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Life-cycle Effects of Health Risk

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Abstract

This paper studies four channels through which health affects individuals: (1) productivity, (2) medical expenditures, (3) available time and (4) survival probabilities, and assesses their roles in determining labor supply, asset accumulation and welfare. Using a life-cycle model calibrated to the U.S. for different education groups, I evaluate the relative importance of each channel and quantify the interactions between them. First, all four channels are important for the macroeconomic variables studied, but the productivity and time endowment channels are the most dominant. I also show that due to significant interactions between channels, they need to be studied within a unified framework over the entire life-cycle. Second, health has larger effects for the non-college than college educated, explaining 35% and 31% of the differences in labor supply and degree of reliance on government transfers across groups, respectively. Health risk accounts for 9% of disposable income inequality for the non-college educated, leading to larger fractions of precautionary savings for this group despite the presence of a consumption floor.[1]

JEL Classification Codes: D91, E21, I14, I31
Keywords: Health, Life Cycle Models, Precautionary Saving, Welfare

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1 Introduction

Concerns regarding financing medical care in the face of aging populations and rising health care costs have led to a rapidly expanding life-cycle model literature incorporating health risk (e.g., Attanasio et al. (2010), French (2005), French and Jones (2011), Hall and Jones (2007), Jung and Tran (2011), Kopecky and Koreshkova (2011), De Nardi et al. (2010), Ozkan (2011), and Palumbo (1999)). This paper builds on the existing literature and attempts to provide a better understanding of the channels through which health and health risk affect individuals and their economic decisions over the life-cycle. The aim is to study the four main channels through which health affects individuals: (1) productivity, (2) medical expenditures, (3) available time and (4) survival probabilities, and to assess their roles in determining labor supply, asset accumulation and welfare, evaluating the relative importance of each channel and quantifying the interactions between them using a life-cycle model calibrated to the U.S. for different education groups.

Statistics indicate that all these four channels are important. For example, 8.4% of working age men report having a health problem or a disability preventing them from working or limiting the kind or amount of work. On average, men in poor health spend between 5 and 10 times as much on medical goods and services as those in good or excellent health, depending on age group. Statistics from the 2010 American Time Use Survey show that men who purchase medical and care services spend on average 1.65 hours per day in this activity, and those who engage in health related self-care (excluding exercise) spend on average 1.5 hours per day, thus limiting the time available for leisure and work. Finally, statistics on survival rates show health risk is closely linked to survival uncertainty: for example, a 65 year old male in poor health has a 7% chance of death within the year compared to only 0.6% for a male in good or excellent health.[2]

French and Jones (2011) is the only existing paper to model all four channels, but since the object of interest is retirement behavior, their paper studies the effects of health on labor supply around retirement age only. Other papers incorporate some but not all four channels, so questions remain regarding which channels are important to model for different economic outcomes and stages of life-cycle.[3] This paper aims to fill this gap in the literature. An important feature here is to study health effects over the entire life-cycle in a unified framework. Lower earnings caused by bad health occur at the same time when required medical expenses increase. A diminished productivity and a decrease in available time due to bad health could force individuals to take time off work, losing income and employer sponsored health insurance precisely when they need it most. The

[2]The statistic on work limitations is calculated using CPS data. Medical expenditures are calculated from the Medical Expenditure Panel Survey, and survival rates are calculated using the Health and Retirement Survey.

[3]For example, French (2005) does not model medical expenditures, Attanasio et al. (2010) do not model the time endowment effect, and Hubbard et al. (1995) do not model the productivity effect nor the time endowment effect. In addition, papers that study health effects before retirement do not look at the importance of individual channels. De Nardi et al. (2010) and Kopecky and Koreshkova (2011) study individual channels, but only after retirement age.

joint occurrences of these effects suggest that it is important to consider how they interact.

There are several motivations for this study. First, evaluating the importance of the four channels contributes to our understanding of why good health is valuable for different education groups, and this is relevant for the branch of literature studying individuals' decisions to invest in health over the life-cycle and for assessing the benefits of government interventions directed at improving health outcomes in different groups. Second, a better understanding of the four channels could aid in the design of policy that lowers the negative effects of bad health by guiding it towards the most important channels. For example, if medical expense risk had the largest welfare effects, efforts should be concentrated on better insuring medical expenses, whereas if health induced productivity risk was the most important, more efforts could be invested in ensuring affected workers had access to paid sick leave or disability insurance. Third, the results may be used as a guide for future research on health risk since they show which channels are the most important to model for different economic outcomes, at different stages of life-cycle, for different education groups.

The framework used is a standard Bewley (1986) life-cycle model with incomplete markets and uninsurable income risk augmented with health shocks as previously done in French and Jones (2011). Since it is important to match the degree of health risk observed in the data, I model partial insurance through a consumption floor, Medicaid and Medicare programs, and employer sponsored health insurance, and study how these mediate the transmission of health effects to individuals. I calibrate the model to the U.S. using data on males, separately for college and non-college education groups, explicitly studying differences between them. The model approximates well government transfers statistics and life-cycle earnings, labor supply and asset profiles observed in the data, enabling me to study the effects of health risk on these variables.

First, I show that health has large implications for the macroeconomic variables studied through all four channels, and that due to significant interactions between them, they need to be studied within a unified framework over the entire life-cycle. However, the productivity and time endowment channels dominate in importance when studying labor supply and welfare and the risks implied by these two channels are the most important in generating income inequality and precautionary savings during working life, whereas medical expenditure risk becomes important only after retirement. Second, the paper shows that the non-college population is subject to much larger health risks than the college population due to their higher probabilities of bad health at any age, the smaller fraction of non-college graduates who have health insurance, and larger productivity drops associated with bad health. In addition, at the lower income levels of the non-college group, fluctuations in incomes and time endowments caused by health imply larger utility changes, making health risk more important. Overall, I find that health effects account for 35% of the difference in labor supply between education groups and for 31% of the difference in the fraction of government transfer recipients observed in the data.

Health induced productivity and time costs are very important for labor supply and asset accumulation decisions during the working stage of life. For example, in the absence of these two effects, non-college labor supply would be 12% higher. Health risk has large effects on asset accumulation since overall, it accounts for 9.4% of disposable income inequality for the non-college group. The risk implied by health's effects on productivity and available time generates large precautionary savings especially for the lower income group since relying on the consumption floor during periods of bad health when leisure time is also low is associated with extremely low utility levels. The risk generated by these two channels accounts for 17% of asset accumulation before the age of 60 for the non-college educated. Finally, health effects have extremely large impacts on welfare: the non-college group's CEV is 17.7% in the absence of productivity, time and medical costs associated with bad health and the college group's CEV is 7.3%. However, fluctuations around the average health levels within age-education groups have relatively small welfare effects (the removal of health risk around average health levels leads to welfare improvements of 1.17% in terms of CEV for the non-college and 0.31% for the college educated).

In addition, I quantify large interactions between health effects. For example, medical expenditures and time endowment costs associated with bad health have greater effects on asset accumulation when health induced productivity costs are also present than in their absence. The joint occurrence of adverse health effects makes them more painful, requiring higher levels of precautionary savings. There are also strong interactions between health effects at different stages of the life-cycle. For example, the presence of medical expenditures after retirement age leads to higher asset accumulation after the age of 60, but medical expenditures before retirement lower disposable incomes and the ability to save. In a model that abstracts from medical expenditures before retirement, the effect of old age medical expenses on asset accumulation after the age of 60 is over predicted by 9% and 11% for non-college and college groups, respectively.

2 Model

I construct a life-cycle model with idiosyncratic labor earnings risk and health status risk, where health effects are modeled based on French and Jones (2011) and Attanasio et al. (2010). An individual's health status is either good *(G)*, average *(A)* or poor *(P)* in any given period. Average and poor health states affect individuals by (1) lowering their productivity, (2) increasing their medical expenditures, (3) decreasing their time endowments and (4) lowering their survival probabilities relative to those in good health. Hence, health status risk adds uncertainty through these four channels. I study non-college and college educated individuals separately, allowing all health effects to differ between these groups.[4] The model is solved in partial equilibrium, assuming a small open economy with a fixed interest rate of 1.04%.

Demographics The age of entry into the labor force is 18 for the non-college group and 22 for college degree holders. I define the non-college group as those with a high-school degree only and no years of college. The college group includes all those with four or more

[4]Related papers that also study health separately by education groups are Attanasio et al. (2010), Hubbard et al. (1995) and Low and Pistaferri (2010).

years of college.[5] Education is taken as predetermined, so the paper studies individuals only at ages after entry into the labor force. This paper abstracts from marriage decisions and the model is written for single male individuals.[6] Everybody retires at the age of 65. (Workers can simply exit the labor force any time, however, social security cannot be collected until the age of 65.) An exogenous retirement age could be problematic since in reality individuals could adjust the age of retirement to better prepare financially for possible medical expenditures later in life. However, these effects are likely to be small. For example, French and Jones (2011) find a significant but small effect of health insurance on retirement.[7]

Individuals face survival uncertainty at every age up to 100 when they die with certainty. The probability of surviving to the next period depends on age (j), health status (h) and education (e), and is given by the function $s(j, h, e)$. The variation in survival probabilities captures the following facts observed in the data: people die at faster rates as they age; they die at slower rates if they are in good health; and the college educated group lives on average to an older age.[8]

Health Status and Medical Costs Health status *(h)* evolves stochastically according to the transition function $\Lambda_{e,j}(h, h')$: the probability of a given health state next period depends on the individual's age, education, and current health state. Transition probabilities are exogenous, so it is assumed that individuals cannot invest time in preventive activities or buy medical goods and services in order to improve the probability of good health.[9] Medical expenditures $m(j, h)$ depend on age and health status. Medical expenditures are modeled as negative income shocks, assuming they must be incurred in every period in order to survive to the next but having no effect on future health status.[10]

[5] I exclude high school and college dropouts since these groups represent smaller fractions of the total adult male population (14% and 25%, respectively) than high school and college graduates (32% and 29%, respectively). The excluded groups are very different from high school and college graduates so they cannot be combined with these categories. While a study of health risk for these two excluded groups would be interesting, in this paper, I focus on the two largest education groups only. Health risk is likely to be much larger for high school dropouts whose health outcomes are significantly worse than those of high school graduates (based on CPS data). The health outcomes of college dropouts are in between those of high school and college graduates, but are in general more similar to those of high school graduates. Differences other than health outcomes (e.g., occupation characteristics and fractions covered by employer health insurance) likely also contribute to higher levels of health risk faced by high school dropouts.

[6] The implications of this assumption are discussed in Section 5.1.

[7] Specifically, they find that raising the Medicare eligibility age from 65 to 67 leads individuals to work only an additional 0.074 years over ages 60–69.

[8] De Nardi et al. (2010) show that mortality rates vary significantly with sex, permanent income and health status, and that this heterogeneity in mortality is important for understanding the savings patterns of the elderly.

[9] Grossman (1972) built the influential model of health production over the life-cycle that accounts for these effects.

[10] In reality, many health expenditures such as annual checkups, blood pressure medication and weight loss programs may be entirely of a preventive nature. Also, low income individuals without insurance often choose not to undergo expensive treatments. Jung and Tran (2011), Halliday et al. (2009), Feng (2009) and Ozkan (2011) are recent working papers featuring endogenous medical expenditures.

In reality, health outcomes are determined by both exogenous factors such as genes, environment and random events, and choice variables such as lifestyles, time spent exercising and health care expenditures. Since the existing literature is inconclusive in assessing the relative importance of these factors, I follow the literature most closely related to my paper in modeling health transition probabilities as exogenous (i.e., French (2005), De Nardi et al. (2010), Attanasio et al. (2010), and French and Jones (2011)). The model best approximates reality when exogenous factors dominate in relative importance. If choice variables played a large role, the model would overstate the amount of health risk faced by individuals as they can in fact invest resources to lower the probabilities of adverse shocks. Moreover, the ability to invest in health would depend on available resources such as income and available time, so the model would fail to capture the tradeoffs between allocating these resources to health production and allocating resources to work, leisure, asset accumulation and consumption.

However, since I allow health transitions to differ by education, the model accounts for the largest sources of heterogeneity in health outcomes. Smith (2007) shows that education is the primary influence through which socioeconomic status impacts future health outcomes, not financial resources. Health behaviors such as smoking are important, but again, these behaviors have a strong correlation with education. Therefore, using education specific average health transitions in the model is reasonable.[11]

All medical expense uncertainty comes from health uncertainty. Several previous papers also model medical expense variation around the deterministic component, but find that shutting down out-of-pocket medical expense risk while keeping average medical expenditures constant (conditional on all of the relevant state variables) has only small effects. De Nardi et al. (2010) and Hubbard et al. (1994) find that conditional on average medical expenses, the risk associated with the volatility of medical expenses has only a small effect on the profiles of median wealth, and Palumbo (1999) finds that eliminating medical expense risk has only small effects on consumption and assets. Due to these finding and the fact that there are already many channels through which health generates uncertainty in the model, I abstract from medical expense variation within health and age groups.

Health Insurance I follow Attanasio et al. (2010) and French and Jones (2011) in modeling three types of medical insurance: employer-based insurance, Medicare and social assistance (Medicaid).

Employer Provided Health Insurance: An exogenous fraction of workers has employer-sponsored health insurance covering k^m percent of total medical expenditures. If workers become unemployed, they no longer hold this insurance. For a fraction of these workers, the employer sponsored health insurance coverage extends into retirement, cover-

[11] The paper does not attempt to explain why health outcomes differ with education. For a discussion of potential factors such as selection effects, unobserved factors influencing both education and health, or the contribution of skills learned in college to health (among others), see for example Grossman and Kaestner (1997), Cutler and Lleras-Muney (2006), Gan and Gong (2007), and Smith (2007).

ing k^{ret} percent of expenditures when they are retired. Let $i \in \{0, 1, 2\}$ denote the insurance type with $i = 0$ indicating no coverage, $i = 1$ indicating employer sponsored coverage only when working, and $i = 2$ indicating coverage extending into retirement. Each individual's type i is determined when he enters the labor force according to a random draw from the distribution $\Omega_e(i)$.[12] This distribution depends on education to capture the fact that college educated individuals are more likely to have jobs that offer more comprehensive health insurance plans.[13] Workers of type $i = 1$ or $i = 2$ pay a premium p^w deducted from their earnings and not subject to income tax. Individuals of type $i = 2$ pay a premium p^{ret} when retired.

Medicare The second form of health insurance is provided by the government through Medicare: starting at the age of 65, all individuals are covered by Medicare with coverage rate k^{med} and premium p^{med}. The government finances the system through the collection of premiums and a proportional payroll tax τ_{Med}.

Medicaid The Medicaid program covers those who cannot afford required medical services. I model this form of insurance through the inclusion of a consumption floor, discussed below.

Social Security and Social Insurance The government runs a social assistance program which guarantees a minimum level of consumption $\bar{c}$ to every individual. When disposable income (net of required medical expenditures) falls below $\bar{c}$, the person receives a transfer tr that compensates for the difference. The Medicaid program covers any medical expenditures that consumption floor recipients cannot afford to pay.[14]

Finally, retirees receive social security payments SS which vary with education but are independent of earning histories and are financed by proportional payroll taxes τ_{SS} paid up to an income threshold $\overline{y}$, set to 2.5 times average earnings.

[12]For simplicity, I follow Attanasio et al. (2010) in assuming that the employer health insurance type is determined at the beginning of life and remains fixed the entire lifetime. See Jeske and Kitao (2009) and Hsu (2011) for models with endogenous insurance decisions where the probability of receiving an offer of employer health insurance evolves jointly with labor productivity shocks.

[13]French and Jones (2011) show that individuals with strong preferences for leisure self-select into jobs that provide health insurance coverage after retirement. Accounting for this self-selection is important for their results, changing the estimated effects of policies such as increasing the Medicare eligibility age. I abstract from modeling this in my paper.

[14]Under the Medicaid eligibility rules prior to 2010, not all individuals below the poverty level were covered by Medicaid. For example, low income males with no disabilities and no children were unlikely to be covered. For simplicity, I do not model the uncertainty of receiving Medicaid. Feng (2009) is a paper that models this. However, the minimum consumption floor in my model is much lower than the federal poverty level (approximately 55% lower), increasing the likelihood that individuals with such low incomes are covered by Medicaid in reality as well.

Preferences Individual preferences are given by:

$$U(c,n,h) = \frac{1}{1-\sigma}[c^{\alpha}(1-n-\theta I_{n>0}-\Phi_1 I_{h=A}-\Phi_2 I_{h=P})^{(1-\alpha)}]^{1-\sigma},$$

where c denotes consumption of non-medical goods; n is the number of hours worked; $I_{n>0}$ is an indicator equal to 1 if the individual is working and 0 otherwise; θ captures the fixed time cost associated with going to work; $I_{h=A}$ and $I_{h=P}$ are indicator functions equal to 1 if the individual is in average or poor health, respectively; and Φ_1 and Φ_2 capture the time costs associated with average and poor health states. I follow French (2005) and French and Jones (2011) in modeling the effect of health on utility as a time cost.[15] Statistics from the National Longitudinal Survey of Youth 1997 and from the American Time Use Survey show that individuals spend a significant amount of time on health care activities such as purchasing medical and care services. Examples of time costs are doctor appointments (e.g., searching for a doctor, making and getting to the appointment, waiting time in the office, talking to the doctor, filling out forms), undergoing tests, procedures and treatments (e.g., surgeries, physiotherapy visits), time spent buying prescribed medication, and time lost due to activity limitations (e.g., walking slower on crutches). Differences across education groups in time costs may arise due to different abilities to plan and follow instructions. For example, Smith (2007) finds that the less-educated have considerable difficulty in disease management using the complex treatments necessary to diminish the negative health consequences associated with diabetes.

The fixed time costs of work stem from getting ready and commuting to work, work-related socializing with co-workers and clients, and worrying and thinking about work-related problems (Donald and Hamermesh (2009)). Differences across education groups may arise due to differences in types of occupations and average commuting times.

For simplicity, I model only the extensive margin of labor supply, so the number of hours worked per week is either 0 or 40 (0.4 in the model). Results in previous literature indicate that health has the largest effects on labor supply through the extensive margin. French (2005) documents small effects of health on hours worked but relatively larger effects on labor force participation. Gallipoli and Turner (2009) show that total hours worked decline dramatically with the onset of disability, but workers' hours change very little while labor force participation drops dramatically for single men.

Labor Productivity Labor productivity is modeled as the sum of a deterministic component w which is a function of health h and age j, an individual fixed effect $\bar{\mu}$ determined at birth, an idiosyncratic transitory shock λ, and an idiosyncratic shock u assumed to follow an AR(1) process with innovation η. All components are allowed to vary with education, but the notation is suppressed.

[15] An alternative way of modeling the effect of health on utility is by lowering the utility received from consumption when health is bad, as in Palumbo (1999) and De Nardi et al. (2010).

$$
\begin{aligned}
lnW &= w(h,j) + \bar{\mu} + \lambda + u,\ where \\
w(h,j) &= \beta_0 + \beta_1 j + \beta_2 j^2 + \beta_3 j^3 + \beta_4 I_{h=A|G} + \beta_5 I_{h=A|G} * j + \beta_6 I_{h=G} + \beta_7 I_{h=G} * j \\
\bar{\mu} &\sim N(0, \sigma^2_{\bar{\mu}}) \\
\lambda &\sim N(0, \sigma^2_{\lambda}) \\
u &= \rho u_{-1} + \eta,\ \eta \sim N(0, \sigma^2_{\eta}).
\end{aligned}
$$

The deterministic productivity component is described in more detail in section 4.2. This component is likely to differ across education groups since (1) college educated individuals receive higher returns to experience and (2) non-college workers in bad health are likely to suffer larger declines in earnings as argued in Attanasio et al. (2010). For example, we should expect to find larger productivity effects for the non-college group since their jobs are on average more physically demanding, requiring good health to perform physical tasks. Also, bad health likely leads to larger drops in observed earnings for non-college workers since they have less paid sick leave. Statistics on employee leave benefits from the Bureau of Labor Statistics reveal that workers in construction, production, transportation, and sales occupations are much less likely to receive paid sick leave than teachers, managers or professional workers.[16]

2.1 Individual's Problem

In each time period, the state of the individual is summarized by the following variables: education attainment e, type of health insurance i, age j, health status h, productivity type $\bar{\mu}$, the realizations of the idiosyncratic labor income shock u and of the transitory shock λ for non-retired individuals, and assets a. In each period, an individual maximizes the expected discounted lifetime utility by choosing the period consumption level c and making a labor force participation decision, n when younger than 65. The problem of a non-retired individual is summarized below.

$$
V(e,i,j,h,\bar{\mu},u,\lambda,a) = max_{(c,n)}\{U(c,n,h) + \beta s(j,h,e) EV(e,i,j+1,h',\bar{\mu},u',\lambda',a')\}
$$

[16] French (2005) and French and Jones (2011) also estimate significant effects of health on productivity but do not allow for differences across education groups.

subject to

$$
\begin{aligned}
a' &= [1+(1-\tau^r)r]a-(1+\tau^c)c+tr+(1-\tau^w)[nW-p^w I_{(=1|i>0,n>0)}-0.5(\tau_{SS}+\\
&\quad +\tau_{Med})min\{nW,\bar{y}\}]-(1-k^w I_{(=1|i>0,n>0)})m(j,h)\\
tr &= max\{0,(1+\tau^c)\bar{c}-[1+(1-\tau^r)r]a-(1-\tau^w)[nW-p^w I_{(=1|i>0,n>0)}-0.5(\tau_{SS}+\\
&\quad +\tau_{Med})min\{nW,\bar{y}\}]+(1-k^w I_{(=1|i>0,n>0)})m(j,h)\}\\
c &\leq \frac{1}{1+\tau^c}[tr+[1+(1-\tau^r)r]a+(1-\tau^w)[nW-p^w I_{(=1|i>0,n>0)}-0.5(\tau_{SS}+\\
&\quad +\tau_{Med})min\,\{nW,\bar{y}\}]-(1-k^w I_{(=1|i>0,n>0)})m(j,h)]\\
lnW &= w(h,j)+\bar{\mu}+\lambda+u\\
h' &\sim \Lambda_{e,j}(h,h')
\end{aligned}
$$

The first constraint summarizes the evolution of assets. Next period assets are equal to current period assets plus interest income (subject to a capital income tax τ^r), plus a government transfer, less consumption (subject to a tax τ^c) plus labor income (net of labor income, Social Security and Medicare taxes and insurance premiums) minus out-of-pocket medical expenditures. $I_{(=1|i>0,n>0)}$ is an indicator equal to 1 for those with employer provided health insurance ($i>0$) who work positive hours, and equal to zero otherwise, so the premium p^w and medical benefits k^w apply only to workers with employer health insurance. The second constraint describes the government transfer tr that guarantees a minimum consumption level $\bar{c}$. The third constraint is a zero borrowing constraint. The final constraints describing wage income and health transitions have been explained previously.

When retired, individuals face a similar problem summarized below.

$$V_r(e,i,j,h,a)=max_{(c)}\,\{U(c,h)+\beta s(j,h,e)EV_r(e,i,j+1,h',a')\}$$

subject to

$$
\begin{aligned}
a' &= [1+(1-\tau^r)r]a-(1+\tau^c)c+tr+SS-[1-k^{med}-k^{ret}\cdot I_{(=1|i=2)}]m(j,h)\\
&\quad -p^{med}-p^{ret}\cdot I_{(=1|i=2)}\\
tr &= max\{0,(1+\tau^c)\bar{c}-[1+(1-\tau^r)r]a-SS+[1-k^{med}-k^{ret}\cdot I_{(=1|i=2)}]m(j,h)\\
&\quad +p^{med}+p^{ret}\cdot I_{(=1|i=2)}\}\\
c &\leq \frac{1}{1+\tau^c}[tr+[1+(1-\tau^r)r]a+SS-[1-k^{med}-k^{ret}\cdot I_{(=1|i=2)}]m(j,h)-p^{med}\\
&\quad -p^{ret}\cdot I_{(=1|i=2)}]\\
h' &\sim \Lambda_{e,j}(h,h')
\end{aligned}
$$

Retirees receive Social Security income SS, pay Medicare premiums p^{med} and receive Medicare benefits covering a fraction k^{med} of total medical expenditures. If individuals have employer sponsored health insurance extending into retirement (the indicator function $I_{(=1|i=2)}$ equals one), they pay additional premiums p^{ret} and an additional fraction k^{ret} of their total medical expenditures is covered by insurance.

3 Data

An ideal data set for this study would be a representative panel of individuals observed over several years containing information on health status, medical expenditures (total and out-of-pocket), insurance, earnings and assets, employment status, education, etc. Unfortunately, no such comprehensive survey exists, so I utilize several data sets which together enable me to estimate the required parameters: (1) Health and Retirement Survey (HRS), (2) Medical Expenditure Panel Survey (MEPS), (3) Current Population Survey (CPS), (4) Survey of Consumer Finances (SCF) and (5) Panel Study of Income Dynamics (PSID).

While most of these surveys extract some information related to health, the HRS and MEPS surveys contain the most detailed variables on health, limitations, disability, insurance and medical expenditures for individuals over time. They have been extensively used and described in previous related literature.[17] An advantage of the MEPS survey is that it includes individuals of all adult ages, however, there are relatively few observations for ages above 70. Therefore, I use as a complement the HRS which is a national panel survey of individuals aged 51 and above containing detailed information on the elderly.[18] Another disadvantage of the MEPS is that a new panel of sample households is selected each year, and data for each panel is collected for only two calendar years. Data from the PSID is used when estimation requires a longer panel dimension. I use the CPS for aggregate statistics that do not require a panel structure due to its large sample size, and finally, the SCF is used because it is one of the few data sets containing detailed information on wealth accumulation. The time period used from most data sets is between 1992 and 2006.

4 Parameter Values and Calibration

Many parameters can be estimated directly from the data sets described above. These are the parameters summarizing health insurance coverage and premiums, health status transitions, medical expenditures, and survival probabilities. In their estimation, I use data on civilian males only and all statistics are calculated using sample weights. Full time workers are defined as workers who are not self-employed, with hourly earnings greater than 5$, and who work more than 30 hours per week and at least 48 weeks per year. Part-time and part-year workers are classified as unemployed. All dollar amounts are CPI adjusted to 2006 U.S. dollars.

Other parameters such as most utility function and earnings process parameters are calibrated to match statistics on saving rates, labor supply, and earnings observed in the data. Finally, Table 1 provides a summary of the demographic structure, tax and social

[17] Examples are Attanasio et al. (2010), Kopecky and Koreshkova (2011), and French and Jones (2011).

[18] I use the RAND HRS Data file which contains data from ten waves of the Health and Retirement Study, including five entry cohorts: the original 1992 Health and Retirement Study (HRS) cohort; the 1993 Study of Assets and Health Dynamics (AHEAD) cohort; the Children of Depression and War Baby cohorts entering in 1998 and Early Baby Boomer cohort entering in 2004. Overall, it incorporates data from 1992-1996, 1998, 2000, 2002, and 2004 final releases, and 2006 early release of HRS data.

security environment, and fixed parameters taken as given in the model. The consumption floor is set to the average government transfer of recipients between the ages of 30 and 55 from various non-health related government welfare programs observed in the CPS. The consumption floor is approximately equal to 10% of each education group's average earnings.[19]

4.1 Parameters Estimated Directly from the Data

Health Insurance Table 2 reports the fraction of the working male population by employer health insurance type, estimated from the CPS, and reports average premiums and insurance coverage rates. The college group contains a smaller fraction of uninsured workers and a significantly higher percentage of workers whose insurance extends into retirement. The annual Medicare premium is set to 779, obtained from an average of CPI adjusted premiums over the sample period. The annual single coverage employer-sponsored health insurance premium is 3,852 for an active worker, and 3,497 for a retired worker over 65. The employee share of this premium is 18 percent for active workers, and 45 percent for retirees. These numbers are calculated according to estimates from Buchmueller et al. (2006).[20] I take the health insurance coverage rates from Attanasio et al. (2010) who estimate $k^{med} = 0.5$, $k^{w} = 0.7$ and $k^{ret} = 0.3$.

Health Status Transitions I use the MEPS data set to estimate health transition probabilities. Respondents report their perceived health status, on a scale from 1 to 5.[21] I

[19] As noted in Hubbard et al. (1995), "measuring the means-tested consumption floor is difficult since potential payments from social insurance programs differ dramatically according to the number of children, marital status, age, and even the recipient's state or city." However, a consumption floor of 10% of average earnings is consistent with previous estimates in the literature, for example, 4,380 1998 $ in French and Jones (2011) who consider childless households. Attanasio et al. (2010) also assume a 10% consumption floor.

[20] Buchmueller et al. (2006) estimate average premiums and employee shares for 2003 using the MEPS data set. I adjust the premiums to 2006 dollars. The data from the MEPS Insurance Component shows that the employee share of the premium while actively working has been very steady over time at around 17 to 18 percent, thus not creating a problem when averaging over the sample period. However, premiums have increased much faster than inflation, more than doubling over time from 1,992 in 1996 to 4,118 in 2006.

[21] The validity of the self-reported health status measure has been discussed extensively in previous literature (e.g., Benìtez-Silva and Ni (2008), Crossley and Kennedy (2002), Baker et al. (2004), and Hurd and McGarry (1995)). The general finding is that this measure is subject to both positive and negative biases arising from endogeneity and measurement error. I also test the validity of this measure using data on functional and activity limitations available in MEPS for 2006. The functional limitations variable is coded "yes" if the respondent has "difficulties walking, climbing stairs, grasping objects, reaching overhead, lifting, bending or stooping, or standing for long periods of time," and "no" otherwise. The activity limitations variable is coded "yes" if the respondent has limitation in work, housework, or school, and "no" otherwise. I find that 61% of those with functional and activity limitations report fair or poor health status, and only 11% of those without such limitations report average or poor health status. This indicates that the self reported health status is indeed imperfect: we should observe 100% of those with limitations reporting fair or poor health. However, the high degree of correlation between these variables provides reasonable

group these five states into three: the good health state (G) corresponds to a self-reported health status of excellent or very good; the average health state (A) corresponds to a self-reported health status of good or fair; and the poor health state (P) corresponds to a self-reported health status of poor.[22] [23] I estimate education and age specific health transition probabilities using a logistic regression model that includes age, age squared and age cubed. Since the MEPS data set contains relatively few observations for individuals older than 80, transition probabilities at these ages are predicted out of sample. Figure 1 shows selected health transition probability age profiles. As expected, the probability of declining health increases with age and the college educated group is less likely to transition to bad health states at almost all ages.

Medical Expenditures Average total health expenditures by age and health status are estimated from MEPS and are reported in Table 3. These expenditures include out-of-pocket expenditures plus what is covered by insurance, but they do not include insurance premiums since these are accounted for separately. Nursing home costs are excluded since these expenditures vary greatly with the type and quality of the facility, and the data does not allow for a separation of these costs into medical and non-medical. Many nursing homes simply provide a more comfortable living environment. I assume that nursing home costs are part of regular consumption.[24] The sample size of individuals over 70 is relatively small in MEPS, so this requires relatively broader age groups in order to maintain a large enough sample of individuals. The HRS data contains only information on out-of-pocket expenditures, so unfortunately it cannot be used to directly estimate total costs.[25]

confidence in the self reported health measure.

[22] The self reported health variable is consistent across the surveys used, having the same ranking and description of health states. However, surveys differ in the frequency of interviews. Since MEPS contains multiple observations for each individual at each age, I calculate the average health status for each individual by age and estimate health transition probabilities from one age to the next.

[23] The grouping is based on observed similarities. Individuals with "excellent" and "very good" health are very similar in terms of labor supply and differences in average earnings are small. The group with "fair" health differs from the "good" and "poor" health groups, but there are more similarities between those in "good" and "fair" health than between "fair" and "poor" health groups.

[24] The model generates higher consumption levels in poor health than in good health states (observed especially in the wealthy elderly group) because the marginal utility of consumption is higher in bad health states due to a lower time endowment (lower leisure time when retired). Also, the very old consume much more in poor health states if they can afford to since poor health is associated with very high probabilities of death at old ages, so their time discount factor is higher. If we consider the consumption value of nursing homes only, then the model could endogenously generate high consumption of nursing homes among the elderly. (The existing literature is inconclusive with respect to the effect of health on the marginal utility of consumption. Lillard and Weiss (1997) estimate that the marginal utility of consumption increases after a health shock. Edwards (2008) also finds that patterns in the data are consistent with a negative cross partial for individuals. However, Finkelstein et al. (2008) estimate that the marginal utility of consumption decreases with bad health.)

[25] Kopecky and Koreshkova (2011) calibrate a medical expenditures process using the HRS.

Survival Probabilities I use the HRS to estimate mortality probabilities by education group, health status and age. The HRS Tracker file reports whether an individual is known or presumed to be alive or has died during the past or current wave of interview. I first calculate a raw measure of mortality probabilities by dividing the number of deaths reported for a given education, health and age group by the number of total respondents in that group, dead or alive. Since the HRS observations are 2 years apart, these raw mortality probabilities are interpreted as the probability of dying in the next two years given the education, health status and age observed in the current interview period. Since some groups have zero or very few observations, this measure leads to very irregular mortality age profiles. To correct this, I run a regression of log raw mortality probabilities on a constant, age, and age squared and obtain the fitted values for ages 53 to 99. Since the HRS contains observations only on the elderly, mortality probabilities at ages younger than 53 are assumed to follow a linear trend from zero to the estimated death probability at the age of 53. I transform these estimates into annual mortality probabilities by assuming that death probabilities in two consecutive age groups are equal, given education and health status.[26] It is assumed that death occurs with certainty at age 100. The estimated mortality probabilities are shown in Figure 2. The figure reveals that mortality rates increase significantly as health status deteriorates, especially at old ages. The college educated have slightly lower mortality probabilities at all ages when in good or average health states and also in poor health states at ages over 75.

4.2 Calibrated Parameters

I jointly calibrate the time discount factor β, the earnings process parameters and the parameters in the utility function associated with the time costs of work and bad health. I use the method of indirect inference first introduced by Smith (1990) and Smith (1993) and extended by Gouriéroux et al. (1993) and Gallant and Tauchen (1996).[27] All these parameters together affect labor supply, observed average earnings and saving rates. A major issue with observed earnings in the data is selection bias: we observe only the earnings of those who choose to work. The data reveals a strong selection effect into the labor force by education, age and health status: on average, we observe that the college group, the healthy groups and the age groups 30-50 supply the most labor to the market (Figure 5). Therefore, we cannot directly estimate the true earnings process parameters through a regression on actual data. Suppose we run the following regression, separately by education, where w represents hourly earnings, j represents age, $I_{h=A|G}$ is an indicator equal to one for those in average or good health, and $I_{h=G}$ is an indicator equal to one for those in good health:

[26] I take the average of the estimated annual mortality probabilities in any two consecutive ages within each education-health group to obtain the final probabilities. This is because I estimate the probability of death at age j by using the probability of death from j to $j+2$, as well as using the probability of death from $j-1$ to $j+1$. The actual probability of death at age j is approximated by taking an average of the two estimates.

[27] Gouriéroux and Monfort (1996) provide a survey of indirect inference.

$$log\, w = \beta_0 + \beta_1 j + \beta_2 j^2 + \beta_3 j^3 + \beta_4 I_{h=A|G} + \beta_5 I_{h=A|G} * j + \beta_6 I_{h=G} + \beta_7 I_{h=G} * j + \varepsilon.$$

It is likely that only workers with very high earnings choose to work in poor health states, implying for example a negative bias on β_4. All other coefficients will be biased for similar reasons. The goal is to infer the unobserved parameters driving the earnings process. I assume that the bias in the earnings profiles of workers is the same in both actual and simulated data. The goal is to find parameter values that when fed into the model generate the same earnings profiles in the model (post-selection into the labor force) as those observed in the data.[28] Since the utility function parameters θ, Φ_1 and Φ_2 are also major determinants of labor force participation through the effect on available leisure time, these parameters need to be calibrated simultaneously.

Table 4 lists the targets used, the sources of different targets, and the model results. The model parameters β_0 to β_7 are identified by targeting the average wages of narrowly defined age groups equally spaced across the working life-cycle, estimated using CPS data.[29] There are significant differences in average earnings profiles across workers of different health status, shown in Figure 4. These differences are used to identify the effects of health on workers' productivities. The time costs associated with working and with average and poor health are identified by targeting the average labor supply between the ages of 30 and 50 of different health status groups, by education. The parameter $\sigma^2_{\bar{\mu}}$ determining the productivity individual fixed effects and the parameters determining the idiosyncratic shocks u, ρ and σ^2_η are identified by targeting their empirical counterparts estimated using PSID data. Similar to Erosa et al. (2011), I calibrate the variance of transitory shocks σ^2_λ by targeting the fraction of workers observed to be employed in two consecutive years in the CPS. As noted in their paper, the larger the variance of transitory wages, the less likely it is that individuals work in consecutive periods.[30] Finally, the time discount factor β is calibrated by targeting the median asset to income ratio of working males between 30 and 50 years of age observed in the SCF data.[31] The calibration weighs all targets equally.

[28] I estimate these parameters in the data using full time and full year male workers. Hourly earnings are calculated as annual earnings divided by hours worked.

[29] Respondents in the CPS report their health status at the time of the survey in March and last year's earnings. Since earnings and health status are not observed at exactly the same time, it is likely that individuals whose health status changes in the first few months of the year introduce a source of error in the estimation. The MEPS data contains information on earnings and health status in the same time period, however, it contains very few individuals in the poor health state who are observed working, making it impossible to estimate the effect of poor health on earnings. However, the two data sets reveal similar differences in earnings age profiles between individuals in average and good health, with only slightly smaller earnings gap in MEPS at relatively older ages.

[30] This method is preferred to targeting the variance of transitory shocks observed in the data since the estimated variation in the transitory component of observed wages may be too large due to the presence of measurement error in hours worked and earnings, as argued in Erosa et al. (2011). (However, since I use only full-time full-year workers, measurement error is likely to be small.)

[31] The target is calculated using SCF data as the median net financial worth to income ratio obtained after excluding individuals in the top 5% of the wealth distribution and excluding workers with incomes

The calibrated parameters are presented in Table 5. The time cost of poor health is very large, equal to 19% and 15% of total available time for non-college and college groups, respectively. The effect of bad health on productivity is also very large. For example, at the age of 45, a non-college individual in good health has 23% higher productivity than a similar individual in average health, who in turn has 25% higher productivity than an individual in poor health. The productivity health effects for the college educated are smaller, equal to 12% and 23%, respectively.

5 Results

5.1 Model Fit

The calibrated model matches the targets closely and performs well in matching other statistics in the data. First, the estimated health transition probabilities and survival probabilities result in a demographic structure closely approximating the data, even for age intervals where probabilities were predicted out of sample. Figure 3 shows the percentage of individuals in each health group by age and education, and compares the profiles in the model with those observed in the combined MEPS and HRS data.[32] The average lifespan is 75 for the non-college and 79 for the college educated in the simulated data, consistent with U.S. life tables by education.[33]

Next, Table 4 shows that the calibration targets are closely matched by the model. Figure 4 plots the earnings age profiles by education and health status in the model and in the data, revealing in general a very good fit: the non-college profiles are only slightly higher in the model than in the data at young ages, and the college profiles are only slightly steeper than in the data. Also, Figure 5 shows that the labor force participation rates by age, health status and education are extremely close to the data at all ages between 30 and 55. It is extremely important for the model to closely match these profiles since a main interest of the paper is to evaluate the impact of health effects on the labor supply of different groups. The key calibrated parameters that enable the model to account for the observed differences in labor supply are the fixed time costs of work, the time costs of average and poor health states, and the productivity costs associated with average and poor

lower than \$9,750 per year as this is on average the minimum income of workers aged 30-50 in the model observed under reasonable parameter values. I use data on financial wealth (excluding non-financial wealth) because there is no mechanism in the model for non-financial wealth accumulation. This may lead to a downward bias in β, and the model may therefore underestimate precautionary savings against possible serious health shocks late in life. Individuals may in fact accumulate wealth through housing to self insure against these shocks.

[32] Since the HRS interviews individuals only every 2 years, the HRS data was not used in the estimation of annual health transition probabilities. I combine the HRS data with MEPS when constructing the above profiles in order to check whether the predicted out of sample health transition probabilities at old ages result in profiles consistent with the data. The figure shows that the model approximates the data well at old ages, however, there is a slightly higher fraction of college educated individuals in good health and slightly lower fraction in poor health after the age of 85 in the data than obtained in the model.

[33] See for example Richards and Barry (1998).

health. A large time cost of poor health is required to match the very low participation levels of those in poor health. Productivity costs account for most differences in labor supply between average and good health states, so the calibrated time costs of average health are low (only 2.5% and 3% of available time for non-college and college groups, respectively). The productivity costs of bad health and the time cost associated with poor health states are higher for the non-college group (Table 5), enabling the model to match the observed differences in labor supply and earnings age profiles observed across education groups.

The model does not replicate the sharp exit from the labor force observed in the data after the age of 60 for the non-college group. In reality, individuals can apply for and start receiving Social Security benefits at the age of 62, so a large fraction of workers retires at this age. Also, the model abstracts from private pensions and does not model pension accrual or the progressive taxation of pension income. French (2005) establishes that the tax structures of Social Security and pensions are very important in explaining the sharp exit from labor force while health plays only a minor role. It is therefore not surprising that the model fails to replicate the data in this respect.[34] The implication is that the model might overpredict the degree of health risk at ages just prior to 65 since it does not allow individuals to withdraw Social Security benefits early in the advent of bad health that makes working more painful.

The model also performs well in matching other statistics in the data that have not been targeted in the calibration. An important aspect of the model is the degree of social insurance available to individuals through the consumption floor because this provides partial insurance against health shocks. Therefore, it is crucial to generate the same degree of reliance on government transfers in the model as in the data. Table 6 shows that the model approximates well the percentage of people receiving transfers (other than Medicaid) observed in the data, and almost perfectly matches the fraction of recipients who are in average or poor health, 64% for the non-college and 43% for the college group.[35] [36] Also, the model matches very well the variance of earnings for the non-college educated between the ages of 30 and 60 (Figure 6), but predicts a steeper growth in earnings inequality over the life-cycle for the college group than in the data.

The model produces a hump shaped consumption-age profile that closely approximates the profile estimated by Aguiar and Hurst (2008) for core nondurables and housing services

[34] Also, preferences for leisure might in reality increase with age resulting in higher rates of exit from the labor force around the age of 60 than in the model. French and Jones (2011) capture this by allowing the fixed cost of work to increase with age. In addition, the time costs associated with poor and average health states might also increase with age. For simplicity, I abstract from these features.

[35] The success of the model in matching these statistics supports the assumption of a 10% consumption floor level as a fraction of average earnings.

[36] Individuals in the CPS are classified as government transfer recipients if they received income from any of the following sources in the previous year: various public assistance programs commonly referred to as "welfare," government programs other than welfare (e.g. unemployment compensation and workmen compensation), Supplemental Security Income (SSI), disability income, child support payments and social security for individuals not yet retired. Also, I include in this group individuals who have received health insurance through Medicaid, SCHIP, or other public insurance.

using the Consumer Expenditure Survey (Figure 7).[37] Average consumption (excluding medical expenditures) increases by 35% between the ages of 25 and 50 in the model compared with approximately 37% found in Aguiar and Hurst (2008). The profile peaks at the age of 54, just two years later than in the data as found in Hansen and Imrohoroglu (2008). The hump shaped profile is generated by non-separable utility, borrowing constraints, uncertain lifetimes in the absence of annuity markets and income uncertainty.[38]

Finally, I compare the median asset accumulation age profiles in the model with the median financial asset profiles observed in the SCF (Figure 6).[39] The model approximates extremely well the college profile until the age of 55, after which asset accumulation in the data is much higher, even after excluding the wealthiest top 5% in the SCF. The model generates higher asset accumulation for the non-college than observed in the data. A possible explanation is that the rates of return on assets differ by education, being higher than the interest rate of 1.04% for the college group and lower for the non-college group due to differences in types of assets held.[40]

Discussion of Importance of Model Assumptions for Results The model assumes individuals are single, when in reality, approximately 65% of working age men are married and have their spouse present in the household. Partners represent a form of insurance against health shocks since they can adjust their assets and labor supply and provide care during periods of bad health. In addition, the partner's health shocks are also sources of risk. Finally, marriage and divorce may depend on health. Gallipoli and Turner (2009) show that following disability shocks, there are increased transfers of time between spouses. Husbands (main-earners) tend to transfer consumption to wives (second-earners) who in turn trade additional consumption insurance for time transfers in periods of need. This is important because it allows the husband to smooth labor supply and achieve greater levels of human capital accumulation and earnings.[41] Therefore, married men experience smaller swings in labor supply than single men due to disability, while spousal labor supply

[37] The profile shown in the figure is constructed after combining the two education groups, assuming 70% of the population belongs to the non-college group and 30% to the college group. I combine the two groups in order to compare the consumption profiles with the estimated profiles found in previous literature where the estimates are not reported by education categories.

[38] Heckman (1974), Bullard and Feigenbaum (2007), Hansen and Imrohoroglu (2008), Thurow (1969), Attanasio et al. (1999) and Gourinchas and Parker (2002) are examples of papers studying how various factors contribute to the humped shape consumption profile.

[39] I use data on financial wealth in the SCF (excluding non-financial wealth) because there is no mechanism in my model for non-financial wealth accumulation.

[40] Health is also related to portfolio choice: previous literature has found strong evidence that higher health risk leads to safer portfolio choice. Since non-college individuals have higher probabilities of bad health (higher health induced risk), they hold safer, lower return assets. (See for example Edwards (2008), Guiso et al. (1996), Rosen and Wu (2004), Heaton and Lucas (2000), Yogo (2009) and Hugonnier et al. (2009).)

[41] Gallipoli and Turner (2009) study household labor supply responses to individual health shocks in a model with endogenous marriage, time transfers between partners and human capital accumulation, and find these model features to be key in generating dynamic labor supply responses to disability shocks matching the data for singles and couples.

responses are mostly negligible. In light of this result, abstracting from marriage implies a negative bias in the estimated time costs associated with bad health since these time costs are mainly identified by targeting the average labor supply by health status, and without the partners' time transfers, labor supply would be lower during periods of bad health.[42]

Also, even though previous literature has shown that changes in labor supply due to health shocks occur mostly on the extensive margin, modeling only the extensive margin may lead to an overestimation of the effects of health shocks for the small fraction of workers who can adjust their work hours since in reality these individuals may continue working part-time, receiving income and possibly still benefiting from the employer health insurance. However, the fraction of part-time workers is relatively small (7% and 6% of the non-college and college groups' labor force). There are differences across health groups: the fraction of part-time workers is 6% among those in good health, 9% among those in average health, and 20% among those in poor health.[43] Therefore, the model may overestimate the health effects associated with bad health, particularly the poor health state. However, because the fraction of individuals in poor health who work at all is quite small (17% and 29% for non-college and college groups), this bias is likely to be small.

Finally, I discuss problems introduced by the aggregation of the five health states observed in the data into three. This gives rise to two problems: (1) within the constructed "good" and "average" health categories, the shares of "excellent"/ "very good" and "good"/ "fair" sub-categories change with age, with slight increases in the shares of "very good" and "fair" within each respective category, implying that the constructed "good" and "average" health categories are actually less healthy at older ages, and (2) the shares of these subcategories differ slightly within education groups, with the college educated containing lower shares of "very good" and "fair" and higher shares of "excellent" and "good" sub-categories (the differences between these shares across education groups are approximately 7% for the sub-category "fair" and 11% for the sub-category "very good"). The first point represents a problem for the interpretation of the health effects that are allowed to vary with age (productivity, medical expenditures and survival) and introduces a bias in the estimated time endowment effect that is age invariant (this will be overestimated at young ages and underestimated at old ages). The second point represents a problem for interpreting differences in estimated heath effects across education groups: the estimated health effects may be to some extent larger for the non-college group because the constructed "good" and "average" health groups are actually less healthy among the non-college educated.[44] Overall, while these problems are present, their magnitudes are relatively small, so the biases introduced

[42] The targets are calculated using both single and married men. I do not restrict the data to only single men since this is a relatively small group with specific characteristics.

[43] Only the fraction for those in poor health differs by education, and equals 22% for the non-college and 17% for the college group. Since the fractions of part-time workers are similar across education groups, the comparison between education groups is not biased by the composition effects of part time work.

[44] Note that this problem may also arise from a measurement error in health: respondents often rank their health based on how it compares with their peers, so a non-college or elderly individual reporting "good" health is likely to have a lower actual health status than a college educated or younger individual reporting "good" health.

should also be small.[45]

5.2 Health Effects on Labor Supply, Asset Accumulation, and Welfare

I first determine the importance of health effects for aggregate labor supply, asset accumulation and welfare by studying how these variables change in the absence of health effects trough a series of experiments: (1) first, I study each effect's individual outcome by eliminating each one separately (for example, all individuals are given the productivities of those in good health); (2) second, I consider the importance of the effects at different stages of the life cycle (for example, I eliminate medical expenditures only before or after retirement age); (3) third, I study the interactions between effects by removing a combination of them simultaneously and (4) finally, I estimate the total effect of health by considering an environment where everyone is in good health with certainly for the entire lifetime. In each experiment, I compare the results to those of the Benchmark model, defined as the calibrated model where all four health channels operate. The results are summarized in Tables 7, 8 and 9.[46]

Each effect considered separately is important for at least one variable, but the productivity and time endowment channels stand out as the most important when studying labor supply and welfare effects, especially in the non-college population. Lower productivity and available time associated with poor and average health states greatly decrease non-college labor supply, especially for those in poor health. In the absence of the productivity effect, non-college labor supply would be 8.9% higher, and in the absence of the time endowment effect, 4.4% higher (Tables 7). In the college group, these numbers are only 1.6% and 1.8%, respectively.[47] On the other hand, the presence of medical expenditures leads to slightly higher labor supply because workers in poor health with employer provided health insurance are more likely to keep working when faced with high medical expenditures.[48] The

[45]Most previous papers modeling health assume only two health states (good and bad). Only Low and Pistaferri (2010) distinguish between moderate and severe work limitations (disabilities). Separating those in average and poor health states is important because it allows the model to capture the important differences observed between these health groups. Even though the probabilities of entering poor health states are low throughout the life cycle, the possibility of this state adds a large amount of risk since this state is associated with much larger effects through all four channels modeled.

[46]The demographic structure of the population in the model does not take into account population growth. It assumes that a constant number of individuals is born every period.

[47]Since the model matches labor supply age profiles in the data extremely well only between the ages of 30 and 60 (see Figure 5), I check whether the results are sensitive to restricting the sample to only 30-60 year olds, and find they change very little. The majority of the numbers presented in Table 7 increase slightly when we consider only 30-60 year olds.

[48]In the Benchmark economy, the average labor supply of non-college workers with tied employer insurance is 4 percentage points higher than that of workers with no insurance. In the data, this difference is much higher (27%) because in reality the provision of employer insurance is positively correlated with wages and job tenure (e.g., Dey and Flinn (2005) and Fang and Gavazza (2011)). The implication is that in reality, workers with no employer health insurance are observed to work less than in the model (because they have lower wages), while those with insurance work more (they have higher wages). The effect on

welfare costs implied by health effects are large, particularly those generated through the productivity and time endowment channels: in their absence, welfare would be 9.1% and 5.5% higher in terms of CEV for the non-college group, respectively, and 2.6% and 2.9% higher for the college group (Table 9).[49]

Asset accumulation is influenced by all health channels but the most important is survival (Table 8). Lower survival rates associated with bad health imply higher future discount rates which significantly reduce average asset accumulation: if all individuals had the survival rates of the healthy, asset accumulation would be 17% higher for the non-college group before the age of 60 and 35% higher after 60, while for the college educated, asset accumulation would be 15% and 49% higher respectively. The results associated with the other channels are more difficult to interpret since they are generated by two different effects: (1) an elimination of health risk (elimination of fluctuations around mean earnings, mean available time, and mean medical expenditures across individuals of different health states), and (2) a level effect from higher average earnings, time endowments, and average disposable incomes when the productivity, time and medical expenditures channels are shut down, respectively. In section 5.3, I study the effects of health risk independent of level effects to shed light on these results.

Next, I show that it is important to model health effects over the entire life-cycle, especially when studying how medical expenditures affect asset accumulation. Even though medical expenditures are highest among the elderly, studying post retirement health expenses in isolation would lead to deceiving results. To illustrate this, I consider the effects of eliminating medical expenditures only before retirement, only after retirement, and for the entire life-cycle (Table 10).[50] Both education groups accumulate more assets after the age of 60 due to old age medical expenditures (their elimination decreases asset accumulation by 37% for the non-college and 22% for the college group). However, medical expenditures before retirement age imply lower disposable incomes from which to save, and hence lower

the results is ambiguous: on the one hand, the model contains a smaller fraction of workers with health insurance who will change their labor supply decisions as a result of the removal of medical expenditures, causing the model to underestimate the importance of medical expenditures, and on the other hand, workers with health insurance in the model have lower earnings than in reality, making them more likely to change their labor supply decisions as a result of the removal of medical expenditures.

[49] Welfare is defined as in Conesa et al. (2009) to equal the ex-ante expected lifetime utility of a new-born agent. It is assumed that all individuals start with zero assets and an average level of labor productivity. Welfare changes are measured in terms of consumption equivalent variation (CEV): switching from a consumption-labor allocation of (c_0; l_0) to (c^*; l^*) results in a welfare change given by $CEV = \left[\frac{W(c*,l*)}{W(c_0,l_0)}\right]^{\frac{1}{\alpha(1-\sigma)}} - 1$. Intuitively, this measures the permanent percentage change in consumption which is equivalent for an agent in expected utility terms to changes in initial conditions that lead to the different consumption-labor allocation. Note that this measure cannot be used to evaluate the welfare effects of changes in survival probabilities since period utility is negative and higher survival rates would lead to a lower expected lifetime utility and a negative CEV. For methods that enable the estimation of the value of changes in longevity, see Usher (1973), Rosen (1988), Murphy and Topel (2003) and Becker et al. (2005).

[50] Note that in the previous experiment with medical expenditures, I assigned all individuals the medical expenditures of the healthy, whereas here I am eliminating them entirely for the age groups considered.

asset accumulation after the age of 60 (their elimination leads to 7.4% and 3% higher asset accumulation for non-college and college groups, respectively). So, when abstracting from medical expenditures during working life, the effect of old age medical expenses on asset accumulation after the age of 60 is overestimated by 9% and 11% for the non-college and college groups, respectively. Taking into account pre-retirement health effects is important because as the example above shows, these effects play a big role in explaining why individuals may appear to save too little for old age medical expenditures.

The interactions between different channels are also important, especially interactions with the two dominant channels during working life, productivity and time. For example, time endowment reductions due to bad health are more painful in the presence of health induced productivity losses. Eliminating either the time endowment or productivity effect leads to lower levels of asset accumulation before the age of 60 since individuals do not need to self insure against these (Table 10). However, while the elimination of the time endowment effect leads to 14% lower average asset accumulation for the non-college in the presence of the other health effects, when the time endowment effect is eliminated in the absence of the productivity effect, asset accumulation declines by only 8.2%. This indicates that additional savings are required to self insure against the joint occurrence of adverse health effects. Similarly, the effect of medical expenditures on asset accumulation before the age of 60 is underestimated by 22% in the absence of the productivity effect for the non-college educated. The joint occurrence of these adverse health effects makes them more painful: not only do poor health individuals have to pay high medical costs, but these expenses are incurred at a time when average earnings are lower. Utility decreases more sharply in the presence of productivity effects because the change in disposable income caused by medical expenditures occurs at lower income levels where the marginal utility of consumption is high.

Finally, I estimate the total impact of health effects, and find that in an economy where all individuals are always in good health with certainty, or where health has no effects, labor supply and welfare increase substantially, especially for the non-college group. Non-college labor supply is 12% higher than in the Benchmark economy in the absence of health effects, while college labor supply is only 2% higher. The non-college group's CEV is 17.7% in the absence of productivity, time and medical costs associated with bad health and the college group's CEV is 7.3%.[51]

The above experiments have revealed consistently that health effects are much larger for the non-college group, resulting in larger percentage changes in the variables studied relative to the Benchmark. One reason for this is that the non-college face higher probabilities of bad health at any age. In addition, the effect of health on productivity is larger for the non-college group. Finally, at the lower income levels of the non-college, fluctuations in incomes and time endowments caused by health imply larger utility changes, making health risk relatively more important. Overall, health effects account for 35% of the 11 percentage point difference in labor supply observed in the data across education groups. The pro-

[51] This welfare gain would be even greater when accounting for the extra years of life gained when health has no effect on survival. As mentioned previously, this cannot be captured by the CEV measure.

ductivity and time endowment effects play the biggest roles since together, they decrease non-college labor supply by 8.6 percentage points while lowering college labor supply by only 2.4 percentage points. Next, the fraction of the non-college educated group receiving government transfers is 9 percentage points higher than that of the college educated in the data.[52] Health effects account for 31% of this difference.[53] Finally, average asset accumulation is 2.63 times higher among college graduates than non-college before the age of 60, and 3.21 times higher after the age of 60 in the model. I find that the differences would be even greater in the absence of health effects (2.89 times before age 60 and 3.37 times after age 60). Section 5.3 discusses the importance of health risk for precautionary savings, independent of level effects, shedding additional light on asset accumulation differences across education groups.

5.3 The Importance of Health Risk

In order to assess the role of health risk alone, this section considers similar experiments as the previous section, but this time only the variation around an average effect is eliminated. For example, I eliminate the productivity risk implied by changes in health status by giving all individuals of a particular age and education group the average deterministic component of wages in that group across individuals of different healths.[54] The time endowment risk is eliminated by decreasing the time endowment of all individuals in a given age-education group by the average health induced time cost incurred by that group. The medical expenditure and survival risks are eliminated similarly, by giving all individuals the average medical expenditures and survival probabilities within age-education groups.

To shed light on the magnitude of health risk, I first study how the variances of earnings and disposable income change relative to the Benchmark when health risk transmitted through each channel is eliminated (Table 11).[55] The elimination of health induced productivity risk has the largest effect, lowering the variance of disposable income by 6.8% for the non-college group. When considering all channels together, health risk accounts for 9.4% of disposable income inequality in the model for non-college and 5.2% for the college educated.

I find that health risk accounts for 18.1% of the non-college group's average asset accumulation before the age of 60, and for 12.1% after 60, whereas for the college educated, health risk accounts for only 2.6% and 1.7% of asset accumulation, respectively (Table 13). Health induced productivity and time endowment risks are particularly important for asset accumulation before age 60 for the non-college group, each accounting for 12.6% of asset

[52] Statistics on labor supply and government transfers are calculated using CPS data.

[53] Health effects account for 52% of the difference observed in the model. However, since the model slightly overestimates the fraction of non-college individuals receiving transfers and slightly underestimates the fraction for the college group, health accounts for only 31% of the total observed difference across education groups in the data.

[54] The average is taken over wages before selection into the labor force takes place. Post-selection, average earnings may not be the same in this experiment as in the Benchmark.

[55] Disposable income is defined as the sum of after tax assets, after tax earnings, Social Security and government transfers minus health insurance premiums and medical expenditures.

accumulation, and together accounting for 17.0%.[56] After the age of 60, medical expenditure risk has a large effect, accounting for 8.1% of asset accumulation. To understand these results, note that the productivity and time endowment effects are very large for the non-college group, implying very large drops in utility especially in poor health states. If individuals choose to work, they enjoy very little leisure while productivity and earnings are also low, and if they take time off work, they receive no earnings while their leisure is still relatively low due to the time costs associated with bad health. Non-college individuals accumulate large fractions of precautionary savings to avoid these periods of low consumption combined with low leisure.

An important factor in the assessment of health risk for different groups of individuals is its interaction with the social insurance safety net modeled as a consumption floor. Hubbard et al. (1995) have shown that in a model with medical expenditure, survival and earning risks, the consumption floor has a large effect on asset accumulation by reducing uncertainty and effectively taxing savings 100% in the advent of bad health or large negative earning shocks that force individuals to rely on the consumption floor, discouraging savings especially for low income individuals. Similar to Hubbard et al. (1994, 1995), I find that the consumption floor has a large negative effect on asset accumulation for the lower education group: in an experiment where the consumption floor is half of its original value, average asset accumulation before the age of 60 increases by 15% for the non-college and only 5% for the college group. In addition, the consumption floor implies lower levels of precautionary savings against health risk for both education groups: in an experiment where the consumption floor is reduced by half, the percentage of asset accumulation accounted for by health risk is 24.5% and 7.3% before the age of 60 for the non-college and college groups, respectively, compared to only 18.1% and 2.6% when the consumption floor is at its original level (Table 13). However, despite the presence of the consumption floor, the non-college group accumulates much higher fractions of precautionary savings against health risk than the college educated. The gap in asset accumulation between education groups is reduced by 7% before the age of 60 and 3% after age 60 due to the presence of health risk.[57] The time endowment channel makes the consumption floor a less attractive insurance option during periods of poor health since utility levels become extremely low when consumption is at a minimum and also leisure is low due to bad health.

It is important to note that people self insure through asset accumulation for a variety of reasons. Transitory earning shocks are important to model because in their presence,

[56]Comparing the results of eliminating health effects as conducted in section 5.2 with the results of eliminating health risk alone, we see the distinction between level effects associated with the four channels and the effects of risk. For example, Tables 8 and 13 reveal that health induced productivity risk is an important precautionary savings motive for the non-college, accounting for 12.6% of average asset accumulation before the age of 60; however, when all productivity costs associated with bad health are eliminated as in section 5.2, individuals have higher average earnings from which to save, so the elimination of health-induced productivity costs lead to only 3.9% lower asset accumulation before the age of 60 for the non-college group relative to the Benchmark.

[57]In the experiment where all health risk is removed, the difference in average asset accumulation between education groups is $89,349 before the age of 60 and $93,528 after age 60 compared to only $83,543 before the age of 60 and $90,882 after age 60 in the Benchmark model.

individuals already accumulate a large amount of assets to self insure. Since the timing of adverse health shocks need not coincide with negative transitory shocks, people are already insured to some extent against health shocks. Omitting the transitory earnings variation would lead to an overestimation of health risk on asset accumulation: the removal of all health risk in the absence of transitory shocks leads to a 25% larger decline in average asset accumulation for the non-college group before the age of 60 than when these shocks are present.

The simultaneous elimination of productivity, available time and medical expenditure risk leads to a welfare increase of 1.17% in terms of CEV relative to the Benchmark for the non-college, and 0.31% for the college educated (Table 12). The time endowment risk has the largest effect on welfare for the non-college (0.7%), followed by medical expense risk (0.67%).[58] The welfare changes associated with the removal of health risk are very small compared to the welfare improvements estimated in section 5.2 (Table 9) associated with the complete elimination of health effects (18% in terms of CEV for the non-college and 7% for the college group), revealing that fluctuations around the average health levels within age-education groups do not have large welfare implications, but the negative effects associated with the average health levels are actually very important.

6 Conclusion

This paper shows that health risk is a major component of overall risk and a big determinant of welfare, labor supply and asset accumulation, especially for the non-college education group. Health affects individuals' decisions through productivity, available time, medical expenditures and survival probability effects and the interactions between these are shown to be large, highlighting the importance of modeling them in a unified framework. The productivity and time endowment channels dominate in importance when studying labor supply and welfare and the risks implied by these two channels are the most important in generating income inequality and precautionary savings during working life.

The results highlight the importance of health effects for the working age population relative to retirees. Even though the probability of bad health is relatively low before the retirement age, health effects during the working stage of life are extremely important for welfare and they generate a large fraction of observed income inequality for the non-college educated. In addition, most negative effects of adverse health affecting the working age population do not come from medical expenditures (on which a lot of the policy debate is focused on) but from losses in productivity and time. Therefore, it would be interesting and

[58] The elimination of productivity risk leads to slightly lower welfare for the college group. When the deterministic component of wages is averaged across health groups at each age, the average is taken over all individuals, workers and non-workers. Since a large fraction of those in poor and average health with lower wages do not work, the average deterministic wage component is lower than the average deterministic component taken only across workers at each age. Therefore, average earnings are lower in the absence of the health induced productivity risk post-selection into the labor force. This negative income effect is large enough for the college group to offset the gains in welfare derived from the elimination of health induced productivity risk.

useful to place more focus on policies and programs affecting these channels compared to insurance against medical expenditures alone. A growing literature studying the disability insurance program is providing new findings on how this program can be reformed to increase welfare (e.g., Low and Pistaferri (2010)). There are several other ways to lower the importance of the productivity and time endowment channels. First, laws that guarantee workers a minimum number of paid sick days or leave could go a long way in insuring productivity losses. The US does not currently have such a law, while countries such as Norway and Finland have very generous paid sick leave systems. Second, it would be interesting to study how government skill training programs could be used to help increase the productivity of workers who are no longer able to work in their previous jobs or occupations due to health shocks. Third, policies that improve the efficiency of the health care system could also be important in diminishing the importance of the time endowment channel.

The findings also have implications for several strands of related literature. For example, the results suggest that it is important to incorporate productivity and time endowment effects when studying individuals' incentives to invest in health over the life-cycle. Good health has a very large welfare value for the non-college group due to its benefits through these channels. Hall and Jones (2007) show that good health is increasingly valuable as incomes rise since health allows people to increase the quantity and quality of life by lowering mortality probabilities. It would be interesting to study the optimal investment in health of the non-college educated group in a model accounting for productivity and time effects and to compare the results with observed investments. Second, it would be interesting to study the contribution of health risk to personal bankruptcy decisions in a model incorporating not only medical expenditures, but also productivity and time endowment effects. There is a relatively large personal bankruptcy literature modeling or documenting the importance of medical expense shocks (e.g., Dranove and Millenson (2006), Gross and Notowidigdo (2011) and Livshits et al. (2010)). However, there are large interactions between medical expenditures and the other channels. Also, health induced productivity and time endowment risks are the most important in generating income inequality, so in general, health shocks may overall play a relatively large role in bankruptcy decisions. I leave these topics for future research.

7 Tables

Table 1: Model Parameters

	Non-college	College
Demographics		
Age of entry into labor force	18	22
Age of retirement	65	65
Average lifespan	75	79
Measure of education types	70%	30%
Taxes (%)		
Capital income tax		40.0
Consumption tax		5.7
Labor income tax	16.0	19.0
Social Security tax		6.2
Medicare tax		1.45
Utility function		
α		0.4
σ		3.0
Social Security and Insurance (2006 dollars)		
Consumption floor	4400	5100
Social Security income when retired	12804	14069
Interest rate		1.04

Table 2: Insurance, premiums and coverage rates

% workers by Employer Provided Health Insurance (EPHI)	Non-college	College
No insurance	18	8
Insurance while working only	54	58
Insurance while working and in retirement	28	35

Insurance premiums (annual amount for single coverage, 2006 dollars)	Total	Employee Share
Medicare premium (part B)	779	779
EPHI Premium (workers)	3852	693 (18%)
EPHI Premium (retirees)	3497	1574 (45%)

Insurance coverage rates, % of total medical expenditures	
Medicare	50%
EPHI, ages<65	70%
EPHI, ages>=65	30%

Table 3: Total Health Expenditures, MEPS

		Health	
	Poor	Average	Good
Age group 18-29	4,577	1,174	607
Age group 30-39	8,373	1,775	874
Age group 40-49	11,286	3,024	1,353
Age group 50-59	11,597	5,433	2,172
Age group 60-64	16,293	7,492	3,205
Age group 65-74	18,578	8,329	4,327
Age group 75-82	18,489	10,233	5,550
Age group 83 +	16,454	9,582	5,943

Note: 2006 US dollars

Table 4: Calibration Targets and Model Results

	Non-College		College		
	Targets	**Model**	**Targets**	**Model**	**Source of Target**
% Poor health working, ages 30-50	17.3	16.4	32.9	33.7	CPS
% Avg. health working, ages 30-50	72.7	71.1	82.9	84.2	CPS
% Good health working, ages 30-50	86.7	86.3	89.7	93.5	CPS
$\hat{\sigma}^2_{\bar{\mu}}$	0.09640	.09214	0.06991	0.07438	PSID regression
$\hat{\rho}$	0.94292	.93200	0.97254	0.97215	PSID regression
$\hat{\sigma}^2_{\eta}$	0.01819	.02194	0.01846	0.02125	PSID regression
% Working 2 consecutive years, ages 30-50	91.6	90.2	93.6	92.8	CPS
Avg. hourly wages, ages 23-26, Poor	11.9	15.0	13.2	15.3	CPS
Avg. hourly wages, ages 33-36, Poor	15.9	17.6	24.0	21.8	CPS
Avg. hourly wages, ages 43-46, Poor	18.0	18.3	29.4	29.3	CPS
Avg. hourly wages, ages 53-56, Poor	18.5	18.4	31.3	31.7	CPS
Avg. hourly wages, ages 25-28, Avg.	14.3	16.1	20.4	20.0	CPS
Avg. hourly wages, ages 25-28, Good	15.8	17.7	22.3	21.7	CPS
Avg. hourly wages, ages 39-42, Avg.	18.7	19.6	30.8	30.1	CPS
Avg. hourly wages, ages 39-42, Good	20.6	22.1	33.7	32.3	CPS
Median assets/income, ages 30-50	.83	.88	1.56	1.34	SCF

Table 5: Calibrated Parameters

	Non-College	**College**
Φ_1(time cost of Avg. health)	P.025	0.0305
Φ_2(time cost of Poor health)	0.193	0.1505
θ (fixed time cost of work)	0.10	0.11
β_0 (constant)	0.80	1.27
β_1 (age)	0.074	0.079
β_2 (age squared)	-0.00097	-0.001096
β_3 (age cubed)	0.0000024	0.0000035
β_4 (Avg. or Good health)	0.226	0.172
β_5 (Avg. or Good health* age)	0.000001	0.0009002
β_6 (Good health)	0.210	.113
β_7 (Good health*age)	0.000001	0.000000001
ρ	0.975	0.979
σ^2_{η}	0.0078	0.02
$\sigma^2_{\bar{\mu}}$	0.22	0.02
σ^2_{λ}	0.01931	0.025
β	0.975	0.978

Table 6: Government Transfers, Model and Data, ages 30-55

% receiving transfers

	Model	**Data**
Non-College	19	14
College	4	5

% transfer recipients in Poor or Average health

	Model	**Data**
Non-College	63	64
College	41	43

Note: Estimates are obtained using CPS data for years 1996-2006.

Table 7: Health Effects and Labor Supply

Percentage Change in Average Labor Supply Relative to Benchmark

			Non-College, by Health		
Health Effect Removed	**Non-College**	**College**	**Poor**	**Average**	**Good**
All	12.1	1.7			
Medical Expenditures	-1.3	-2.1	-46.3	-3.3	0.4
Survival	0.4	0.7	7.3	1.2	0.3
Productivity	8.9	1.6	181.5	20.0	0.0
Time Endowment	4.4	1.8	272.6	5.3	0.4
Productivity and Time Endowment	12.0	2.8	398.1	23.5	0.0

Table 8: Health Effects and Asset Accumulation

Percentage Change in Average Assets Relative to Benchmark

	Ages $<$ 60		**Ages $>$ 60**	
Health Effect Removed	**Non-College**	**College**	**Non-College**	**College**
All	-0.7	9.3	32.4	39.1
Medical Expenditures	-4.1	-2.4	-17.5	-7.8
Survival	16.7	14.6	35.1	49.2
Productivity	-3.9	-0.8	15.2	2.5
Time Endowment	-14.0	-3.0	-5.6	-1.6
Productivity and Time Endowment	-12.1	-3.1	12.5	1.0

Table 9: Health Effects and Welfare

Consumption Equivalent Variation (CEV) Relative to Benchmark (%)

Health Effect Removed	Non-College	College
Medical Expenditures	3.01	1.83
Productivity	9.07	2.55
Time Endowment	5.50	2.94
Productivity and Time Endowment	15.37	5.72
Productivity and Medical Expenditures	11.75	4.31
Productivity, Time Endowment and Medical Expenditures	17.73	7.33

Table 10: Importance of Health Effects Interactions for Asset Accumulation

	Ages < 60		Ages > 60	
Health Effect Removed	**Non-College**	**College**	**Non-College**	**College**
Medical Expenditures, ages >= 65	-12.7	-9.9	-36.9	-22.0
Medical Expenditures, all ages	-5.5	-6.6	-32.9	-21.3
Medical Expenditures, ages < 65	7.2	3.2	7.4	3.0
M.E., ages > 65, in absence of M.E. at ages < 65	-12.7	-9.8	-40.3	-24.3
% difference if not accounting for M.E. at ages <65	0	-1.0	9.2	10.5
Time Endowment	-14.0	-3.0	-5.6	-1.6
Time Endowment and Productivity	-12.1	-3.1	12.5	1.0
Productivity	-3.9	-0.8	15.2	2.5
Time Endowment, in absence of Productivity effect	-8.2	-2.3	-2.7	-1.5
% difference if not accounting for Productivity effect	-41.4	-23.3	-51.7	-6.3
Medical Expenditures	-4.1	-2.4	-17.5	-7.8
Medical Expenditures and Productivity	-7.1	-3.2	-3.3	-5.4
Productivity	-3.9	-0.8	15.2	2.5
M.E., in absence of Productivity effect	-3.2	-2.4	-18.5	-7.8
% difference if not accounting for Productivity effect	-22.0	0	5.7	0

Notes: 1. M.E. = Medical Expenditures; 2. In the first set of experiments, the removal of the Medical Expenditure effect at the specified ages means that these age groups incur zero medical expenditures; 3. In the third set of experiments, the removal of the Medical Expenditure effect implies that all individuals incur the medical expenditures of those in good health.

Table 11: Health Risk Effects on Earnings and Income Inequality

% Change in Earnings and Disposable Income Variance Relative to Benchmark (Ages<65)

	Earnings		**Disposable Income**	
Health Risks Removed	**Non-College**	**College**	**Non-College**	**College**
All	-3.5	-1.9	-9.4	-5.2
Medical Expenditures	-1.6	0.1	4.6	4.9
Survival	-0.6	-1.5	-0.4	-0.5
Productivity	-2.1	-0.7	-6.8	-1.2
Time Endowment	-2.4	-1.7	-3.1	0.7
Productivity and Time Endowment	-3.3	-0.7	-5.7	0.6
Productivity and Medical Expenditures	-3.0	-2.2	-4.3	-2.4
Productivity, Time Endowment and Med. Exp.	-4.1	-0.6	-9.7	-4.7

Table 12: Effects of Health Risk on Welfare

% Consumption Equivalent Variation (CEV) Relative to Benchmark

Health Risk Removed	**Non-College**	**College**
Medical Expenditures	0.67	0.32
Productivity	0.17	-0.08
Time Endowment	0.70	0.19
Productivity and Time Endowment	1.08	0.24
Productivity and Medical Expenditures	0.59	0.15
Productivity, Time Endowment, and Med. Exp.	1.17	0.31
Medical Expenditures, ages < 65	0.54	0.17
Medical Expenditures, ages $>= 65$	0.13	0.12

Table 13: Effects of Health Risk on Asset Accumulation

% Change in Average Assets Relative to Benchmark

	Ages $<$ 60		Ages $>$ 60	
Health Risk Removed	**Non-College**	**College**	**Non-College**	**College**
All	-18.1	-2.6	-12.1	-1.7
Medical Expenditures	-1.7	-1.4	-8.1	-3.4
Survival	0.5	-1.0	1.7	0.9
Productivity	-12.6	-2.2	-5.6	-0.2
Time Endowment	-12.6	-2.5	-7.9	-3.8
Productivity and Time Endowment	-17.0	-1.9	-7.4	-1.6
Productivity and Medical Expenditures	-12.2	-3.6	-12.0	-7.1
Productivity, Time Endowment and Med. Exp.	-19.0	-4.0	-13.9	-4.7
Medical Expenditures, ages $<$ 65	-0.6	-0.6	-0.9	0.6
Medical Expenditures, ages $>$ =65	-1.7	-2.2	-7.0	-4.7
All, in Absence of Transitory Earnings Shocks*	-22.6	-4.5	-12.6	-3.5
All, Consumption Floor is .5 of Original*	-24.5	-7.3	-16.0	-1.2

**The reported results are net of the effects of removing transitory earnings shocks and of decreasing the consumption floor by 0.5.*

8 Figures

Figure 1: Health Transitions

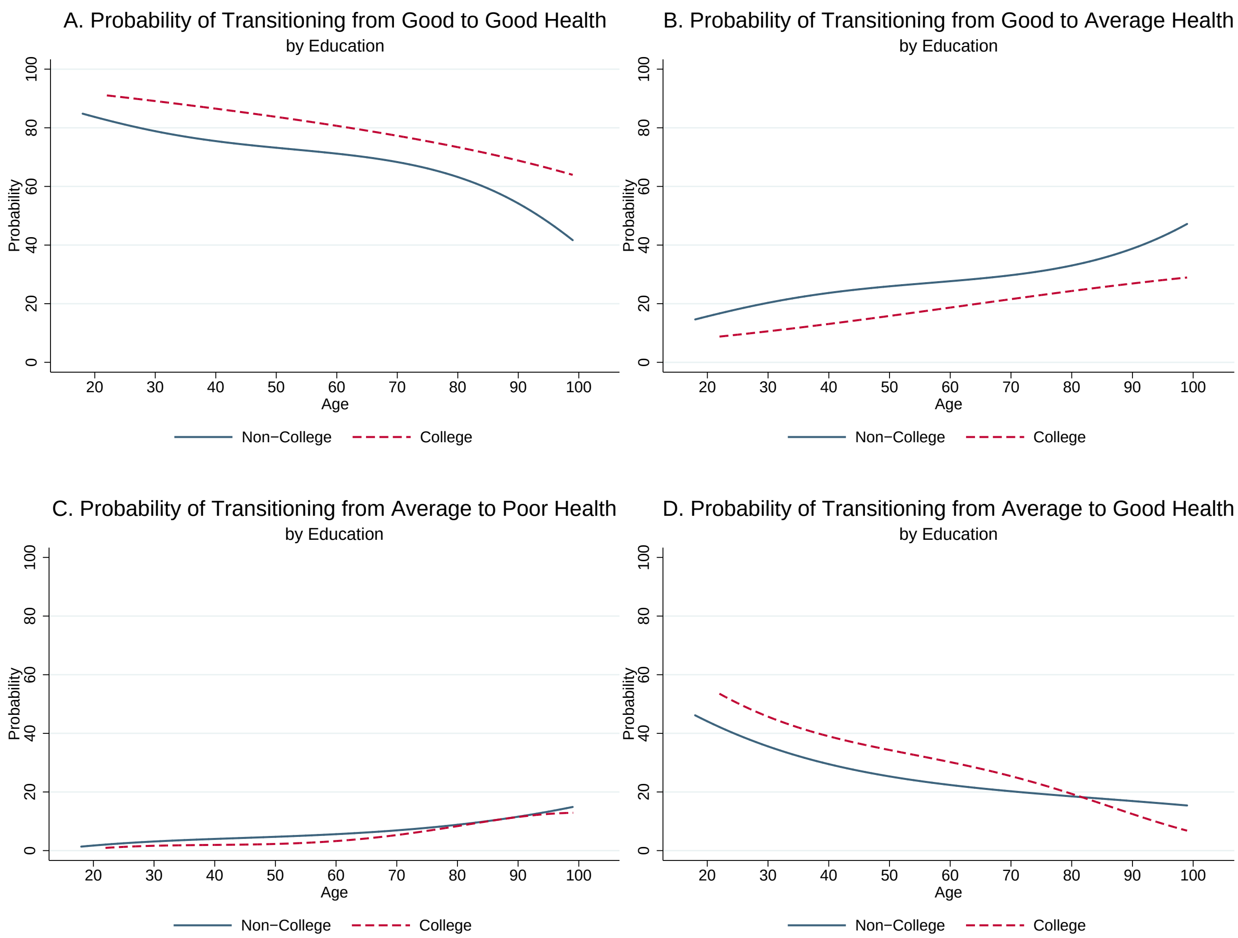


Figure 2: Probability of Death by Education and Health Status

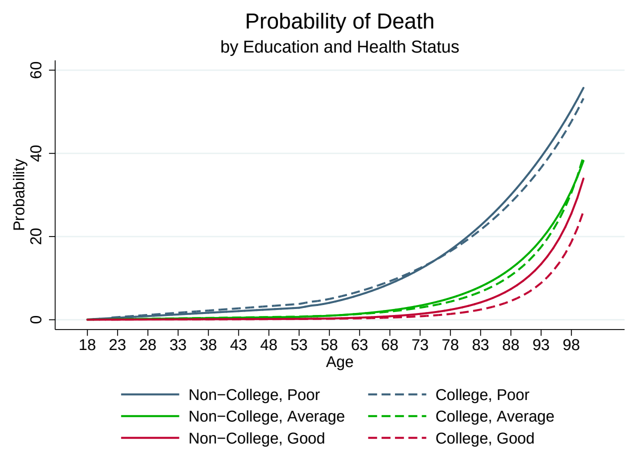
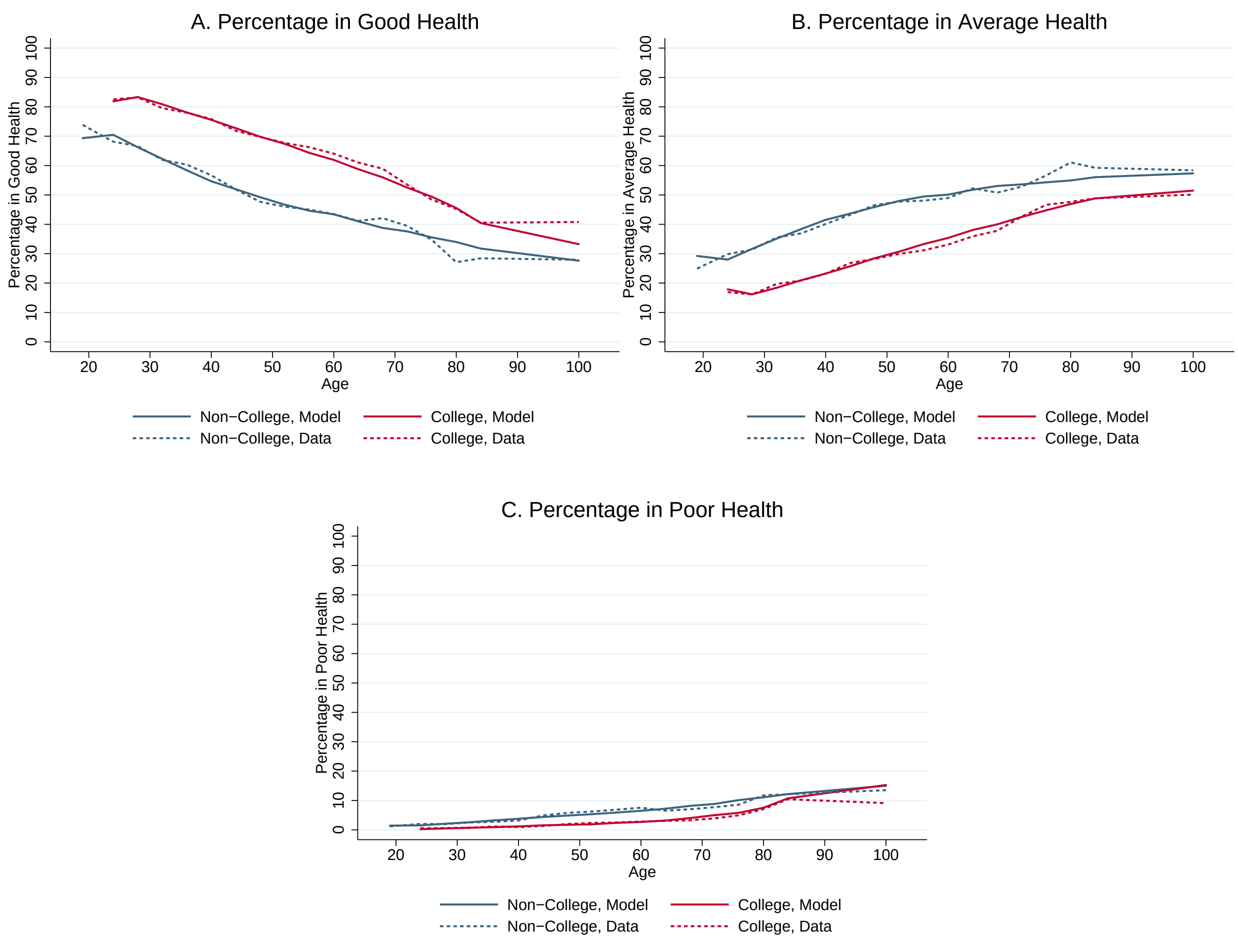
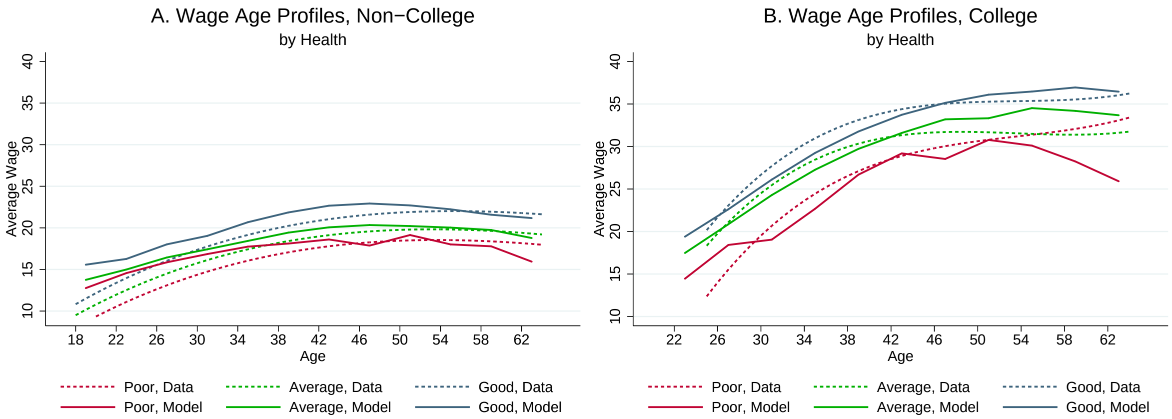


Figure 3: Percentage of Population by Health Status, Data and Model



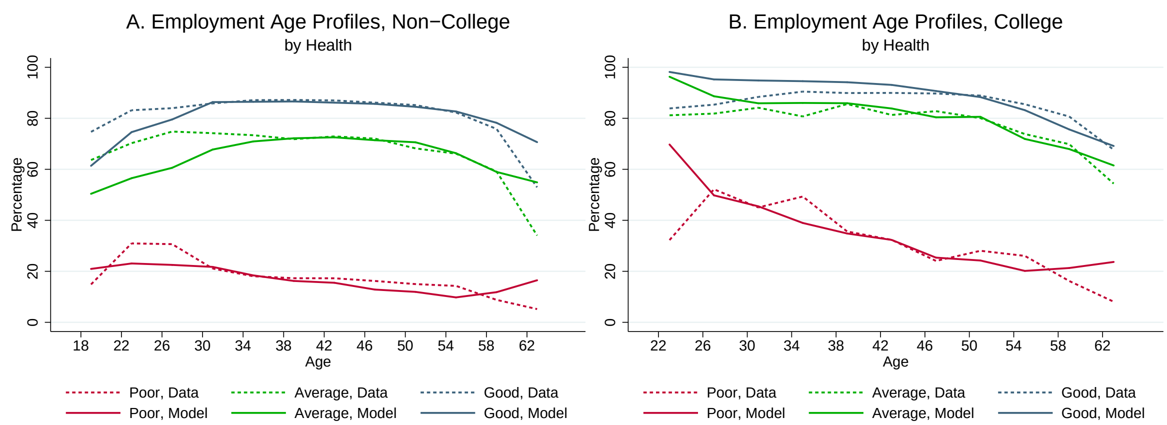
Note: Data sources: MEPS and HRS combined.

Figure 4: Wage Age Profiles, by Education and Health, Model and Data



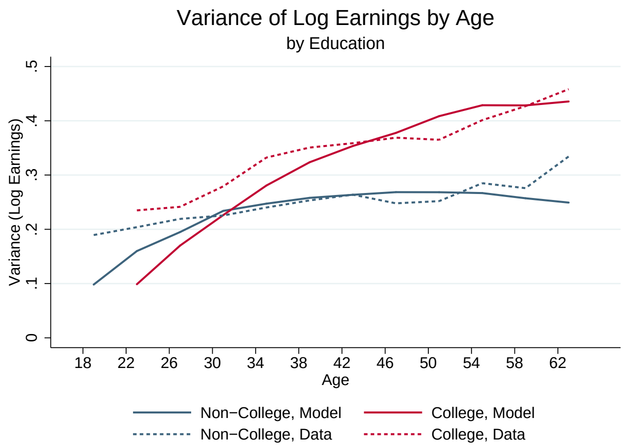
Notes: 1. Data source: CPS. 2. Data profiles smoothed by taking averages within age groups combining 4 ages.

Figure 5: Labor Force Participation, by Education and Health, Model and Data



Notes: 1. Data source: CPS. 2. Data profiles smoothed by taking averages within age groups combining 4 ages. 3. The 95% Confidence Intervals are well within 1 percentage point of the estimated means, with only a few exceptions.

Figure 6: Variance of Earnings Age Profiles, Model and Data



Notes: 1. Data source: CPS. 2. Data profiles smoothed by taking averages within age groups combining 4 ages. 3. The observations in the CPS with earnings in the top 1% of the college group are excluded. 4. Figure constructed using earnings of full time, full year workers with wages higher than 5$ per hour.

Figure 7: Average Consumption Age Profile, Model

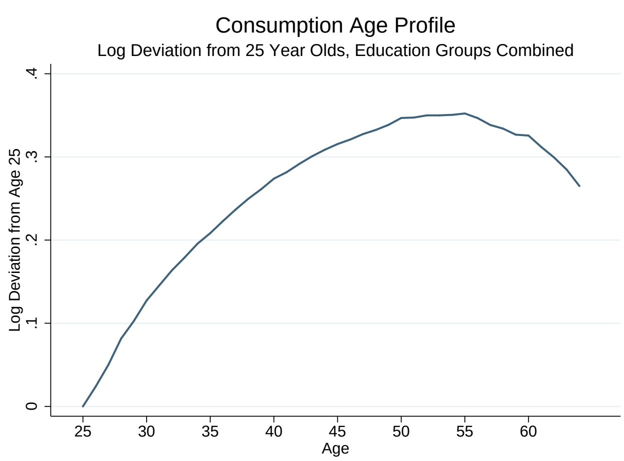
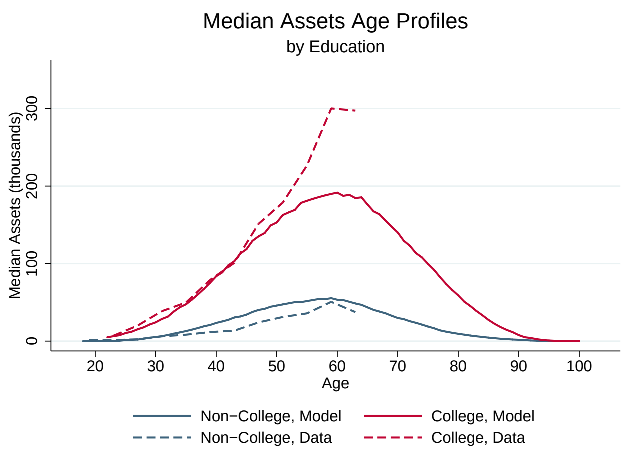


Figure 8: Asset Accumulation Age Profiles, Model and Data



Notes: 1. Data source: SCF. 2. 95% Confidence Intervals are very close to the estimated SCF medians and are not shown.

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