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Health, Health Insurance, and Retirement: A Survey

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Abstract

The degree to which retirement decisions are driven by health is a key concern for both academics and policy makers. In this review, we survey the economic literature on the health–retirement link in developed countries. We describe the mechanisms through which health affects labor supply and discuss how these mechanisms interact with public pensions and public health insurance. The historical evidence suggests that health is not the primary source of variation in retirement across countries and over time. Furthermore, the decline of health with age can only explain a small share of the decline in employment near retirement age. Health considerations nonetheless play an important role, especially in explaining cross-sectional variation in employment and other outcomes within countries. We review the mechanisms through which health affects retirement and discuss recent empirical analyses.

1. INTRODUCTION

Old age is characterized by declining health and reduced labor supply. How are these developments related? Although everyone eventually becomes too sick to work, people may retire well before then. The health–retirement link is particularly germane to the reform of public pension programs. Responding to fiscal pressures, many countries have restructured their pension programs to encourage later retirement (French & Jones 2012). Such reforms are unlikely to be successful, however, if older individuals are too unhealthy to significantly extend their careers. On the other hand, if individuals are retiring in good health, they may be receptive to incentives for continued work.

In this article, we review the evidence for developed countries on the health–retirement link and its implications for public policy. Extending the work of earlier, more general reviews (French & Jones 2012, Blundell et al. 2016b), we examine the relationship between health and retirement in some detail. The literature contains a variety of methodologies, ranging from broad historical reviews to fully articulated dynamic models. This allows us to assess economic mechanisms and document empirical relationships.

Over the past century, there has been a pronounced decline in the labor supply of older men. Given that life expectancy (even at older ages) has increased over the same period, the decline in labor supply is clearly not due to health.[1] Much of the decline is due instead to increases in retirement income, including but not limited to significant increases in public pensions. Even in the past two decades, when this decline has stopped and, in many countries, reversed, employment appears to have, in general, grown more slowly than work capacity (Coile et al. 2017).

The effects of health on retirement are more apparent in cross-sectional relationships. All else being equal, people in worse health are less likely to work. Several mechanisms are possible. Illness can make work extremely unpleasant. Bad health can also reduce worker productivity. People in sufficiently bad health may receive disability benefits, and people receiving disability benefits are usually prohibited from working. Finally, with shorter expected life spans, individuals in bad health may not need to work as long accumulating financial and pension wealth for their retirements.

Health may also affect labor supply through medical expenses. Because many US workers only receive health insurance while they continue to work, expensive medical conditions may lead them to delay retirement. Alternatively, uninsured workers may leave their jobs in order to qualify for health care provided through disability or means-tested social insurance.

The rest of this review is organized as follows. In Section 2, we document the patterns of health and labor supply for older workers over the past century. In Section 3, we survey recent evidence on how cross-sectional differences in health affect the labor supply and wages of older workers. In Section 4, we use a structural model to illustrate how health affects retirement. In Section 5, we discuss findings from recent structural studies. In Section 6, we conclude and offer some suggestions for future work.

2. HISTORICAL TRENDS

The health of older individuals has improved dramatically over the past 90 years. **Figure 1** shows that the life expectancy of 65-year-old men in the United States and the United Kingdom has risen from approximately 11 years in 1920 to over 18 years today. Longer life spans do not automatically imply longer potential working lives, as individuals may be spending more of their lives incapacitated by illness. A large body of work shows, however, that people are carrying

[1] As discussed in Section 2, these increases in expected life spans have also been increases in expected healthy life spans.

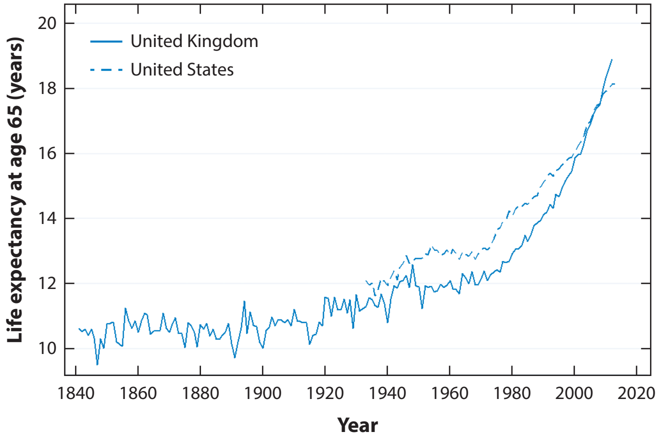

Figure 1

Life expectancy of men at age 65 from 1840 to present in the United Kingdom (*solid line*) and the United States (*dashed line*). UK data are taken from the Office for National Statistics. US data are taken from the Human Mortality Database. Figure reproduced from Blundell et al. (2016b) with permission.

their good health into older ages as well. **Table 1**, taken from Costa (2002), shows functional limitation rates for veterans of the Union Army (from the US Civil War) and for older men in the National Health and Nutrition Examination Survey (NHANES). The NHANES cohort, born roughly 85 years after the Union Army veterans, has considerably lower limitation rates. By way of example, 28.5% of the Union Army veterans ages 50–64 had difficulty walking, nearly three times the fraction in the NHANES.[2] Recent studies utilizing detailed modern data sets show that healthy life spans are continuing to increase. Chernew et al. (2016) find that between 1992 and 2008, healthy life spans in the United States increased by 1.8 years. Looking across countries and time, Milligan & Wise (2012, figure I.21) show that, among men ages 60–64, recent decreases in mortality rates correlate closely with decreased self-reports of fair or poor health. Results from the Global Burden of Disease Study (Vos et al. 2015) suggest that much of the worldwide increase in life expectancy is an increase in healthy life expectancy (see also Costa 1998, Manton et al. 2008, Cutler et al. 2014). The unresolved question appears not to be whether unhealthy life spans are increasing more slowly than total life spans, but rather whether unhealthy life spans are increasing at all (Chernew et al. 2016).

These improvements in health, however, have not led to increased work. **Figure 2** shows long-term employment trends for men ages 65 and older in the United States and the United Kingdom. Between 1880 and 1980, the employment rate for these men fell from three-quarters to less than one-fifth. France and Germany experienced similar trends (Costa 1998). In her historical review, Costa (1998) concludes that the labor supply of the elderly has fallen for two reasons. The first is that decreases in the cost of recreational goods, along with an increased capacity for independent living, have made retirement more attractive. The second is that retirement income has grown.

[2]Costa (2002) constructs three sets of limitation rates from the Union Army data to control for various measurement issues. **Table 1** displays the benchmark measures, but the other measures are similar. She further argues that "several tests indicate that this sample is representative of the general population in terms of wealth and, circa 1900, in terms of mortality experience" (Costa 2002, p. 135). Costa (2002) also calculates limitation rates for a few conditions from the 1994 National Health Interview Survey (NHIS), which resemble their NHANES counterparts.

Table 1 Functional limitation rates for older men in percent

Limitation	Union Army Data (1900 and 1910)	NHANES Data (1988–1994)
Ages 50–64		
Difficulty bending	44.4	7.5
Difficulty walking	28.5	10.4
Paralysis	4.8	0.9
Blindness in at least one eye	3.4	1.5
Deafness in at least one ear	3.2	1.4
Ages 60–74		
Difficulty bending	53.8	16.1
Difficulty walking	36.6	13.8
Paralysis	6.1	2.7
Blindness in at least one eye	4.5	3.1
Deafness in at least one ear	4.1	2.7

Abbreviation: NHANES, National Health and Nutrition Examination Survey. Table reproduced from (Costa 2002, table 3) with permission.

Older individuals have become increasingly able to support themselves through personal savings, private pensions, and public pensions.

Several theoretical papers analyze how increased longevity affects retirement. Bloom et al. (2014) provide a particularly intuitive treatment. They point out that a key factor is the extent to which longer life spans lead to larger potential lifetime earnings. As long as growth in potential earnings is at least proportional to the growth in life expectancy, and as long as leisure is a normal good, workers should respond to longer life spans by lengthening their retirements. Bloom et al.

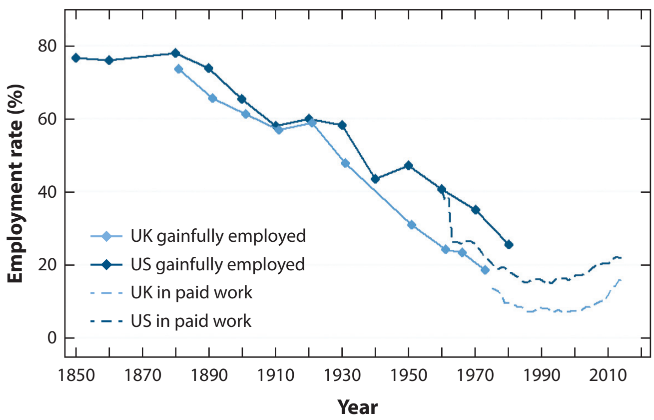

Figure 2

Employment rate of men age 65 and over in the United Kingdom (*light blue lines*) and United States (*dark blue lines*) who are gainfully employed (*solid lines*) or in paid work (*dashed lines*). Data for the United States are taken from Moen (1987) and the Organisation for Economic Co-operation and Development. Data for the United Kingdom are taken from Matthews et al. (1982) and the UK Labour Force Survey. Figure reproduced from Blundell et al. (2016b) with permission.

(2014) show that retirement ages should in fact rise less than proportionally with expected life spans, as compounding interest allows workers to retire at relatively younger ages. Nonetheless, Bloom et al. (2014), along with most other analyses, conclude that increased longevity should cause retirement ages to rise rather than fall (see also Hammermesh 1984, Chang 1991, Kalemli-Ozcan & Weil 2010, d'Albis et al. 2012).

Several recent studies assess Costa's hypotheses with quantitative models. All of these analyses consider the sustained increase in wages that has occurred over the past century. If the income effects of these wage increases dominate the substitution effects, the fraction of life spent in retirement should rise. Calibrating their model to the wage increases and mortality declines observed in the United States, Bloom et al. (2014) find that the model reproduces the decline in retirement ages observed over the past 50 years. Restuccia & Vandenbroucke (2013) conclude that almost all of the decrease in working hours between the 1870 and 1970 birth cohorts can be attributed to higher wages. Kopecky (2011) considers the observed decline in the price of leisure goods, in addition to the increase in wages, in a model where time and leisure goods are combined to provide leisure services. She finds that, together, these changes can explain most of the observed decrease in retirement ages. Although higher wages are the dominant factor, cheaper leisure goods are also important.

Much attention has been given to another secular trend, the expansion of public pensions. When they were introduced in 1889, the eligibility age for public pensions in Germany was 70. In 1916, the age was lowered to 65. Today, workers in Germany with sufficiently long earnings histories can retire at age 63, and unemployment and disability insurance (DI) allow for even earlier retirement (Börsch-Supan & Jürges 2012, Kemptner 2016). In the United Kingdom, the eligibility age fell from 70 in 1909 to 65 in 1925. Whereas the initial eligibility age for the US Social Security program was 65, in 1961 workers were allowed to retire at age 62 in exchange for lower annual benefits. In addition to allowing older individuals to afford longer retirements—a standard wealth effect—many public pension programs generate substitution effects that encourage retirement. For example, Social Security recipients traditionally faced the earnings test, where earnings above a certain threshold led to reduced benefits.[3] Moreover, Social Security recipients face higher effective income tax rates because the portion of Social Security benefits subject to income taxation is increasing in total income (Jones & Li 2017). Applying a comprehensive fiscal analyzer to data from the Survey of Consumer Finances, Auerbach et al. (2016) find that many older workers face marginal net tax rates of 50% or higher.

More recent evidence from an expanded set of countries points to similar conclusions. Blundell et al. (2016b) show employment rates over the past 50 years for men and women in several developed countries. In most countries, the trend of employment has been U-shaped for those ages 60–64, falling until the 1990s and rising afterward. In contrast, health improved throughout the entire period. Coile et al. (2017) document how the relationship between health and work has changed over time. In each of 12 countries, they find employment and mortality—a proxy for health—at each age in a particular calendar year, allowing them to express employment as a function of mortality. They find that employment at any given value of mortality fell much more between 1977 and 1995 than between 1995 and 2010 (Coile et al. 2017, figure 3 and table 3). In fact, whereas employment at older ages fell between 1977 and 1995, employment at older ages rose between 1995 and 2010. These changes in employment generally coincided with changes in

[3]Even though benefits lost through the earnings test were credited to future benefits, the credits were generally less than actuarially fair, so that the earnings test was, on net, an earnings tax. The empirical consensus is that the partial elimination of the earnings test in 2000 increased labor supply (Engelhardt & Kumar 2014).

public pension systems. Until the 1990s, public pensions evolved in ways that discouraged work at older ages; more recent reforms have encouraged work (French & Jones 2012, Blundell et al. 2016b). Using a structural general equilibrium model, Ferreira & dos Santos (2013) study the increase in retirement experienced in the United States between 1950 and 2010. They conclude that most of the increase was due to enhancements to Social Security and the introduction of Medicare health insurance for the elderly.

Cross-country analyses corroborate the importance of pensions. Using an approach similar to that of Coile et al. (2017), Milligan & Wise (2012) calculate employment as a function of mortality for 2005. Comparing seven developed countries, they show that the functions differ greatly (Milligan & Wise 2012, figure I.9), suggesting strongly that health cannot be the sole determinant of retirement. Gruber & Wise (2004) show that, in the 11 countries they study, labor force exits are concentrated around legislated early and normal pension retirement ages. Duval (2003) calculates the decrease in lifetime benefits and additional payroll taxes that workers incur when they delay claiming their public pensions. He finds that employment rates at older ages tend to be lower in countries where these implicit taxes are high. Using dynamic structural models, Erosa et al. (2012), Wallenius (2013), Alonso-Ortiz (2014), and Laun & Wallenius (2016) all conclude that much of the variation in retirement across developed countries can be explained by differences in their public pension systems.

Because pensions likely reflect societal preferences for retirement (e.g., Bloom et al. 2014), identifying their independent contribution to retirement trends is difficult. In any event, the long-term trend in retirement has not followed the long-term trend in health. Although bad health undoubtedly continues to force many older people out of the labor market, many other retirees could still work if they so chose. Moreover, the variation in retirement across developed countries appears to be due mostly to institutional differences.

3. CROSS-SECTIONAL RELATIONSHIPS

3.1. Health Measurement

Even if health has not been the key driver of longer-term retirement trends, it may well have significant predictive power at the household or individual level. Any analysis of these microlevel relationships, however, is complicated by difficulties in measuring health itself (detailed discussions of these issues include Currie & Madrian 1999, O'Donnell et al. 2015, Blundell et al. 2016b). Older surveys containing employment data often contain little health-related data. Fortunately, many large surveys—such as the Health and Retirement Study (HRS) and the English Longitudinal Study of Ageing (ELSA) and their international counterparts—now contain numerous subjective and objective health measures. But even these measures have their limitations.

Table 2 presents summary statistics for a number of health measures in the ELSA. The first set of measures contains objective measures of specific health conditions. Although these measures are accurate—there is little ambiguity as to whether an individual has received cancer treatments—they suffer from several conceptual difficulties. First, objective measures are specific rather than comprehensive. Important medical conditions may not be reported. Second, many objective measures are binary variables that do not capture the severity of the health problems. Third, the link between any specific objective health condition and labor supply can depend as much on the individual's occupation as on the condition's severity. Arthritis that would sideline a roofer may not hinder an office worker at all. As a result, health conditions alone are noisy signals of work capacity (Currie & Madrian 1999). These problems are all variants of classical measurement error that likely bias the estimated effect of health toward zero.

Table 2 ELSA data: description of health variables for a selected sample

Variable	Description	*N*	Min	Max	Mean	SD
Objective health measures						
Cancer	Received cancer treatment in past 2 years	41,361	0	1	0.02	0.15
Diabetes	Taking medication for diabetes	41,356	0	1	0.05	0.22
Sight	Reported poor eyesight	41,358	0	1	0.02	0.14
Hearing	Reported poor hearing	41,360	0	1	0.03	0.17
Blood pressure	Taking medication for high blood pressure	41,389	0	1	0.24	0.42
Arthritis	Reported arthritis this wave	41,154	0	1	0.28	0.45
Psychiatric problems	Reported psychiatric problem this wave	41,391	0	1	0.07	0.25
Difficulty walking one block	Mobility: does not (0), does (1)	41,297	0	1	0.09	0.28
Difficulty sitting for 2 hours	Mobility: does not (0), does (1)	41,297	0	1	0.13	0.34
Difficulty getting up from a chair	Mobility: does not (0), does (1)	41,297	0	1	0.21	0.41
Difficulty climbing several flights of stairs	Mobility: does not (0), does (1)	41,297	0	1	0.28	0.45
Difficulty climbing one flight of stairs	Mobility: does not (0), does (1)	41,297	0	1	0.10	0.30
Difficulty stooping, kneeling, or crouching	Mobility: does not (0), does (1)	41,297	0	1	0.30	0.46
Difficulty lifting or carrying 10 pounds	Mobility: does not (0), does (1)	41,297	0	1	0.18	0.38
Difficulty picking up a dime	Mobility: does not (0), does (1)	41,297	0	1	0.04	0.20
Difficulty extending arms	Mobility: does not (0), does (1)	41,297	0	1	0.09	0.29
Difficulty pushing or pulling a large object	Mobility: does not (0), does (1)	41,297	0	1	0.13	0.34
Difficulty walking across the room	ADL: does not (0), does (1)	41,299	0	1	0.02	0.15
Difficulty getting dressed	ADL: does not (0), does (1)	41,299	0	1	0.10	0.30
Difficulty bathing or showering	ADL: does not (0), does (1)	41,299	0	1	0.07	0.26
Difficulty eating	ADL: does not (0), does (1)	41,299	0	1	0.02	0.12
Difficulty getting in or out of bed	ADL: does not (0), does (1)	41,299	0	1	0.05	0.23
Difficulty using the toilet	ADL: does not (0), does (1)	41,299	0	1	0.03	0.16
Subjective health measures						
Health limits activities	Does not (0), does (1)	39,421	0	1	0.53	0.50
General health	Excellent (1), very good (2), good (3), fair (4), poor (5)	36,231	1	5	2.59	1.11
Health limits work	Does not (0), does (1)	33,341	0	1	0.25	0.43

Abbreviations: ADL, activity of daily living; ELSA, English Longitudinal Study of Ageing; SD, standard deviation.

Included in our list of objective measures are self-reports of one's ability to perform activities of daily living (ADLs) such as walking or getting dressed. These measures are not clearly objective, as they are in no way based upon a doctor's diagnosis, but they are linked to the ability to perform specific tasks. Related measures include instrumental ADLs, such as cooking or managing money, and cognitive measures, such as remembering words. Although these variables are not listed in **Table 2**, they can be found in the HRS, ELSA, and related surveys.

The second set of measures shown in **Table 2** are subjective measures. These include self-assessed health status—self-reports of whether the respondent's health is excellent, very good, good, fair, or poor—and self-reports of whether the individual is limited in their ability to do work or other activities. Subjective measures have the benefit of being simple measures that incorporate all health conditions. In addition, subjective measures are better directed to economic concepts such as work capacity. In the example above, if a particular arthritic condition impedes a roofer but not an office worker, the roofer should report a work limitation whereas the office worker should not. However, subjective measures are always subject to reporting error, and they are often relatively crude measures, taking on only a handful of values. If unbiased, the measurement error in subjective measures will result in an attenuation effect parallel to that associated with objective measures. On the other hand, health measures may also suffer from justification bias, where those who are not working inaccurately claim to be unhealthy in order to justify their work status (see, e.g., Butler et al. 1987). This would likely lead researchers to overstate the effect of health on labor supply.

Stern (1989) suggests using objective health measures to instrument for more subjective measures. Bound (1991) shows that this procedure produces estimates that are close to those found by simply using the subjective measures (although the procedure can affect the estimated value of financial incentives). This suggests that, for the subjective health measures, the effects of measurement error and justification bias roughly offset. Blundell et al. (2017) come to similar conclusions. Dwyer & Mitchell (1999) and McGarry (2004) circumvent concerns about justification bias by examining the relationship between health and expected, rather than realized, retirement. Because in this approach retirement has not been realized, there is little need to justify retirement status by reporting bad health. The authors continue to find strong links between subjective health measures and retirement. Benitez-Silva et al. (2004) find that they cannot reject the hypothesis that self-reported disability is an unbiased measure of true disability, although Kreider & Pepper (2007) find that nonworkers tend to overreport disability rates.

An important issue is whether the effects of health on economic outcomes are best studied using cross-sectional or panel data methods. Cross-sectional estimates may overstate the effect of health on work and wages because of reverse causality. This reverse causality could come from a number of sources. First, it could be that higher incomes cause better health. For example, those with higher income may be able to purchase better nutrition and health care or face less stress. Indeed, epidemiologists attribute most of the correlation between health and income to income's effect on health, rather than vice versa; Brunner (2017), in a recent review, discusses how low social status affects the risk of cardiovascular disease and other stress-related health problems. Second, the reverse causality could be due to other factors that lead to both good health and high earnings. It may be the case that those who are more patient tend to both work more and invest more in their health. Likewise, high-income parents may invest more in both the health and the education of their children, leading health and income to be positively correlated at older ages. Case et al. (2002) show that not only is children's health positively related to household income, but the relationship between household income and children's health becomes more pronounced as children age. Part of the relationship can be explained by the arrival and impact of chronic conditions.

One approach to this problem is to use panel data approaches, such as fixed effects, first differencing, or controlling for initial health and other conditions. These panel data estimators exploit contemporaneous changes in health and employment. It seems plausible that most of these changes are the result of health shocks affecting work and wages, rather than sudden declines in employment affecting health.

Panel data approaches lead to much smaller estimates of the effects of health on work and wages than do cross-sectional estimators. When estimating the effect of health on employment, Blundell et al. (2017) show that ordinary least squares estimates of the effect of health on employment are close to 10 times as large as first difference estimates. This suggests that cross-sectional estimates overstate the effect of health on work and wages.

However, there are reasons to believe that first difference estimates understate the true causal effects of health. Perhaps the most important reason is that the measurement error in health is likely to be large, for the reasons given above, leading first difference estimators to suffer from attenuation bias. Related to the issue of measurement error is the fact that some health shocks are relatively transitory, whereas other shocks are more permanent. Blundell et al. (2017) show that the employment responses to permanent health shocks are much bigger than the employment responses to transitory shocks. Snapshot health indicators that measure health at a particular point in time may not be able to distinguish transitory health conditions that should not affect employment from permanent health conditions that should (Blundell et al. 2017).

3.2. Health and Income

Table 3 uses data from the NHIS to show how several health indicators vary by age, education, and income in the United States. Health and income have a strong positive relationship. To get a better sense of this relationship, O'Donnell et al. (2015) decompose the Gini index for income in the United States, the Netherlands, and China. In each country, they regress individual income on age, gender, education, race, region, and self-assessed health, allowing them to express each person's income as the sum of a predicted value and a regression residual. This allows them to find the marginal impact of each variable on the Gini index by fixing the variable across all individuals, recomputing each person's income, and recomputing the Gini index. Using this method for the United States, they show that self-assessed health explains (in a statistical sense) 6.5% of income inequality. This is similar to the shares for race and age, but about one-third of that for education. If employment is added to the regression, the share falls to 4.0%, showing that much, although far from all, of health's relationship with income operates through employment. Although these shares are small, most of the income variation is not explained by any covariate whatsoever: Not controlling for employment, self-assessed health accounts for 15% of the explained income inequality in the United States. It accounts for similar shares in the Netherlands (15%) and China (10%). O'Donnell et al. (2015) note that their calculations utilize only one measure of health, and a discrete-valued and potentially noisy measure at that. Expanding and improving the set of measures should increase the share of inequality explained by health.

3.3. Health and Employment

A large body of work shows that health and employment have a positive cross-sectional relationship. Currie & Madrian (1999) review the older evidence; O'Donnell et al. (2015) discuss recent studies.

Table 3 shows that, as people age, they become more likely to be in fair or poor health, have chronic conditions that limit their activities, or find themselves limited in or unable to work. A rough sense of how this affects labor supply can be found in **Figure 3**, which shows profiles of the relationship between age and employment for male heads of households. **Figure 3** is taken from French (2005), who uses a fixed effects estimator, corrects for measurement error in health, and uses data from the Panel Study of Income Dynamics (PSID) for the years 1968–1997. Comparing the profiles for (self-assessed) healthy and unhealthy men yields three conclusions. First, individuals in bad health have significantly lower employment rates at most ages. Second, the difference in employment rates between healthy and unhealthy people is especially large for those in their fifties. Third, most of the decline in employment between ages 55 and 70 is explained by declining employment by age, conditional on health, rather than declines in health; health is not the principal driver of retirement. For example, French (2005) finds that the increase in the number of unhealthy individuals from age 55 to age 70, from 20% to 37%, is far smaller than the

Table 3 Percent of individuals reporting different health conditions by age and socioeconomic status in the United States, 2014

	Self-assessed health		Usual activities limited by chronic conditions	Limited in work[a]	Unable to work[a]
	Fair	Poor			
All	7.0 (0.10)	2.1 (0.06)	12.2 (0.15)	2.8 (0.08)	6.2 (0.13)
Age					
11 and younger	1.2 (0.11)	0.2 (0.03)	7.5 (0.27)	NA	NA
12–17	1.8 (0.17)	0.3 (0.09)	9.1 (0.40)	NA	NA
18–44	5.0 (0.15)	1.1 (0.06)	5.7 (0.15)	1.7 (0.08)	3.2 (0.12)
45–64	11.6 (0.25)	3.9 (0.14)	16.3 (0.32)	4.0 (0.15)	10.6 (0.27)
65–74	14.5 (0.49)	4.9 (0.30)	25.1 (0.62)	7.9[b] (0.48)	11.6[b] (0.55)
75 and older	18.0 (0.60)	6.9 (0.41)	42.9 (0.92)	NA	NA
Family income					
Less than $35,000	12.8 (0.25)	4.4 (0.15)	21.7 (0.33)	5.1 (0.19)	15.4 (0.33)
$35,000–$49,999	7.6 (0.30)	2.1 (0.17)	12.2 (0.40)	3.1 (0.23)	6.1 (0.33)
$50,000–$74,999	5.5 (0.26)	1.4 (0.13)	9.8 (0.33)	2.7 (0.19)	3.8 (0.23)
$75,000–$99,999	4.0 (0.27)	1.0 (0.14)	8.1 (0.34)	2.2 (0.20)	2.6 (0.20)
$100,000 or more	3.2 (0.17)	0.6 (0.08)	6.8 (0.26)	1.4 (0.14)	1.6 (0.12)
Education[c]					
Less than a high school diploma	19.8 (0.46)	6.8 (0.31)	24.3 (0.55)	4.4 (0.27)	14.2 (0.48)
High school diploma or GED	11.9 (0.30)	3.8 (0.17)	17.6 (0.36)	3.7 (0.18)	9.4 (0.30)
Some college	9.2 (0.26)	2.6 (0.14)	15.2 (0.33)	3.5 (0.17)	7.1 (0.24)
Bachelor's degree or higher	4.2 (0.18)	1.2 (0.10)	8.6 (0.25)	1.8 (0.11)	2.1 (0.13)

Standard errors are in parentheses. Data are summaries of National Health Interview Survey data taken from the Centers for Disease Control and Prevention Tables of Summary Health Statistics (tables P-1a, P-2a, P-4a; available at **https://www.cdc.gov/nchs/nhis/shs/tables.htm**). Abbreviation: NA, not available.

[a]Ages 18–69.

[b]Ages 65–69.

[c]Age 25 and older.

drop in employment, from 87% to 13%. Even if men in bad health did not work at all, declining health could explain only a fraction of retirement. In the employment profiles shown in **Figure 3**, bad health can explain only 7 percentage points of the 74-percentage-point drop.

Using data from 12 countries, Coile et al. (2017) reach similar conclusions. Applying the approach developed by Cutler et al. (2013), for each country they combine a collection of health indicators into a health index (as in Poterba et al. 2011) and then compare the employment rates of older people to those of younger people in similar health. Comparisons in all 12 countries suggest that health, on average, declines with age. They show that among men ages 50–54, those residing 10 percentage points higher in their country's health (index) distribution are between 2.7% and 7.7% more likely to be working (Coile et al. 2017, table 4). The range for women, 0.6–6.0%, is similar. However, the declines in health observed in their data are much too small to explain the declines in employment observed over the same ages.

Several recent studies exploit panel data to better capture health dynamics and control for fixed effects. Bound et al. (1999) conclude that declines in health, as opposed to poor health itself, are important predictors of retirement. In contrast, Disney et al. (2006) find that both current and lagged health are positively related to employment. They attribute the differences between

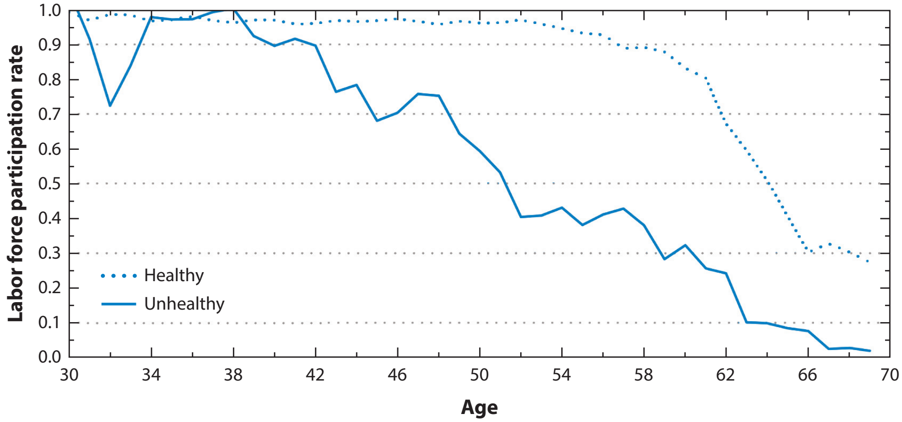

Figure 3

Employment status of healthy (*dotted line*) and unhealthy (*solid line*) US men age 30–70. Data are taken from the Panel Study of Income Dynamics. Figure reproduced from French (2005) with permission.

their results and those of Bound et al. (1999) to differences in the time series properties of their respective health measures. Blundell et al. (2017) show that the process for health contains distinct persistent and transitory components. Employment responds more to permanent than transitory health shocks. Furthermore, the lags of these shocks appear to be important. As a result, the long-run effect of a permanent shock is bigger than the short-run effect.

We should reiterate that these estimates are very sensitive to the measures and methods used. For example, Bound et al. (1999) use a dynamic framework that includes lags of health, and instrument for subjective health measures with objective conditions. They find that bad health reduces employment rates by 55 percentage points for men and 46 percentage points for women. In contrast, McClellan (1998) estimates how the onset of new health conditions affects employment using only objective conditions and contemporaneous changes in health and employment. He finds that major conditions (such as cancer, heart disease, and lung disease) reduce employment 18–26 percentage points, whereas minor conditions (such as hypertension and diabetes) reduce employment only 2–6 percentage points.

3.4. Health and Hours of Work Among Workers

The PSID data in **Figures 3** and **4** show annual hours of work for employed men. Comparing **Figures 3** and **4** shows that bad health reduces both employment and hours worked when employed, but that most of the variation is coming from the employment margin. This should not be too surprising, as most people work either full time or not at all. For example, Blundell et al. (2016b) show that, among US men ages 60–64, 44.7% do not work at all, 47.4% work at least 1,500 hours per year (50 weeks at 30 hours per week), and only 8% work between 1 and 1,500 hours per year. More generally, most of the reduction in labor supply associated with retirement takes place along the extensive (employment) margin rather than along the intensive (hours) margin. The prevailing explanation for this finding is that there are fixed costs to work, for both employers and employees, that discourage small amounts of hours (Rogerson & Wallenius 2013, Blundell et al. 2016b).[4] These fixed costs are an important element in the model we analyze below.

[4]Fan (2015) develops a model where sharp retirement is driven by habit persistence.

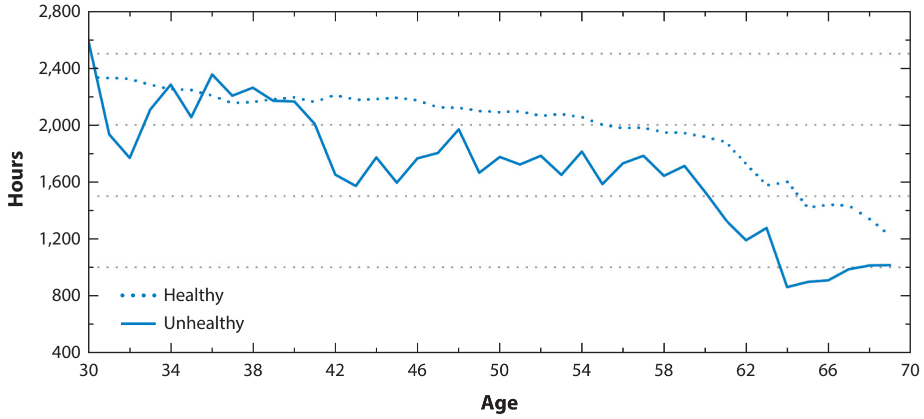

Figure 4

Annual hours of work for employed healthy (*dotted line*) and unhealthy (*solid line*) US men. Data are taken from the Panel Study of Income Dynamics. Figure reproduced from French (2005) with permission.

3.5. Health and Wages

Individuals in poor health may be less productive, leading their wages to be lower. Surveying the recent literature, O'Donnell et al. (2015) conclude that bad health leads to modestly lower wages.

Estimating the impact of health on wages is more difficult than estimating its impact on hours or employment because we can only measure wages for those who work. Because people in poor health are less likely to work than those in good health, it may be the case that the only people in poor health who work are those who receive unusually good wage draws. This would lead us to overstate the wages of the unhealthy and understate the wage gap between the healthy and the unhealthy.

Figure 5 presents estimates of the impact of age and health on wages from French (2005). These estimates are from a fixed effects regression of wages on a full set of age dummies, and age dummies interacted with health, with corrections for measurement error in health. The figure shows that the wages of those who self-report being in bad health are approximately 10% lower.

The fixed effects estimator identifies the effect of health on wages from the wage changes of those who were in good health one year and in bad health the next. This does not fully overcome the selection problem, however, because the potential wages of nonworkers remain unobserved. Whereas the fixed effects estimator demeans the wages of each individual in the sample, the individual-specific mean is based only on observed wages. The fixed effects estimator thus measures the wage growth rates of individuals who continue to work. If wage growth rates for workers and nonworkers are the same, composition bias problems—the question of whether high-wage or low-wage individuals drop out of the labor market—will not be a problem. However, if individuals with worsening health are more likely leave the market because of a sudden wage drop, then wage growth rates for workers with worsening health will have a greater upward bias than wage growth rates for nonworkers with stable health. This will lead the fixed effects estimator to understate the wage losses associated with worsening health.

French (2005) addresses this problem by using an estimated structural model of labor supply. This model creates selection because individuals in the model work only when it is in their interest to do so. He finds the wage profiles that, when fed into the model and used to generate artificial wage histories, yield the same fixed effect regression coefficients for workers as the data.

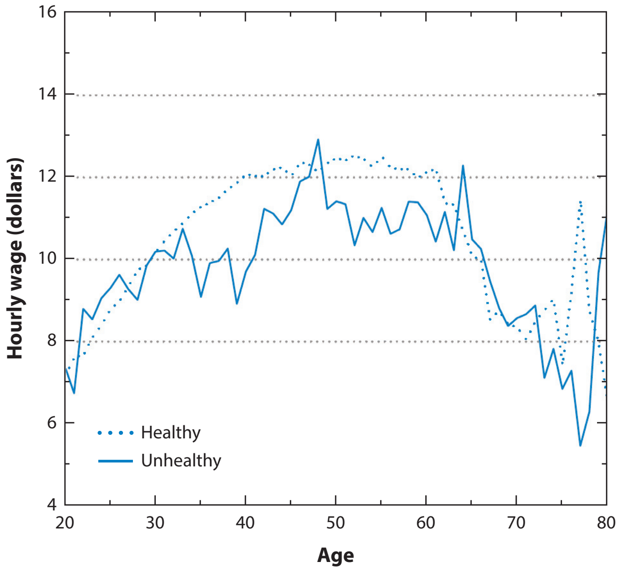

Figure 5

Wages of healthy (*dotted line*) and unhealthy (*solid line*) US men. Data are taken from the Panel Study of Income Dynamics. Figure reproduced from French (2005) with permission.

Using this approach, he finds that failing to account for selection leads to a 2-percentage-point underestimation of the wage gap between healthy and unhealthy people.

Capatina (2015) adopts a similar strategy, calibrating the wage process that allows the model-simulated wage data for workers to match the cross-sectional wage data from the Current Population Survey. She finds that bad health leads to significant reductions in wages. Her estimates imply that for people under the age of 65 without a college education, wages for those in average and poor health are 19% and 36% lower, respectively, than wages for those in good health. For those with a college education, the corresponding reductions are 14% and 28%, respectively.

4. A STRUCTURAL MODEL OF SAVING AND LABOR SUPPLY

The reduced-form evidence presented in the previous section suggests that bad health is associated with lower labor supply. However, these reduced-form estimates often fail to identify the mechanisms by which health affects retirement. Structural models can, in principle, allow us to quantify the channels—preferences, productivity, and financial incentives—through which health affects behavior. Several recent studies have made good progress on this front.

To fix ideas, in this section we exposit a fairly standard structural model, namely the model formulated and estimated by French & Jones (2011), to illustrate some of the key channels by which health impacts retirement. This model has been found to fit the data well but is parsimonious enough to make clear many key retirement incentives.

4.1. The Model

In the French & Jones (2011) model, people choose consumption, labor supply, and whether or not to apply for Social Security. They are allowed to save, but they cannot borrow against future labor, private pension, or Social Security income. When making these decisions, they are faced with several forms of uncertainty: survival uncertainty, health uncertainty, wage uncertainty, and medical expense uncertainty.

Consider a household head seeking to maximize his expected discounted lifetime utility at age t, $t = 30, 31, \ldots, 94$. Each period that he lives, the individual derives utility from consumption, C_t, and hours of leisure, L_t, according to

$$U(C_t, L_t) = \frac{1}{1-\nu}\left(C_t^{\gamma} L_t^{1-\gamma}\right)^{1-\nu}. \qquad 1.$$

The quantity of leisure depends on the individual's labor supply and health:

$$L_t = L - N_t - \phi_P P_t - \phi_{\mathrm{RE}} P_t(1 - P_{t-1}) - \phi_H H_t, \qquad 2.$$

where L is the individual's total annual time endowment. Participation in the labor force is denoted by P_t, a 0–1 indicator equal to 1 when hours worked, N_t, are positive. The fixed cost of work, ϕ_{Pt}, is treated as a loss of leisure. Including fixed costs helps us capture the empirical regularity that annual hours of work are clustered around 2,000 hours and 0 hours per year. The fixed cost of reentry, ϕ_{RE}, limits the extent to which older workers churn in and out of the labor market. The quantity of leisure also depends on an individual's health status through the 0–1 indicator H_t, which equals 1 when the individual's health is bad—in other words, there is a fixed cost of being in poor health. Including a time cost of bad health helps us capture the empirical regularity that sick people work less.

Individuals weight future utility using the subjective discount factor β. Their age of death is uncertain. A worker alive at age t with health status H survives to age $t+1$ with probability $s_{t,H}$. Workers who die value bequests of assets, A_t, according to the function $b(A_t)$.

Worker health is also uncertain, following an age-dependent Markov transition matrix. As a matter of notation, let $\pi_{t,H,H'}$ denote the probability (conditional on surviving) that a worker with age-t health status H has age-$t+1$ health status H'.

The logarithm of wages at time t, $\ln W_t$, is a function of hours worked, age, health status, and the autoregressive component ω_t:

$$\ln W_t = \alpha \ln N_t + W(H_t, t) + \omega_t, \qquad 3.$$

where the function $W(N_t, t)$ is the one that fits the wage profile in **Figure 5**, after controlling for hours worked. The adjustment for hours of work, $\alpha \ln N_t$, reflects the finding of Aaronson & French (2004) and Casanova (2013) that switching from full-time to part-time work leads to lower wages. The idiosyncratic component of wages, ω_t, follows an AR(1) process. At time t, the individual knows ω_t but is uncertain about its future values.

The asset accumulation equation is

$$A_{t+1} = A_t + Y_t + F_t - C_t - M_t, \quad A_{t+1} \geq 0, \qquad 4.$$

where Y_t is total post-tax income from all sources. In more detail, this can be written as

$$Y_t = Y(rA_t + ys_t + pb_t, W_t N_t, B_t \times ss_t), \qquad 5.$$

where $Y(\cdot)$ is a function converting pre-tax income to post-tax income; ys_t is spousal income, assumed to be exogenous; pb_t denotes benefits from private pensions; ss_t denotes Social Security benefits; and B_t is the 0–1 indicator that equals 1 when the individual has applied for Social Security benefits. The details of how we model private pensions and Social Security are explained in French (2005) and French & Jones (2011).

The variable M_t denotes the individual's out-of-pocket medical expenditures, the sum of deductibles, copayments, and insurance premia. Medical expenditures depend on the individual's health insurance, HI_t, his health, H_t, and residual uncertainty captured by the term ζ_t. The individual's work decisions may affect his health insurance, but in all other respects, both his health and his medical expenditures are exogenous.

Finally, the variable F_t captures government transfers not related to Social Security or universal health insurance. F_t includes means-tested social insurance, such as the Supplemental Security Income and Medicaid programs in the United States. As in the work of Hubbard et al. (1994, 1995), these programs are modeled as a consumption floor, where government transfers guarantee a minimum level of consumption. F_t can also include payments made under public DI programs. Because individuals cannot legally work and draw benefits at the same time, being eligible for DI benefits provides a strong work disincentive. However, to be eligible for DI benefits, an individual must have a certified work disability, and the approval process is often slow and uncertain. We use the variable $DI \in \{\text{not applying, under review, receiving benefits}\}$ to denote the individual's DI status.

Letting $AIME_t$ index Social Security wealth, the individual's state vector is $X_t = (A_t, \omega_t, H_t, HI_t, \zeta_t, AIME_t, B_{t-1}, DI_{t-1})$.[5] In recursive form, the consumer's problem can be written as

$$V_t(A_t, \omega_t, H_t, HI_t, \zeta_t, AIME_t, B_{t-1}, DI_{t-1}) = \max_{C_t, H_t, B_t \geq B_{t-1}, DI_t} \Bigg\{ \frac{1}{1-\nu}\left(C_t^{\gamma} L_t^{1-\gamma}\right)^{1-\nu}$$

$$+ \beta s_{t,H_t} E_t\Big(V_{t+1}(A_{t+1}, \omega_{t+1}, H_{t+1}, HI_{t+1}, \zeta_{t+1}, AIME_{t+1}, B_t, DI_t)\Big) + \beta(1 - s_{t,H_t}) b(A_{t+1}) \Bigg\}, \quad 6.$$

subject to the equations described above and the laws of motion for HI_t, ζ_t, $AIME_t$, and DI_t. The decision rules are solved recursively, starting with the bequest function at age $T = 95$ and working backward. Because there is no closed-form solution to the problem, the state variables are discretized into a finite number of points on a grid and the value function is evaluated at those points. With the decision rules in hand, we can then simulate artificial life histories and compare the artificial data to actual data. This allows us to estimate the model through the method of simulated moments (see, e.g., Gourinchas & Parker 2002, Cagetti 2003, French 2005). French & Jones (2011) show that the estimate fits quite well HRS data on employment, hours of work, and assets.

4.2. How Health Affects Retirement

An important implication of there being fixed costs to work is that when the net benefit from working is small, small changes in wages or other incentives can lead potential workers to switch between large amounts of work and no work at all, resulting in a high elasticity of labor supply. Conversely, when the net benefit of working is large—positive or negative—the supply of labor is inelastic.

As discussed by French (2005), French & Jones (2012), Karabarbounis (2016), and Blundell et al. (2016b), workers (at least males) are more likely to be indifferent toward work near the ends of their careers. For example, French & Jones (2012, table 2) show that, for the model developed by French (2005), the labor supply elasticity for a temporary (1-year) wage change rises from 0.36 at age 40 to 1.28 at age 60. Worsening health is only one reason for this. As workers age, they

[5] Pension wealth and spousal income are treated as functions of the other state variables and are thus not state variables themselves. Our approximation of pension wealth also requires us to make adjustments to current income, which can be considered a part of pb_t (see French 2005, French & Jones 2011).

may accumulate larger stocks of liquid financial assets or gain greater access to previously illiquid pensions. The tax and pension incentives facing them may be increasingly unfavorable toward work. Their wages may be falling. Most aging workers thus pass from receiving a large net benefit from work, to receiving a relatively small benefit from work, to facing a large net loss. During the intermediate period, when retirement occurs, their labor supply can be quite elastic. This is one reason why changes in public pensions appear to have such large effects (French & Jones 2012, Blundell et al. 2016b). This also implies that health conditions that had no effect on employment at younger ages may induce retirement at older ages. Such a dynamic is consistent with **Figure 3**, which shows that, until healthy workers begin retiring in bulk at age 60, the employment gap between healthy and unhealthy workers increases with age.

Bad health can discourage work through five distinct channels, all of which can be expressed using the model just presented.

The first channel is that of preferences. Bad health can raise the marginal utility of leisure relative to that consumption (Capatina 2015). This is embodied in Equation 2, where bad health reduces the agent's time endowment.

The second channel is that of productivity. Bad health can lower workers' productivity and resulting wage offers. This can be seen in Equation 3, where the function $W(H_t, t)$ captures the negative impact of health on wages.

The third channel is that of life expectancy. With shorter expected life spans, individuals in bad health may not need to work as long accumulating financial and pension wealth for retirement. This effect operates through the term s_{t,H_t} in Equation 6. It also operates through the Social Security system. Individuals who claim Social Security benefits at younger ages receive lower annual benefits. This implies that, all else equal, unhealthy workers are more likely to claim Social Security at younger ages. Because the receipt of Social Security benefits discourages work through the earnings test (Engelhardt & Kumar 2014), income taxation (Jones & Li 2017), or the relaxation of liquidity constraints (Kahn 1988), unhealthy workers are also most likely to retire at younger ages. An additional dynamic not captured in the model, where wages are exogenous, is that bad health may discourage the accumulation of human capital.

The fourth channel is that of DI benefits. People in sufficiently bad health may qualify for benefits from firm- or government-based disability programs. This is embodied by the term F_t in Equation 4, which in turn depends on the disability indicator DI_t. Those receiving benefits have incentives to reduce labor supply through several channels. First, the benefits provide income, allowing individuals to purchase more leisure. Second, in many countries, those earning above a certain amount (called the substantial gainful activity level in the United States) will lose benefits. Third, in the United States, DI beneficiaries can receive public health insurance through the Medicare or Medicaid programs. In this case, too, excessively high income will trigger the loss of benefits.

The fifth channel is that of medical expenses. Prior to the Affordable Care Act (ACA, also known as Obamacare), many US workers could receive actuarially fair health insurance only while they continued to work. In such cases, expensive medical conditions could induce a form of job lock, where workers delayed retirement to maintain their health insurance coverage. These dynamics are captured in the dependence of out-of-pocket medical expenditures, M_t, on health insurance, HI_t, and the institutions linking health insurance to work. Alternatively, poor individuals may qualify for means-tested public health insurance (e.g., Pashchenko & Porapakkarm 2017), and DI recipients in the United States gain access to public health insurance provided through Medicare (e.g., Kitao 2014, Kim 2012). These mechanisms, operating through the variables F_t and M_t, discourage work.

Most studies consider only a subset of these channels. For example, French (2005) and Capatina (2015) consider four of the five channels but do not account for disability benefits. Kitao (2014) accounts for DI but uses very stylized models of demographic transitions and health insurance.

4.3. The Determination of Health

In the model articulated above, health and employment are related because health alters wages and other work incentives. As we noted above, however, much attention has also been given to the possibility that the causality runs at least in part from income to health. Reviewing the literature, O'Donnell et al. (2015) conclude that in developed countries, most of which have universal health care, the causal effect of income on health is not proven. The effect, should it exist, is most likely to operate through child development: "The evidence that childhood health is influenced by economic background and determines adult economic outcomes is persuasive but not yet concrete" (O'Donnell et al. 2015, p. 1514).

The canonical economic model of endogenous health determination is that of Grossman (1972), where individuals combine their personal time and health care services to invest in their health capital. Quantitative versions of the Grossman model have become increasingly common: Recent applications include those of Yogo (2009), Khwaja (2010), Davis (2006), Halliday et al. (2016), Hugonnier et al. (2012), Scholz & Seshadri (2016), Ozkan (2014), and Cole et al. (2016). Nonetheless, the structural model developed above is consistent with much of the retirement literature in that health is assumed to be exogenous. De Nardi et al. (2016) review the literature on how health care affects health status and conclude that most of the leading studies on this topic find small effects. This suggests that treating health as exogenous is a reasonable simplification, at least for older individuals, who have established health histories and habits and broad access to public health insurance. Models with both retirement and health investment include those of Blau & Gilleskie (2008), Fonseca et al. (2009), Li (2015), and Pelgrin & St-Amour (2016).[6]

Table 3 also shows a strong negative relationship between health and education. Looking at the United States, the United Kingdom, and France, Coile et al. (2017) document that people in the lower educational attainment quartiles are more likely to have fair or poor self-assessed health than those at the top. Bound et al. (2014) find a similar educational gradient for mortality rates in the United States. Disentangling the interactions between health, education, and income, if even feasible, lies well outside the scope of this article (useful reviews include Deaton 2003, Cutler & Lleras-Muney 2012, and O'Donnell et al. 2015). In the context of the structural model developed above, it is important to recognize that education can help forecast both health and wages and may signal unobserved differences in patience, risk aversion, self-control, or attitudes toward work. Many structural models of retirement include education in their state vector.

5. RECENT STRUCTURAL EVIDENCE ON HOW HEALTH AFFECTS RETIREMENT

5.1. Preferences, Productivity, and Survival

Capatina (2015) develops a life-cycle model of US workers where health affects time endowments, labor productivity, mortality, and medical expenses. She finds that the main channels by which

[6]Blau & Gilleskie (2008), Fonseca et al. (2009), and Li (2015) do not discuss how their results would change if medical expenses were treated as exogenous. Pelgrin & St-Amour (2016) briefly discuss the role of endogenous medical spending but conduct no quantitative assessments. Theoretical analyses that embed retirement decisions within the Grossman framework include those of Wolfe (1985) and Galama et al. (2013).

health affects earnings are its effect on productivity and time lost to bad health. These mechanisms are much stronger for individuals without a college education. For this group, eliminating the productivity losses due to bad health would lead labor supply to increase by 7.4% (Capatina 2015, table 7). Eliminating the time cost of bad health would lead labor supply to increase by 3.3%. Likewise, Gustman & Steinmeier (2015) find that moving the population to good health would delay retirement by one year.

Capatina (2015) finds that removing the life-span reductions associated with bad health would lead to large increases in saving, especially at older ages, but would have relatively little effect on labor supply. In Capatina's experiment, the incidence of bad health and the productivity losses and time costs associated with it remain at their baseline levels. As a result, increased life spans are not matched by "proportional" (Bloom et al. 2014) increases in potential lifetime earnings, and their effects on labor supply are modest. Capatina (2015) also holds fixed the parameters of the Social Security system.

Haan & Prowse (2014) construct and estimate a similar model for single German workers and use it to forecast how these workers will respond to increased longevity. In contrast to Capatina (2015), Haan & Prowse (2014) allow increases in longevity to be accompanied by increases in pension age thresholds and employment opportunities. The last modification is particularly important because their data show that job offer rates decrease rapidly and involuntary separations rise rapidly as workers approach the full public pension age. They find that, if life spans increase by the expected 6.4 years but there are no other changes, years of work after age 40 increase by only 6 months. With such a limited employment response, increased longevity will render the German pension system insolvent. In contrast, if the full pension age (and employment opportunities) increases by 3.76 years, years of work will increase by almost 3 years. This will be sufficient to keep the pension system in balance.

An important feature of mortality risk is that not only mortality but also mortality rates are uncertain. In many structural models, this mechanism is captured by allowing mortality rates to depend on health, which is itself stochastic. This linkage has subtle but important effects. For example, Reichling & Smetters (2015) examine how health-related mortality risk reduces the demand for annuities. Because a bad health shock simultaneously raises a person's expected (current) medical expenses and lowers their expected life span, it simultaneously lowers an annuity's actuarial value and raises the need for liquid wealth. Sun & Webb (2009) and Imrohoroglu & Kitao (2012) make a related point in the context of Social Security. Recall that workers who start receiving Social Security benefits at older ages receive higher annual benefits. Although the optimal claiming age depends in large part on a worker's expected life span, uncertain mortality introduces precautionary considerations. Workers may delay claiming to guard against the possibility that they receive a positive longevity shock in the future.

5.2. Disability Insurance

DI is an important pathway to early retirement, especially because disabling conditions are most likely to occur at older ages. Modeling DI is often challenging because the benefit approval process can be complicated and uncertain. The most common reasons for applying for benefits in the United States are musculoskeletal (such as back injuries) and mental health problems, both of which are difficult to diagnose. Furthermore, in order to be eligible for benefits, the individual must be out of the labor force, including during the process of applying for benefits.

Most structural studies of DI emphasize the modeling and measurement of health. Bound et al. (2010) and Iskhakov (2010) treat health as a latent variable. Treating true health as unobserved affects the way in which eligibility for disability benefits is determined within the model and how health is measured when estimating the model from the data. Bound et al. (2010) find that when health is treated as a latent variable, the estimated behavioral effects of health are smaller than when health is measured in more conventional ways. As we discuss in Section 3.1, reduced-form estimates of the effects of health are sensitive to how health is measured. Structural studies such as those of Bound et al. (2010) and Iskhakov (2010) could help determine which health measures are best. Laun & Wallenius (2016) use a calibrated model with latent health to examine how the effects of DI differ across countries.

Low & Pistaferri (2010) and Benitez-Silva et al. (2011) add savings to the model, so that self-insurance through savings can serve as an alternative to disability benefits. Kitao (2014) calibrates a model with uncertain medical spending as well as disability. This is an important extension because beneficiaries of the US Social Security Disability Insurance (SSDI) program also become eligible for Medicare health insurance. Kitao (2014) finds that if the Medicare benefits were removed, SSDI recipiency would fall by 30%. Kim (2012) considers similar issues in an estimated model. He finds that the Medicare component of SSDI reduces the employment rate of men ages 23–62 by 0.7 percentage points.

French & Song (2016) estimate a dynamic programming model of employment and the disability application process, fitting the model to administrative data on flows into the SSDI program, appeal rates of those denied, and the labor supply of those allowed and denied benefits during the application process. They account for the fact that, by law, individuals cannot work and draw benefits at the same time. Furthermore, those applying for benefits or appealing a benefit denial will receive a technical denial if they work. French & Song (2016) account for the fact that many of those who apply for benefits are initially denied but remain out of the labor force so that they can appeal their rejection. They find that failing to account for these dynamic incentives would significantly understate the true work disincentive of DI.

Jacobs (2015) builds on the observation that the risks of disability vary greatly by occupation. She builds a life-cycle model where individuals consider disability risks and the insurance provided by DI when choosing occupations. She finds that the loss from eliminating DI is equivalent to a 7-percentage-point reduction in lifetime consumption for white collar workers and a 12-percentage-point reduction for blue collar workers.

Some studies consider potential reforms to the US DI system. Under current rules, individuals with earnings above a (low) ceiling lose all their disability benefits. Benitez-Silva et al. (2011) consider a reform that allows disability beneficiaries to keep 50 cents of each dollar they earn. The impact of this reform depends on whether beneficiaries believe that earnings make them more likely to undergo continuing disability reviews. They also conclude that the reform would not significantly increase the number of beneficiaries through induced entry. Yin (2015) finds that introducing partial DI would lead to financial savings and higher welfare for the disabled.

Milligan & Wise (2012, figure I.1) calculate disability recipiency rates at age 64 for eight countries and find rates ranging from less than 10% to over 35%. These differences may be due to cross-country variation in the disability programs themselves or to variation in the programs for which DI can substitute. A number of studies consider interactions between DI and other transfer programs. Considering the Netherlands, Heyma (2004) finds that restrictions on DI would lead more workers to use unemployment insurance, leading employment at age 60 to increase by only 1.7 percentage points. Iskhakov (2010) finds that some Norwegian workers would respond to the elimination of the early retirement option by acquiring partial disability benefits (available in Norway) but few would acquire full benefits. Laun & Wallenius (2015) use a calibrated model to assess the effects of recent reforms to the Swedish pension system. They find that these reforms have little effect on the use of DI, as disability benefits were more generous than standard pensions even before the pension reforms.

Kitao (2014) finds that DI amplifies the effect of reforms to the US Social Security and Medicare systems. In particular, reforms that increase the need for retirement wealth encourage workers to stay in the labor force rather than take early retirement through DI. Nonetheless, more analysis is needed. For example, the data show that increases in the normal retirement age tend to increase entry into DI. It would be useful to have a model to better assess the mechanisms behind these changes and to better assess the optimality of increasing the normal retirement age.

5.3. Medical Spending Risk and Health Insurance

A major risk to people in the United States is the possibility of facing high medical spending when uninsured. This risk can impact retirement through multiple channels.

First, this risk may be an important driver of savings (Palumbo 1999; De Nardi et al. 2010, 2016; Kopecky & Koreshkova 2014). This, in turn, may affect labor supply, as workers may seek higher earnings to build up their precautionary savings.

Second, this risk implies that health insurance may have significant effects on labor supply. In the United States, the majority of households with heads younger than 65 receive health insurance through their employers. Prior to the ACA, this was the only group health insurance available to most of them, and the insurance was available only while they continued to work.[7] For this reason, many individuals may have been working not just for their salaries but also for the health insurance provided by their employers. This relationship changes abruptly at age 65, when almost everyone qualifies for Medicare health insurance provided by the US government. Once individuals become eligible for Medicare, the health insurance incentive for work largely vanishes.

Consistent with this view, individuals who would lose their health insurance if they retired before age 65 tend to remain at their jobs about 6 months longer than those who can retain their coverage postretirement. This has been documented by Madrian (1994), Rust & Phelan (1997), and Blau & Gilleskie (2001), among others. Rust & Phelan (1997) and French & Jones (2011) show that the differences in employment among health insurance types is largely explained by the greater tendency of individuals whose health insurance is tied to their jobs to remain in the labor market until they are eligible for Medicare at age 65. **Figure 6**, taken from French & Jones (2011), shows that those whose health insurance is tied to their jobs have high job exit rates at age 65, whereas those with access to postretirement retiree coverage tend to leave at 62, when they can first receive Social Security benefits. Those with no employer-provided health insurance have less pronounced spikes at both ages.

Structural work on this issue began with Gustman & Steinmeier (1994). They estimate that retiree coverage reduces time spent in the labor force by 0.1 years, a much smaller effect than the reduced-form estimates. One likely reason why Gustman & Steinmeier (1994) find small effects is that they assume that medical expenses are certain, and they find that the average employer contribution to health insurance is small. However, if employer-provided coverage allows workers to reduce their exposure to medical expense risk and actuarially fair insurance is not available in the nongroup market, workers may value their insurance benefits well above the benefits' actuarial cost. Rust & Phelan (1997), who allow medical expenses to be risky, find labor supply responses to employer-provided insurance that are much larger. Blau & Gilleskie (2006) allow couples to insure through joint labor supply,[8] whereas Blau & Gilleskie (2008) reduce medical spending risk

[7]Employees can buy health insurance from their former employers at (unsubsidized) group rates via the COBRA provision for up to 18 months after they leave their jobs.

[8]van der Klaauw & Wolpin (2008) and Casanova (2011) also consider the importance of spouses in structural models with medical spending but do not focus on the effects of health insurance.

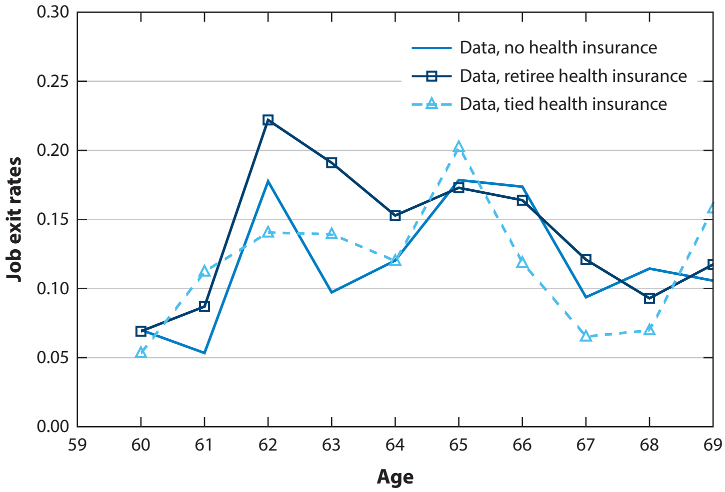

Figure 6

Job exit rates of household heads aged 60–69 by health insurance type: no health insurance (*solid line*), postretirement retiree health insurance (*squares*), or health insurance tied to their jobs (*triangles*). Data are taken from the Health and Retirement Study. Figure reproduced from French & Jones (2011) with permission.

by allowing medical spending to be endogenous. Perhaps not surprisingly, the effects of health insurance reported in these two studies are smaller than those of Rust & Phelan (1997), albeit larger than those of Gustman & Steinmeier (1994).

Rust & Phelan (1997) and Blau & Gilleskie (2006, 2008) assume that an individual's consumption equals their income net of out-of-pocket medical expenses and thus ignore their ability to self-insure through saving. French & Jones (2011), who allow workers to accumulate assets, find health insurance effects that are larger than those of Blau & Gilleskie (2006, 2008) but smaller than those of Rust & Phelan (1997). French & Jones (2011) find that Medicare was approximately as important as Social Security in determining retirement for the cohort that turned 65 in the late 1990s. In their model, raising the Medicare eligibility age from 65 to 67 leads individuals to work an additional 0.074 years over ages 60–69, whereas eliminating two years' worth of Social Security benefits increases time spent in the work force by 0.076 years. All of these studies match better the reduced-form relationships between health insurance and retirement than does that of Gustman & Steinmeier (1994), showing the importance of catastrophic medical expense risk for understanding retirement. In contrast, Gustman et al. (2016), using a model with medical expense risk, still find the effects of health insurance on retirement to be modest.

Pelgrin & St-Amour (2016) estimate a life-cycle model of labor supply, saving, and health capital accumulation with health insurance. They consider the many decision margins that health insurance might impact, including saving, health, and labor supply. Fonseca et al. (2009) use a similar model to analyze the causes of the growth in life expectancy and medical spending between 1965 and 2005. They conclude that increases in health insurance generosity and improvements in medical technology play roughly even roles in the expansion of medical spending. Technology improvements explain most of the increase in longevity.

Several recent papers consider how the ACA health care reforms might affect retirement. French et al. (2016) estimate a structural model that accounts for two important provisions of the ACA: (*a*) the expansion of the Medicaid health insurance program for low-income individuals younger than 65, including the elimination of the wealth test, and (*b*) the reforms to the private nongroup insurance market, including the introduction of income-based subsidies. Both reforms should strengthen the ability of households to maintain health insurance coverage after leaving the jobs, which should affect their retirement decisions. Li (2015) analyzes the ACA reforms in a general equilibrium model with endogenous health. She pays particular attention to the interactions between the ACA reforms and SSDI, finding that expanded access to health insurance reduces the rate at which people develop disabilities, reducing the net cost of the ACA.

Hansen et al. (2014) develop a life-cycle model where individuals can buy into Medicare, the principal public health insurance program for elderly Americans. Medicare buy-in has been advocated by several Democratic presidential candidates, including Al Gore and, more recently, Hillary Clinton. Hansen et al.'s (2014) calibrations suggest that the market for Medicare buy-in will not develop without subsidies because of adverse selection driven by the option of private insurance. The subsidies needed to make the program effective among the target population (ages 55–64), however, would require only a small increase in labor taxes.

Many US households receive health insurance through the Medicaid program, which is means-tested. In principle, means-tested health insurance, which is more targeted than universal coverage, could be very effective. However, it also distorts incentives to work, save, and consume medical care. Pashchenko & Porapakkarm (2016, 2017) find that the work disincentives of Medicaid are significant and costly. Mulligan (2013) argues that, because the subsidies for private health insurance provided in the ACA decrease with household income, they, too, discourage work. Jung & Tran (2016) also find that the redistribution channel is key to the ACA reforms.

Interestingly, preliminary evidence suggests that the ACA reforms had, at most, a modest effect on retirement patterns. For example, Levy et al. (2015) compare states that offered Medicaid expansions with those that did not. They find that the expansions appear to have had virtually no effect on retirement. Whether these results suggest that Medicaid has no impact on retirement or only that we can rule out extremely large work disincentives from the Medicaid expansion remains to be seen. Evidence from the Oregon Health Insurance Experiment also suggests a very small Medicaid work disincentive. Baicker et al. (2014) find that access to Medicaid via the experiment lottery reduced employment rates by a statistically insignificant 2 percentage points.

We have emphasized how health insurance reduces medical spending risk and how this might affect retirement. As discussed in Section 4.3, medical spending may also affect the progression of health over the life cycle. Because of its dynamic effects on both medical spending risk and health, the provision of employer-provided insurance might increase the value of an employment relationship (Fang & Gavazza 2011) or affect it in other ways (Aizawa & Fang 2013).

6. CONCLUSIONS AND SUGGESTIONS FOR FUTURE WORK

Over the past century the developed world has enjoyed an increase in healthy life spans accompanied by a move toward earlier retirement. These trends, coupled with reduced fertility and increasing medical costs, have led to persistent fiscal imbalances. Many countries have responded with policy reforms intended to promote later retirement. The academic literature on health and retirement contains important lessons for those seeking reform.

First, the long-term decline in retirement has not been driven by health. More plausible explanations are the wealth effects of higher wages, incentives generated by public pension and DI programs, or declines in the cost of goods complementary to leisure.

Second, the cross-sectional data show that unhealthy people retire earlier. It is much less clear whether, in general, bad health is a compelling force, a tipping factor in an environment already conducive to early retirement, or a gateway to disability benefits. Both reduced-form and structural comparisons suggest that much of the cross-country variation in retirement comes from differences in public pensions and DI. The increases in labor supply that have followed recent pension reforms suggest the same thing.

The myriad of ways in which bad health can affect retirement—e.g., preferences, productivity, mortality expectations, the need for health insurance (in the United States)—along with overlapping and interacting government programs, provide a showcase for careful structural analysis. A particularly promising topic is the intersection of old-age policy reform and income- and education-based differences in health. Chetty et al. (2016) show that during the period 2001–2014, the life expectancy at age 40 for men in the top 1% of the US income distribution was 14.6 years longer than for those in the bottom 1%; the gap for women was 10.1 years. Waldron (2007), De Nardi et al. (2010), and Pijoan-Mas & Ríos-Rull (2014) report similar results for older individuals. Jacobs (2015) shows that blue-collar workers are much more likely to suffer disabilities. This raises a host of compelling questions. For instance, is the US Social Security system progressive? Although the formula converting lifetime earnings to annual benefits is progressive, the tendency of richer individuals to receive longer benefit streams is regressive (for recent quantitative analyses, see Goda et al. 2011, Natl. Acad. Sci. Eng. Med. 2015). Other policies and proposed policy reforms deserve similar attention.

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