The Journal of the Economics of Ageing 9 (2017) 172–184

Contents lists available at ScienceDirect

The Journal of the Economics of Ageing

journal homepage: www.elsevier.com/locate/jeoa

Full length article

The asset cost of poor health

James M. Poterba [a,*], Steven F. Venti [b], David A. Wise [c]

[a] MIT and NBER, United States
[b] Dartmouth College and NBER, United States
[c] Harvard University and NBER, United States

ARTICLE INFO

Article history:
Available online 22 February 2017

ABSTRACT

This paper examines the correlation between poor health and the evolution of wealth for households in the first nine waves of the Health and Retirement Survey (HRS). It complements previous studies that have enumerated specific financial costs of poor health, such as out of pocket medical expenses or lost earnings. Because poor health can affect wealth accumulation through several channels, the "asset cost" measure can provide additional insight on the health-wealth nexus. We develop a simple measure of health status based on the first principal component of HRS survey responses on self-reported health status, diagnoses, ADLs, IADLs, and other indicators of underlying health. We find a large and substantively important correlation between this health measure and wealth accumulation. Within each 1994 asset quintile, individuals in the top third of the 1994 health status distribution averaged 50 percent more wealth in 2010 than those in the bottom third of that distribution.

Paying for uninsured health care costs is a major concern of many elderly households. Out-of-pocket expenditures for health care are one potential cost of poor health, but there are others. Those in poor health may need to renovate their homes or to relocate, they may experience lower earnings in their pre-retirement years, and they may also need to hire service providers for non-health services such as cleaning and shopping. Because poor health is often persistent, it can deplete resources over a long period of time.

This paper examines the relationship between poor health and the evolution of household wealth for those near and post retirement. We call this "the asset cost of poor health." It is a more inclusive measure of the financial cost of poor health than the measures used in earlier studies, and it has the potential to capture out-of-pocket medical expenses as well as other health-related costs.

Previous studies of the late-life financial cost of poor health have typically relied on one of two empirical strategies. The most common approach is to estimate out-of-pocket expenditures for health care. Marshall et al. (2011), for example, develop a comprehensive measure of these costs, based on information recorded in both the core (living) and exit (deceased) interviews in the Health and Retirement Study (HRS). They give careful consideration to the imputation of missing values and to the treatment of unusually large expenditures. They estimate that out-of-pocket spending in the last year of life averages $11,618. They also find substantial heterogeneity. The value at the 90th percentile is $29,335, at the 95th percentile is $49,907, and at the 99th percentile is $94,310. Kelley et al. (2012) consider the five year period prior to death, and estimate 90th percentile spending values of approximately $90,000.

De Nardi et al. (2015) analyze data from the Medicare Current Beneficiary Survey (MCBS), a nationally representative sample of the over-65 population, and find a similarly concentrated pattern of outlays. They estimate that out-of-pocket spending by those in the top five percent of the spending distribution averages $26,930 ($2014), and that the mean for the whole Medicare beneficiary population is $2,740. Their estimates are lower than those of the two preceding studies, which is not surprising given that their sample is substantially younger. Other studies that have estimated the distribution of out-of-pocket medical costs include De Nardi et al. (2010), French and Jones (2004), Hurd and Rohwedder (2009), Palumbo (1999) and Webb and Zhivan (2010). None of these studies focuses on the last year of life. By examining only out-of-pocket medical costs, and omitting indirect costs and non-health-care costs that may be incurred because of poor health, these studies may understate the total financial cost of poor health.

An alternative approach, which has been followed in some prior studies, is to infer the financial consequences of poor health from the change in household wealth following specific health shocks. For example, Smith (1999, 2004) investigates how wealth responds to major health events using the early waves of the HRS. Coile and Milligan (2009), Wallace et al. (2013, 2014) and Wu (2003) consider how wealth changes around specific acute health events

* Corresponding author.
E-mail address: poterba@mit.edu (J.M. Poterba).

http://dx.doi.org/10.1016/j.jeoa.2017.02.001
2212-828X/

and new diagnoses, also using the HRS. These studies show that specific major health events have substantial financial repercussions. While capturing the potential indirect costs of health shocks, they focus on relatively short intervals after such shocks. They also omit the potential costs of chronic poor health, which may not be associated with specific health shocks.

We estimate the asset cost of poor health by studying the evolution of household net assets as a function of household health status. Our goal is to capture not only the relationship between health and wealth that is due to the direct out-of-pocket cost of health care, but also the relationship that is induced by other costs that are associated with poor health. The asset cost measure can capture the cumulative effect of all of the adverse financial consequences of poor health over a long period of time. We do not attempt to identify the specific expenditures associated with poor health that lead to a draw down, or a slower growth rate, of household net worth. While more inclusive than previous measures, the asset cost measure also suffers from one potential drawback: it can be affected by voluntary changes in consumption that are associated with poor health, such as a higher rate of spending in anticipation of a shorter life.

We examine data from nine waves of the HRS, from 1994 to 2010. We do not use the first wave (1992) because of data limitations. We focus on the original HRS cohort, which consists of households containing at least one respondent between the ages of 51 and 61 in 1992. We emphasize the asset cost of poor health for persons in two-person households, although we also present summary results for single-person households. It is widely recognized that while health can affect wealth, wealth may also affect health. By defining health status at the beginning of a sixteen year period, and studying the evolution of wealth over that period, we try to emphasize the links from health to wealth and not the reverse causality.

Our analysis is divided into six sections. The first describes our procedure for estimating the evolution of assets, and the second presents our health status index that is constructed from HRS responses. We emphasize the properties of the index that are particularly important for our analysis. Section three describes the evolution of net assets by health quintile. The fourth section presents our estimates of the asset cost of poor health for two-person households. We compare the asset growth of individuals with similar asset holdings, but different health status, in 1994, using two methods. The first is a difference-in-difference estimator that compares the increase in assets between 1994 and 2010 for persons who had similar assets, but different health status, in 1994. The second is a matching estimator proposed by Abadie et al. (2004) and Abadie and Imbens (2006). Both approaches suggest that the asset cost of poor health is substantial. Conditioning on assets in 1994, in 2010 the assets of those in good health in 1994 were at least 50 percent greater than the assets of those in poor health in 1994. For example, for married persons in the middle of the asset distribution and in the bottom third of the health distribution in 1994, net assets increased from about $220,000 in 1994 to about $255,000 in 2010. For those in the same place in the asset distribution in 1994, but in the top third of the health status distribution, assets increased to $460,000. Section five reports parallel findings on the asset cost of poor health for one-person households. There is a brief conclusion.

The evolution of assets

HRS respondents were first surveyed in 1992 when they were between the ages of 51 and 61 and subsequently resurveyed every other year through 2010 (when they were age 69–79). We analyze individuals in one-person and two-person households separately. For two-person households, the HRS reports assets at the household level, reflecting the difficulty of assigning the ownership of assets, such as housing or jointly held financial assets, to individual household members. Thus for each individual in a two-person household our asset measure is total household assets. For consistency we also assign the sum of both partners' earned and annuity income to individuals in two-person households. Our health measure is the average health status of the two household members. For two-person households with both members between the ages of 51 and 61 in 1992, our sample includes two observations with identical wealth and health data, but different individual-specific attributes such as age.

Our analysis begins in 1994 because an index of health status – an important component of our analysis – could not be constructed from the data available for 1992. We calculate asset growth for each of the eight two-year intervals between the 1994 and 2010 survey waves. Our "assets" variable is actually a measure of net worth: it equals the sum of equity in owner-occupied housing, IRA balances (which include rollovers from 401(k) accounts), Keogh balances, other financial assets, and the value of vehicles, less debt. The value of business assets and other real estate are excluded. Balances in 401(k) plans are not included because 401(k) reporting limitations in the HRS, as explained in Poterba et al. (2011). We emphasize the assets in our composite because households directly control their draw-down. We do not include the asset value of annuities received from Social Security or from defined benefit pension plans.

Poterba et al. (2011) report that the reported assets for HRS respondents are affected by apparent reporting errors and that the resulting means are unstable from year to year. We therefore estimate simple reduced form equations for asset holdings in each sample year, and then compute fitted values from these equations to track the effect of health status on asset holdings. Our procedure involves three steps:

(i) We estimate separate GLS regressions for assets at the beginning and end of each interval, allowing the residual variance to differ from interval to interval. For each family status transition group (i.e. individuals in one-person or two-person households), we estimate a specification of the form:

$$A_{ibj} = \alpha_b + \sum_{j=1}^{J} \delta_{bj} I_j + \varepsilon_{ibj}$$
$$A_{iej} = \alpha_e + \sum_{j=1}^{J} \delta_{ej} I_j + \varepsilon_{iej} \tag{1}$$

A_{ibj} and A_{iej} respectively denote the level of assets for person i at the beginning (b) or end (e) of interval j. I_j is an indicator variable for the jth interval.

(ii) To obtain trimmed means, for each interval and for each family status group, we eliminate observations with residuals in the top and bottom one percent of the residual distribution. In cases where there are fewer than 100 observations in an interval we exclude the observations with the highest and lowest residuals.

(iii) We then re-estimate (1) using the trimmed data.

The resulting estimates of (δ_{bj}, δ_{ej}) and the intercepts (α_b, α_e) are shown in Table 1-1.

Fig. 1-1 plots the predicted asset values for the beginning and ending year in each of the eight intervals for individuals in continuing two-person households. The asset balances shown for the 1994–1996 interval are for persons in two-person households in both 1994 and 1996 and the balances shown for 1996 and 1998

Table 1-1
GLS estimates of beginning and end of interval assets, persons in two-person households age 51 to 61 in 1992, trimmed means.

Interval	Beginning of period wealth			End of period wealth		
	Coefficient	s.e.	z	Coefficient	s.e.	z
1996–1998	29,318	6280	4.7	74,497	7861	9.5
1998–2000	99,939	7813	12.8	129,678	9075	14.3
2000–2002	155,853	9052	17.2	119,763	8544	14.0
2002–2004	145,570	8547	17.0	167,075	9678	17.3
2004–2006	196,878	9854	20.0	208,965	10,460	20.0
2006–2008	237,534	10,540	22.5	194,602	10,252	19.0
2008–2010	222,677	10,302	21.6	173,673	10,374	16.7
Constant	300,443	4030	74.5	322,146	4477	72.0
N	39918			39849		
Wald chi-squared statistic	1333			894		
prob > chi-squared value	0.0000			0.0000		

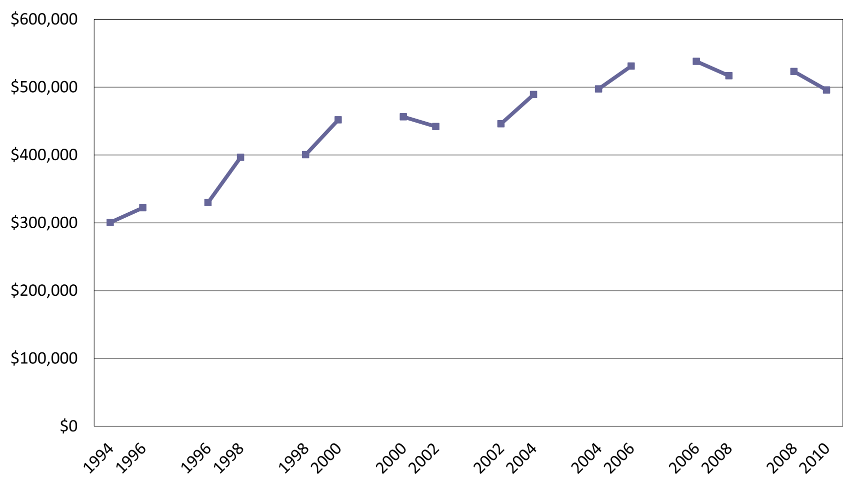

Fig. 1-1. Predicted assets by year, all persons in continuing two-person households age 51–61 in 1992.

pertain to persons who were in two-person households at both the start and end of this period. Some individuals included in the 1994–1996 interval are not included in the 1996–1998 interval because their spouse died, they were divorced, or they separated during the second interval. This is reflected in the difference in the mean assets at the end of the 1994–1996 interval and the beginning of the 1996–1998 interval. In most, but not all, instances, the predicted asset mean at the beginning of one interval is greater than the predicted asset mean at the end of the prior interval. This reflects a negative correlation between wealth and mortality, and wealth and divorce, within our sample. All dollar values here and throughout the paper have been converted to 2010 dollars using the CPI-U. Mean real assets increased by 31 percent over the 16-year period. Assets peaked in 2006 and declined in both the 2006–2008 and 2008–2010 intervals.

An index of health status

To understand the relationship between health and the evolution of assets, we need to distinguish individuals by health status. We construct a health index which can be used to group persons by health status at the beginning of each two-year interval. This index has been applied in Poterba et al. (2013) and Heiss et al. (2014). Wallace et al. (2014) develop a health index based on many of the same HRS responses using item response theory rather than principal components.

Table 2-1
Health index weights (principal component loadings).

Variable	Loading
Difficulty walking several blocks	0.294
Difficulty lift/carry	0.277
Difficulty push/pull	0.272
Difficulty with an ADL	0.267
Difficulty climbing stairs	0.261
Health problems limit work	0.259
Difficulty stoop/kneel/crouch	0.257
Self-reported health fair or poor	0.255
Difficulty getting up from chair	0.248
Difficulty reaching/extending arms up	0.210
Health worse in previous period	0.208
Difficulty sitting two hours	0.184
Ever experience arthritis	0.183
Difficulty picking up a dime	0.153
Hospital stay	0.148
Ever experience heart problems	0.146
Home care	0.144
Back problems	0.136
Doctor visit	0.134
Ever experience psychological problems	0.131
Ever experience stroke	0.125
Ever experience high blood pressure	0.120
Ever experience lung disease	0.120
Ever experience diabetes	0.107
Nursing home stay	0.069
BMI at beginning of period	0.065
Ever experience cancer	0.057

The HRS contains a large number of detailed questions that can be used to construct an index of health. We use responses to the 27 questions that are shown in Table 2-1, and obtain the first principal component of the responses to these questions. The first principal component is the weighted average of the health indicators with weights chosen to maximize the proportion of the variance of the individual health indicators that can be explained. We construct this index using data for all five of the HRS cohorts for the years 1994 through 2010. We also combine the data for men and women. Although in previous analyses we estimated separate principal component weights for men and women and for different years, the results were sufficiently similar that we combined all years and both genders for this analysis. (see Table 2-2)

The principal component loadings (weights) are shown in Table 2-1. The index gives the highest weights to self-reported health ("health limits work" and "health fair or poor") and to ADLs and IADLs. Much less weight is given to questions about whether the respondent ever experienced specific health problems. We conjecture that this is because of a high correlation between many of the ADL and IADL measures, and a lower correlation of these variables with specific health shocks. We convert the first principal component into percentile scores, with a higher score indicating better health, and group persons by quintiles of this score. For two-person households, each individual is assigned the average of the percentile scores of the two household members.

The index is strongly predictive of future health events such as a stroke or the onset of cancer or diabetes. Fig. 2-1 shows the probability that selected health events occur by 2010 for individuals stratified by 1994 health quintile. The health events shown include mortality, significant new diagnoses (diabetes, cancer, lung disease, and heart disease), stroke, whether the respondent self-reported poor health, and whether the respondent had had a hospital stay by 2010. The health index is strongly related to these subsequent health events. Although we do not report linear probability models for each of these eight future health events as a function of the health index, the index is a statistically significant predictor for all of them.

The health index displays a strong correlation with economic outcomes prior to 1994, as well as to outcomes in 1994 and in 2010. Table 2-3 shows outcomes for persons in two-person households in 1994. It combines the income (or assets) of both partners. Column 1 shows that Social Security lifetime earnings (through 1992) are increasing in 1994 health status, from about \$1,290,000 for those in the lowest quintile to about \$1,690,000 for those in the highest. Because annual Social Security earnings are subject to a cap, this difference may understate the actual earnings difference between those in the highest and lowest health quintiles. Column 2 shows that for persons in households with at least one working member in 1994, household earnings increase ranged from about \$37,700 in the lowest health quintile to about \$91,200 in the highest. Column 3 shows household annuity income in 1994, primarily Social Security retirement and disability benefits and private pension benefits, for those between the ages of 53 and 63. These annuity streams are determined primarily by lifetime income, but we are unlikely to observe them for individuals in this age group who in good health and who are still working. In column 4 we also show household annuity income in 2010 when most persons are retired. Finally, column 5 shows household net assets in 1994. These range from an average of about \$155,000 for persons in the worst health quintile to about \$375,000 for those in the best.

The findings in Table 2-3 suggest a clear relationship between health in 1994 and various measures of economic status before and after 1994. These findings are consistent with the large literature on the health-wealth gradient. Our focus is not, however, on the retrospective links between health status and economic circumstances, but on the prospective association between health status in 1994 and the evolution of economic status in later years.

We rely on a simple principal component index of health status because it has substantial predictive power for the post-retirement evolution of assets. We also considered an alternative index based on the prediction of mortality. Such a mortality "propensity score" index gives much greater weight to the "ever experienced" health elements and less weight to the "number of ..." health elements than the principal component index. It also has much less explanatory power for the evolution of assets.

The evolution of assets by health status

To examine the evolution of assets for persons with different levels of health, and to explore the effect of earned income and annuity income on the evolution of assets, we estimate two equations for asset holdings:

$$\begin{aligned} A_{ibj} &= \alpha_b + \sum_{j=1}^{J} (\delta_{bj} + \beta_{bj} h_i + \gamma_{bj} y_i + \lambda_{bj} a_i) I_j + \varepsilon_{ibj} \\ A_{iej} &= \alpha_e + \sum_{j=1}^{J} (\delta_{ej} + \beta_{ej} h_i + \gamma_{ej} y_i + \lambda_{ej} a_i) I_j + \varepsilon_{iej} \end{aligned} \tag{2}$$

Table 2-2
Percentage of HRS respondents age 51 to 61 in 1992 who are deceased by the beginning of each wave, by health quintile in 1994.

Year	1994 health quintile				
	1 (low)	2	3	4	5 (high)
Men					
1996	12.9	4.5	2.2	1.6	0.8
1998	20.6	9.0	5.7	3.1	2.3
2000	29.6	16.6	9.7	5.6	3.9
2002	38.3	23.8	13.2	9.4	6.1
2004	45.6	29.5	16.2	12.3	8.4
2006	53.9	34.3	20.5	16.1	10.3
2008	57.6	39.4	26.2	19.5	13.7
2010	63.5	46.2	33.0	24.9	18.4
Women					
1996	5.0	1.6	0.7	0.4	0.2
1998	9.3	3.3	2.1	1.7	0.7
2000	14.0	6.5	3.5	2.6	1.3
2002	19.4	9.8	5.8	4.1	2.3
2004	23.2	12.1	6.9	5.0	2.9
2006	28.1	16.3	9.1	6.9	3.8
2008	33.0	19.6	11.4	8.7	5.0
2010	40.4	25.9	16.2	11.4	7.8

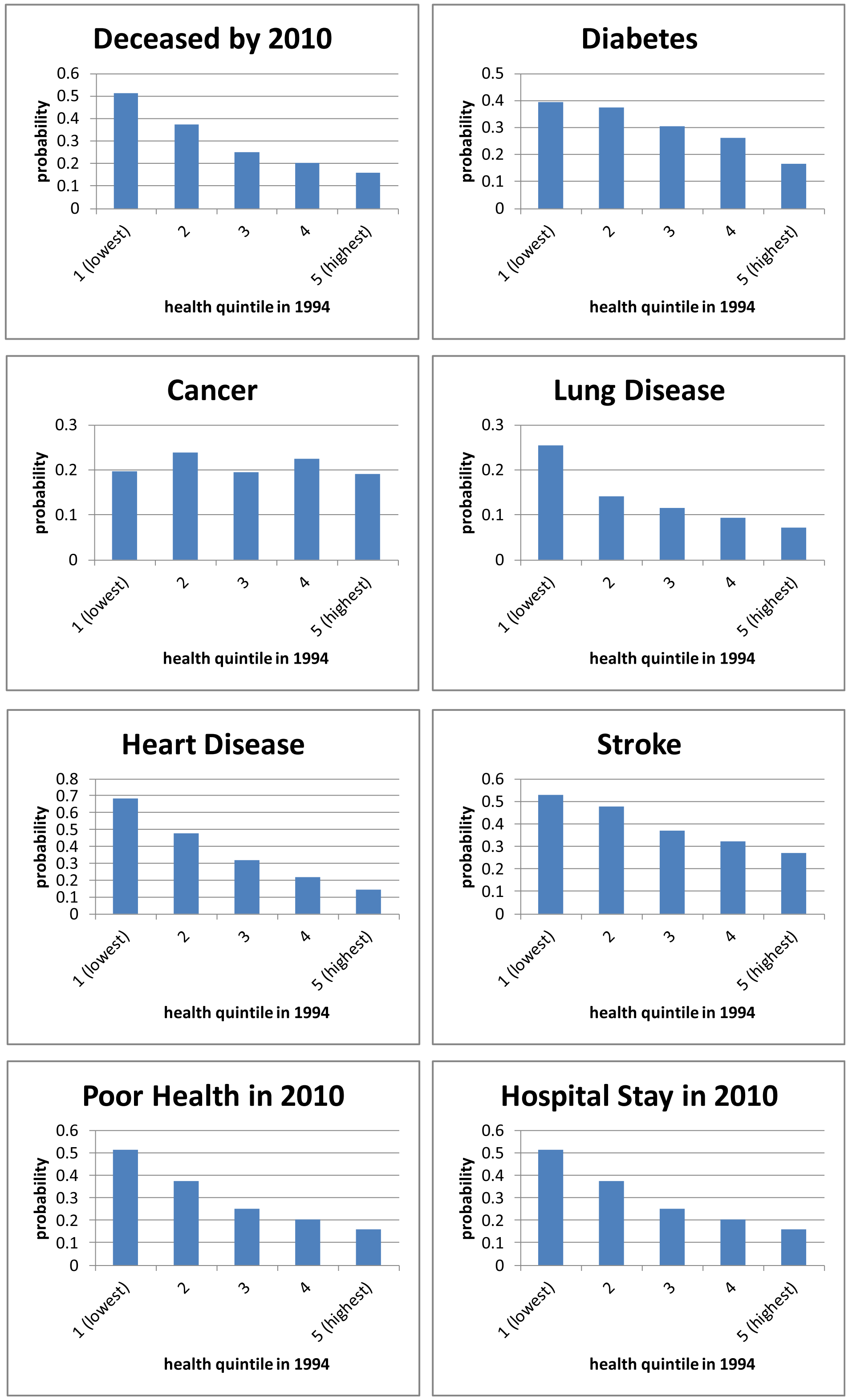

Fig. 2-1. Probability of health events by 2010 by health quintile in 1994, all persons age 53 to 63 in 1994.

The dependent variables, assets at the beginning and end of each interval, are defined as in Eq. (1). I_j is an indicator variable for the jth interval. In addition, h represents health, y represents earned income, and a represents annuity income. Health is expressed as a percentile where an individual in the first percentile ($h = 1$) is in the poorest health and a person in the 100th percentile is in the best health. Our estimates are based on trimmed data as described in our estimation of Eq. (1).

Table 3-1 reports estimation results. The first two columns show estimates that include only health status and indicator

Table 2-3
Lifetime earnings, assets and income of persons married in 1994 by health quintile in 1994 (in 2010 dollars).

1994 health quintile	Lifetime SS earnings in 1994	Mean earnings in 1994 (if positive)	Annuity income in 1994 (if positive)	Annuity income in 2010 (if positive)	Assets in 1994	Percent with earnings in 1994	Percent with annuity income in 1994	Percent with annuity income in 2010
1st (lowest)	1289,632	37,711	19,142	31,083	155,150	65.1	65.7	99.2
2nd	1516,351	56,928	24,626	32,537	219,210	77.3	48.6	99.6
3rd	1574,600	65,175	26,764	34,855	277,524	83.9	40.8	99.6
4th	1724,274	76,354	29,113	37,192	366,781	86.5	35.4	99.5
5th (highest)	1691,507	91,193	29,851	37,934	374,913	88.2	29.9	99.3

Table 3-1
GLS estimates of beginning and end of interval assets, persons age 51 to 61 in 1992 in continuing two-person households, trimmed means.

Interval	Beginning of period wealth			End of period wealth			Beginning of period wealth			End of period wealth		
	Coefficient	s.e.	z	Coefficient	s.e.	z	Coefficient	s.e.	z	Coefficient	s.e.	z
1996–1998	−28,714	17,291	−1.7	−35,372	21,745	−1.6	−37,652	16,973	−2.2	−66,349	21,908	−3.0
1998–2000	−70,245	21,983	−3.2	−21,546	25,711	−0.8	−102933.6	22,242	−4.6	−31,380	26,301	−1.2
2000–2002	−49,916	26,047	−1.9	−71,361	24,034	−3.0	−58,970	26,444	−2.2	−81,778	24,538	−3.3
2002–2004	−94,339	24,636	−3.8	−99,528	27,746	−3.6	−131,533	24,854	−5.3	−183,215	28,112	−6.5
2004–2006	−116,590	28,937	−4.0	−132,884	30,473	−4.4	−215,922	27,882	−7.7	−132,487	30,387	−4.4
2006–2008	−150,332	31,477	−4.8	−1,65,833	30,587	−5.4	−151,228	31,503	−4.8	−163,326	31,186	−5.2
2008–2010	−192,328	31,549	−6.1	−153,057	32,035	−4.8	−183,971	31,898	−5.8	−19,116	32,839	−5.2
Health index												
1994–1996	4006	191	20.9	4744	212	22.4	2802	186	15.0	3598	208	17.3
1996–1998	5098	234	21.8	6764	316	21.4	3867	230	16.8	5611	309	18.2
1998–2000	7105	332	21.4	7486	395	18.9	6204	331	18.8	6310	401	15.7
2000–2002	7716	410	18.8	8204	361	22.7	6405	415	15.4	6289	360	17.5
2002–2004	8371	383	21.8	9607	436	22.0	6664	378	17.6	7479	428	17.5
2004–2006	9678	466	20.8	10,914	486	22.5	7367	450	16.4	9105	480	19.0
2006–2008	10,968	511	21.5	11,167	485	23.0	9104	509	17.9	9395	486	19.3
2008–2010	11,268	506	22.3	10,323	505	20.4	9458	507	18.7	8648	507	17.1
Earned income												
1994–1996							4.36	0.20	22.3	5.17	0.23	22.3
1996–1998							5.09	0.25	20.7	5.55	0.29	19.0
1998–2000							5.14	0.31	16.6	4.28	0.31	13.6
2000–2002							4.28	0.32	13.5	5.01	0.29	17.1
2002–2004							5.14	0.30	17.1	7.14	0.34	21.3
2004–2006							7.03	0.17	40.9	4.01	0.29	14.1
2006–2008							3.85	0.30	13.0	4.44	0.36	12.2
2008–2010							3.91	0.35	11.2	4.64	0.38	12.3
Annuity income												
1994–1996							1.46	0.06	26.5	1.50	0.08	19.9
1996–1998							1.55	0.08	19.3	1.82	0.10	18.7
1998–2000							1.50	0.11	13.7	1.71	0.15	11.6
2000–2002							1.59	0.15	10.7	2.05	0.13	16.4
2002–2004							2.07	0.12	16.6	2.48	0.17	14.4
2004–2006							3.10	0.17	18.4	2.33	0.23	10.0
2006–2008							2.38	0.24	9.8	1.46	0.27	5.5
2008–2010							1.67	0.27	6.3	1.92	0.25	7.7
Constant	85,425	10,953	7.8	67,948	12,103	5.6	15,259	10,603	1.4	−12,694	12,082	−1.1
N	39,895			39,823			39,961			39,895		
Wald chi-squared value	5026			4739			10,137			7982		
prob > chi-squared value	0.0000			0.0000			0.0000			0.0000		

variables for each interval as independent variables. The effect of health is very large and the estimates trend upward with year (age). For example, in the first year of an interval, a one percentile point improvement in health is associated with a rise in assets by $4,006 in 1994 and by $11,268 in 2010. For the last year of an interval, a one percentile point increase in health is associated with greater assets of $4,744 in 1996 and $10,323 in 2010.

We use these estimates to assess how assets evolve for persons with different levels of health. We stratify individuals into five health quintiles. For each health quintile and for each two-year interval, we predict beginning and end of interval wealth, separately. For example, to predict assets for a person in the bottom quintile (a value of h between 1 and 20 percent) we set h to 10. For the second quintile h is set to 30.

Fig. 3-1 shows profiles based on the estimates in columns 1 and 2 of Table 3-1 and distinguished by quintiles of health. The profiles are upward sloping, but there are "dips" associated with financial market declines in 2000 to 2002, 2006 to 2008 and 2008 to 2010. There is a strong relationship between health and both the level of assets in 1994 and the subsequent growth in assets. In 1994, the household assets of persons in the poorest health quintile were only 28 percent of the assets of persons in the best health quintile. By 2010, the assets of those in the poorest health were slightly under $20,000, compared with $125,000 in 1994, while

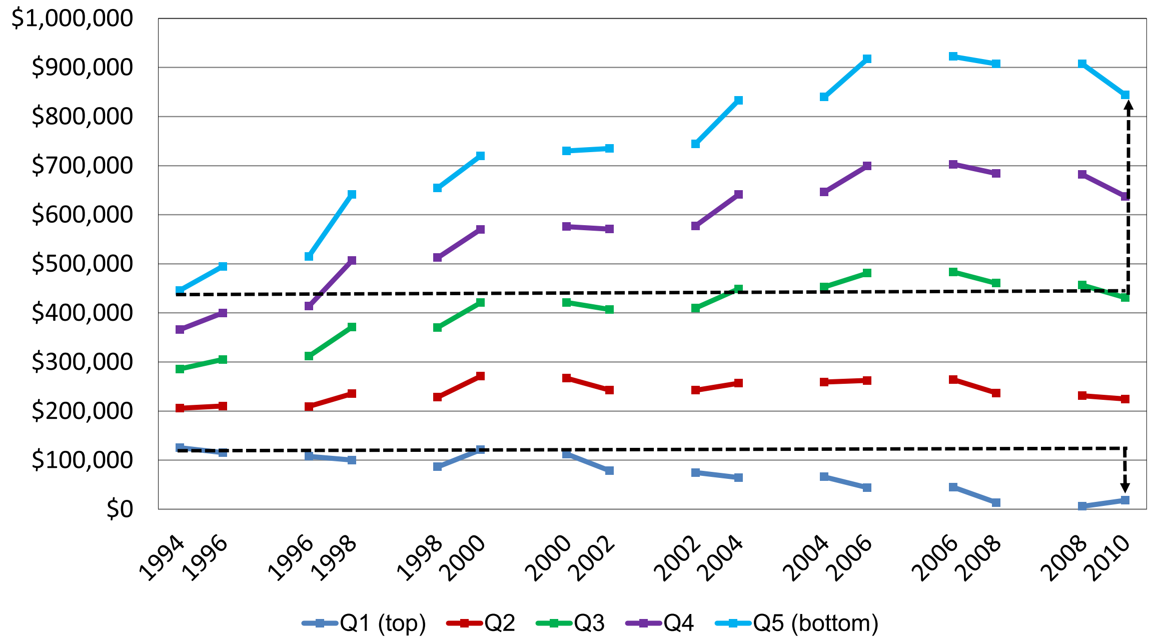

Fig. 3-1. Predicted assets by year, all persons in continuing two-person households, by health quintile for persons age 51–61 in 1992.

the assets of those in the best health were over $840,000, having risen from $445,945. Two sets of heavy dashed lines show that the assets of households in the top health quintile increased considerably, but the assets of persons in the lowest health quintile declined. The assets of those in the poorest health decreased by $107,000, while for those in the best health, they increased $397,983 for those in the best health. This difference is the key to our measurement of the asset cost of poor health.

Columns 3 and 4 of Table 3-1 control for annuity income and earned income, as well as health. Note first that the estimated coefficient of health is reduced substantially when annuity income and earnings are added. The average attenuation over all years is about 20 percent. Fig. 3-2 shows estimates with and without annuity and earned income. The earned income and annuity variables are correlated with health status (as shown in Table 2-3) and some of the effect of poor health is accounted for by lower earnings and annuity income. This result presages our later findings which suggest that low levels of earnings and other annuitized income sources contribute to the asset cost of poor health.

The last two columns of Table 3-1 show the estimated effect of each income source on beginning and ending asset balances. Higher levels of annuity income and earned income reduce the need to draw down assets to pay for health related costs. Fig. 3-3 shows the estimated relationships between an additional dollar of annuity income, an additional dollar of earned income, and assets. Both effects are large. For example, an additional dollar of annuity income is associated with an increase in beginning-of-period assets of between $1.50 and $2.40 in most intervals. The association between earned income and beginning-of-period assets is even larger. For example, one dollar of additional earned

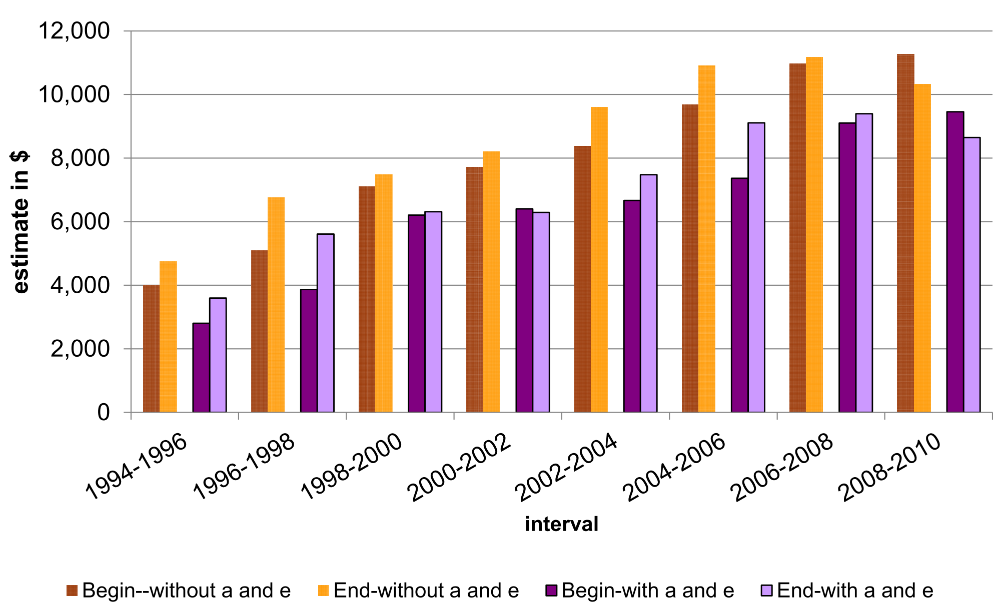

Fig. 3-2. Effect of a one percentile increase in health on beginning and end of interval assets, without and with controlling for annuity and earned income.

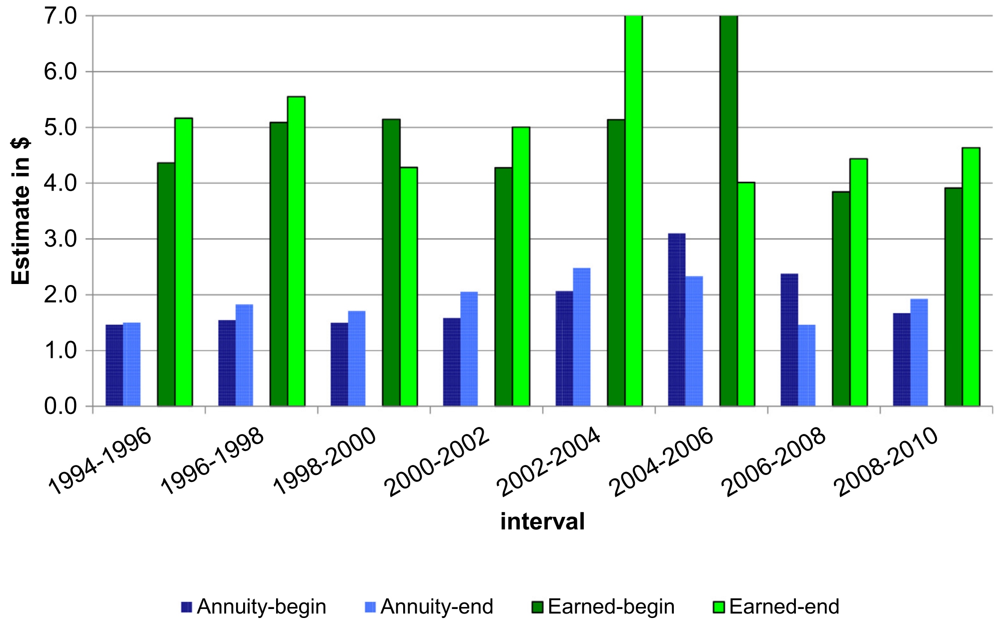

Fig. 3-3. Effect of $1 of annuity income and earned income on beginning and end of interval assets.

income is associated with an increase in beginning of period assets of $4.36 in the first interval and of $3.91 in the last interval. Most respondents are still working during the first interval (1994–1996) and most are retired during the last interval (2008–2010), but even at the beginning of the last interval nearly 40 percent of married respondents report that at least one household member is employed.

Estimating the asset cost of poor health

Fig. 3–1 presents the evolution of assets distinguished by quintiles of the health index. It reports the predicted values by health quintile based on the health index at the beginning of each interval, thus showing how the change in assets within each interval is related to health for that interval. The selection effect of persons moving from two-person to one-person households, which results primarily from the death of a spouse or divorce, is reflected in the difference between the predicted value of assets at the end of one interval and at the beginning of the next interval. These selection effects are typically positive but small. Those who remain in two-person households from the end of one interval to the beginning of the next, and who have not only survived through the interval but also have been married to a spouse who survived, have slightly higher mean assets than those who experience a transition from a two-person to a one-person household during the interval.

For some cases, however, the selection effects are large. For persons in the top health quintile, for example, assets at the end of the 1996–1998 interval are $641,336 and those at the beginning of the 1998–2000 interval are $654,592. This effect may be due in part to the better health of those who survive from one interval to the next, even though the calculation applies to persons in the top quintile of the distribution of health in each interval.

Fig. 3-1 shows that the assets of those in the top health quintile in 1994 increased much more between 1994 and 2010 than the assets of those in the lowest health quintile in 1994. This reflects the long-run asset cost of poor health, which we measure in two ways. First, we compute the increase in assets between 1994 and 2010 for persons who in 1994 had similar asset levels but different health status. Second, we apply the matching estimator proposed by Abadie et al. (2004) and Abadie and Imbens (2006), comparing the 2010 assets of a person with good health in 1994 to the 2010 assets of a person with poor health in 1994, conditional on holding similar assets in 1994.

There could be unobserved differences in saving propensities between more and less healthy households in 1994, even conditioning on their asset holdings. Since health status is persistent, some of those who were in poor health in 1994 might have had high saving propensities, and would have had high wealth levels all else equal, had they not been required to draw down their assets in prior years for health spending. The existence of such households could induce a negative correlation between health status and unobserved but persistent saving propensity, so the observed post-1994 difference between the asset change for those in good and poor health in 1994 might understate the asset cost of poor health.

We estimate the asset cost of poor health separately for those in each of the five 1994 asset quintiles, grouping individuals within these quintiles into three groups, "terciles," based on health status in 1994. We denote individuals in the poorest 1994 health tercile as the "control" group and those in the second and third terciles as the "treatment" groups The difference-in-difference estimate of the asset cost of poor health can be calculated as

$$[A_{T10} - A_{T94}] - [A_{C10} - A_{C94}] \tag{3}$$

for each of the five 1994 asset quintiles where A denotes predicted mean assets and the subscripts C and T denote the "control" and "treatment" groups respectively. To estimate this difference, the typical regression specification is

$$A_i = \alpha_{94} + \alpha_{T94} T_i + \gamma Y_{10} + t Y_{10} \cdot T_i + \varepsilon_i \tag{4}$$

where t is the "treatment" effect. When the same persons are observed in 1994 and 2010, we can calculate the change for each person and allow for individual-specific effects, u_i. The equations for assets in 1994 (A_{i94}), assets in 2010 (A_{i10}), and the change in assets between 1994 and 2010 are:

$$\begin{aligned} A_{i94} &= \alpha_{94} + \alpha_{94T} T + \quad + u_i + \eta_{i94} \\ A_{i10} &= \alpha_{94} + \alpha_{94T} T + \gamma_{10} + tT + u_i + \eta_{i10} \\ A_{i10} - A_{i94} &= \gamma_{10} + tT + \eta_{i10} - \eta_{i94} \end{aligned} \tag{5}$$

We estimate the treatment effect by estimating the last equation. When we add covariates X_i to the specification, the estimation equation becomes:

$$\begin{aligned} A_{i94} &= \alpha_{94} + \alpha_{94T}T + \quad + \beta_{94}X_{i94} + u_i + \eta_{i94} \\ A_{i10} &= \alpha_{94} + \alpha_{94T}T + \gamma_{10} + tT + \beta_{94}X_{i10} + u_i + \eta_{i10} \\ A_{i10} - A_{i94} &= \gamma_{10} + tT + \beta_{10}X_{i10} - \beta_{94}X_{i94} + \eta_{i10} - \eta_{i94} \end{aligned} \tag{6}$$

One limitation of the differences in differences approach is that the initial assets of the "treatment" and "control" groups may differ, even though we perform the analysis separately by initial asset quintile. The matching estimator addresses this issue by matching each person in the treatment group to a similar person in the control group. We obtain matching estimates separately for each 1994 asset quintile; we match by 1994 assets within quintile. As in our earlier estimation of asset levels, we trim the data on asset changes to reduce the effect of apparent reporting errors. Within each asset quintile we drop the observations in the top and bottom one percent of the distribution of asset changes between 1994 and 2010. In some specifications we also use age, earned income and annuity income as matching variables. We use four matches for each treatment respondent; Abadie et al. (2004) find that works well.

Table 4-1 shows estimates for the five 1994 asset quintiles, with persons within each asset quintile grouped into health terciles. To illustrate the approach, consider the third asset quintile. The difference-in-difference estimates show that the assets of households in the second health tercile increased by \$128,560 more (between 1994 and 2010) than the assets of the households in the first health tercile (the "control" group). Below we sometimes refer to this estimate as the asset cost based on the second tercile. The assets of households in the third health tercile (best health) increased by \$208,551 more than the assets of the households in the first health tercile. The matching estimates are very similar—\$147,451 and \$198,175 respectively. This is also the case for other asset quintile groups.

Both estimation methods suggest that asset cost of poor health is substantial, and that it is greater for persons with high asset balances in 1994. Even among persons in the same 1994 asset quintile, in all but one case those in good health in 1994 had accumulated at least 50 percent more assets by 2010 than those in poor health in 1994.

The matching method yields estimates of the asset cost of poor health averaged over all asset quintiles. Table 4-2 shows matching estimates for both health terciles and for health quintiles, averaged over all 1994 asset levels. The tercile estimates indicate that on average the assets of persons in the best health (the third tercile) increased by \$208,295 more than the assets of persons in the worst health (first tercile). The quintile estimates show that the persons in the best health (the fifth quintile) had \$245,677 more assets than persons in the worst health quintile. The increase in assets for persons in the middle tercile (\$112,349) is also close to the increase in assets for persons in the middle quintile (\$101,609).

These estimates suggest that poor health could be associated with a reduction of more than \$200,000 in household net worth over 16 year period. This is a larger value than the cumulative cost of out-of-pocket medical expenses examined in previous studies. There are two likely explanations for this finding: household wealth is a much more inclusive measure of financial cost than out-of-pocket expenditures, and our analysis considers the cumulative cost of poor health over a much longer period than most previous studies. These findings suggest that insurance policies that address only the costs of medical care associated with poor health are likely to provide only partial insurance against the full cost of chronic health conditions.

We now explore how the asset cost of poor health is attenuated by the receipt of Social Security benefits, DB pension annuities, and earned income. The diagram below illustrates the various potential ways in which poor health may affect the evolution of assets. We highlight two key pathways. First, poor health may be associated with high post-retirement medical costs which may slow asset accumulation or require draw-down. This pathway has been the primary focus of studies of late-life medical spending and its impact on financial status. Second, poor health may contribute to low earnings while working and to a shorter working life, which can reduce post-retirement asset balances in three ways. First, low pre-retirement earnings reduce the level of Social Security and private pension annuities that are available to pay health-related costs in retirement. Second, low pre-retirement earnings are associated with low asset balances upon entry into retirement. Third, low earnings late in life, either from continuing to work at a primary job or from working at a later-career job after retiring from a primary job, can affect asset growth directly by restricting ability to meet medical costs without tapping into assets.

Table 4-1
Difference-in-difference and matching estimates of the long-run "asset cost" of poor health, persons age 51 to 61 in continuing two-person households.

1994 asset quintile	Health tercile	Difference-in-difference estimates				Matching estimates	
		Mean of total assets		Diff-in-diff 1994 vs 2010	t-stat	coefficient	t-stat
		1994	2010				
1st (lowest)	1 (worst)	27,864	91,599				
	2	36,202	143,219	43,282	3.15	39,236	2.80
	3 (best)	33,562	237,090	139,793	8.11	112,900	5.92
2nd	1 (worst)	123,103	170,822				
	2	122,166	224,020	54,135	3.38	60,858	3.22
	3 (best)	125,277	288,647	115,651	7.15	115,174	6.67
3rd	1 (worst)	219,043	254,522				
	2	216,471	380,510	128,560	4.72	147,451	5.81
	3 (best)	217,012	461,042	208,551	7.91	198,175	6.81
4th	1 (worst)	365,758	452,249				
	2	374,872	556,907	95544	2.65	89,979	2.61
	3 (best)	379,531	641,988	175,966	4.86	207,466	5.16
5th (highest)	1 (worst)	924,182	946,429				
	2	929,136	1144,556	193,173	1.37	276,091	2.34
	3 (best)	988,151	1487,404	477,006	3.63	411,646	2.69

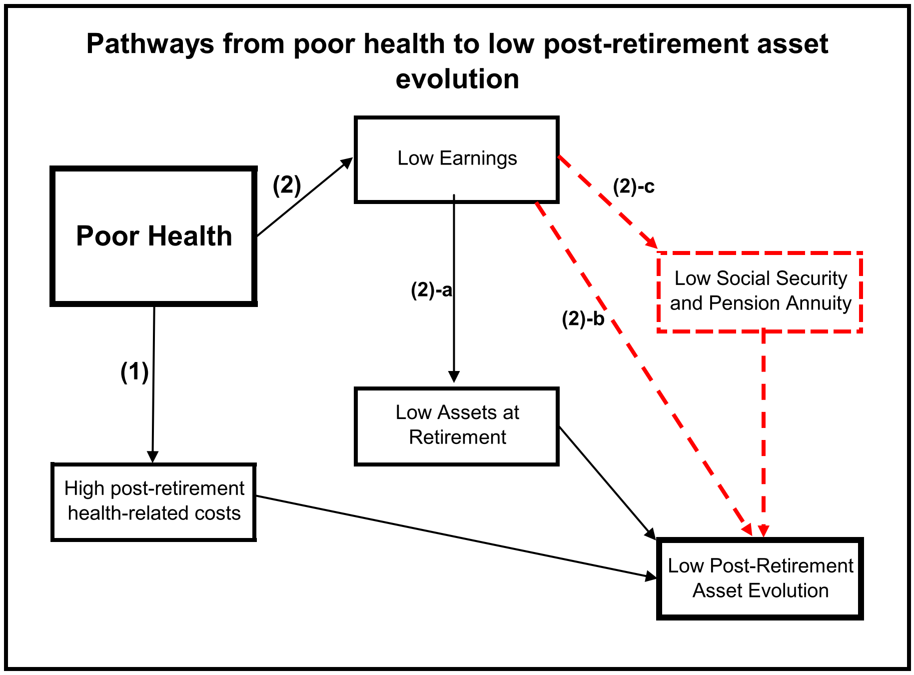

Table 4-2
Matching estimates of the long-run "asset cost" of poor health, persons age 51 to 61 in continuing two-person households, all asset quintiles combined, for health terciles and for health quintiles.

1994 asset quintile	Health tercile	Coefficient	t-stat	Health quintile	Coefficient	t-stat
	1 (worst)			1 (worst)		
All	2	112,349	5.6	2	22,019	1.1
	3 (best)	208,295	6.84	3	101,609	4.14
				4	160,186	6.55
				5 (best)	245,677	6.42

The results in Table 2-3 confirm the connections between poor health and low lifetime earnings. Poor health is not only associated with lower lifetime earnings, it is also correlated with low earnings in 1994, low annuity income, and low assets in 1994. The estimates of the asset cost of poor health in Table 4-1 and Table 4-2 above represent the combined effect of both of the pathways that link poor health and asset levels.

The entries in the last two columns of Table 3-1 show that assets are positively related to annuity income, consisting largely of Social Security benefits, earned income, as well as to health. One way to estimate the share of the asset cost of poor health that is accounted for by low earned income or low annuity income is to compute difference-in-difference and matching estimates of the asset cost of poor health controlling for earned income and annuity income. Table 4-3 shows matching estimates with and without these controls. A comparison suggests that for persons in the lower asset quintiles some of the estimated asset cost is "explained" by lower earned and annuity income. Including these controls reduces the estimates of the asset cost of poor health by 22%, 25%, 13%, 49%, and 1% for the first to fifth asset quintiles respectively. Table 4-4 shows comparable estimates based on the difference-in-difference method. A comparison of the two sets of estimates in this case suggests that between 14 and 40 percent of the estimated asset cost is accounted for by lower earned and annuity income—37%, 25%, 17%, 40%, and 14% for the first to fifth asset quintiles respectively.

One-person households

Our analysis so far has focused on individuals w/ho were part of continuing two-person households in each of the two-year intervals covered by the HRS. For comparison, we also estimate the asset cost of poor health for individuals in continuing one-person households. We report only estimates based on the matching method; as in the case of continuing two-person households, the difference-in-difference results are very similar. Fig. 5-1 shows the average evolution of assets for continuing one-person households and Fig. 5-2 shows the evolution by health quintiles. These figures are analogous to Figs. 1-1 and 3-1 for individuals in two-person households. The general pattern of asset evolution is very similar to that found for two-person households. The asset levels are much lower however, as comparison of Figs. 1-1 and 5-1 shows. Fig. 5-2 shows very large differences in assets by health for one-person households. In 1994, the average of assets of one-person households in the poorest health quintile was 19 percent of the average for one-person households in the best health decile. In 2010, it was 25 percent.

Table 5-1 shows matching estimates of the asset cost of poor health for one-person households, grouped into asset quintiles and then into health terciles within each asset quintile. Only one of the estimated effects is statistically significant. This is likely a consequence of the relatively small sample size: there are only 936 one person households, compared with 3978 two-person households. There are very few single individuals in poor health (the lowest health tercile) and in the upper two asset quintiles (33 in the fourth asset quintile, 24 in the top one), so the "control" group is quite small and the estimates are imprecise. Table 5-2 shows matching estimates for all asset quintiles combined, using both terciles and quintiles for health. Even here only one of the estimates by tercile is statistically significant, although the quintile effects are more precisely measured. In the top health quintile, the

Table 4-3
Matching estimates of the long-run "asset cost" of poor health, persons age 51 to 61 in continuing two-person households, with and without matching on earned income, annuity income, and age.

1992 asset quintile	Health tercile	Matched on assets in 1994		Matched on assets, annuity income, earned income, and age in 1994 & 2010	
		Coefficient	t-stat	Coefficient	t-stat
1st (lowest)	1 (worst)				
	2	39,236	2.80	22,694	1.72
	3 (best)	112,900	5.92	87,636	4.38
2nd	1 (worst)				
	2	60,858	3.22	23,965	1.35
	3 (best)	115,174	6.67	86,920	5.11
3rd	1 (worst)				
	2	147,451	5.81	70,465	2.76
	3 (best)	198,175	6.81	172,395	5.34
4th	1 (worst)				
	2	89,979	2.61	66,366	1.66
	3 (best)	207,466	5.16	106,224	2.44
5 (highest)	1 (worst)				
	2	276,091	2.34	107,929	1.74
	3 (best)	411,646	2.69	408,558	2.77
All	1 (worst)				
	2	112,349	5.6	88,584	4.50
	3 (best)	208,295	6.84	197,193	6.57

Table 4-4
DD estimates of the long-run "asset cost" of poor health, persons age 51 to 61 in continuing two-person households, with and without controlling for earned income, annuity income, and age.

1994 asset quintile	Health tercile	No controls		Controlling for annuity income, earned income, and age in 1994 & 2010	
		Coefficient	t-stat	Coefficient	t-stat
1st (lowest)	1 (worst)				
	2	43,282	3.2	22,694	1.7
	3 (best)	139,793	8.4	87,636	4.4
2nd	1 (worst)				
	2	54,135	3.5	23,965	1.4
	3 (best)	115,651	7.3	86,920	5.1
3rd	1 (worst)				
	2	128,560	4.9	70,465	2.8
	3 (best)	208,552	8.1	172,395	5.3
4th	1 (worst)				
	2	95,544	2.7	66,366	1.7
	3 (best)	175,966	4.9	106,224	2.4
5 (highest)	1 (worst)				
	2	193,173	1.4	187,929	1.7
	3 (best)	477,006	3.8	408,558	2.8

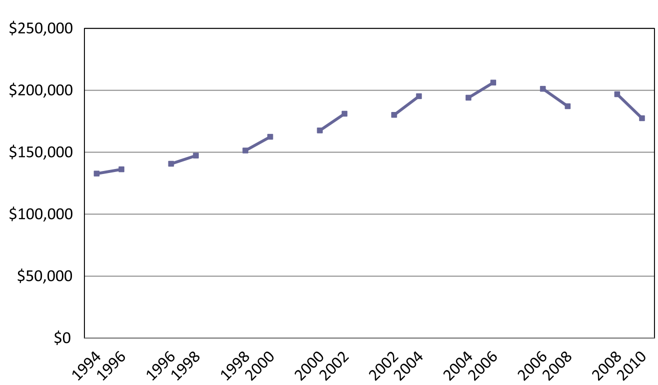

Fig. 5-1. Predicted assets by year, all persons in continuing one-person households age 51–61 in 1992.

asset cost of poor health (computed for all 1994 asset categories) is $99,021.

Table 5-3 shows matching estimates of the cost of poor health with and without controlling for annuity income and earned income, for health terciles, for all asset groups combined. The estimates for the middle tercile suggest that for one-person households about 32 percent of the asset cost of poor health can be attributed to low income. Somewhat surprisingly, the point estimate of the asset cost for those in the top health tercile is higher when we control for earned and annuity income, but we cannot reject the null hypothesis that the estimates are the same with and without these controls.

Summary and discussion

Survey evidence suggests that health care costs are a major financial concern of many elderly households. The distribution of

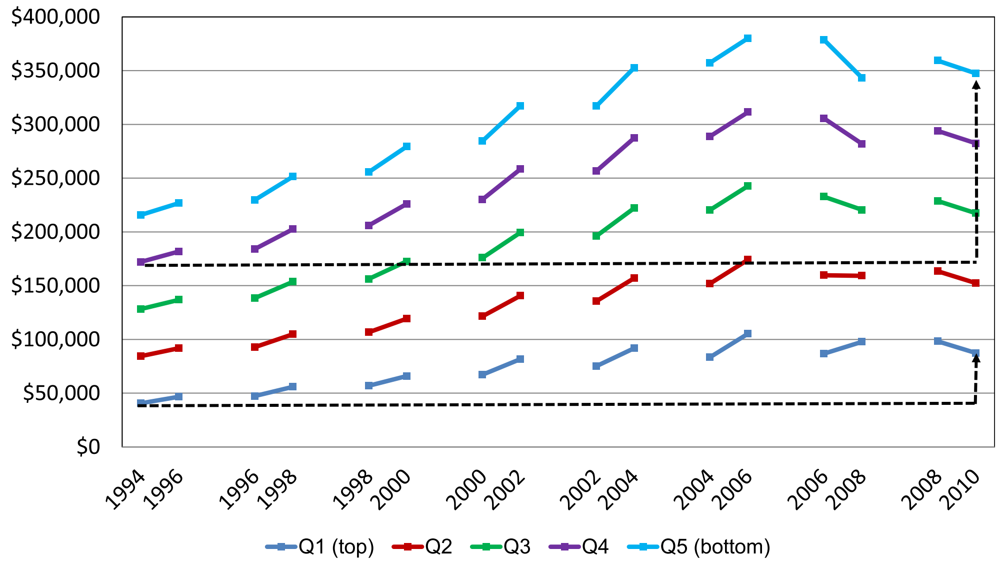

Fig. 5-2. Predicted assets by year, all persons in continuing one-person households, by health quintile, age 51–61 in 1992.

Table 5-1
Matching estimates of the long-run "asset cost" of poor health, persons age 51 to 61 in continuing one-person households.

1994 asset quintile	Health tercile	Coefficient	t-stat
1st (lowest)	1 (worst)		
	2	13,413	1.41
	3 (best)	1,00,228	2.60
2nd	1 (worst)		
	2	2316	0.19
	3 (best)	33,723	1.95
3rd	1 (worst)		
	2	64,697	1.73
	3 (best)	41,290	1.83
4th	1 (worst)		
	2	−66,369	−1.46
	3 (best)	−22,631	−0.48
5th (highest)	1 (worst)		
	2	123,630	1.35
	3 (best)	212,256	1.53

costs associated with late-life medical needs is a key input to the design of both private retirement saving programs and public social insurance programs that seek to ensure living standards in retirement. Previous research has documented that out-of-pocket medical costs are both substantial and skewed.

The cost of poor health includes not only the risk of substantial out-of-pocket health care expenditures, but also a number of indirect costs that could be associated with lost earnings, lifestyle modification, and with the use of various service providers. We compare the evolution of net worth over a long period for those who are in and near retirement and who exhibit different levels of health to capture the cumulative financial consequences of poor health. Our estimates are based on nine waves of the HRS, which tracks the experience over a sixteen year period (1994–2010) of the cohort that was age 51–61 in 1992. They suggest that the total financial cost of poor health may be substantially greater than most estimates of out-of-pocket medical spending suggest. By 2010, conditional on assets in 1994, persons in the top third of the health distribution on average accumulated at least 50 percent more assets than persons in the bottom third of the health distribution. For example, among married persons in the third asset quintile we find that between 1994 and 2010, those in the top third of the health distribution accumulated about $200,000 more assets than those in the bottom third.

Poor health can reduce assets through higher levels of health-related expenditures and through reduced earnings, which not only reduce labor income but also future Social Security and other annuity income in retirement. Between 20 to 40 percent of the asset cost of poor health seems to be attributable to the lower earned income and annuity income of persons in poor health. Income is protective of assets, which may explain why assets rise by more for households with greater earned income and annuity income. Our findings are consistent with the large literature on the health-wealth gradient: we find a strong correlation between health status in 1994, when respondents were between the ages of 53 and 63, prior earnings, asset accumulation in 1994, and the subsequent evolution of assets.

Our results offer insights on the design of retirement income programs and on the degree to which current public and private health insurance programs shield households from the financial costs of poor health. The current system includes private health insurance coverage for individuals under the age of 65, Medicare and supplemental insurance plans for those over the age of 65,

Table 5-2
Matching estimates of the long-run "asset cost" of poor health, persons age 51 to 61 in continuing one-person households, all asset quintiles combined, for health terciles and for health quintiles.

1994 asset quintile	Health tercile	coefficient	t-stat	Health quintile	coefficient	t-stat
				1 (worst)		
	1 (worst)			2	38,429	2.36
All	2	24,022	1.38	3	63,116	2.66
	3 (best)	76,225	2.79	4	81,112	3.09
				5(best)	99,021	2.62

Table 5-3
Matching estimates of the long-run "asset cost" of poor health, persons age 51 to 61 in continuing one-person households, with and without matching on earned income, annuity income, and age.

1994 asset quintile	Health tercile	Matched on assets in 1994		Matched on assets, annuity income, earned income, and age in 1994 & 2010	
		Coefficient	t-stat	Coefficient	t-stat
	1 (worst)				
All	2	24,022	1.38	16,353	0.93
	3 (best)	76,225	2.79	86,092	3.18

and Medicaid for indigent persons of all ages. De Nardi et al. (2016) have recently shown that Medicaid is an important source of insurance not just for persons with permanently low income, but also for high-income individuals who live long lives and are hit by expensive health shocks. Benefit payments under each of these programs are triggered by specific and identifiable medical costs. A recent study of hospital admissions by Dobkin et al. (2016) suggests that even insured persons are exposed to considerable uninsured financial risk, primarily through lost earnings and unreimbursed out-of-pocket costs.

Our asset cost measure, which considers financial consequences over a longer period of time, provides greater evidence of an adverse financial effect of poor health. Our findings suggest that current public and private health insurance programs only partially indemnify individuals against the costs of poor health. This may reflect substantial non-reimbursable costs associated with poor health, as well as the way Social Security and defined benefit pension programs that link retirement income to pre-retirement earnings can transform a health-related earnings loss before retirement into a post-retirement loss in annuity income.

While we have focused on the attractive features of the asset cost measure, in particular its ability to capture a more comprehensive set of poor health-induced outlays than an itemized list of medical costs, it also suffers from an important potential shortcoming. Because the asset cost measure reflects differences in non-health-related expenditures between those in good and poor health, any differences that are not appropriately viewed as costs of poor health will create measurement error and potential bias. For example, if the onset of poor health reduces an individual's capacity to consume by limiting mobility, travel opportunities, and the ability to consume food away from home, then non-health consumption might drop when health deteriorates. Scholz and Seshadri (2016) provide some evidence on the interaction between health status and post-retirement consumption. This reduction in spending is not a cost of poor health, and it would induce a downward bias in the measured asset cost of poor health. Alternatively, an individual in poor health might revise down his life expectancy and resolve to "consume before it's too late" or to increase *inter vivos* transfers. Such actions could accelerate the draw-down of assets, resulting in a larger measured asset cost of poor health. Assessment of these potential biases, and comparison of their magnitudes, is left to future work.

Acknowledgement

This research was supported by the U.S. Social Security Administration through grants #10-P-98363-1-05 and #10-M-98363-1-01 to the National Bureau of Economic Research as part of the SSA Retirement Research Consortium. Funding was also provided through Grant No. P01 AG005842 from the National Institute on Aging. The authors are grateful to James Smith, the editor, and two anonymous referees for helpful comments. Poterba is a trustee of the College Retirement Equity Fund (CREF), a provider of retirement income services. The findings and conclusions expressed are solely those of the authors and do not represent the views of SSA, any agency of the Federal Government, TIAA, or the NBER.

References

Abadie, Alberto, Imbens, Guido, 2006. Large sample properties of matching estimators for average treatment effects. Econometrica 74 (1), 235–267.
Abadie, Alberto, Drukker, David, Herr, Jane, Imbens, Guido, 2004. Implementing matching estimators for average treatment effects in Stata. Stata J. 4 (3), 290–311.
Coile, Courtney, Milligan, Kevin, 2009. How household portfolios evolve after retirement: The effect of aging and health shocks. Rev. Income Wealth 55 (2), 226–248.
De Nardi, Mariacristina, French, Eric, Jones, John, 2010. Why do the elderly save? The role of medical expenses. Journal of Political Economy 118 (1), 39–75.
De Nardi, Mariacristina, French, Eric, Jones, John, McCauley, Jeremy, 2015. Medical spending of the U.S. elderly. Mimeo, University College, London.
De Nardi, Mariacristina, French, Eric, Jones, John, 2016. Medicaid insurance in old age. Am. Econ. Rev. 106 (11), 3480–3520.
Dobkin, Carlos, Finkelstein, Amy, Kluender, Raymond, and Notowidiglo, Matthew J. 2016. The Economic Consequences of Hospital Admissions. NBER Working Paper no. 22288.
French, Eric, Jones, John, 2004. On the distribution and dynamics of health care costs. J. Appl. Econ. 19 (6), 705–721.
Heiss, Florian, Venti, Steven, Wise, David, 2014. The Persistence and Heterogeneity of Health among Older Americans. NBER Working Paper no. 20306.
Hurd, Michael, Rohwedder, Susann, 2009. The Level and Risk of Out-of-Pocket Health Care Spending. Michigan Retirement Research Center Working Paper No. 2009-218.
Kelley, Amy S., McGarry, Kathleen, Fahle, Sean, Marshall, Samuel, Qingling, Du, Skinner, Jonathan, 2012. Out of pocket spending in the last five years of life. J. Gen. Internal Med. 28 (2012), 304–309.
Marshall, Samuel, McGarry, Kathleen, Skinner, Jonathan, 2011. The risk of out-of-pocket health care expenditure at the end of life. In: Wise, D. (Ed.), Explorations in the Economics of Aging. University of Chicago Press, Chicago, pp. 101–128.
Palumbo, Michael, 1999. Uncertain medical expenditures and precautionary saving near the end of the life cycle. Rev. Econ. Stud. 66 (2), 395–421.
Poterba, James, Venti, Steven F., Wise, David A., 2011. Family status transitions, latent health, and the post-retirement evolution of assets? In: Wise, D. (Ed.), Explorations in the Economics of Aging. University of Chicago Press, Chicago, pp. 23–69.
Poterba, James, Venti, Steven, Wise, David A., 2013. Health, education, and the post-retirement evolution of household assets. J. Human Capital 7 (4), 297–339.
Scholz, John Karl, Seshadri, Ananth, 2016. The Interaction Between Consumption and Health in Retirement, University of Michigan Retirement Research Center Working Paper 2016-344.
Smith, James P., 1999. Healthy bodies and thick wallets: the dual relation between health and economic status. J. Econ. Perspect. 13 (2), 145–166.
Smith, James P., 2004. Unraveling the SES-health connection. Popul. Devel. Rev. Supplement: Aging, Health Public Policy 30, 108–132.
Wallace, Geoffrey, Haveman, Robert, Holden, Karen, Wolfe, Barbara, 2013. Health and wealth in early retirement. In: Couch, Kenneth, Daly, Mary, Zissimopoulos, Julie (Eds.), Lifecycle Events and Their Consequences: Job Loss, Family Change and Declines in Health. Stanford University Press.
Wallace, Geoffrey, Haveman, Robert, Wolfe, Barbara, 2014. Health status, health shocks, and asset adequacy over retirement years. University of Wisconsin-Madison, Department of Economics, Mimeo.
Webb, Anthony, Zhivan, Natalia, 2010. "What is the Distribution of Lifetime Health Care Costs?" Issue Brief 10-4. CRR, Boston College.
Wu, Stephen, 2003. The effects of health events on the economic status of married couples. J. Human Resour. 38, 219–230.