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THE LONG REACH OF EDUCATION:
EARLY RETIREMENT

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ABSTRACT

The goal of this paper is to draw attention to the long lasting effect of education on economic outcomes. We use the relationship between education and two routes to early retirement – the receipt of Social Security Disability Insurance (DI) and the early claiming of Social Security retirement benefits – to illustrate the long-lasting influence of education. We find that for both men and women with less than a high school degree the median DI participation rate is 6.6 times the participation rate for those with a college degree or more. Similarly, men and women with less than a high school education are over 25 percentage points more likely to claim Social Security benefits early than those with a college degree or more. We focus on four critical “pathways” through which education may indirectly influence early retirement – health, employment, earnings, and the accumulation of assets. We find that for women health is the dominant pathway through which education influences DI participation. For men, the health, earnings, and wealth pathways are of roughly equal magnitude. For both men and women the principal channel through which education influences early Social Security claiming decisions is the earnings pathway. We also consider the direct effect of education that does not operate through these pathways. The direct effect of education is much greater for early claiming of Social Security benefits than for DI participation, accounting for 72 percent of the effect of education for men and 67 percent for women. For women the direct effect of education on DI participation is not statistically significant, suggesting that the total effect may be through the four pathways.

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The central goal of this paper is to draw attention to the long lasting influence of education. It is of course not news that education is an important determinant of a person's life course. The focus in this paper is the relationship between the level of education and two routes to early retirement. One is through the Social Security Disability Insurance program (DI), with very few people leaving DI once accepted. The second is through the early claiming of Social Security retirement benefits by those who have not already retired through the DI program. These routes are used disproportionately by those who are ill-prepared to work longer because of health or other reasons. The analysis brings to the fore just how important and long-lasting the influence of education can be. The magnitude of the "education effect" on these retirement outcomes is likely to be surprising to many readers. The results demonstrate not only the enormous influence of education but also that change in the breadth and depth of education may play an important role in improving preparation for retirement in the future. To fix a wide range of problems that we face it will likely be necessary to address the critical role played by education. Retirement, and preparation for retirement, is thus in part simply an example to bring attention to the far-reaching influence of a key foundation for well-being throughout the life course.

We begin by considering the relationship between education and the receipt of DI benefits for persons between the ages of 50 and 62. Then we consider the early claiming of Social Security benefits by persons between the ages of 62 and 65 who are not receiving DI benefits at 62. Education may affect DI participation and early claiming of Social Security benefits in many ways. For both routes to retirement we emphasize four critical pathways – health, employment, earnings, and the accumulation of assets – through which education may indirectly influence early retirement decisions. Education may affect DI decisions or the early claiming of Social Security benefits indirectly through each of these pathways. But education may also have an additional direct effect on both routes to retirement that does not operate through the designated pathways. We estimate both the direct and indirect influence of education on these routes to retirement.

We emphasize the influence of education on the preparedness for retirement as well as retirement. In many ways retirement and the preparation for retirement are simply two sides of the same coin. We often gauge how well a person is prepared for retirement by the level of assets a person has accumulated by retirement ages. But preparation for retirement also encompasses the ability to choose the age at which a person would prefer to retire. Those with sufficient assets as they approach retirement ages have greater flexibility in choosing a retirement age than those with limited assets. An advantage of one additional year of work is that accumulated assets must provide support for one fewer year in retirement. If a person has not accumulated sufficient assets however, the option of delaying the claiming of Social Security benefits is limited. Poor health also limits additional years in the labor force. So does unemployment or job loss when retirement ages near; a person who is not employed nearing retirement age is unlikely to be able to work longer and to delay the receipt of Social Security benefits. Likewise, if a person's earning capacity is low, the option of delaying claiming of Social Security benefits is limited. On the other hand, good health, a job, and greater earning capacity allow greater flexibility in choosing the most advantageous retirement age. At younger ages, poor health, unemployment, low earnings capacity, and limited assets make DI benefits more appealing or even necessary. Thus although the formal analysis is directed to quantifying the relationship between education and retirement by way of DI and the early claiming of Social Security benefits, the pathway variables that are assumed to influence retirement are the same variables that determine the preparation for retirement, in particular the flexibility to choose a preferred retirement age.

Several recent papers – Autor, Katz and Kearney (2006), Goldin and Katz (2008), and Agemoglu and Autor (2012) for example – emphasize the changing education composition of the workforce and its lasting effects in the labor market. They consider the relationship between educational trends and the restructuring of the U.S. labor market in recent decades. In particular, they highlight the concern that the growth in the education of the workforce has failed to keep pace with the growth of high-skill jobs. One widely studied consequence has been growing earnings inequality or “job polarization.” Here, we emphasize another critical aspect of the effect of education on labor market experience: the relationship between education and routes to retirement.

In this paper education is taken to be a *marker* for all that accompanies education and that may influence the effect of education on retirement through our pathways.

We recognize that the pathway approach that we present is only one possible way of exploring the relationship between education and DI participation and between education and the early claiming of Social Security benefits. There are at least three issues that arise in this regard. One is that we focus attention on four pathways, but there may be others. For example one of the pathway variables to DI participation (and perhaps more so to early claiming of Social Security benefits) might be life expectancy. That is, education affects life expectancy which in turn affects the decision to delay receipt of Social Security benefits. We do not include life expectancy but we do include health which is strongly related to life expectancy

A second issue concerns the specific mechanisms through which education influences each of the pathways. See Grossman (2006) and Cutler and Lleras-Muney (2006, 2007, 2010, 2011) for more complete discussions of possible mechanisms linking education to health and Ludwig, Kling, and Mullanaithan (2011) for a potential approach to identifying such mechanisms. In this analysis we make no attempt to identify these mechanisms.

A third, and related issue, is that it may not be education per se that works through the pathways, but rather unobserved attributes associated with education, a long-standing issue in economics. Nevertheless, on balance, most analysts accept that education of a given level is required for employment on specific jobs and that education is an important determinant of earnings. Again, in this paper education level is taken as a marker for all that accompanies education without attempting to explore the mechanisms underlying the strong positive association between education and pathways to retirement such as health and wealth. Rather, the goal is to highlight the magnitude of the relationship between education and an important life event – retirement and the preparation for retirement.

The remainder of the paper is in four sections. Section 1 presents descriptive data that help to motivate and support the more formal analysis that follows. Section 2

presents the analysis of DI participation. Section 3 presents the analysis of the early claiming of Social Security benefits. Section 4 is a summary and discussion.

1) Descriptive data

The descriptive data emphasize the substantial relationship between education and the pathway variables – health, employment, earnings, and assets – through which education is assumed to influence DI participation and the early claiming of Social Security benefits. We begin by describing the striking relationship between education and DI participation and early claiming of SS benefits and then turn to the relationship between education and the pathway variables.

Disability Insurance and Early Claiming of SS Benefits: Table 1-1 shows the proportion of women and men who ever applied for and who were ever approved for DI, by level of education and health status. The table is based on pooled data for the years 1994 to 2010 from the Health and Retirement Study (HRS). Health status is indicated by health quintile which is based on a health index that is explained below. The top panel shows the proportion of persons age 50 to 62 who ever applied for DI benefits. The middle panel shows the proportions approved for DI. Both education and health are strongly related to DI approval. For any health quintile, persons with low levels of education are much more likely to be approved for DI than those with more education. For women in the poorest health, for example, 51 percent of those with less than a HS degree apply for DI and are approved compared to 35 percent for women with a college degree or more. Overall, 25 percent of women with less than a HS degree apply for DI and are approved compared to 5 percent for women with a college education. For men the approval rate is 27 percent for those with less than a high school education compared to 5 percent for those with a college degree or more.

The bottom panel of Table 1-1 shows the proportion of persons – not on DI at age 62 – claiming Social Security benefits before the normal retirement age. Overall 71 percent of women with less than a HS degree claim Social Security benefits early but only 44 percent of those with a college degree or more claim early. For men, 66 percent of those with less than a HS degree claim Social Security benefits early compared to only 40 percent of those with a college degree or more.

Table 1-1. The proportion of persons who ever applied for SSI or SSDI, the proportion between the ages 50 and 62 who were ever approved for SSI or SSDI, and the proportion between the ages 62 and 64 who claimed Social Security benefits early, by gender, by health quintile, and by education.

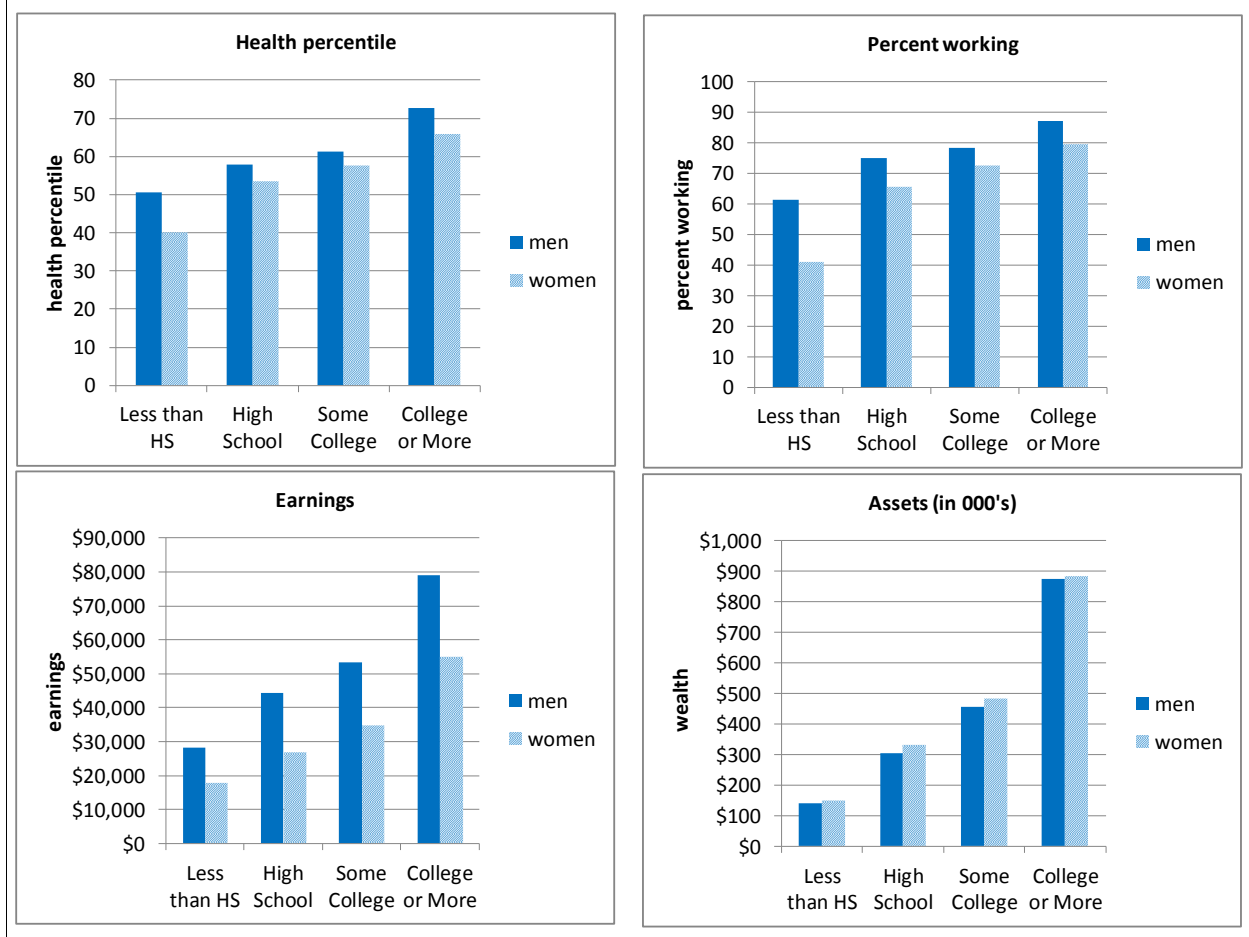
Education	Women						Men						
	Applied for DI						Applied for DI						
	Health quintile						Health quintile						
	1st (low)	2nd	3rd	4th	5th	All	1st (low)	2nd	3rd	4th	5th	All	
< HS	0.76	0.34	0.16	0.08	0.17	0.39	0.78	0.48	0.23	0.12	0.16	0.36	
GED or HS grad	0.61	0.23	0.09	0.04	0.05	0.19	0.71	0.33	0.14	0.07	0.07	0.21	
Some college	0.62	0.20	0.09	0.04	0.04	0.15	0.72	0.32	0.10	0.06	0.04	0.17	
College or more	0.43	0.11	0.04	0.01	0.01	0.06	0.57	0.22	0.08	0.03	0.02	0.07	
All	0.64	0.22	0.09	0.04	0.04	0.18	0.72	0.34	0.12	0.06	0.05	0.18	
	Approved for DI												
	1st (low)	2nd	3rd	4th	5th	All	1st (low)	2nd	3rd	4th	5th	All	
< HS	0.51	0.19	0.09	0.05	0.11	0.25	0.63	0.34	0.16	0.09	0.11	0.27	
GED or HS grad	0.47	0.15	0.06	0.03	0.03	0.13	0.57	0.24	0.09	0.05	0.05	0.16	
Some college	0.48	0.14	0.07	0.03	0.02	0.11	0.49	0.23	0.06	0.03	0.03	0.11	
College or more	0.35	0.09	0.03	0.01	0.01	0.05	0.48	0.17	0.04	0.02	0.01	0.05	
All	0.47	0.14	0.06	0.02	0.03	0.13	0.56	0.24	0.08	0.04	0.04	0.13	
	Early Social Security claiming												
	1st (low)	2nd	3rd	4th	5th	All	1st (low)	2nd	3rd	4th	5th	All	
< HS	0.81	0.63	0.71	0.72	0.62	0.71	0.66	0.76	0.73	0.56	0.62	0.66	
GED or HS grad	0.61	0.68	0.61	0.66	0.52	0.62	0.62	0.58	0.56	0.51	0.58	0.56	
Some college	0.75	0.52	0.54	0.55	0.39	0.52	0.65	0.48	0.53	0.5	0.52	0.52	
College or more	0.53	0.57	0.46	0.45	0.34	0.44	0.28	0.34	0.47	0.44	0.37	0.4	
All	0.69	0.62	0.58	0.59	0.45	0.57	0.59	0.56	0.55	0.49	0.49	0.52	

The Pathway Variables and Education: The empirical model we develop below considers how education may influence DI participation, and then the early claiming of Social Security benefits, through four pathways – health, employment, weekly earnings, and accumulated assets. Figure 1-1a shows four subpanels for persons 50 to 59 – health, employment, weekly earnings, and accumulated assets. The panels show that there are large differences by level of education for each of these pathways, highlighting the “education advantage.” We see that those with more

education are in much better health, are more likely to be working between the ages of 50 and 59, earn much more, and have much greater assets.¹

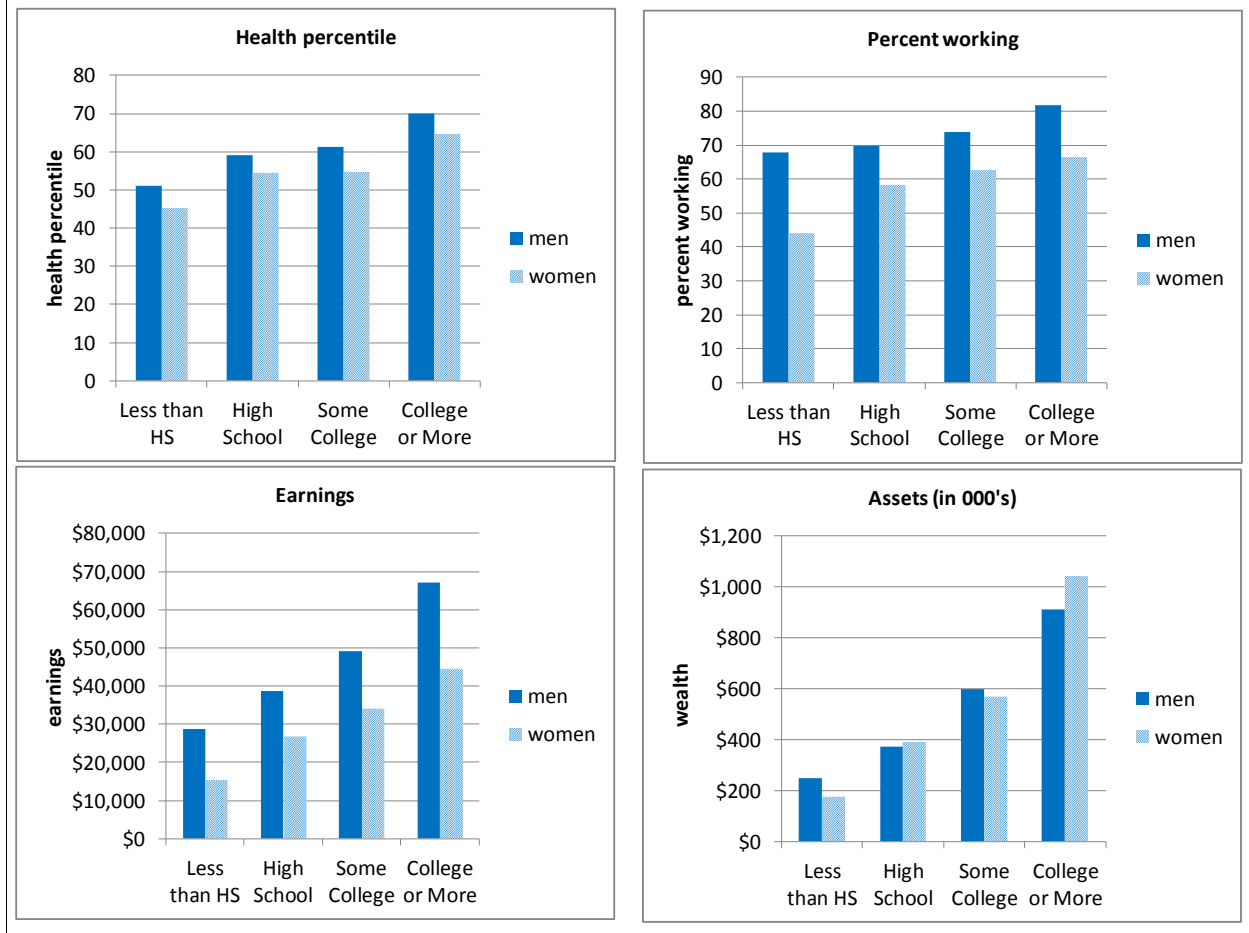
Figure 1-2b shows four analogous panels but for persons 60 to 61 who are not on DI. This is to show the relationship between education and each pathway for persons eligible to claim early Social Security benefits. Health, earnings, and assets are strongly related to level of education. There is also a noticeable relationship between education and the proportion working at ages 60 and 61, especially for women.

Figure 1-1a. Differences in pathway variables by level of education for persons age 50-59



¹ Here assets are defined to include financial assets (including assets held in IRAs, Keoghs, 401(k)s and similar accounts), housing and other real estate (less mortgage debt) and business assets. The capital value of annuities such as Social Security benefits and defined benefit pension plans are not included.

Figure 1-1b. Differences in pathway variables by level of education for persons age 60 to 61



The Health Index: The health index used to construct the quintiles in Table 1 and the health panels in Figures 1 and 2, as well as the empirical analysis in sections 3 and 4, is the first principle component of 27 health indicators reported in the HRS. Construction of the index and its properties are described in some detail in Poterba, Venti, and Wise (2013a). For convenience, an updated version of that discussion is reproduced in the Appendix to this paper.

How long a person expects to live may be an important consideration in the timing of the receipt of Social Security benefits, with those expecting short lives more likely to claim benefits earlier. As noted above, we do not include subjective life expectancy as one of the pathways through which education influences DI, or in particular, the early claiming of Social Security benefits. We do, however, include health, and both subjective and actual mortality are likely to be strongly related to health. Table 1-2 below, calculated from the mortality model in Heiss, Venti, and Wise

(2014), shows simulated actual life expectancy at age 66 for men and women, by level of education and selected health deciles. These simulated life expectancies vary by nearly a factor of three for both men and women. Simulated life expectancies by gender and age generated by this model closely match actual life tables. We use the simulated life expectancies because actual life expectancies are not available by level of education and health status.

Level of Education	Health Decile at Age 66						All
	1	3	5	6	8	10	
Men							
Less than high school	9.33	13.19	15.10	16.01	18.32	21.45	15.58
High school degree	10.31	14.28	16.35	17.22	19.55	22.63	16.77
Some college	10.71	14.73	16.88	17.67	20.03	23.10	17.24
College or more	12.79	17.03	19.15	19.91	22.27	25.03	19.40
All	10.66	14.68	16.73	17.57	19.91	22.93	17.12
Women							
Less than high school	10.06	14.62	17.03	18.12	20.74	24.21	17.51
High school degree	12.26	17.21	19.67	20.54	23.13	26.26	19.90
Some college	12.94	17.96	20.40	21.27	23.76	26.81	20.59
College or more	14.42	19.50	21.91	22.75	25.03	27.92	22.01
All	12.11	16.99	19.42	20.35	22.88	26.05	19.69

The Accumulation of Assets: One of the pathways we emphasize is accumulated assets at retirement. Mean asset balances by level of education are shown in Table 1-3 and the share of total assets held in each asset type is shown in Table 1-4. The total assets of those with a college degree or more are 4.5 times as large as the total assets of those with less than a high school degree. The share of assets held in different asset types also varies greatly. Social Security wealth accounts for almost 50 percent of the total assets of those with less than a high school degree but only about 16 percent of the assets of those with a college degree or more.² Almost 23 percent of the total assets of those with a college degree or more are in financial assets but only about 8 percent of the total assets of those less than high school degree is in

² In this table the capitalized value of annuity streams (Social Security and defined benefit pension benefits) is calculated as the survival probability weighted net discounted present value of expected benefits.

financial assets. Almost 20 percent of the total assets of those with a college degree or more is in personal retirement accounts (401(k)s, IRAs, Keoghs and similar tax-advantaged retirement accounts) but only 4 percent of the total assets of those with less than a high school degree is in personal retirement accounts. Overall, non-annuity assets account for about 73 percent of the wealth of those with a college degree or more but only about 41 percent of the wealth of those with less than a high school degree.

Table 1-3. Mean assets for households aged 65-69 in 2010 by level of education and marital status

Asset Category	< High School	High School	Some College	College or More
All Households				
Financial Assets	28,335	70,401	103,331	354,487
Non-Mortgage Debt	-2,975	-6,961	-7,860	-3,781
Home Equity (primary home)	62,575	121,220	133,501	252,521
Home Equity (second home)	7,834	12,575	18,453	52,857
Other Real Estate	17,607	34,447	32,172	112,542
Business Assets	13,866	29,922	30,505	69,504
Personal Retirement	13,925	70,768	99,980	306,760
- IRAs & Keoghs	11,497	49,831	74,208	189,521
- 401(k)s and Similar Plans	2,428	20,936	25,772	117,240
Social Security	172,992	228,127	238,789	242,646
Defined Benefit Pension	33,279	67,641	94,639	172,316
Non-Annuity Net Worth	141,167	332,372	410,082	1,144,890
Net Worth	347,438	628,141	743,509	1,559,852
Lifetime Earnings	921,198	1,706,600	1,849,256	2,362,983

Table 1-4. Share of total assets held in each asset type for households aged 65-69 in 2010 by level of education and marital status

Asset Category	< High School	High School	Some College	College or More
All Households				
Financial Assets	8.2	11.2	13.9	22.7
Non-Mortgage Debt	-0.9	-1.1	-1.1	-0.2
Home Equity (primary home)	18.0	19.3	18.0	16.2
Home Equity (second home)	2.3	2.0	2.5	3.4
Other Real Estate	5.1	5.5	4.3	7.2
Business Assets	4.0	4.8	4.1	4.5
Personal Retirement	4.0	11.3	13.4	19.7
- IRAs & Keoghs	3.3	7.9	10.0	12.1
- 401(k)s and Similar Plans	0.7	3.3	3.5	7.5
Social Security	49.8	36.3	32.1	15.6
Defined Benefit Pension	9.6	10.8	12.7	11.0
Non-Annuity Net Worth	40.6	52.9	55.2	73.4
Net Worth	100.0	100.0	100.0	100.0

The Less Educated Save Less, Given Lifetime Earnings: Asset balances can be decomposed into two components: one is lifetime earnings (LE) and the other is the propensity to save out of lifetime earnings (PS). That the less educated earn less over their lifetimes is well known. Perhaps not so well known is that, given lifetime earnings, those with less education save substantially less than those with more education.

Table 1-5 shows the ratio of mean total assets to mean lifetime earnings by lifetime earnings decile for the four levels of education that we use throughout the analysis.³ The table shows that (with only one exception) at each level of lifetime earnings the ratio of mean assets to mean lifetime earnings increases systematically with the level of education. Averaged over all lifetime earnings deciles, the ratios are 0.16, 0.18, 0.25, and 0.40 respectively for those with less than a high school degree, with a high school degree, with some college, and with a college degree or more. We refer to the ratio of assets to lifetime earnings as the propensity to save. The unusual

³This calculation is made for the subset of HRS respondents that have linked Social Security earnings records. Although we refer to the ratio of mean wealth to mean lifetime earnings as the propensity to save, we recognize that is a simplification. Many factors other than lifetime earnings and the propensity to save determine assets at retirement, including bequests and gifts received and the rate of return on investments. For much of the population, however, the saving rate out of earnings is likely to be a key factor.

values for the lowest earnings decile are likely due to large assets of persons whose earnings may not be covered by Social Security and thus have no or low reported Social Security earnings.

Table 1-5. Ratio of mean assets to mean lifetime earnings, by lifetime earnings decile and by level of education

Lifetime earnings decile	Less than HS	GED or HS graduate	Some college	College or more
1	0.55	0.44	0.71	2.27
2	0.13	0.25	0.43	0.80
3	0.12	0.24	0.26	0.51
4	0.14	0.18	0.24	0.39
5	0.13	0.15	0.20	0.31
6	0.14	0.15	0.22	0.37
7	0.18	0.16	0.25	0.38
8	0.14	0.18	0.24	0.41
9	0.14	0.18	0.25	0.41
10	0.28	0.21	0.27	0.36
all	0.16	0.18	0.25	0.40

Personal Retirement Account (PRA) Ownership and Account Balances:

Figures 1-6a (males) and 1-6b (females) are reproduced from Poterba, Venti, and Wise (2013b). The figures summarize the relationship between earnings, health, marital status, and education on the one hand, and PRA ownership (left panel) and PRA account balances (right panel).⁴ Note that these figures pertain to PRA assets only and earnings in the figures pertain to earning in the prior wave. The most striking result is the strong relationship between PRA ownership and education, controlling for earnings. For example, for men, the increase in the probability of PRA ownership associated with having a high school degree – compared to less than a high school degree – is over

⁴ Figure 1-6a is based on estimated marginal effects from a probit model of PRA ownership. Figure 1-6b is based on a poisson regression model for the balance in PRA accounts for households with a positive balance. In both cases estimates were obtained from data for the 2004 and 2006 waves of the HRS (pre-dating the financial crisis). The earnings variable used in these figures is annual earnings.

nine times as great as the increase associated with a \$10,000 increment in earnings and ten times as great as the increase associated with a 10 percentile point increase in health. The effect of a college degree (relative to less than a high school degree) is over 15 times as large as the increase associated with a \$10,000 increment in earnings and almost 17 times as great as a ten percentile point increase in health.

Figure 1-6a. Effect of attributes on PRA ownership and PRA balances, males

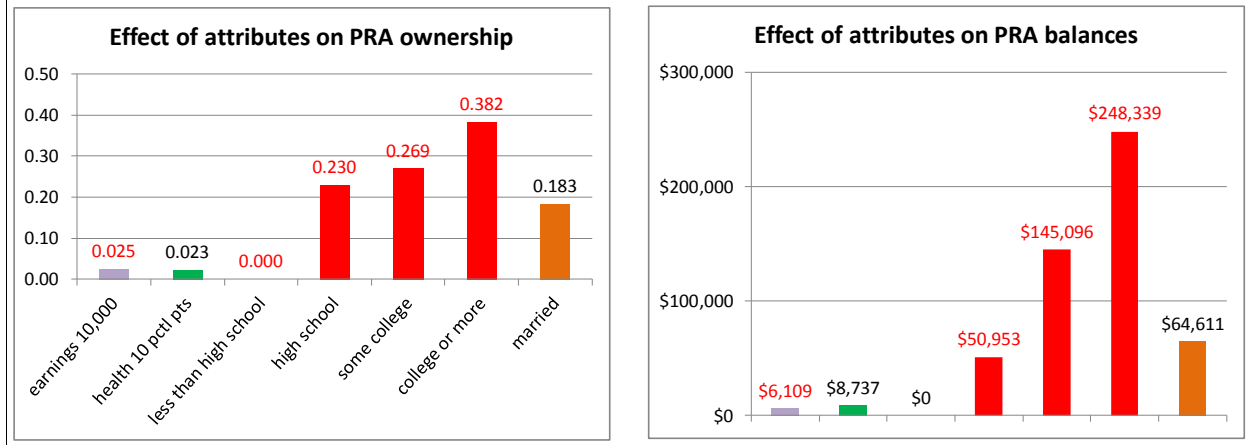
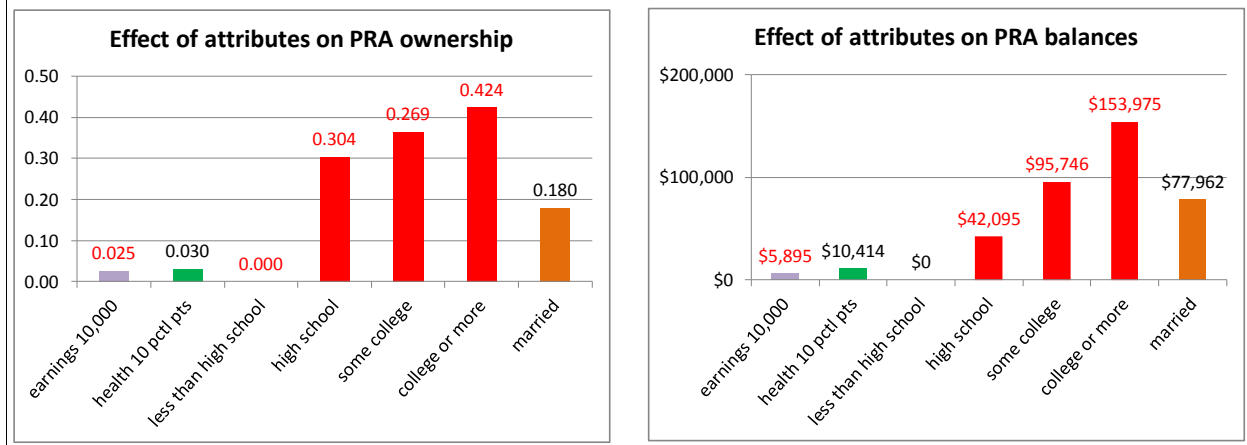


Figure 1-6b. Effect of attributes on PRA ownership and PRA balances, females



Controlling for earnings, the association between education and the PRA balance is also very large. That is, it is not just higher earnings that education delivers; among those with the same level of earnings, those with more education also save more, as is also highlighted in Table 1-5. While a \$10,000 increment in earnings is associated with about a \$6,000 increment in the PRA balance, the effect of education ranges from about \$51,000 for a high school degree (relative to less than a high school degree) to almost \$250,000 for a college degree or more (relative to less than a high school degree). For

both PRA ownership and the PRA balance given ownership, the relationship between these outcomes and a ten percentage point increase in health is approximately equivalent to the effect of a \$10,000 increase in earnings. Men who are married are also substantially more likely than single men to have a PRA and to have larger PRA balances given ownership. The results for women are very similar to the results for men.

2) Disability Insurance Participation

The analysis pertains to persons between the ages of 50 and 62. We exclude persons over the age of 62 because of eligibility for early Social Security benefits at that age. The analysis is based on the 1996 to 2010 waves of the Health and Retirement Study (HRS). There are approximately two years between each wave of the HRS. In each wave we include only those persons who have not previously received DI. We determine (by using the date benefits were first received) whether a person is a first-time recipient of DI benefits over a two-year period. An important consideration is that DI benefits cannot commence until at least five months after the disability onset.⁵ This waiting period means that each pathway variable must be measured at least five months prior to the date at which DI is initially received.⁶ Table 2-1 shows summary data by age of the first receipt of DI for all HRS respondents who ever received DI over the 1996 to 2010 period. The percent receiving benefits is lowest at ages 50 to 53; between ages 54 and 61 the percent is larger and fairly uniform by age.

⁵ Moreover, not all initial applications are approved – about 40-50 percent of all DI recipients were approved after (sometimes multiple) re-application, thus further delaying the receipt of benefits for many eventual recipients.

⁶ Values for each of the pathway variables are obtained in each survey wave. We then look ahead one year to see if the respondent began receiving DI in a two-year window. For example, if a respondent is interviewed on June 1, 2000 we collect values of the pathway variables on this date. Our indicator of DI receipt is whether the respondent began receiving DI in the two-year window between June 1, 2001 and June 1, 2003.

Age	N	percent	cumulative
49	73	2.86	26.39
50	94	3.68	30.07
51	100	3.92	33.99
52	115	4.50	38.49
53	109	4.27	42.76
54	155	6.07	48.83
55	129	5.05	53.88
56	133	5.21	59.08
57	145	5.68	64.76
58	154	6.03	70.79
59	143	5.60	76.39
60	144	5.64	82.03
61	144	5.64	87.67
62	138	5.40	93.07

We emphasize again that education has both direct and indirect effects on DI participation choices. Education may affect DI decisions indirectly by affecting an individual’s health, assets, employment status, or earnings capacity. Education may also have effects on DI choices that do not operate through any of the four pathways we describe; we label this the “direct” effect of education.

Estimation of the Relationship between Education and DI: We estimate three probit specifications to understand the relationship between education and DI participation. The first specification is simply the relationship between DI participation and the level of education, given by:

$$(2-1) \quad DI = s_1LHS_i + s_2HS_i + s_3SC_i + s_4CM_i + \varepsilon_i$$

Here *LHS* represent less than a high school degree, *HS* represent high school degree (or GED equivalent), *SC* represents some college, and *CM* represents a college degree or more. The second specification is the relationship between DI participation and each of the four pathways without controlling for education, given by:

$$(2-2) \quad DI = c + p_1H_i + p_{21}E_{1i} + p_{22}E_{2i} + p_3W_i + p_4A_i + \eta_i$$

In this specification the “employment” pathway is represented by two variables: E_1 indicates whether the respondent was employed and E_2 represents years since the respondent was last employed. The second employment variable is included so that

whether a person was employed is not equated with being out of the labor force for a long period of time. Also, H represents health, W represents weekly earnings (in \$1,000) if employed, and A represents non-annuity assets. Employment, earnings, health, and assets are obtained from the most recent HRS wave that is at least one year prior to the date DI participation is observed. The third specification includes both the pathway effects and indicator variables for level of education which are intended to capture the direct effect of education not accounted for by the pathway variables and is given by:

$$(2-3) \quad DI = c + \tilde{p}_1 H_i + \tilde{p}_{21} EM_{1i} + \tilde{p}_{22} EM_{2i} + \tilde{p}_3 W_i + \tilde{p}_4 A_i + \tilde{s}_1 LHS_i + \tilde{s}_2 HS_i + \tilde{s}_3 SC_i + \tilde{s}_4 CM_i + \mu_i$$

The effect of education through the pathways in specification (2), for example, can be obtained from the following decomposition:⁷

$$(2-4) \quad \frac{dDI}{dE} = \frac{dDI}{dH} \frac{dH}{dE} + \frac{dDI}{dEM_1} \frac{dEM_1}{dE} + \frac{dDI}{dEM_2} \frac{dEM_2}{dE} + \frac{dDI}{dW} \frac{dW}{dE} + \frac{dDI}{dA} \frac{dA}{dE}$$

where, for example, $\frac{dDI}{dH}$ is the estimated marginal effect of H from the probit model (\tilde{p}_1)

and $\frac{dH}{dE}$ is the change in health associated with different levels of education. For this

analysis the $\frac{dH}{dE}$ term is approximated by the difference in health between those without

a high school degree and those with a college degree or more. Thus the effect of

education on DI through the health pathway $\frac{dDI}{dH} \frac{dH}{dE}$ is given by $\frac{dDI}{dH} (H_{CM} - H_{<HS})$. The

effect of education through each of the other pathway is calculated analogously.

Estimated Marginal Effects for the Three Specifications: Table 2-2 shows the estimates (marginal effects) for the three specifications described above. The estimates for specification 1 simply show the total marginal effect of each level of education on the probability of initial DI participation. Men with a college degree or more

⁷ For specification (2) the decomposition is incomplete because it excludes the direct (i.e. not through the pathways) effect of education on DI. However, Tables 2-4 and 3-3 below compare the sum of the pathway effects and the direct effect of education for DI and for early claiming respectively.

are 2.23 percent less likely than those with less than a high school degree to be approved for DI between waves of the HRS. This is a large effect compared to the mean actual probability of DI participation for men with less than a high school degree is of 2.98 percent. Women with a college degree or more are 1.97 less likely to be approved than women with less than a high school degree, again a large effect compared to the mean actual probability of DI participation for women with less than a high school degree of 2.17 percent. We sometimes refer to the total “education effect” as 2.23 percent for men and 1.97 percent for women.

Specification 2 shows the marginal effects of each of the pathway variables without controlling for education. Thus this specification allocates all of the effect of education on DI participation to the pathway variables. For both men and women, all of the pathway variables are statistically significant with the exception of weekly earnings.⁸ Specification 3 includes the pathway variables as well as the education indicators to capture the direct effect of education that does not operate through the pathway variables. This specification minimizes the proportion of the education effect on DI that is captured by pathway variables. The top panel under this specification shows the estimated marginal effect of each pathway variable on DI participation. The bottom panel shows the (direct) effect of education controlling for the pathway variables. Note that for women, after controlling for the effect of the pathway variables, the estimated additional direct effect of education on DI participation is not statistically significant. For men, the direct effect of education is statistically significant for two of the three education levels.

⁸ All dollar amounts are in year 2010 dollars.

Table 2-2. Probit marginal effects for the probability of receipt of DI benefits for persons who did not receive DI benefits in the previous wave, age 50 to 62, by gender, three specifications.

Specification 1. Education only

Variable	Men		Women	
	Estimate	z	Estimate	z
HS	-0.0049	-1.21	-0.0014	-0.42
Some college	-0.0155	-3.30	-0.0059	-1.56
College or more	-0.0223	-4.42	-0.0197	-4.08
Pseudo R ²	0.0329		0.0187	

Specification 2. Pathway variables only

Health	-0.0004	-6.11	-0.0006	-9.00
Not employed	0.0141	3.23	0.0065	2.34
Years since last job	-0.0039	-3.59	-0.0017	-3.75
Weekly earnings (\$1,000's)	-0.0047	-1.83	0.0004	0.75
Assets (\$10,000's)	-0.0001	-2.44	-0.0001	-2.00
Pseudo R ²	0.1075		0.1261	

Specification 3. Pathway variables and education

Health	-0.0004	-5.88	-0.0005	-9.00
Not employed	0.0145	3.32	0.0067	2.32
Years since last job	-0.0039	-3.57	-0.0017	-3.74
Weekly earnings (\$1,000's)	-0.0033	-1.30	0.0007	1.51
Assets (\$10,000's)	-0.0001	-1.88	0.0000	-1.50
High school	-0.0023	-0.58	0.0046	1.26
Some college	-0.0110	-2.36	0.0026	0.64
College or more	-0.0114	-2.20	-0.0062	-1.20
Pseudo R ²	0.1182		0.1316	

Figure 2-1a. Cumulative distribution of the probability of initial DI receipt for persons with less than a high school degree and for persons with a college degree or more, men

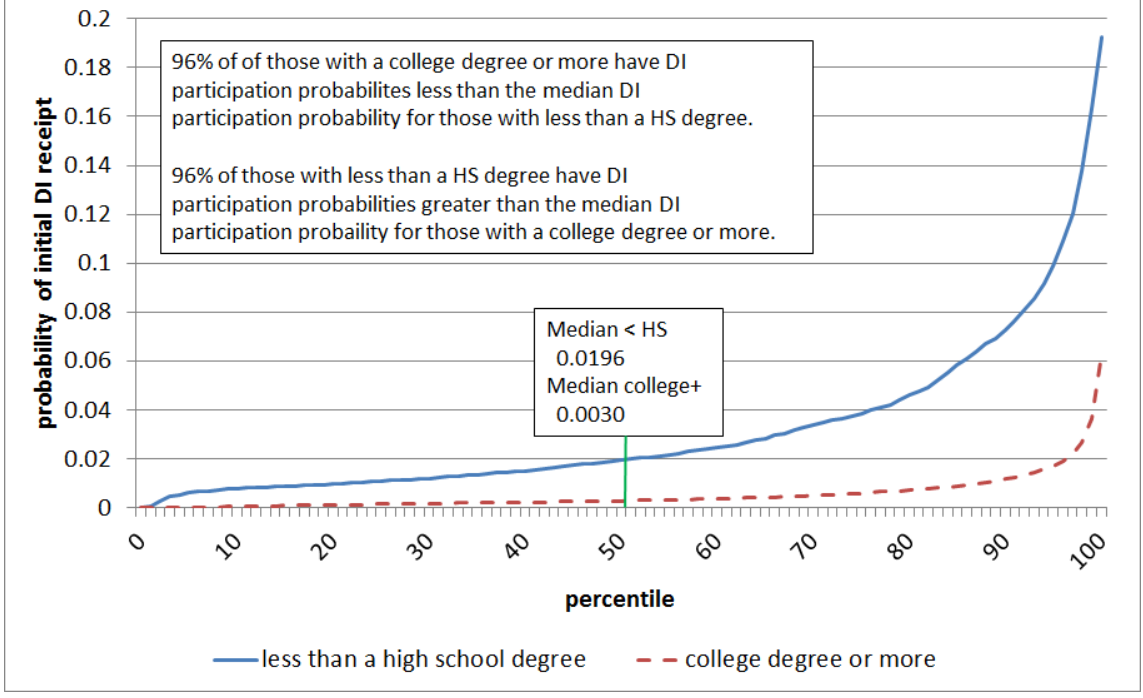
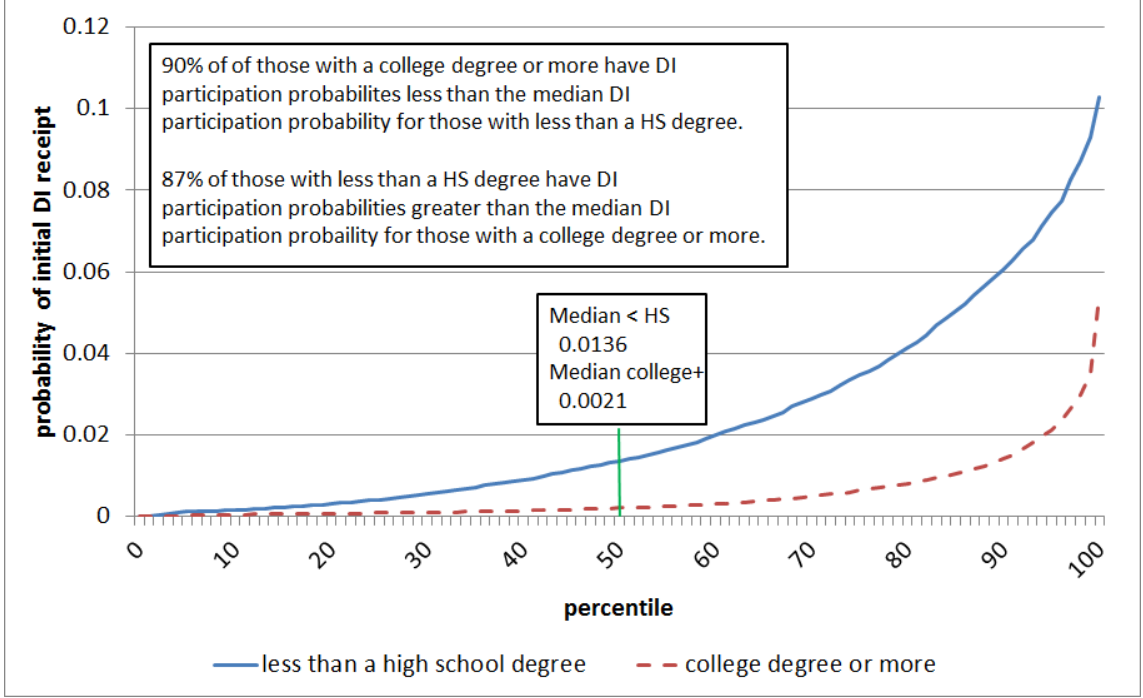


Figure 2-1b. Cumulative distribution of the probability of initial DI receipt for persons with less than a high school degree and for persons with a college degree or more, women



To put these estimates in perspective we have calculated the probability of initial DI participation for persons with less than a high school degree and for persons with a college degree or more, for men and women separately. The cumulative distribution of the probabilities is shown for men and for women in Figures 2-1a and 2-1b respectively. The distributions for the two levels of education are very different for both men and women. For example, the median DI participation rate for men with less than a high school degree is 0.0196 and the median for men with a college degree or more is 0.0030, a 6.6 fold difference. Ninety six percent of those with a college degree or more have participation probabilities that are less than the median for those with less than a high school degree. On the other hand ninety six percent of those with less than a high school degree have participation probabilities that are greater than the median for those with a college degree or more. A similar, though slightly less extreme, pattern can be seen in figure 2-1b for women.

Pathway and Direct Effects of Education: Table 2-3 shows the mean values for each of the pathway variables and the difference between the means of those with less than a high school education and of those with a college degree or more. The differences in the pathway variable means are substantial for each of the pathway variables.

We estimate the effect of education on DI participation through each of the pathways using the decomposition described above. The effect of education E through health H , for example, is given by: $\frac{dDI}{dH} \frac{dH}{dE} = \frac{dI}{dH} (H_{College} - H_{<HS})$. Here dI / dH is the estimated marginal effect reported in Table 2-2 and $(H_{College} - H_{<HS})$ is obtained from the last column of Table 2-3. Thus for specification 2 the pathway effect for health is $-0.0004 \times 13.9 = -0.0053$ for men. This implies that the effect of education through the health pathway accounts for about one half of one percent of the overall difference in DI participation rates between persons with a college degree or more and persons with less than a high school degree.

Table 2-3. Means of variables by level of education					
	Level of education				Difference college+ minus < HS)
	less than high school	high school degree	some college	college or more	
Health					
men	61.0	63.8	65.6	74.9	13.9
women	48.1	58.7	62.0	68.2	20.1
Percent not employed					
men	19.1	15.3	14.0	8.7	-10.4
women	49.1	27.5	23.1	17.6	-31.5
Years since last job					
men	0.65	0.57	0.43	0.21	-0.44
women	2.69	1.73	1.44	1.24	-1.45
Weekly earnings					
men	\$531	\$759	\$952	\$1,708	\$1,177
women	\$212	\$384	\$531	\$931	\$719
Assets					
men	\$195,837	\$339,274	\$468,496	\$903,119	\$707,282
women	\$193,817	\$357,286	\$532,727	\$885,248	\$691,431

These pathway effects are shown in Table 2-4a. For specification 2, the sum of the pathway effects is about 1.7 percent for men and 1.4 percent for women. Based on specification 3, the sum of pathway effects is about 1.3 percent for men and for women. Recall that in specification 3 in Table 2-2 the estimated marginal effects of the education variables are not statistically significant for women. Moreover, the results in Table 2-4a show that for women there is only a small reduction in the sum of the pathway effects when education is included (specification 3) compared to the specification without education (specification 2).

A key finding is that for both men and women few of the estimated coefficients on the pathway variables estimated in specification 2 are changed much when the education variables are added in specification 3. The estimated coefficients on health, not employed, and years since last job – that are estimated precisely in both specifications – are changed by less than 3 percent for both men and women. The estimated coefficients on weekly wage and assets for men are reduced by about 30 percent. The estimated coefficient on assets for women is reduced by about 27 percent.

The coefficient of weekly wage for women is not statistically significant in either specification.

Table 2-4a. Estimates of the effect of education on the probability of initial DI claim through each pathway, by model specification and gender.

<i>Pathways</i>	Model without education dummies (specification 2)		Model with education dummies (specification 3)	
	Men	Women	Men	Women
	Health	-0.0053	-0.0110	-0.0052
Not Employed	-0.0014	-0.0020	-0.0015	-0.0021
Years since Last Job	0.0017	0.0024	0.0017	0.0025
Weekly Earnings	-0.0055	0.0003	-0.0039	0.0005
Assets	-0.0062	-0.0041	-0.0043	-0.0030
Sum pathway effects	-0.0168	-0.0144	-0.0131	-0.0131
Total effect of education from model with educ dummies only	-0.0223	-0.0197	-0.0223	-0.0197

Table 2-4b. Percent of the total effect of education on initial DI participation through each pathway and the direct non-pathway effect, by model specification and gender

<i>Pathways</i>	Model without education dummies (specification 2)		Model with education dummies (specification 3)	
	Men	Women	Men	Women
	Health	23.9%	56.0%	23.1%
Not Employed	6.5%	10.3%	6.7%	10.6%
Years since Last Job	-7.6%	-12.4%	-7.6%	-12.5%
Weekly Earnings	24.6%	-1.5%	17.4%	-2.4%
Assets	27.9%	20.7%	19.1%	15.2%
Sum of pathway effects	75.3%	73.2%	58.7%	66.4%
Non-pathway direct education effect	24.7%	26.8%	41.3%	33.6%
Total effect of education	100.0%	100.0%	100.0%	100.0%

Note: Bold indicates significant at 10% level or better (for included pathway effects).

Table 2-4b shows the pathway and non-pathway effects as a percent of the total effect of education. In specification 2, the pathway effects account for 75.3 percent of

the total education effect for men and 73.5 percent for women. In specification 3, the pathway effects account for 58.7 percent and 66.4 percent of the total effect of education for men and women respectively. In particular, as noted above, few of the pathway percentages change much when the direct effect of education is added to the specification. Although there is a rather close relationship between the level of education and the mean of pathway variables, the correlation between education and each of the pathway variables is not great enough to prevent precise estimation of both direct and indirect effects of education on DI participation.

Decomposition of the Wealth Effect: The level of assets can be expressed as the product of two components – lifetime earnings (LE) and the propensity to save out of lifetime earnings (SP). This decomposition of the effect of education on DI participation is described by:

$$(2-5) \quad \frac{dDI}{dA} \frac{dA}{dE} = \frac{dDI}{dA} \frac{d(LE \times SP)}{dE} = \frac{dDI}{dA} = \frac{dLE}{dE} SP + LE \frac{dSP}{dE} =$$

$$\frac{dDI}{dA} \left\{ (LE_{college} - LE_{<HS}) SP + (SP_{college} - SP_{<HS}) LE \right\}$$

To calculate the LE and SP components, we need lifetime earnings, which we obtain from Social Security records that are available for 66 percent of our sample. The first four columns of Table 2-5 below show mean non-annuity assets, lifetime earnings, and the savings propensity by level of education for the subsample of respondents for whom we have linked earnings records.

Table 2-5. Means of variables by level of education						
Component	Level of education				Difference (College+ minus <	Grand mean
	<HS	HS degree	Some college	College or more		
Assets						
men	\$161,315	\$294,005	\$464,516	\$893,383	\$732,068	\$510,068
women	\$162,588	\$329,985	\$492,801	\$901,785	\$739,197	\$498,566
Lifetime earnings						
men	\$1,037,393	\$1,805,977	\$1,939,314	\$2,264,646	\$1,227,253	\$1,890,004
women	\$1,004,416	\$1,744,898	\$1,879,923	\$2,261,382	\$1,256,966	\$1,825,705
SP (ratio of means)						
men	0.16	0.16	0.24	0.39	0.24	0.270
women	0.16	0.19	0.26	0.40	0.24	0.273

The data in Table 2-5 can be used to calculate the decomposition in equation 2-6. The effects of education attributable to the LE and SP components for specifications 2 and 3 are shown in the Table 2-6 below. Notice first that for specification 2 the sum of the LE and SP components (that together comprise the effect of education on DI participation through the asset pathway) is -0.0069, but the estimated effect of education through the asset pathway in specification 2 is -0.0062 (from Table 2-4a), a difference of 9.9%. The difference is due primarily to the different samples used in the two calculations. For specification 3 the sum of the LE and SE components also differs from the estimated asset effect by 9.9%.

For men, almost 58 percent of the effect of education through the asset pathway is due to the lower saving propensity of those with less education. About 42 percent is due to the lower lifetime earnings of those with the least education. The relative shares accounted for by the LE and SP components are the same for both specifications. For women, about 56 percent of the effect of education through the asset pathway is due to the lower saving propensity of those with the least education and about 44 percent to the lower lifetime earnings of those with the least education.⁹

⁹ Note that the shares have to be the same for specifications 2 and 3, as can be seen in the last line of equation 2-6— dDI / dA is different for specifications 2 and 3, but the rest of the equation (the part used to calculate the shares) is identical for both specifications.

Table 2-6. Comparison of decomposition estimates with specifications 2 and 3 estimates

	men		women	
	Calculated values and estimates	Percent of total	Calculated values and estimates	Percent of total
Using specification 2 coefficients				
LE component	-0.0029	42.2%	-0.0020	44.2%
SP component	-0.0040	57.8%	-0.0026	55.8%
Total	-0.0069		-0.0046	
Specification 2 estimate	-0.0062		-0.0041	
Difference decomposition vs. estimates	9.9%		10.9%	
Using specification 3 coefficients				
LE component	-0.0020	42.2%	-0.0015	44.2%
SP component	-0.0027	57.8%	-0.0019	55.8%
Total	-0.0047		-0.0034	
Specification 3 estimates	-0.0043		-0.0030	
Difference decomposition vs. estimates	9.9%		10.9%	

The Changing Effect of Education over Time: We want to simulate the probability of DI participation for persons with less than a HS degree and those with a college degree or more for each HRS wave from 1996 and 2008. In doing this, we assume that the estimated marginal effect of each pathway variable shown in Table 2-2 remains constant over time. Thus any change in the relationship between education and DI participation will be due to changes in the pathway variables over time. To illustrate, Table 2-7 shows the effect of education through each pathway for persons in 1996 (top panel) and 2008 (bottom panel). The calculations are for men based on specification 3. The first two columns in each panel show mean values of each of the pathway variables for persons without a high school degree and for persons with a college degree or more. The third column shows the difference between those with less than a high school degree and those with a college degree or more. Notice that the difference between the college or more group and the less than high school group increased between 1996 and

2008 for three of the pathway variables: health, assets, and the likelihood of not being employed. The result is an increase in the effect for each of these pathway variables shown in the last column – the product of the marginal effect of each pathway variable shown in column 4 and the difference between levels of education shown in column 3 – and a 25 percent increase in the sum of the pathway effects, from -0.0107 in 1996 to -0.0138 in 2008. These data show that over the 12 year interval between 1996 and 2008, the likelihood of initial DI receipt has increased more for the less educated than for the highly educated. This divergence is due, in substantial part, to the widening gaps in health, assets, and employment between those with more and less education.

Table 2-7. Pathway effects in 1996 and 2008, for men					
pathway	< HS	college or more	difference	coefficient	pathway effect
1996					
health	61.4	75.2	13.8	-0.00037	-0.0051
not employed	21.9	11.4	-10.5	0.01447	-0.0015
years on last job	0.76	0.25	-0.51	-0.00390	0.0020
weekly earnings	\$534	\$1,452	\$918	-0.00329	-0.0030
assets	\$167	\$671	\$504	-0.00006	-0.0030
sum of pathway effects					-0.0107
2008					
health	58.1	73.7	15.6	-0.00037	-0.0058
not employed	26.2	13.1	-13.1	0.01447	-0.0019
years on last job	0.61	0.24	-0.37	-0.00390	0.0014
weekly earnings	\$461	\$1,328	\$867	-0.00329	-0.0029
assets	\$197	\$975	\$778	-0.00006	-0.0047
sum of pathway effects					-0.0138

We can also use the parameter estimates to simulate the probability of initial receipt of DI by year for those with less than a HS education and those with a college degree or more. These simulated probabilities are shown in Table 2-8 for each of the HRS waves between 1996 and 2008. For men with less than a HS degree the probability of initially receiving DI is 3.1 percent in 1996 and 3.9 percent in 2008, an increase of over 27 percent. The probability of initial DI receipt was virtually unchanged for college graduates over this same period. The pattern for women is similar.

Note that these probabilities could be calculated directly from the data used in the estimation. There are, however, advantages to the simulated probabilities. One is that the simulated probabilities show the effect of changes over time in the levels of pathway variables shown in Table 2-7 for members of each education group. Recall that we assume that the estimated marginal effect of each pathway variable shown in Table 2-2 remains constant over time and thus that any change in the relationship between education and DI participation is due to changes in the pathway variables over time. Another advantage is that the simulated probabilities are smoother and, unlike the probabilities calculated directly from the data, they are not subject to small sample variation. Perhaps the most important advantage is that the simulations demonstrate that if we had estimates of pathway variable differences like those in Table 2-7, from any source, we would be able to simulate DI participation in earlier years, even in the absence of data on DI participation, if we assume that the education effects that we estimate for the post-1996 period also apply to earlier years.

Table 2-8. Simulated probability of initial receipt of DI in each year, for men and women

year	Men		Women	
	less than HS degree	college or more	less than HS degree	college or more
1996	0.031	0.006	0.022	0.005
1998	0.030	0.005	0.019	0.005
2000	0.029	0.005	0.023	0.005
2002	0.031	0.006	0.022	0.006
2004	0.033	0.005	0.025	0.006
2006	0.035	0.006	0.026	0.006
2008	0.039	0.006	0.029	0.006

Finally, Table 2-9 shows the correspondence between the simulated DI probabilities and the actual probabilities. With the exception of the initial receipt of DI at ages 51 and 52, the actual and the simulated values are quite close. The sample sizes for ages 51 and 52 are very small and a large fraction of the sample at these ages is composed of younger wives of men selected as HRS respondents. The estimated probabilities for these two ages lead to a small difference in the cumulated probabilities from age 50 to age 62. There is no difference in the cumulated probabilities from age 53 to age 62.

Table 2-9. Fit: probability of initial receipt of DI at each age and cumulative over ages, actual and predicted

Age	Probability of DI over two years*		Cumulative from age 50**		Cumulative from age 53**	
	predicted	actual	predicted	actual	predicted	actual
50	0.012	0.015	0.012	0.015		
51	0.013	0.004	0.018	0.017		
52	0.013	0.007	0.025	0.021		
53	0.013	0.012	0.031	0.027	0.013	0.012
54	0.013	0.013	0.037	0.033	0.019	0.018
55	0.013	0.013	0.044	0.039	0.026	0.025
56	0.014	0.015	0.051	0.047	0.033	0.032
57	0.015	0.013	0.058	0.054	0.040	0.039
58	0.015	0.015	0.066	0.061	0.048	0.047
59	0.016	0.020	0.074	0.071	0.055	0.056
60	0.017	0.017	0.082	0.079	0.064	0.065
61	0.016	0.019	0.091	0.089	0.072	0.074
62	0.016	0.013	0.098	0.095	0.080	0.080

* The probability shown is the probability that a person will begin to receive DI over the next two years.

** Calculation of the cumulative assumes that the probability of DI receipt over a one year period is half that of the two-year probability

3) Early Claiming of Social Security Benefits

Estimated Marginal Effects of Three Specifications: The analytic approach we follow to understand the relationship between education and early claiming of Social Security benefits is the same as the approach followed in the analysis of DI participation. We begin by estimating three specifications analogous to the specifications estimated for DI participation. The dependent variable is whether a person begins receiving early Social Security benefits (at ages of 62, 63, or 64). The pathway variables are measured in the most recent HRS wave prior to becoming eligible for early benefits at age 62.

The results are reported in Table 3-1. Specification 1, including only education indicator variables, shows that men with a college degree or more are over 25 percent less likely to claim Social Security benefits early than men with less than a high school degree. Women with a college degree or more are almost 27 percent less likely to claim Social Security benefits early than women with less than a high school degree. (The

probabilities for men are 40.4 for those with a college education or more and 65.9 percent for those with less than a high school degree. The probabilities for women are 57.3 and 70.6 percent respectively.)

Table 3-1. Probit marginal effects for the probability of early receipt of SS benefits, by gender, three specification.

Variable	Men		Women	
	Estimate	z	Estimate	z
Specification 1. Education only				
HS	-0.1010	-2.60	-0.0913	-2.89
Some college	-0.1385	-3.34	-0.1871	-5.52
College or more	-0.2536	-6.58	-0.2653	-7.64
Pseudo R ²	0.0205		0.0241	
Specification 2. Pathway variables only				
Health	-0.0005	-0.94	-0.0016	-4.18
Not employed	0.1266	3.82	0.0622	1.95
Years since last job	0.0445	11.20	0.0325	9.32
Weekly earnings (\$1,000	-0.0394	-2.32	-0.1068	-2.52
Assets (\$10,000's)	-0.0003	-1.99	-0.0002	-1.59
Pseudo R ²	0.1231		0.1331	
Specification 3. Pathway variables and education				
Health	-0.0001	-0.17	-0.0014	-3.54
Not employed	0.1302	4.00	0.0479	1.65
Years since last job	0.0434	11.18	0.0329	9.36
Weekly earnings (\$1,000	-0.0338	-2.15	-0.0913	-2.47
Assets (\$10,000's)	-0.0001	-0.82	0.0000	-0.13
HS	-0.0905	-2.56	-0.0601	-2.02
Some college	-0.1112	-2.88	-0.1143	-3.50
College or more	-0.1844	-4.82	-0.1807	-4.95
Pseudo R ²	0.1331		0.1437	

Data are from the 1998 - 2010 waves of the HRS. Pathway variables are from last wave before age 62

Specification 2 includes only pathway variables and thus assumes that all of the influence of education on early retirement is through the pathway variables. Perhaps most striking is that for men, the effect of health on early retirement is not statistically

significant. The estimated coefficient on health for women is much larger than for men and highly significant.

Specification 3 allows education to influence retirement through the pathway variables, but also includes education indicators to capture the direct effect of education not accounted for by the pathway variables. This specification minimizes the proportion of the education effect on early claiming that is captured by the pathway variables. The top panel under this specification shows the estimated marginal effect of each pathway variable on early claiming. The bottom panel shows the (direct) effect of education controlling for the pathway variables.

Three results stand out. First, the direct effect of education is statistically significant and large (about 18 percentage points between the highest and lowest levels of education) for both men and women. The direct effect of education on the early claiming of Social Security benefits may arise if, for example, persons with more education are in occupations that provide more job satisfaction or are in occupations that are less physically demanding or are more attached to their jobs than those with less education.

Second, despite the large and significant direct effect of education, few of the estimated coefficients on the pathway variables change much when the education variables are added in specification 3, and most of the coefficients that change substantially were not statistically significant in specification 2.

Third, when the direct effect of education is added in specification 3, the small estimated effect of assets on the early claiming of Social Security benefits in specification 2 is essentially zero in specification 3. The estimated effect of assets is likely to be biased downward because of error in the measurement of assets. However, experimentation with different approaches to trim asset “outliers” does not yield large or more precise estimates of the effect of assets on early claiming.

Pathway and Direct Effects of Education: Table 3-2 shows the *mean* values of the pathway variables by level of education for both men and women observed in the wave just before the age of eligibility for early Social Security benefits. It is clear that there is a strong relationship between the *mean* level of education and each of the pathway variables, with the exception of years since last job for women. The differences

in the *means* between those with a college degree or more and those with less than a high school degree are substantial.

	Level of education				Difference College+ minus < HS)
	less than high school	high school degree	some college	college or more	
Health					
men	55.4	59.4	61.7	70.3	14.9
women	45.5	54.6	58.3	64.7	19.2
Percent not employed					
men	26.5	23.7	25.5	20	-6.5
women	57.7	40.5	31.3	29.1	-28.6
Years since last job					
men	2.34	2.52	2.08	1.75	-0.59
women	3.17	3.39	2.83	3.13	-0.04
Weekly earnings					
men	\$506	\$625	\$781	\$1,279	\$774
women	\$179	\$274	\$425	\$660	\$481
Assets					
men	\$209,756	\$409,913	\$616,562	\$1,023,354	\$813,598
women	\$228,582	\$431,038	\$620,725	\$962,932	\$734,350

Note: Data are from the 1998 - 2010 waves of the HRS. Pathway variables are from last wave before age 62

Table 3-3a shows estimates of the effect of education through each of the pathway variables and the sum of these pathway effects for specifications 2 and 3. To estimate the effect of education through each of the pathways, we follow the same approach we used in analyzing DI participation. Recall that the effect of education E on the early claiming of Social Security benefits (SS) through health H , for example, is given by: $\frac{dSS}{dH} \frac{dH}{dE} = \frac{dSS}{dH} (H_{College} - H_{<HS})$. Here dSS / dH is the estimated marginal effect reported in Table 3-1 and $(H_{College} - H_{<HS})$ is obtained from the last column of Table 3-2.

For both men and women the sum of the pathway effects is about 25 percent lower when education is added to the specification. In both specifications the sum of the pathway effects is somewhat greater for women than for men.

Table 3-3a. Estimate of the effect of education on the probability of early receipt of SS benefits through each pathway, by model specification and gender.

Pathway and education effects	Model without education dummies (specification 2)		Model with education dummies (specification 3)	
	Men	Women	Men	Women
<i>Pathways:</i>				
Health	-0.0068	-0.0315	-0.0012	-0.0267
Not Employed	-0.0083	-0.0177	-0.0085	-0.0137
Years since Last Job	-0.0262	-0.0011	-0.0255	-0.0011
Weekly Earnings	-0.0305	-0.0514	-0.0261	-0.0439
Assets	-0.0216	-0.0140	-0.0088	-0.0012
Sum of pathway effects	-0.0933	-0.1158	-0.0702	-0.0867
Total effect of education from model with educ dummies only	-0.2536	-0.2653	-0.2536	-0.2653

Table 3-3b. Percent of the total education effect on probability of early receipt of SS benefits accounted for by each pathway, by model specification and gender

Pathway and non-pathway	Model without education dummies (specification 2)		Model with education dummies (specification 3)	
	Men	Women	Men	Women
<i>Pathways:</i>				
Health	2.7%	11.9%	0.5%	10.1%
Not Employed	3.3%	6.7%	3.3%	5.1%
Years since Last Job	10.3%	0.4%	10.1%	0.4%
Weekly Earnings	12.0%	19.4%	10.3%	16.6%
Assets	8.5%	5.3%	3.5%	0.5%
Sum of pathway effects	36.8%	43.6%	27.7%	32.7%
Non-pathway direct education effect	63.2%	56.4%	72.3%	67.3%
Total effect of education	100.0%	100.0%	100.0%	100.0%

Note: Bold indicates significant at 10% level or better (for included pathway effects).

For the most part, however, the estimated effect of education through the pathway variables is not changed greatly when education is controlled for. For women the estimated effect of education through three pathway variables – health, weekly

earnings, and years since last job – is changed by 15 percent or less; for the not employed variable the reduction is 23 percent. For men the change for three pathways – weekly earnings, not employed, and years since last job – is 14 percent or less. For men the effect of health is reduced from -0.0068 to -0.0012 when education is added, but health is not an important determinant of the pathway effects in either specification. However, health is very significant for women. Comparing specifications 2 and 3 for men, the only other substantial change is the reduction in the effect of education through assets when education is added; the effect of assets is reduced from -0.0216 to -0.0088. For women, the asset pathway also becomes less important when the education variables are added; the effect of assets is reduced from -0.0140 to -0.0012.

In short, there is an important direct effect of education on the early claiming of Social Security benefits, but the addition of education has only a modest effect on the estimated effect of education through most of the pathway variables. The pathway variable most affected is the reduction in the estimated effect of wealth, and that effect is greatest for men. The effect through health is also reduced for men, but health is not an important component of the total pathway effect for men.

Table 3-3b is similar to Table 3-3a but shows the pathway and non-pathway effects as a percent of the total effect of education. In specification 2, the effect of education through the pathways accounts for 36.8 percent of the total effect of education for men and 43.6 percent for women. In specification 3, the pathway effects account for 27.7 percent and 32.7 percent of the total effect of education for men and women respectively. Note again, however, that most of the pathway percentages are changed only modestly when the direct effect of education is introduced – the same percentage changes as discussed above with respect to Table 3-3a. In particular, similar to the results for DI participation, although the data in Table 3-2 suggest a rather close relationship between the level of education and the mean of the pathway variables, the correlation between the individual pathway values and the level of education variables is not great enough to prevent us from estimating both the direct and indirect (pathway) effects of education on the early claiming of Social Security benefits.

The finding that assets have essentially no effect on the early claiming of Social Security at all when the direct effect of education is controlled for seems surprising. In most retirement models (Gustman and Steinmeier (1986), Stock and Wise (1990), Rust and Phelan (1997), and Blau (2008) for example) assets affect the retirement decision. Perhaps this is because these models do not include education in the specification. When education is controlled for in a regression analogue of the option value model, the effect of assets on retirement is insignificant. See for example Coile (2014), Banks, Emerson, Tetlow (2014), and other papers in Wise (forthcoming).

Finally, Table 3-4 shows actual and predicted proportion claiming early Social Security benefits by level of education. The fit is very close.

Table 3-4. Probability of early Social Security receipt by gender and level of education, all years mean, actual and predicted							
Gender	Level of education					All	Diff: College+ <HS
	Less than HS	HS degree	Some college	College or more			
Actual							
Men	0.6587	0.5594	0.5213	0.4044	0.5170	-0.2543	
Women	0.7057	0.6186	0.5205	0.4390	0.5727	-0.2667	
Predicted							
Men	0.6593	0.5594	0.5172	0.4013	0.5153	-0.2580	
Women	0.7035	0.6186	0.5204	0.4332	0.5712	-0.2703	

4) Summary and Discussion

The goal of this paper is to draw attention to the long lasting influence of education. To illustrate this influence we focus on the relationship between the level of education and two routes to early retirement – the Social Security Disability Insurance program (DI) and the early claiming of Social Security retirement benefits. These routes are followed disproportionately by those who are typically ill-prepared to work longer because of health or other reasons. Of men with less than a high school degree, 27 percent are approved for DI between the ages 50 and 62; of those with a college degree or more only 5 percent in this age range are approved for DI. Of men with less than a high school degree who are not on DI at age 62, 66 percent claim Social Security

benefits before the normal retirement age; of those with a college degree or more, 40 percent take Social Security benefits early. The percentages are similar for women

For both routes to retirement we focus on four critical pathways – health, employment, earnings, and the accumulation of assets – through which education may indirectly influence DI and early retirement decisions. We emphasize that in addition to these indirect effects of education through the pathways, education may also have an additional direct effect on both routes to retirement that does not operate through the designated pathways. Both the direct and indirect effects are estimated.

The analysis of DI participation considers the probability that a person between the ages of 50 and 62 is first approved for DI between the approximate 2-year intervals between waves of the Health and Retirement Study (HRS) from 1996 to 2010. The early claiming of Social Security benefits is also based on HRS data, but considers whether a person not on DI at age 61 begins receiving early Social Security benefits (at the ages of 62, 63, or 64).

We find that the median simulated initial DI participation rate over a two-year HRS interval for men with less than a high school degree is 0.0196 and the median for men with a college degree or more is 0.0030, a 6.6 fold difference. The DI participation rate for women with less than a high school degree is 0.0136 and the median for women with a college degree or more is 0.0021, a 6.5 fold difference. Men with a college degree or more are over 25 percentage points less likely to claim Social Security benefits early than men with less than a high school degree. Women with a college degree or more are almost 27 percentage points less likely to claim Social Security benefits early than women with less than a high school degree.

One way to summarize key findings is by the proportion of the total effect of education that is accounted for by the influence of education through the pathways (indirect effect) and the proportion accounted for by the direct effect of education. These proportions are shown for DI (top panel) and early Social Security claiming (bottom panel) in the accompanying tabulation. Two sets of proportions are shown: those on the left pertain to a model specification that does not control for the level of education and those on the right control for the level of education. Essentially, these two sets of estimates reflect the upper and lower bounds of the effect of education through the

Percent of total effect of education accounted for by pathway effects and by the direct effect of education				
	Without education levels		With education levels	
	Men	Women	Men	Women
Disability Insurance				
Pathway effects	75.3%	73.2%	58.7%	66.4%
Direct effect	24.7%	26.8%	41.3%	33.6%
Early Claiming of Social Security Benefits				
Pathway effects	36.8%	43.6%	27.7%	32.7%
Direct effect	63.2%	56.4%	72.3%	67.3%

pathway variables. These results highlight the importance of the indirect effect of education. For example, Table 1-1 shows that for both men and women education is strongly related to DI participation.

For women, however, the estimates suggest that it is only the indirect effect of education that influences DI participation; controlling for the pathways – health, employment, wage, and assets – the direct effect of education is not statistically significant. Thus it is not only the level of education itself that matters but the relationship between education and the pathways, all important determinants of life satisfaction more broadly. The relative effect of education on DI through the pathways is somewhat less for men but still very important, and much less for early claiming of Social Security benefits for both men and women.

We emphasize two features of these estimates. First, the effect of education through the pathways is substantially larger for DI participation than for early Social Security claiming, whether education is controlled for or not. The estimates in the left panel suggest that the pathway variables account for 75.3 percent of the total effect of education on DI participation for men and 73.2 percent of the total effect for women. Comparable percentages for the early Social Security claiming decision are 36.8 percent and 43.6 percent. Estimates controlling for the level of education (right panel) also show that the effect of education through the pathways is also greater for DI than for early claiming. Second, the percent accounted for by the pathway effects is lower when the direct effect of education is allowed for (by including education levels in the estimation specification). The smallest reduction is for DI participation for women – 73.2 to 66.6 percent. Indeed, the estimated direct education effects for women, on which this difference is based, are not significantly different from zero.

Perhaps the most important finding is that for both DI and early claiming, few of the estimated coefficients on the pathway variables estimated in the specification without the direct effect of education (education levels) are changed much when the education variables are added to the specification. In particular, although there is a rather close relationship between the level of education and the mean of pathway variables, the correlation between education and each of the pathway variables is not great enough to prevent precise estimation of both direct and indirect effects of education on DI participation. That is, it is evident that the influence of education on DI participation and on the early claiming of Social Security benefits occurs both indirectly through the four pathways as well as directly, not by way of the pathways.

There are two perhaps unexpected findings with respect to early claiming of Social Security benefits. One is that health is not an important determinant of early claiming for men, although we find that health is an important determinant for women. The second unexpected finding is that non-annuity assets are not an important determinant of the early claiming of Social Security benefits. On the other hand we find that the direct effect of the level of education is a very important determinant of early claiming of Social Security benefits.

How should we interpret the direct effect of education on the early claiming of Social Security benefits? As noted in the body of the paper, the direct effect of education on early claiming may arise for example if persons with more education are in occupations that provide more job satisfaction or are in occupations that are less physically demanding, are more attached to their jobs than those with less education, or have more opportunities for continued work in their 60's. In other words, as we know, the job a person has is determined in large part by that person's level of education. These features of occupations are also picked up in part by the earnings and employment pathways which are strongly related to the job a person has and likely the health pathway as well. We could include more pathways such as life expectancy, as mentioned above, or prior job, which is highly related to the earnings and employment pathways, for example. Thus it seems difficult to decide what relevant additional pathways might be. In sum, we believe that the parsimonious specification we use provides an informative description of the importance of education in DI participation

and in early claiming of Social Security benefits. The importance of education in these routes to retirement is of course only one of many influences of education that might be used to illustrate the long arm of education.

The key findings of the paper seem robust to alternative presentations of the data. The effect of education on early retirement is huge. Most of the effect of education on DI participation is indirect through the effect of education on health, wealth, earnings and employment. Most of the effect of education on the early claiming of Social Security benefits is accounted for by the direct effect of education and not indirectly by way of the effect of education through the health, wealth, earnings, and employment pathways.

Appendix on Measuring Health

Our analysis depends critically on measuring health status. We use a health index that is based on respondent-reported health diagnoses, functional limitations, medical care usage, and other indicators of health contained in the HRS. We use the first principal component of the 27 indicators of health status that are shown in Appendix Table 1. The first principal component is the weighted average of the health indicators where the weights are chosen to maximize the proportion of the variance of the individual health indicators that can be explained by this weighted average. The variables in the table are ordered by the principal component loadings.

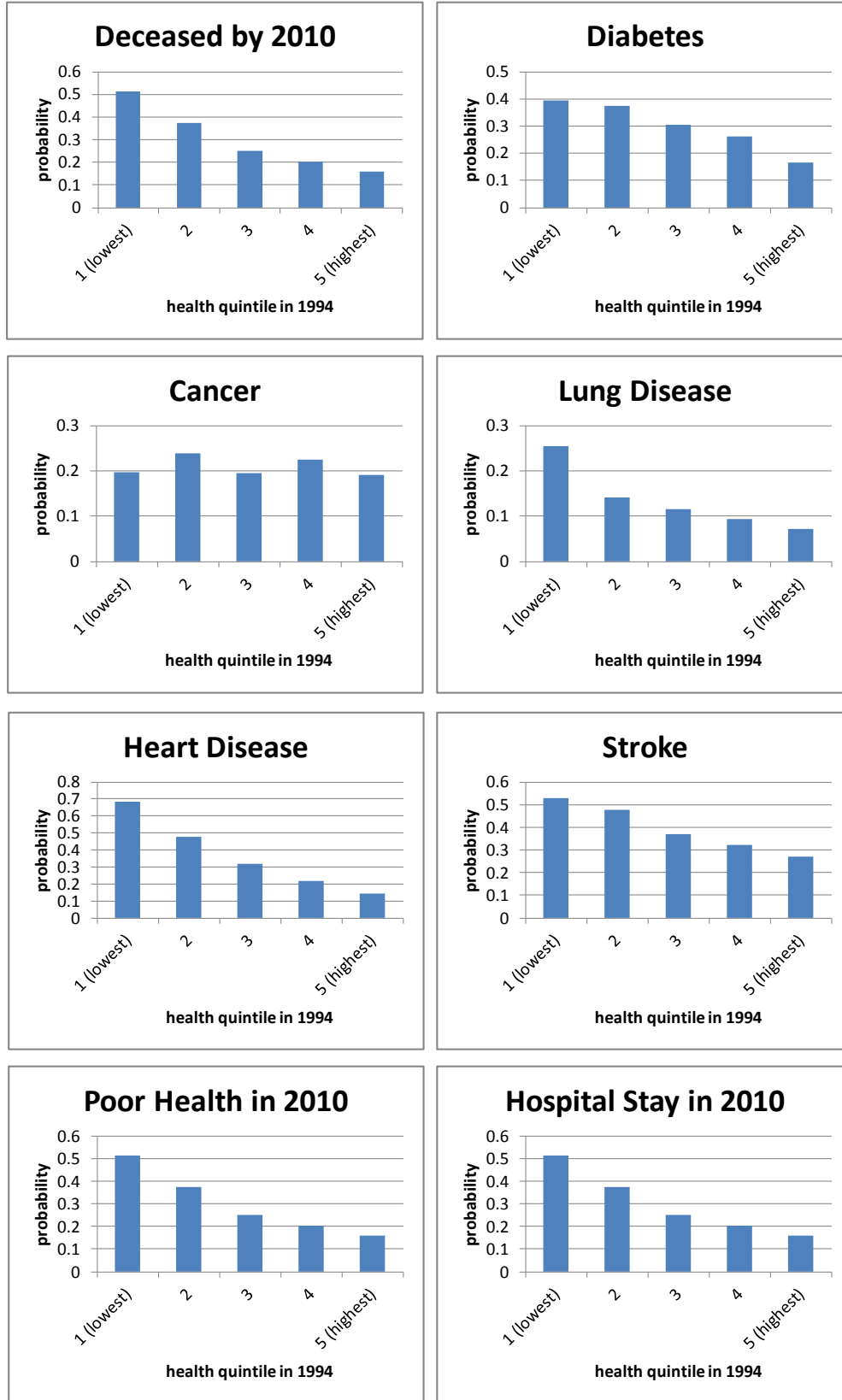
Appendix Table 1. Health index weights (principal component loadings)	
Variable	Loading
Difficulty walking several blocks	0.294
Difficulty lift/carry	0.277
Difficulty push/pull	0.272
Difficulty with an ADL	0.267
Difficulty climbing stairs	0.261
Health problems limit work	0.259
Difficulty stoop/kneel/crouch	0.257
Self-reported health fair or poor	0.255
Difficulty getting up from chair	0.248
Difficulty reach/extend arms up	0.210
Health worse in previous period	0.208
Difficulty sitting two hours	0.184
Ever experience arthritis	0.183
Difficulty pick 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

This index used here is identical to that used in Heiss, Venti and Wise (2014) and is an updated version of the index used in Poterba, Venti and Wise (2013a). Prior work has shown that separate estimates of the index for each wave of the HRS produce similar factor loadings, so this version of the index pools all waves. We have also combined men and women based on the similarity of factor loadings. We use data from all five HRS cohorts spanning the years 1994 to 2010 to estimate the principal component index.¹⁰ The estimated coefficients are used to predict a “raw” health score for each respondent. For presentation purposes we convert these raw scores into percentile scores for each respondent at each age.

The health status index that we use in this paper is a cardinal measure. It has several important properties. 1) It is strongly related to the evolution of assets, as shown in Poterba, Venti and Wise (2013a). 2) It is strongly related to mortality. The upper left panel of Appendix Figure 1, abstracted from Heiss, Venti and Wise (2014) shows the relationship between the health index in 1994 and mortality in 2010 for members of the HRS cohort. Among those in the poorest health in 1994, approximately 51 percent are deceased by 2010. Among persons in the best health only about 16 percent are deceased by 2010. 3) It is strongly predictive of future health events such as stroke and the onset of diabetes, as is also shown in the remaining panels of Appendix Figure 1. The index value in 1994, however, has little predictive power for future episodes of cancer. 4) It is strongly related to economic outcomes prior to 1994, such as earnings, and to economic outcomes in later years.

¹⁰ The full set of questions was not asked of all respondents for the HRS cohort in 1992 and the AHEAD cohort in 1994. Thus we have excluded all data for these two cohorts.

Appendix Figure 1. Probability of health events by 2010 by health quintile in 1994, all persons age 53 to 63 in 1994



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