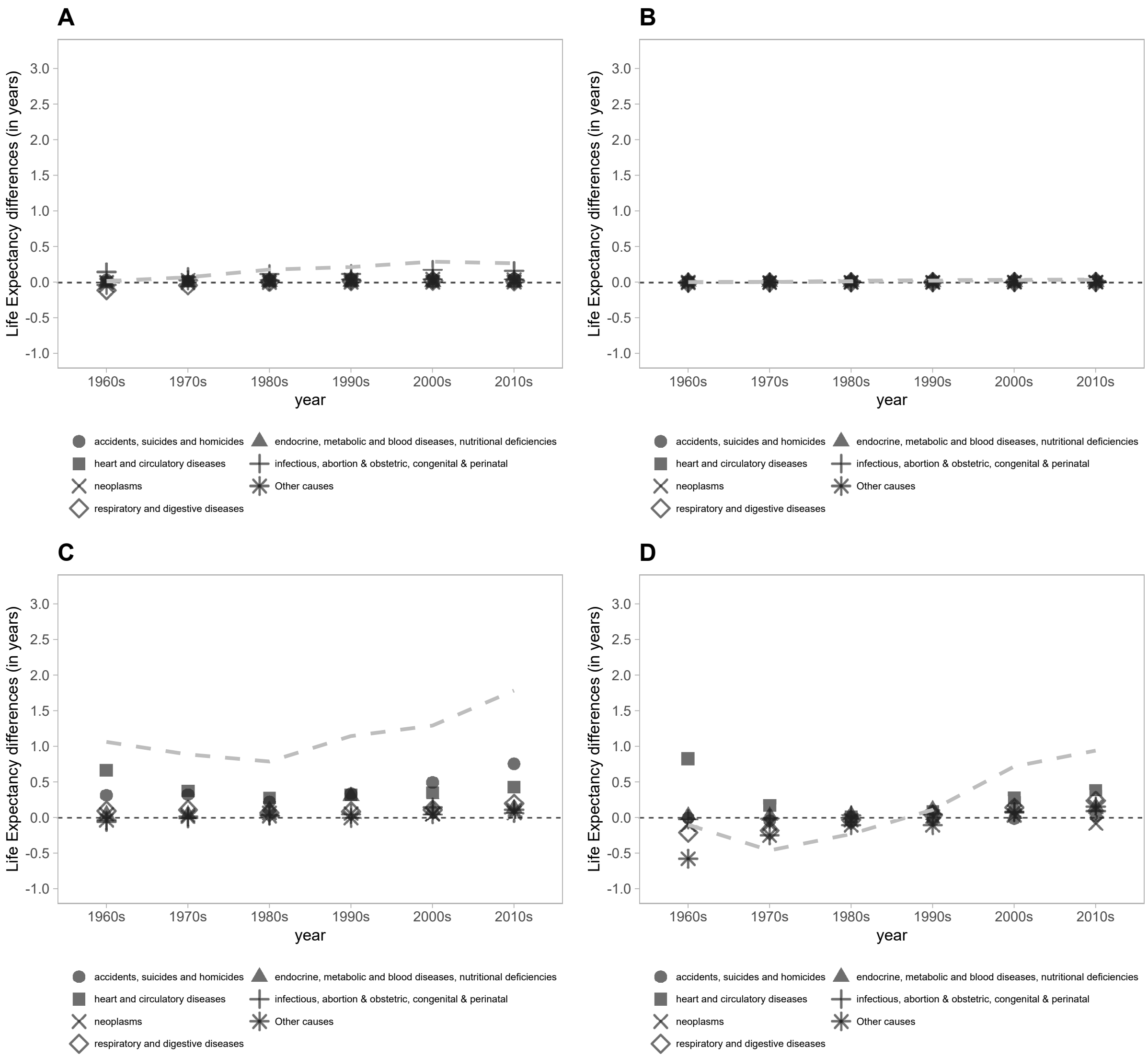

Figure A.2: Decomposition of Differences in Life Expectancy. Panel A: Contribution of age-specific mortality. Panel B: Contribution of cause-specific mortality. The dashed line plots the difference in life expectancy between the OECD sample and the US. The dots represent the contribution of age-specific and cause-specific mortality to this difference. Sources: Human Mortality Database and WHO Mortality Database

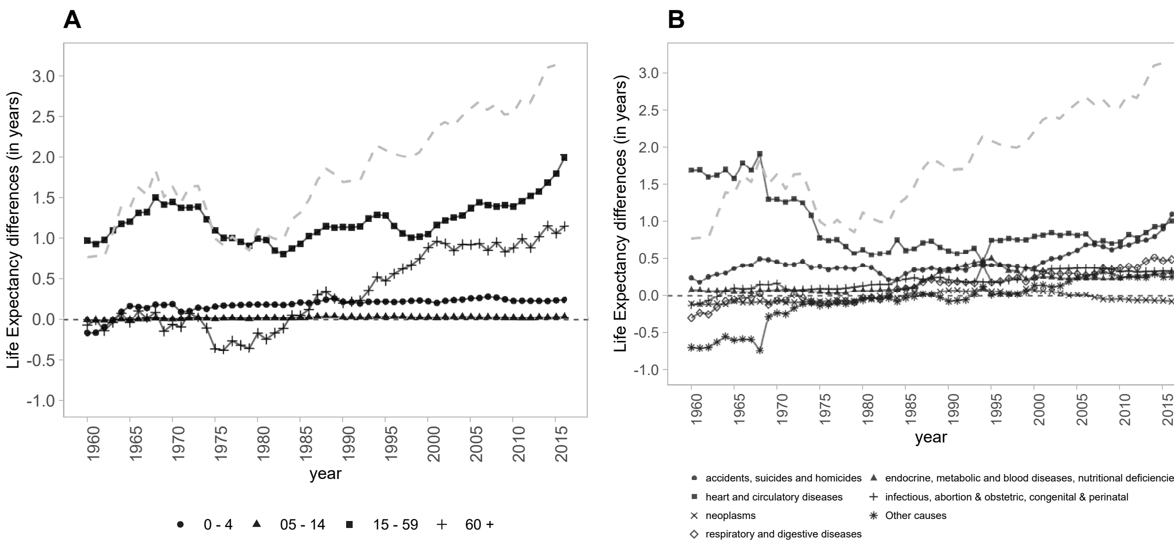

Figure B.1: Contribution of Age-Specific Mortality joinpoint regressions. Panel A: 0-4 years old. Panel B: 5-14 years old. Panel C: 15-59 years old. Panel D: 60+ years old. Dots represent yearly contribution of age-specific mortality to the difference in life expectancy in the US and OECD sample. Lines represent the estimated slopes. Slopes' values and standard errors are presented in detail in Table B.1. Source: Human Mortality Database and WHO Mortality Database.

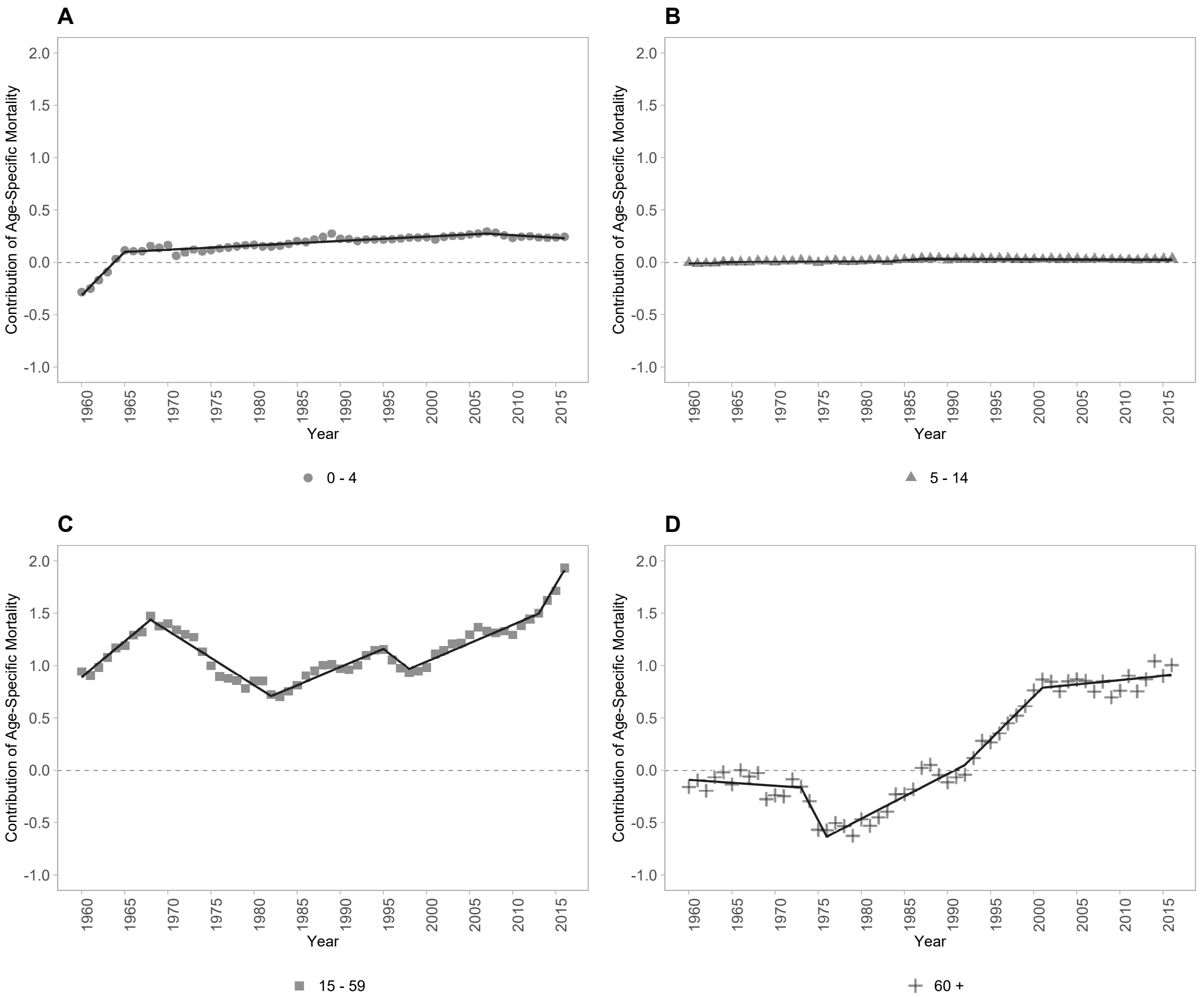

Figure C.1: Contribution of Cause-Specific Mortality joinpoint regressions. Panel A: accidents, suicides and homicides. Panel B: endocrine, metabolic and blood diseases, nutritional deficiencies. Panel C: heart and circulatory diseases. Panel D: infectious, abortion obstetric, congenital perinatal. Panel E: neoplasms. Panel F: respiratory and digestive diseases. Panel G: Other causes. Dots represent yearly contribution of cause-specific mortality to the difference in life expectancy in the US and OECD sample. Lines represent the estimated slopes. Slopes' values and standard errors are presented in detail in Table C.1. Source: Human Mortality Database and WHO Mortality Database

(a)

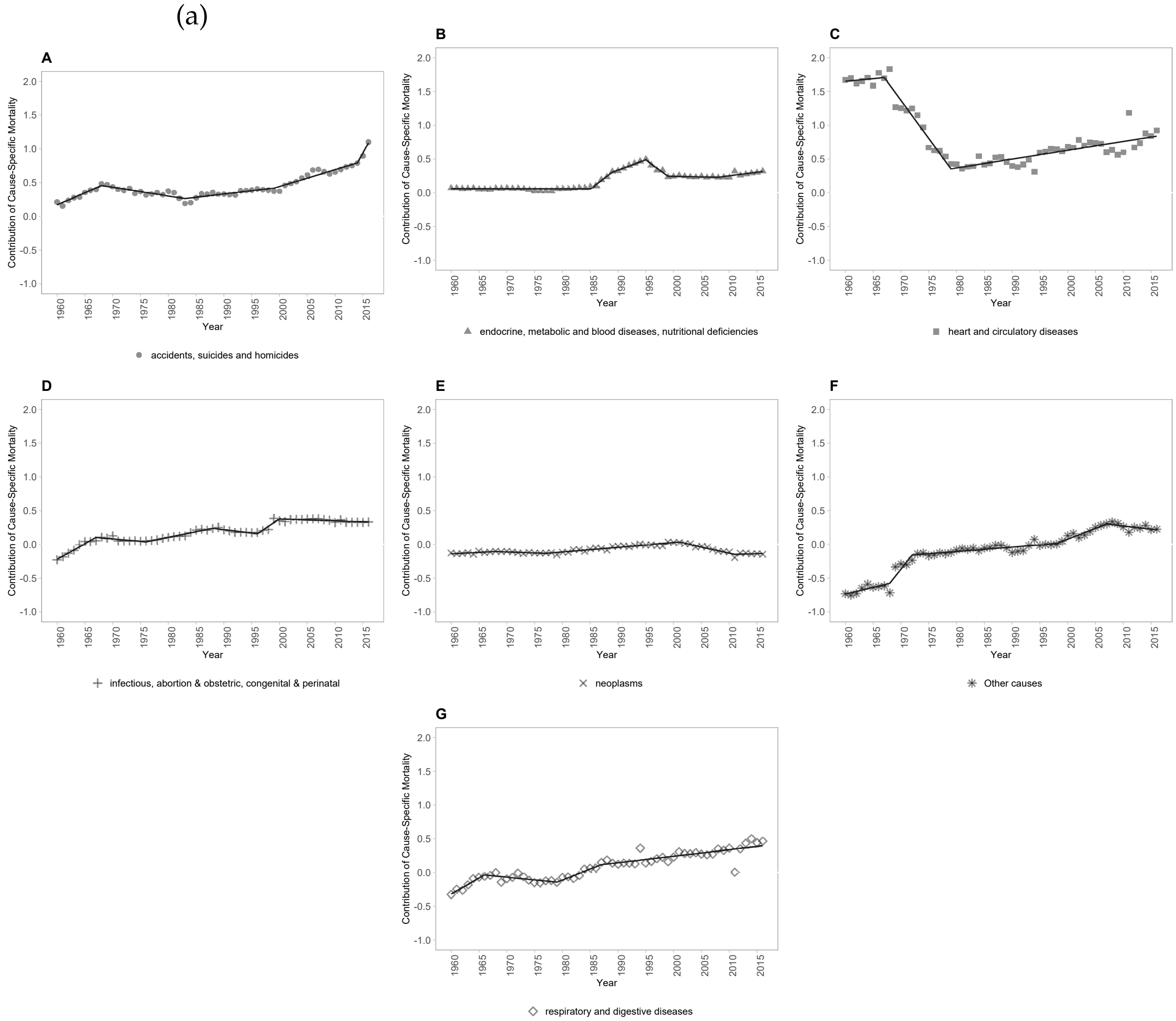

Figure D.1: Decomposition of Differences in Life Expectancy Attributable to Smoking. Dots represent the contribution of mortality attributable to smoking to the differences in life expectancy between the US and OECD. Sources: Human Mortality Database and WHO Mortality Database, Preston et al. (2011)

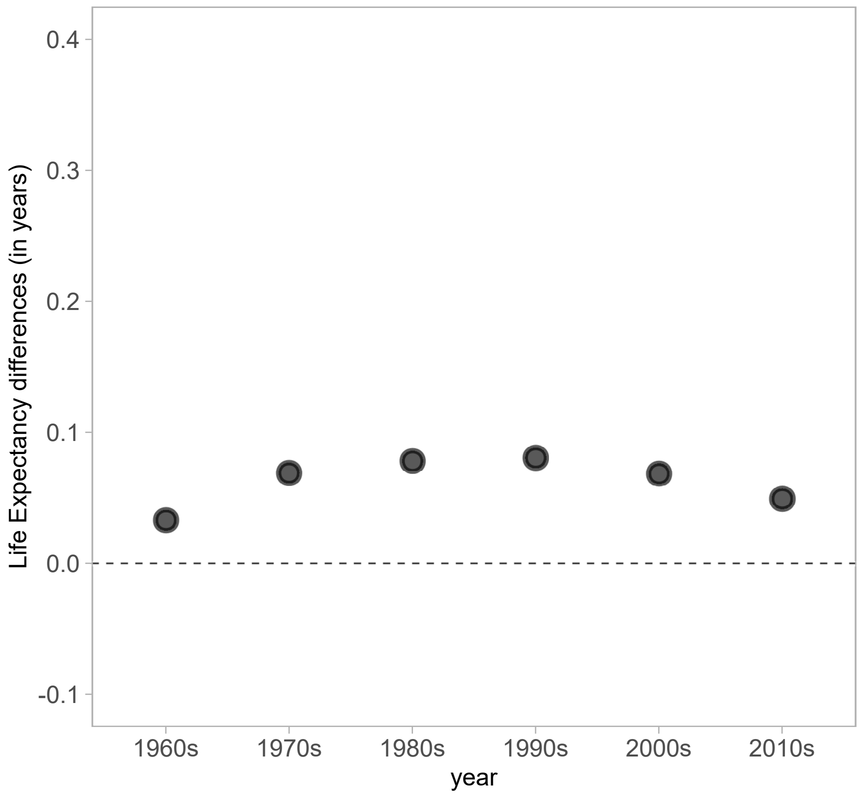

Figure D.2: Effects of Mortality Attributable to Smoking on Life Expectancy. The lines represent the years of life expectancy lost due to mortality attributable to smoking in the US and OECD. Sources: Human Mortality Database and WHO Mortality Database, Preston et al. (2011)