Life-cycle Effects of Health Risk

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Abstract

In order to design and understand the effects of health care policy reforms, we need to better understand the different ways in which health affects individuals and their economic decisions. 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., 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, and due to significant interactions between them, 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. Finally, improving non-college health outcomes leads to large welfare gains, higher labor supply, and lower reliance on government welfare programs. Reducing health risk by improving health care system efficiency also results in large welfare gains, but expanding insurance coverage has relatively small benefits.[1]

JEL Classification Codes: D91, E21, I14, I31

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1 Introduction

Health care system reform is a contentious topic of debate highlighting the need for a better understanding of how health affects individuals and their economics decisions. Current statistics suggest that health risk is a major component of overall risk and a big determinant of welfare with potential large macroeconomic implications. For example, "using a conservative definition, 62.1% of all bankruptcies in 2007 were medical" (Himmelstein et al. (2009)).[2] In order to predict the effects of upcoming changes to the U.S. health care system on the type and degree of health risk faced by individuals, it is important to understand the different channels through which health affects individuals and their economic consequences.

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. An important feature of this paper is to study these 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 joint occurrences of these effects suggest that it is important to consider how they interact.

The contribution of my paper is to assess the relative importance of each channel and quantify the interactions between them and between how they operate at different stages of the life-cycle. This evaluation is crucial for designing and predicting the outcomes of health care reforms. 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. Second, I find that health affects education groups differently, with larger effects for non-college individuals, explaining a significant fraction of the difference in labor supply and degree of reliance on government transfers across groups. Health risk leads to much larger precautionary savings in the non-college than college group. Finally, I show that differences in health outcomes across education groups are very important and improving non-college health closer to college levels results in large welfare gains, higher labor supply, and significantly lower reliance on government welfare programs. Policies such as Medicaid expansion and increased insurance coverage have relatively small benefits.

The framework used is a standard Bewley (1986) life-cycle model with incomplete markets

[2] Bankruptcies are classified as "medical" based on debtors' stated reasons for filing, income loss due to illness, and the magnitude of their medical debts.

and uninsurable income risk augmented with health shocks as previously done in French and Jones (2011). To make the model realistic and useful for policy evaluation, I also 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 in order to explicitly study 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.

French and Jones (2011) is the only existing paper to model all four channels through which health affects individuals. However, the object of interest in their paper is retirement behavior, and while they conduct a policy experiment related to Medicare in this framework, they only consider the effects on the labor supply around retirement age. Different from their paper, I study each channel separately and analyze health effects at different stages of the life-cycle. I find that the risk implied by health's effects on productivity and available time generates strong precautionary saving motives accounting for 17% of asset accumulation before the age of 60 for the non-college educated. In bad health states, lower average earnings and time endowments imply very large drops in utility. The risk of entering these extremely low utility states generates a strong incentive to self insure through asset accumulation against the loss of income and possible bankruptcy. Also, in the absence of health effects on productivity and time endowments, non-college labor supply increases by 12%. On the other hand, lower survival rates associated with bad health greatly discourage asset accumulation at all stages of the life-cycle. The presence of medical expenditures encourages labor force participation since individuals can benefit from employer provided health insurance when employed, and medical expense risk leads to modest precautionary savings when young and significantly higher levels when old.

The results show that even though the probability of bad health before retirement age is relatively small, the presence of health risk still has large consequences especially through the productivity and time endowment channels. Papers such as De Nardi et al. (2006) and Kopecky and Koreshkova (2009) study the importance of individual health effects, but only after retirement age, and are therefore unable to capture some of the largest health effects. Of the few papers that study health effects before retirement, none looks at the importance of individual effects.

In addition, I show that due to interactions between health effects at different stages of the life-cycle, papers that model health risk only after retirement cannot accurately estimate their importance in isolation. Medical expenditures are a good example: for non-college graduates, 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. Kopecky and Koreshkova (2009) who study the effects of out-of-pocket health expenses on asset accumulation in a model with no health effects before retirement age likely overestimate these effects.

I also quantify significant interactions between different types of health effects. Papers that model only a few of the channels studied in this paper may wrongly estimate the importance of a particular health effect by missing the interactions.[3] For example, I find that 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. Average non-college asset accumulation before the age of 60 resulting from the presence of the time endowment effect is underestimated by 41% in the absence of the productivity effect, while asset accumulation resulting from the presence of medical expenditures is underestimated by 22%. The joint occurrence of adverse health effects makes them more painful, requiring higher levels of precautionary savings. Hubbard et al. (1995) who model earnings risk independent of health together with medical expense and survival risk would likely underestimate the importance of health expense risk on asset accumulation since negative earnings shocks in their model are less likely than in reality to coincide with negative income shocks generated by high medical expenditures.

I consistently find larger health effects for the non-college educated. One reason is that they face higher probabilities of bad health at any age. Also, bad health lowers non-college productivity to a greater extent. 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 more important. Overall, 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. Finally, I find that the non-college group accumulates much higher fractions of precautionary savings against health risk than the college despite the presence of an asset based means-tested consumption floor, reducing the gap in asset accumulation between education groups by 7% before the age of 60 and 3% after age 60. The time endowment risk and the health induced productivity risk generate large precautionary savings especially for the lower income group since relying on the consumption floor during

[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.

periods of bad health when leisure time is also low is associated with extremely low utility levels. Overall, health risk accounts for 9.4% of disposable income inequality for the non-college group.

I use the model to conduct several counter-factual experiments that shed light on the importance of different model environment aspects that are important for the degree of health risk faced by individuals: health transition probabilities, efficiency of the health care system (reflected in the time and medical costs incurred), and degree of health insurance coverage through employers and Medicaid. The results suggest that due to the presence of many channels, improvements in non-college health transition probabilities have very large benefits. For example, when the probabilities of transitioning to bad health of the non-college are decreased to the levels of college graduates, non-college welfare improves by 4.7% in terms of CEV. The percentage of the non-college population relying on social insurance programs drops by 16%, lowering Medicaid government expenses by 34% and other welfare program expenses by 16%. The benefits associated with improvements in the other aspects of the environment are in general lower both in terms of welfare gains and reductions in government expenditures because they only diminish the effects of health through one or two of the transmission channels studied, implying relatively small effects when other important channels remain operative.

2 Model

In this paper, 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.[4] 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.[5] The model is solved in partial equilibrium, assuming a small open economy with a fixed interest rate of 1.04%.

[4] Most previous models modeling health assume only two health states (good and bad). Only Low and Pistaferri (2010) distinguish between moderate and severe work limitations (disabilities). I find important differences between the effects of average and poor health states.

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

Demographics The age of entry into the labor force is 18 for the non-college group and 22 for college degree holders. 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.) 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.[6]

An exogenous retirement age could be problematic since for example individuals might retire at older ages if they expect high medical expenditures late in life. However, these effects are likely to be small. French and Jones (2011) find a significant but small effect of health insurance on retirement.[7]

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.[8] 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.[9]

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 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. (2006), Attanasio et al. (2010), and French and Jones (2011)). The model best approximates reality

[6] De Nardi et al. (2006) found that mortality rates vary significantly with sex, permanent income and health status. They find that allowing for differences in life expectancy leads to a noticeable effect on asset decumulation for retirees, especially at the top end of the permanent income distribution.

[7] Specifically, they find that raising the Medicare eligibility age from 65 to 67 leads to an increase in labor force participation for those aged 60-67 by only .07 years.

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

[9] 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) and Feng (2009) are recent working papers featuring endogenous medical expenditures.

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.[10]

All medical expense uncertainty comes from health uncertainty. Several previous papers (e.g., De Nardi et al. (2006), Hubbard et al. (1994) and Kopecky and Koreshkova (2009)) also model medical expense variation around the deterministic component. However, De Nardi et al. (2006) 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 a relatively small effect. Due to this finding and the fact that there are already many channels through which health generates uncertainty in my model, I abstract from this feature.

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, covering 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 $\Omega_e(i)$.[11] 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.[12]

[10]For example, individuals in bad health might work less in order to devote more time to taking care of their health, but they will also have incentives to work more in order to have income for better medical treatments.

[11]For simplicity, I follow Attanasio et al. (2010) in assuming that the employer health insurance type is determined in the beginning of life and lasts forever. See Hsu (2008) for a model where an individual's employer health insurance type changes over the life-cycle with probabilities that depend on the agent's work status and permanent income level.

[12]French and Jones (2011) show that individuals with strong preferences for leisure self-select into jobs that provide health insurance coverage after retirement. Properly 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.

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.[13]

Finally, retirees receive social security payments SS_t 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.

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

[13] 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.

(2011) in modeling the effect of health on utility as a time cost.[14] 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 modeling the extensive margin alone captures the most important effect of health on labor supply. French (2005) documents small effects of health on hours worked but relatively larger effects on labor force participation.

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 μ 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.

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

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 productivity since their jobs are more likely to require physical ability and health as argued in Attanasio et al. (2010). French (2005) and French and Jones (2011) estimate significant effects of health on productivity but do not consider differences across education groups.

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

[14] 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 De Nardi et al. (2006). However, using the NLSY, I find supporting evidence that those in average and poor health states spend a significant amount of time on health care activities: those in average health spend 39 minutes per day and those in poor health spend 82 minutes per day on average, i.e. 4.55% and 9.57% of total leisure time, respectively.

μ, 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.

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

subject to

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

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 $\overline{c}$. 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

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

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) National Longitudinal Survey of Youth 1997 (NLSY), (5) Survey of Consumer Finances (SCF) and (6) 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 literature.[15] 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.[16] Another disadvantage

[15]Examples are Attanasio et al. (2010), Kopecky and Koreshkova (2009) and French and Jones (2011).

[16]I use the RAND HRS Data file which contains data from ten waves of the Health and Retirement Study,

of 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. The SCF is used because it is one of the few data sets containing detailed information on wealth accumulation, and finally, the NLSY contains information on individual time spent on health care activities. 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. 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 years of college. 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. 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 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.[17]

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.

[17] 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, 4,118 1998 $ in French and Jones (2011) who consider childless households. Attanasio et al. (2010) also assume a 10% consumption floor.

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).[18] 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. I 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.[19] 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 estimated 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.

The self-reported health measure is imperfect since respondents could hold different views of what good and bad health states entail (e.g., individuals with long term disabilities may classify themselves in good health if they do not suffer from any illnesses). To test the validity

[18] 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.

[19] 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, assigning a health status of Poor, Average or Good. I then estimate health transition probabilities from one age to the next.

of this measure, I use data on functional and activity limitations available in MEPS for 2006 only.[20] 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 some confidence in the self reported health measure.[21]

Medical Expenditures Average total health expenditures by age and health status are estimated from MEPS and are reported in Table 3. These expenditures include the out-of-pocket expenditures plus what is covered by insurance, but they do not include nursing home costs and insurance premiums since these are accounted for separately. The sample size of individuals over 70 is relatively small in MEPS, so this requires relatively broader age groups in order to have enough individuals. The HRS data contains only information on out-of-pocket expenditures, so unfortunately it cannot be used to directly estimate total costs.[22]

My paper takes the view that nursing homes are luxury goods, so nursing home costs are not included in medical expenditures. Instead, they are simply part of regular consumption. This view is consistent with De Nardi et al. (2006) who argue that medical expenditures after the age of 85 are luxury goods based on the observation that there are huge differences in out of pocket expenditures between the top and bottom income quintiles after this age. The top 10% of spenders account for 57% of total health expenditures and the top 1% for 25% when nursing home costs are included. Since I want to capture the role played by *required* medical expenses (as much as the data allows), I exclude nursing home costs. However, my model endogenously 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 (less leisure).[23] The very old

[20] These variables are available for MEPS Panel 10, rounds 3, 4 and 5, and Panel 11, rounds 1, 2 and 3.

[21] The validity of the self-reported health status measure has been discussed extensively in previous literature. Examples include Benìtez-Silva and Ni (2008), Crossley and Kennedy (2002), Baker et al. (2004), and Hurd and McGarry (1995).

[22] Kopecky and Koreshkova (2009) calibrate a medical expenditures process using the HRS.

[23] 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

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. Consumption at old age is likely to be goods and services such as nursing homes. In contrast, Kopecky and Koreshkova (2009) treat nursing home expenditures as exogenous.

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.[24] Finally, I impose 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

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.

[24] 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.

extended by Gouriéroux et al. (1993) and Gallant and Tauchen (1996).[25] 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:

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

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.[26] 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.[27] 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

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

[26] I estimate the parameters in the data using male full time workers. Observations are weighted using sample weights. Hourly earnings are calculated as annual earnings divided by hours worked.

[27] 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.

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 σ_μ^2 determining the productivity individual fixed effects and the parameters determining the idiosyncratic shocks u, ρ and σ_η^2 are identified by targeting their empirical counterparts estimated using PSID data. I do not calibrate the variance of the productivity transitory shock σ_λ^2 in the same way since the estimated variation in the transitory component of observed wages is extremely large due to the presence of measurement error in hours worked and earnings.[28] Similar to Erosa et al. (2011), I calibrate the variance of transitory shocks σ_λ^2 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. 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.[29] The calibration weighs all targets equally.

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 estimated out of sample. Figure 3 shows the percentage of individ-

[28] Erosa et al. (2011) find that the variances of transitory true wages for college and non-college groups are relatively small, and that the variances of measurement error in earnings and in hours contribute significantly to the total transitory variation in "observed" wages.

[29] 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 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.

uals 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.[30] 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.[31]

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 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.[32] The implication is that the model might overpredict the

[30]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 estimated 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.

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

[32]Also, preferences for leisure might in reality increase with age resulting in higher rates of exit from 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, indicating that health is an important reason for bankruptcy both in the model and data.[33] [34]

The model also produces a hump shaped consumption-age profile that closely approximates the profile estimated by Aguiar and Hurst (2008) for core nondurables and housing services using the Consumer Expenditure Survey (Figure 6).[35] 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.[36]

Finally, I compare the median asset accumulation age profiles in the model with the median financial asset profiles observed in the SCF (Figure 7).[37] The model approximates extremely

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.

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

[34]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.

[35]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.

[36]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.

[37]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.

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.[38]

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.[39]

Each effect considered separately is important for at least one variable. 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). On the other hand, the presence of medical expenditures leads to higher labor supply because workers with employer provided health insurance are more likely to keep working when faced with high medical expenditures. This is supported by the result that in the Benchmark economy, the average labor supply of non-college workers with tied employer insurance is 3.9 percentage points higher than that of workers with no insurance. Eliminating the medical expenditure effect leads to 1.3% lower labor supply for

[38]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).)

[39]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.

non-college, generated mostly by a decrease of 46% and 3% in the labor supply of those in poor and average health states, respectively. The 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% and 5.5% higher in terms of CEV, respectively (Table 9).[40]

Asset accumulation is influenced by all health channels (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. On the other hand, the medical expenditures, productivity and time endowment effects imply greater asset accumulation before the age of 60. For example, in the absence of time costs associated with bad health, asset accumulation would decrease by 14% for the non-college and 3% for the college educated. These results are generated by two different effects: first, an elimination of health risk (elimination of fluctuations around mean health effects), and second, a level effect from higher average earnings, more available time, and higher 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.

I find that it is important to model health effects over the entire life-cycle. To illustrate this, I take the example of medical expenditures and consider the effects on asset accumulation of eliminating medical expenditures only before retirement, only after retirement, and for the entire life-cycle (Table 10).[41] I find that both education groups accumulate more assets after the age of 60 in the presence of old age medical expenditures (the elimination of post retirement medical expenditures decreases asset accumulation by 37% for the non-college and 22% for the college group). On the other hand, medical expenditures before retirement age imply lower disposable incomes from which to save, leading to lower asset accumulation after the

[40]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).

[41]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.

age of 60 (the elimination of medical expenditures before retirement age leads to 7.4% and 3% higher asset accumulation for non-college and college groups, respectively). In a model that abstracts from medical expenditures before the age of 65, 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. Kopecky and Koreshkova (2009) model out-of-pocket health expenses after retirement age only and find they go a long way in accounting for differences in asset holdings across permanent income groups; however, they likely overestimate the importance of post retirement health expenses since they do not account for health effects before retirement age that lower disposable incomes.[42]

The interactions between different types of health effects are important for similar reasons. 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. Hubbard et al. (1995) who model earnings risk independent of health together with medical expenses and survival risk likely underestimate the importance of health expenses on asset accumulation for this reason.

Finally, 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

[42] In the example above, I showed the importance of modeling only medical expenditures before the age of 65. However, the productivity and time endowment effects before the age of 65 further reduce disposable incomes, so in their absence, the effect of medical expenditures after retirement on asset accumulation is likely to be overestimated by even more.

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%.[43]

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, I find that health effects account for 35% of the 11 percentage point difference in labor supply observed in the data across education groups. The productivity 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.[44] Health effects account for 31% of this difference.[45] 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). The following section 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 the previous section, eliminating productivity, time endowment, survival and medical expenditure effects entailed both (1) an elimination of health risk (elimination of fluctuations around mean earnings, mean available time, mean survival probabilities, and mean medical expenditures across individuals of different health states), and (2) a level effect from higher average earnings, greater time endowments, longer lives, and higher average disposable incomes. 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

[43] 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.

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

[45] 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.

all individuals of a particular age and education group the average deterministic component of wages in that group across individuals of different healths. Since average wages are the same as in the Benchmark, we are able to isolate the effect of health induced productivity risk.[46] 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 get an idea about the magnitude of health risk, I first study how the variance of earnings and disposable income changes relative to the Benchmark when health risk transmitted through each channel is eliminated (Table 11).[47] 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. As a reference, I also calculate the contribution of transitory earning shocks to inequality and find that they account for only a slightly higher fraction of income inequality for the non-college group (10.4%), and a much higher fraction for the college educated (28.9%).

I find that health risk accounts for 18.1% of non-college 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 accumulation, and together accounting for 17.0%.[48] 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

[46]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.

[47]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.

[48]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.

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. 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.[49] The time endowment and the health induced productivity risks generate large precautionary savings especially for the lower income groups since relying on the consumption floor during periods of poor health when leisure time is also low is associated with extremely low utility levels that individuals try to avoid.

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, 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 shock. Models that do not include earning shocks (other than those generated by health status) such as in Attanasio et al. (2010) and models that exclude all transitory variation in earnings such as Hubbard et al. (1995) would likely overestimate the effects 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

[49] 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.

for non-college before the age of 60 than in the presence of shocks.

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%).[50] 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 for welfare.

5.4 Model Counter-factuals and Health Policy

I use the calibrated model to conduct several counter-factual experiments in order to evaluate the importance of various features of the model environment. The first set of couter-factual experiments considers the effects of improved non-college health outcomes, shedding light on the importance of health transition probabilities in the model. The second set of experiments analyzes the role played by health care system efficiency by considering different environments where medical and time costs associated with bad health are lower.[51] The third experiment considers the effects of mandated employer provided health insurance, and the final experiment is a public finance experiment of expanding Medicaid insurance where the additional government expenditures are financed through lump sum taxes.

Improving Health Outcomes in the Non-college Group The data reveals that the non-college educated have significantly higher probabilities of bad health at any given age

[50]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.

[51]Since there is large uncertainty regarding the type of policies and associated costs involved in making improvements in health outcomes and health care system efficiency, I abstract from conducting full policy evaluations that account for costs involved and transition effects. However, the counter-factual experiments are useful in evaluating the importance of these aspects of the model and estimating the benefits associated with different degrees of improvements in these areas.

compared to college graduates (Figure 1).[52] In order to understand the role played by health transition probabilities in the model for the non-college, I conduct several experiments where the transition probabilities of the non-college approach those of the college by 25%, 50%, 75% and finally where they are equal. Studying these scenarios is also relevant for policy evaluation since, while highly uncertain, various recent health care reform provisions might succeed in closing this gap in health outcomes.[53] Survival rates conditional on education, health and age are left unchanged.

Tables 14 and 15 show the effects of improving non-college health outcomes. When non-college health transition probabilities equal those of the college educated, non-college labor supply and asset accumulation increase, and welfare increases by 4.7% in terms of CEV relative to the Benchmark.[54] The percentage of non-college graduates receiving the consumption floor declines from 18.9% to 15.9%, indicating a decline in the number of bankruptcies due to medical reasons. In addition, the average government transfer amount (excluding Medicaid) per non-college individual declines by 16%, and the average Medicaid amount spent per non-college person declines by 34% from 545$ to only 357$, a substantial amount considering that Medicaid expenditures were 2.7% of GDP in 2009.[55] Because I model all four channels through which health affects individuals, an improvement in average health status leads to large benefits because all effects and interactions are accounted for. Models that do not account for all four channels would underestimate the benefits of improving health outcomes.[56]

[52] Grossman and Kaestner (1997), Mirowsky and Ross (1998), Gan and Gong (2007) and Cutler and Lleras-Muney (2006) are a few examples of papers studying the reasons for this disparity. They find that some of the most important contributing factors are differences in occupational choice, incomes, access to care, differences in behavior such as smoking, drinking, diet, exercise, use of illegal drugs, household safety, use of preventive medical care, and care for hypertension and diabetes. In addition, those predisposed to illness when young are less likely to graduate from college, as shown in Gan and Gong (2007) resulting in a selection effect.

[53] I do not consider the effort costs of improving health by individuals or the necessary increase in taxes needed to finance policies that target these goals, leaving these issues for future research. Examples of policies that might close the gap in health outcomes can be found in the 2010 Patient Protection and Affordable Care Act. (A list of provisions can be found in the "Implementation Timeline" available on the Henry J. Kaiser Family Foundation website, http://www.kff.org/.) New health plans are required to provide at a minimum coverage without cost-sharing for preventive services. Medicare will start covering personalized prevention plans and comprehensive health risk assessments. Medicaid enrollees will be given incentives to participate in comprehensive health lifestyle programs and meet certain health behavior targets.

[54] Asset accumulation increases due to a positive income effect from better health. Precautionary savings are expected to decrease since the probabilities of bad health are lower.

[55] This figure was calculated using total Medicaid expenditures (federal, state and local) obtained from the Department of Health and Human Services, Centers for Medicare and Medicaid Services, https://www.cms.gov/NationalHealthExpendData/02_NationalHealthAccountsHistorical.asp.

[56] For example, in a model abstracting from health induced productivity risk, non-college welfare increases by only 1.0% and the average Medicaid amount per non-college person declines by only 28% when the non-college are given the health transition probabilities of the college. (These results are calculated relative to a new benchmark where the productivity risk is also absent.)

Tables 14 and 15 also reveal that even more modest improvements in non-college health outcomes lead to very large benefits, for example increasing welfare by 2.4% when probabilities approach those of the college half way.

Improving Efficiency: Lowering Medical and Time Costs The efficiency cost of the U.S. health system has been estimated at between 20 and 30% of health care spending, or 3 to 5% of GDP (Fisher et al. (2003); Skinner et al. (2005)).[57] These inefficiencies imply not only higher medical costs but also wasted time as patients may see many skilled specialists who fail to co-ordinate with one another, running duplicative or unnecessary tests and failing to provide the recommended medical care. In order to estimate the impact of inefficiencies in the model, I conduct several experiments where medical costs and time costs associated with bad health states decline by between 10 and 30% (Tables 16 and 17).[58]

When both medical and time costs decline by 30%, we observe only a small change in labor supply (0.7% for non-college) since individuals have more time to allocate to work when in bad health but less incentive to keep working to keep the employer health insurance when medical costs are lower. Also, asset accumulation is lower (declining by 8.7% for the non-college group before the age of 60) since lower time and medical costs decrease the need for precautionary savings. Welfare increases by 3.5% in terms of CEV for the non-college group. The percentage of government transfer recipients declines by 7% in the non-college group and 10% in the college group relative to Benchmark levels since fewer individuals go bankrupt due to time and medical costs. However, this decline is relatively small because receiving the consumption floor in times of poor health becomes more attractive when time endowment costs are lower. The average Medicaid amount spent per capita declines by approximately 35%, slightly more than the 30% decrease in medical costs. Finally, the average government transfer amount (excluding Medicaid) per person declines by 7% for the non-college and 8% for the college group. The benefits are lower in scenarios where these costs decline by smaller

[57] Garber and Skinner (2008) show that most evidence indicates that the U.S. lags behind other wealthy countries in terms of productive and allocative efficiency. The U.S. is productively inefficient due to its fragmented care, high administrative costs, and heterogeneity in treatment because of race, income, and geography. It is allocatively inefficient relative to other countries because it is more likely to pay for diagnostic tests, treatments, and other forms of care before effectiveness is established and with little consideration of the value they provide. It also has poorly restrained incentives for overutilization and pays high prices for inputs (e.g. U.S. physicians' salaries are significantly higher than in most other countries).

[58] Several provisions of the 2010 Patient Protection and Affordable Care Act target these inefficiencies. For example, effective as of 2012, the Centers for Medicare and Medicaid Services will begin tracking hospital readmission rates and provide financial incentives to reduce preventable readmissions. As of 2013, a national pilot program will be established for Medicare on payment bundling to encourage doctors, hospitals and other care providers to better coordinate patient care. In 2015, Medicare will create a physician payment program aimed at rewarding quality of care rather than volume of services.

fractions.

Expanding Employer Sponsored Insurance In the Benchmark model, individuals with employer provided health insurance are better off in terms of CEV by between 1.4% and 2.8% depending on education and type of insurance (Table 20). The expansion of employer health insurance is one of the main provisions of the 2010 Patient Protection and Affordable Care Act: for example, effective in 2014 employers with 50 or more workers will be required to provide health insurance plans to employees or pay a fine. To study the importance of employer heath insurance in the model and estimate the potential benefits of this health reform, I conduct an experiment where all individuals are given employer health insurance, keeping constant the fractions of those with tied insurance and with insurance that continues into retirement. In this experiment, the cost of insurance (measured as the percentage difference between premiums and expected benefits) is the same as in the Benchmark economy.[59]

The results show that there are only small welfare gains and small declines in the percentage of government transfer recipients as a result of expanding employer health insurance to all workers (Tables 18 and 19). The effects are small because only 18% of non-college and 8% of college educated workers lack employer health insurance in the Benchmark economy. Since poor health greatly increases the likelihood of unemployment due to time and productivity costs and since the unemployed still no not keep the employer health insurance, only a small fraction of those in poor health benefits from this reform. Therefore, individuals with the largest medical expenditures who need insurance the most are least likely to benefit.

Expanding Medicaid to Low Income Groups Medicaid insurance, like the consumption floor, plays an important role in lowering medical expenditure risk for low income individuals. In the Benchmark model, as in the U.S. system so far, the Medicaid program covers the medical expenditures of very poor individuals who would not be able to afford the required medical expenditures as well as a minimum level of consumption without government support. To assess the importance of Medicaid in the model, I study the effects of expanding the program

[59]The cost of insurance is very high in the model, at 54% of premiums paid. In reality the cost of insurance is only approximately 12%. The difference arises partly because individuals in the model pay premiums for single coverage, which are about 44% higher than the average per enrollee premiums in a family health insurance plan. Also, in reality, moral hazard leads to higher health care utilization of those insured. The model does not capture this, and therefore health care expenditures are lower in the model for those with insurance. Despite the high costs, individuals in the model are better off with insurance because the employer is assumed to pay for a large fraction of premiums, as is the case in reality. With mandated employer health insurance, we might observe a small decline in average wages since employers are likely to transfer some of the costs to workers by offering them health benefits but lower wages. I do not account for this in this experiment. I leave these issues to be studied in future work.

to all individuals with incomes below 133% of the current poverty level.[60] This change implies that individuals can receive Medicaid even when they hold sufficiently large amounts of assets making them ineligible to receive the consumption floor. All unemployed individuals have their medical expenditures covered by Medicaid.[61] I study this particular change since one of the provisions of the 2010 Patient Protection and Affordable Care Act taking effect in 2014 is expanding Medicaid to all individuals not eligible for Medicare under age 65 with incomes up to 133% of the poverty level.[62]

I first study the effects of this expansion leaving taxes unchanged, then conduct a public finance experiment where the additional government expenditures are financed through lump sum taxes. In the first case, Medicaid expansion leads to a decrease in labor supply (7% and 6% for the non-college and college groups, respectively) since all unemployed individuals receive free medical care. Welfare improves by 1.8% and 1.2% in terms of CEV for the two education groups (Table 18). However, the fraction of Medicaid recipients increases from 18% to 25% for non-college and from 3% to 11% for college individuals, and total Medicaid expenditures increase by 93%. Government expenditures on the consumption floor program decrease by only 8% (Table 19).

In contrast, with a government budget balancing lump sum tax of $720 per person (placed on both education groups), welfare decreases by 1.5% for non-college and 1.8% for college educated individuals in terms of CEV. To understand this, note that a relatively high tax is necessary since Medicaid expansion leads to lower labor supply and hence a decrease in labor income taxes collected by the government. Also, despite the Medicaid expansion, the tax is sufficiently high to lead to a slight increase in the percentage of non-college individuals relying on government transfers. Therefore, Medicaid expansion to low income groups is associated with costs that are greater than the benefits of reduced medical expenditure risk. This result may be reversed if the expansion led to improved health outcomes in low income groups by encouraging them to seek the necessary medical care which they may lack in reality.

[60] The federal poverty level is $10,890 in 2011. This is a relatively large expansion of the Medicaid program. In the Benchmark model, only those receiving the consumption floor (equal to 45% of the current poverty level for the non-college and 52% for the college group) were covered by Medicaid.

[61] This policy could go a long way in improving the average health of low income groups by encouraging them to seek treatment. However, since it is difficult to predict the extent of this effect, I abstract from it in this exercise, and focus instead only on the direct effect of expanding insurance coverage.

[62] Health care reform will in fact expand health insurance for low income individuals to a greater extent since as of 2014, families with incomes up to 250% of the federal poverty level start receiving cost sharing subsidies, and premium subsidies will become available to families with incomes between 133-400% of the federal poverty level to purchase insurance through the Exchanges. The experiment conducted here does not take into account these additional reforms.

6 Conclusion

This paper shows that health affects individuals' decisions to work and save significantly through productivity, available time, medical expenditures and survival probability channels. Since adverse health impacts individuals simultaneously through all four channels, there are large interactions between effects. The paper emphasizes that a unified framework is important in policy evaluation and shows how the evaluation of health effects is likely to be biased in previous literature that does not account for all channels.

I show that health effects and health risk are quantitatively much larger for high school educated individuals than for the college educated. Health status risk accounts for 9% of disposable income inequality in the non-college group, and the health induced productivity risk plays a major role, alone accounting for 7% of income inequality. Health risk accounts for 18% of average asset accumulation before the age of 60 and 12% after age 60 for the non-college educated, driven mostly by the health induced productivity and time endowment risks when young and medical expenditure risk at older ages. Overall, health explains 35% of the difference in labor supply and 31% of the difference in the degree of reliance on government transfers observed across education groups.

An important reason for the large degree of health risk faced by the non-college group is that health outcomes are on average worse. I quantify the benefits of improving non-college health by gradually changing health transition probabilities to approach those of the college group and find that the welfare benefits and reductions in government expenditures are extremely large. I also study the effects of lowering health risk by altering other aspects of the environment, such as increasing health care system efficiency (lowering medical and time costs associated with adverse health) and increasing the availability of health insurance, both employer and government provided. I find that in general the benefits are relatively small if we assume that health outcomes remain unchanged.

Future work in this area that will add to our understanding of health risk includes the incorporation of an endogenous health process in the model (since individuals can to some extent control the amount of health risk they face through investment in health) and the consideration of family characteristics (since the presence of a spouse and children impacts the degree of health risk faced by individuals). A better understanding of the tradeoffs between health investment and consumption of goods and leisure is particularly important for the evaluation of policy aimed at improving health. Considering that improvements in health outcomes for the low education group are associated with large benefits, this is an important topic 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
$\hat{\sigma_{\mu}^2}$	0.09640	.09214	0.06991	0.07438	PSID regression
$\hat{\rho}$	0.94292	.93200	0.97254	0.97215	PSID regression
$\hat{\sigma_{\eta}^2}$	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)	0.025	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_{η}^2	0.0078	0.02
σ_{μ}^2	0.22	0.02
σ_{λ}^2	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

% of low income earners (<10,000$) receiving transfers		
	Model	**Data**
Non-College	83	59
College	36	42

% 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
Productivity and Medical Expenditures	7.9	-0.2	85.4	19.8	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
Productivity and Medical Expenditures	-7.1	-3.2	-3.3	-5.4

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
Transitory earnings shocks removed	-3.0	-5.6	-10.4	-28.9

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.*

Table 14: Improving Non-College Health Outcomes: Effects on Labor Supply, Asset Accumulation and Welfare

% Change in Labor Supply Relative to Benchmark

	Non-College
25% closer to College	1.7
50% closer to College	2.8
75% closer to College	4.0
College levels	5.2

% Change in Average Assets Relative to Benchmark

	Non-College	
	Ages<60	**Ages>60**
25% closer to College	0.3	2.7
50% closer to College	1.2	6.5
75% closer to College	1.6	9.6
College levels	3.0	13.8

% CEV Relative to Benchmark

	Non-College
25% closer to College	1.2
50% closer to College	2.4
75% closer to College	3.5
College levels	4.7

Table 15: Improving Non-College Health Outcomes: Effect on Government Transfers for Non-College

	% Receiving Government Transfer (excluding Medicaid)
Benchmark	18.9
25% closer to College	17.9
50% closer to College	17.2
75% closer to College	16.6
College levels	15.9
	Average Transfer Amount Per Person ($) (excluding Medicaid)
Benchmark	752
25% closer to College	715
50% closer to College	686
75% closer to College	660
College levels	635
	Average Medicaid Amount Per Person ($)
Benchmark	545
25% closer to College	491
50% closer to College	443
75% closer to College	400
College levels	357

Table 16: Effects of Improved Health Care System Efficiency on Labor Supply, Asset Accumulation and Welfare

% Change in Labor Supply Relative to Benchmark

	Non-College	**College**
10% lower medical and 30% lower time costs	1.3	0.3
20% lower medical and 10% lower time costs	0.0	-0.7
20% lower medical and 20% lower time costs	0.5	-0.5
20% lower medical and 30% lower time costs	1.1	-0.3
30% lower medical and 30% lower time costs	0.7	-0.8

% Change in Average Assets Relative to Benchmark

	Ages $<$ 60	
	Non-College	**College**
10% lower medical and 30% lower time costs	-7.1	-2.3
20% lower medical and 10% lower time costs	-3.5	-2.2
20% lower medical and 20% lower time costs	-5.4	-2.5
20% lower medical and 30% lower time costs	-7.9	-2.9
30% lower medical and 30% lower time costs	-8.7	-3.4

	Ages $>$ 60	
	Non-College	**College**
10% lower medical and 30% lower time costs	-6.1	-3.6
20% lower medical and 10% lower time costs	-8.3	-5.2
20% lower medical and 20% lower time costs	-9.0	-5.4
20% lower medical and 30% lower time costs	-9.9	-5.6
30% lower medical and 30% lower time costs	-13.6	-7.6

% CEV Relative to Benchmark

	Non-College	**College**
10% lower medical and 30% lower time costs	2.3	1.4
20% lower medical and 10% lower time costs	1.7	1.3
20% lower medical and 20% lower time costs	2.3	1.6
20% lower medical and 30% lower time costs	2.9	1.9
30% lower medical and 30% lower time costs	3.5	2.3

Table 17: Effects of Improved Health Care System Efficiency on Government Transfers

	% Receiving Government Transfer (excluding Medicaid)	
	Non-College	**College**
Benchmark	18.9	3.0
10% lower medical and 30% lower time costs	18.1	2.8
20% lower medical and 10% lower time costs	17.8	2.8
20% lower medical and 20% lower time costs	17.8	2.8
20% lower medical and 30% lower time costs	17.7	2.8
30% lower medical and 30% lower time costs	17.5	2.7
	Average Transfer Amount Per Person ($) (excluding Medicaid)	
	Non-College	**College**
Benchmark	752	120
10% lower medical and 30% lower time costs	725	114
20% lower medical and 10% lower time costs	715	113
20% lower medical and 20% lower time costs	711	112
20% lower medical and 30% lower time costs	708	112
30% lower medical and 30% lower time costs	700	110
	Average Medicaid Amount Per Person ($)	
	Non-College	**College**
Benchmark	545	102
10% lower medical and 30% lower time costs	470	85
20% lower medical and 10% lower time costs	419	76
20% lower medical and 20% lower time costs	414	75
20% lower medical and 30% lower time costs	411	74
30% lower medical and 30% lower time costs	355	64

Table 18: Effects of Expanded Health Insurance on Labor Supply, Asset Accumulation and Welfare

% Change in Labor Supply Relative to Benchmark

	Non-College	**College**
Mandated EPHI	1.0	0.4
Medicaid Expansion (no change in taxes)	-7.1	-5.6
Medicaid Expansion (financed through taxes)	-7.5	-4.3

% Change in Average Assets Relative to Benchmark

	Ages < 60	
	Non-College	**College**
Mandated EPHI	-1.7	0.2
Medicaid Expansion (no change in taxes)	6.2	1.8
Medicaid Expansion (financed through taxes)	5.2	-0.1

	Ages > 60	
	Non-College	**College**
Mandated EPHI	0.7	1.0
Medicaid Expansion (no change in taxes)	-1.7	-1.4
Medicaid Expansion (financed through taxes)	0.5	-0.1

% CEV Relative to Benchmark

	Non-College	**College**
Mandated EPHI	0.3	0.1
Medicaid Expansion (no change in taxes)	1.8	1.2
Medicaid Expansion (financed through taxes)	-1.5	-1.8

Note: EPHI=Employer Provided Health Insurance

Table 19: Effects of Expanded Health Insurance on Government Transfers

	% Receiving Government Transfer (excluding Medicaid)	
	Non-College	**College**
Benchmark	18.9	3.0
Mandated EPHI	18.5	2.9
Medicaid Expansion (no change in taxes)	17.6	2.4
Medicaid Expansion (financed through taxes)	19.3	2.9
	Average Transfer Amount Per Person ($) (excluding Medicaid)	
	Non-College	**College**
Benchmark	752	120
Mandated EPHI	738	116
Medicaid Expansion (no change in taxes)	700	96
Medicaid Expansion (financed through taxes)	891	138
	Average Medicaid Amount Per Person ($)	
	Non-College	**College**
Benchmark	545	102
Mandated EPHI	526	98
Medicaid Expansion (no change in taxes)	950	439
Medicaid Expansion (financed through taxes)	937	419

Table 20: Welfare Benefits of Employer Provided Health Insurance (EPHI)

% CEV relative to having no EPHI in Benchmark Model

	Non-College	**College**
EPHI, Workers Only	2.04	1.42
EPHI, Workers and Retirees	2.81	2.15

8 Figures

Figure 1: Health Transitions

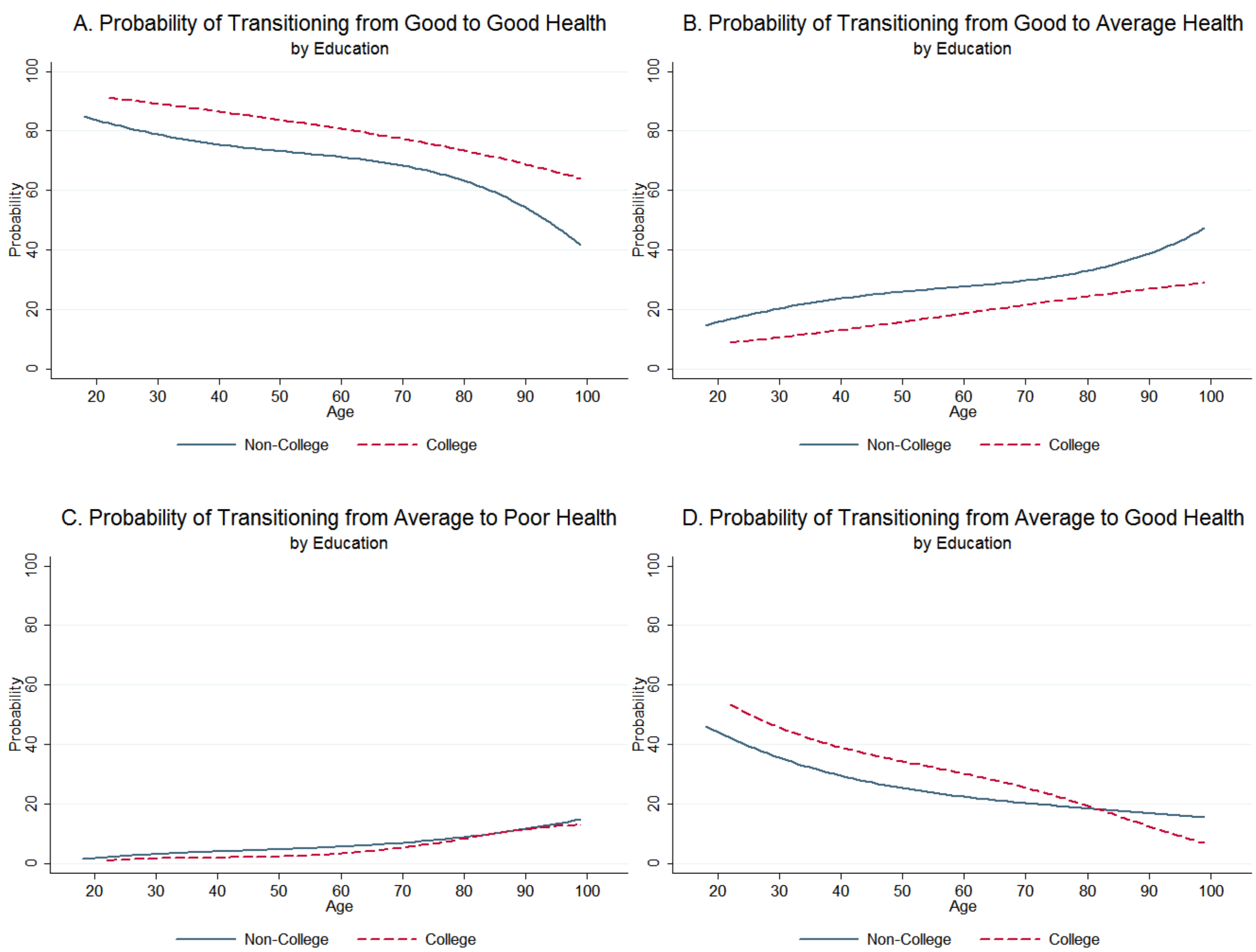


Figure 2: Probability of Death by Education and Health Status

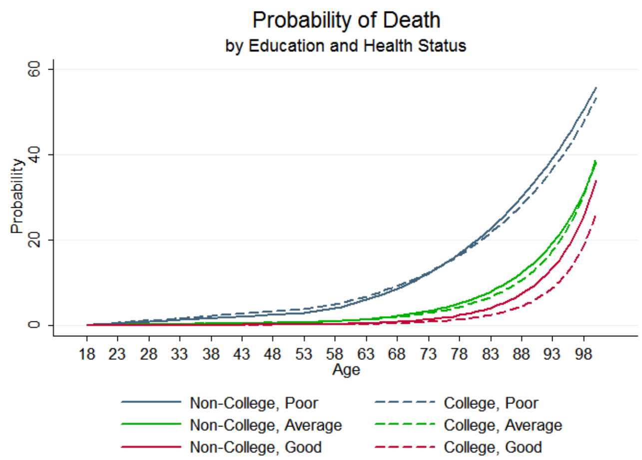
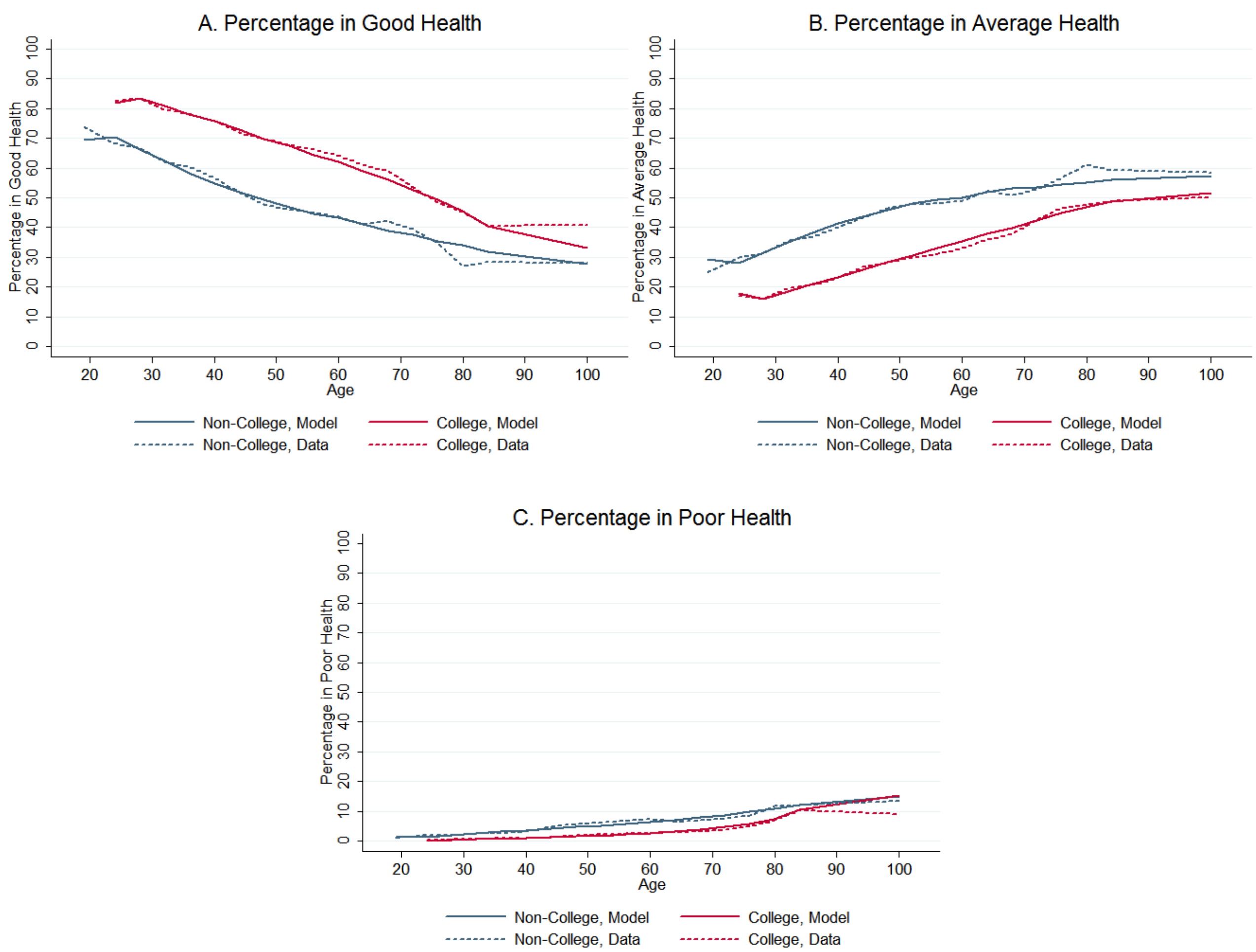
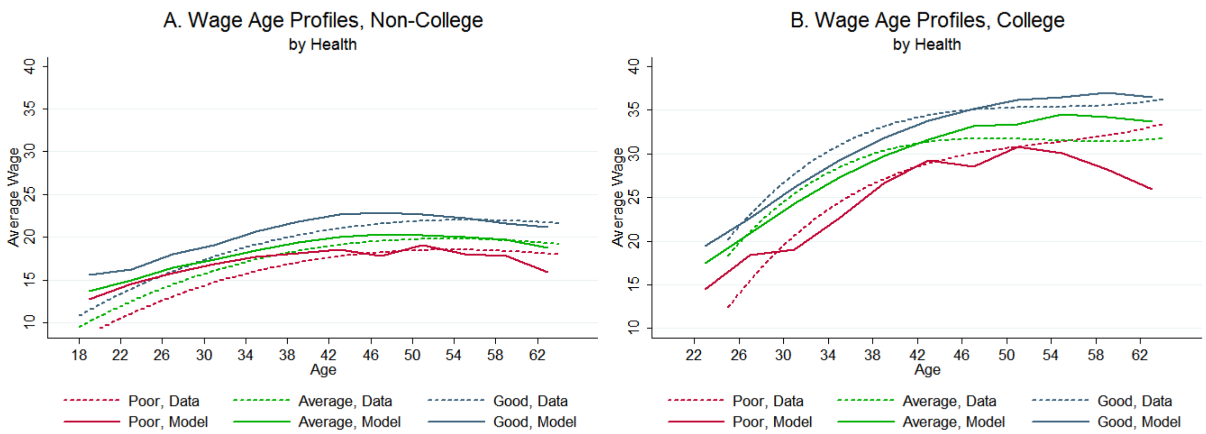


Figure 3: Percentage of Population by Health Status, Data and Model



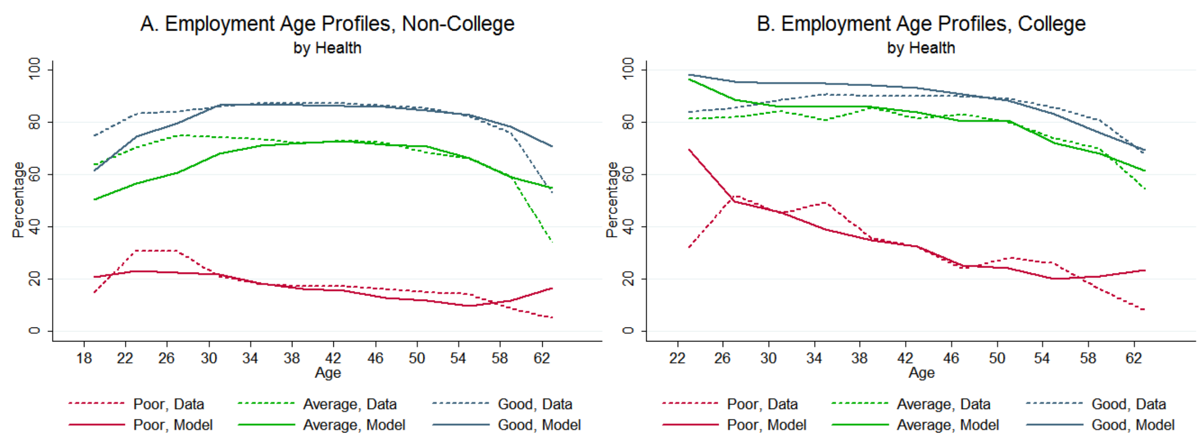
Note: Data sources: MEPS and HRS combined.

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: Average Consumption Age Profile, Model

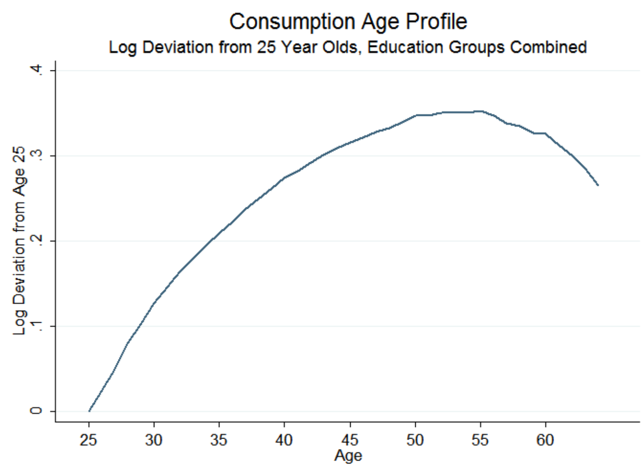
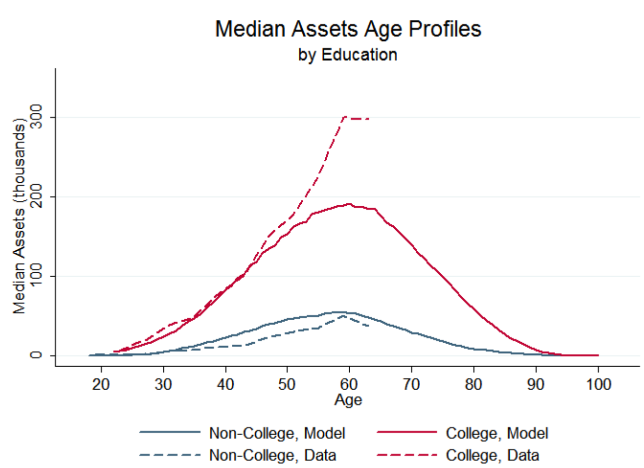


Figure 7: Asset Accumulation Age Profiles, Model and Data



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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