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Heterogeneity in Health State Dependence of Utility

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Abstract:

This study re-examines Health and Retirement Study (HRS) data in order to ascertain whether there is heterogeneity in the health dependence of utility over gender, race and ethnicity. This study begins with theoretical and empirical models used by Finkelstein, et al. (2010) relaxing the assumptions of those models to allow for differential effects by gender, race and ethnicity. We estimate fixed-effects models using the sample which is above age 50 and not in labor force and has medical insurance. We use objective reports of seven health conditions (hypertension, stroke, arthritis, cancer, diabetes, chronic lung disease, and heart disease). We use subjective well-being and a composite well-being measure (mental health index) developed by Center for Epidemiologic Studies Depression scale (CES-D) (which is the 'sum of six negative indicators' minus 'two positive indicators') as a proxy measure of utility. The nonlinear Blinder-Oaxaca decomposition was used to identify the contribution of each predisposing (age, gender, risk attitude, region) and need factors (self perception of health and physician's judgment about health) in explaining the gender, race and ethnicity differences in utility and to estimate the residual unexplained difference. Coefficients of health indicators, income, risk attitude, marital status and age turn out to be significant in explaining race, gender and ethnicity utility gap.

Using happiness as a utility proxy and objective health measures in our baseline model, we find heterogeneity of health state dependence of utility among hispanic and non-hispanic and whites, and black; males and females. Since, there is heterogeneity in the health dependence of utility, the policies like Medicare, Medicaid and Social Security would have varying impact on people depending upon gender, race and ethnicity.

Introduction:

The Epidemiology literature has several empirical evidences (Grant, Hicks, Taylor et al. 2009; Levy 2005; Nohria, Vaccarino and Krumholz 1998; Chin and Goldman 1998) that diseases impact gender and race differently due to biological and social construction. Contingent upon the findings of Epidemiology literature, the study of gender and race differences is becoming important, not only in the occurrence of health conditions, but also in the impact, treatments and outcomes of diseases. Health differences as well as health disparity over gender, race and ethnicity are amongst the major concerns in the U.S. health care nowadays especially after Institute of Medicine report[1]. A disparity connotes an unfair difference across racial/ethnic groups. For instance, an unfair difference in health care utilization, quality of care, or access to care is a disparity. The epidemiology literature shows that different diseases impact different gender, races and ethnicities differently. The differences exist not only in the impact of disease but also in the quality of life after disease, efficacy of medications for treatment of the disease, comorbidity of various diseases, as well as mortality rate of various chronic diseases. In the presence of the above mentioned differences, the relationship between health state and utility might also vary over gender, race and ethnicity. The objectives of this study are: (1) to examine gender heterogeneity in health state dependence of utility, and (2) contingent upon results of the first objective, to identify the contribution of observed factors behind gender difference in health state dependence of utility using the nonlinear Blinder-Oaxaca decomposition.[2]

[1] "Disparities in the health care delivered to racial and ethnic minorities are real and are associated with worse outcomes in many cases, which is unacceptable."
-- Alan Nelson, chair of the committee that wrote the Institute of Medicine report, Unequal Treatment: Confronting Racial and Disparities in Health Care.

[2] We used Stata-11 for non-linear Blinder-Oaxaca decomposition. Its non-linear version was included in Stata on 08/25/2011 which allows us to do the decomposition with logit.

This study aims at testing the hypothesis of presence of heterogeneity in the health state dependence of utility. We use Health and Retirement Study (HRS) data in order to ascertain whether there is a gender, race and ethnicity difference in the variation of marginal utility of consumption over different health states. We use both objective and subjective measures of health.

Moreover, this study also provides an opportunity to draw a comparison between the results of objective and subjective health measures. We use happiness as a utility proxy. As an alternative we also use Center for Epidemiologic Studies Depression scale (CES-D) in place of happiness. CES-D is a composite well-being measure (mental health index) which is the 'sum of six negative indicators' minus 'two positive indicators'. The negative indicators measure whether the respondent experienced the following six sentiments all or most of the time: depression, everything is an effort, sleep is restless, felt alone, felt sad, and could not get going. The positive indicators measure whether the respondent felt happy and enjoyed life, all or most of the time.

The remainder of the chapter proceeds as follows: Section Two presents the intuition and purpose behind this study. Section Three discusses previous literature. Section Four presents our theoretical arguments and assumptions and hypotheses which this study is going to examine. Section Five describes the data, methods and empirical model used for the main analysis, and how we construct variables from that data. Section Six presents the empirical results from our analysis, including some robustness checks. Section Seven concludes and discusses the directions for further work.

II. Purpose:

Based on the two categories of literature (health disparity literature and the health dependence of utility literature, which is discussed in section three):

1. There exists gender, race and ethnicity differences not only in the impact of disease but also in the quality of life after disease, efficacy of medications for treatment of the disease, comorbidity of various diseases, as well as mortality rate of various chronic diseases.
2. There exists health state dependence of marginal utility which can be negative as well as positive.

What makes this study different from the previous studies is that this study combines the above mentioned two literatures. Our hypothesis is that there is heterogeneity in the health state dependence of marginal utility over gender, race and ethnicity. In other words, the relationship between health state and marginal utility also varies over gender, race and ethnicity. If there is gender, race and ethnicity heterogeneity in the utility among different health states, the policies like Medicare, Medicaid and Social Security would have varying impact on people depending upon their gender, race and ethnicity.

III. Previous Literature and Background

We divide the literature for this study into two categories: first is the utility and health literature, and the other is gender, race and ethnicity literature.

In utility and health literature seminary work has been done by Richard J. Zeckhauser (1970, 1973), Kenneth J. Arrow (1974), Viscusi and Evans (1990, 1991a, 1991b) followed by Halliday (2008) and Finkelstein et al. (2009, 2011). In early 1970s Richard J. Zeckhauser (1970, 1973), Kenneth J. Arrow (1974) had developed the models of health care in which utility functions in the good and the poor health states assumed quite different shapes. Later in the 1990s Viscusi and Evans (1990) using the chemical worker survey (1982)[3] ascertain the findings of Zeckhauser and Arrow. Viscusi and Evans find that the marginal utility of income depends on the health state. They elicit the fallacy of monetary equivalence for a job injury. The logic behind monetary equivalence is that the death means fall in income, and thereby an increase in marginal utility of income. Their study finds that MU of income/money falls with the onset of job illness/injury. They find that less than full insurance is one of the most appropriate and significant implications of decline in marginal utility of income/wealth in ill health state.

Halliday (2008) studies the heterogeneity in health state dependence using Panel Study of Income Dynamics (PSID) data from 1984-1997 on self reported health status. He uses this state wide data set containing information on clinical risk factors for cardiac surgery. For half of the population he finds modest degree of state dependence whereas for the other half he finds degree of health state dependence to be near one but their health status mostly does not change over the life span. Author holds that though improvements in medical care leads to modest improvements in health, there may be larger potential gains to identifying as well as targeting factors that influence individual heterogeneity since the state dependence is mostly driven by individual characteristics.

Finkelstein et al. (2009) discuss various approaches/methods of measuring health dependence of marginal utility of consumption. Finkelstein et al. (2011) find that marginal utility of consumption depends on health states. Using empirical analysis based on Health and Retirement Study (HRS) data they find 10 to 25 % decline in the marginal utility of consumption

[3] 1982 Chemical worker survey is the subsample of workers analyzed in Section III. of Viscusi and O’Connor (1984)

due to one standard deviation increase in chronic health condition. This has impact on optimal health insurance levels and life cycle savings.

The second category of literature (which is more of a medical field literature) is related to gender, race and ethnicity differences in the impact of various diseases, in the quality of life after disease, efficacy of medications for treatment of the disease, comorbidity of various diseases, as well as mortality rate of various chronic diseases.

Ioannidis et al. (2004) test whether race influences the impact of gene variant on the disease risk by examining the genetic effects for 43 gene-disease associations across 697 study populations of various racial groups. The frequencies of the genetic marker of interest in the control populations (58%) showed large heterogeneity across races. However, they also found that though gene-disease associations vary in frequency across populations, but their biological impact on the risk for common diseases may usually be consistent across race.

Ward et. al (2004) using the data from the Surveillance, Epidemiology, and End Results (SEER), (SEER provides data not only on cancer incidence, stage of cancer at diagnosis, and mortality, but also on survival for Whites, African Americans, Hispanic/Latino, American Indian/Alaskan Native, and Asian/Pacific Islander population) as well as using census data on county find the presence of disparities in cancer incidence, mortality, and survival in relation to race/ethnicity. Even when census tract poverty rate is accounted for, African American, American Indian/Alaskan Native, and Asian/Pacific Islander men and African American and American Indian/Alaskan Native women have lower five-year survival than non-Hispanic Whites. They find that the death rate from cancer among African American males is 1.4 times higher than that among White males; for African American females it is 1.2 times higher. The more detailed analyses of selected cancers also show even larger variations in cancer survival by gender, race and ethnicity.

Grant, Hicks, Taylor et al (2009) using the data from a sub-population with diabetes from 4060 adults aged18 years and over living in South Australia found that men and women face different challenges in the management of diabetes. They also found that the effect of body weight, chronic stressors, psychological resources and life events was stronger in women as compared to men.

Chin and Goldman (1998), using a dataset on 435 patients admitted nonelectively in an urban university hospital during 1993-1994 find that there exists a gender differences in one year survival and self-reported quality of life (health related) among the patients admitted with heart failure even after adjusting for clinical and socioeconomic variables. They also find that women had less improvement in physical health status and perceived their quality of care to be lower.

Nohria, Vaccarino and Krumholz (1998) in their study on myocardial infarction using the medline database from 1966 to 1997 find that women fare worse as compared to men. Women sustaining a myocardial infarction have a higher crude, short-term mortality rates than men in their study. Other than age the authors identified several other factors like an increased incidence of cardiac risk factors, decreased efficacy of therapeutic modalities (thrombolytics and aspirin), and a tendency toward the underuse of these treatments in women relative to men, that might also contribute toward the worse prognosis of women.

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In the field of health and aging research it is well known by now that women outlive men on an average (Jennifer Ward-Batts, 2001; Case and Deaton, 2002). Women also differ in self-reporting of their health than men. There are evidences that women report lower subjective well-being as well as lower health-related quality of life (HRQOL) than men (Chin and Goldman 1998).

Gender difference also exists in mortality in coronary artery bypass surgery (Hannan et al. 1992). Gender comes out to be a significant predictor of mortality in the study done by Hannan et al. in 1992 using a state-wide data base containing clinical risk factors for cardiac surgery. The crude mortality rates for coronary artery bypass surgery for men was 3.08% and for women were 5.43% in New York State in 1989. Risk-adjusted (indirectly standardized) mortality rates were 3.33% and 4.45% for men and women, respectively. The risk-adjusted odds ratio of women to men experiencing in-hospital death was 1.52.

There are gender differences in comorbidity as well as psychological comorbidity (Levy 2005, Hesselbrock, Mayer, Keener 1985). Levy (2005) examines gender differences in attention-deficit hyperactivity disorder (ADHD) symptom comorbidity with oppositional defiant disorder, conduct disorder, separation anxiety disorder, generalized anxiety disorder, speech therapy, and remedial reading in children. Study finds that internalizing disorders are more common in females.

Verbrugge (1989) finds gender differences in HRQOL. Verbrugge (1989) points out some theoretical explanations for women's reduced HRQOL which includes hormonal differences, lifestyle differences, variations in perception of illness, variation in the ways men and women convey symptoms, and differences in the care each sex receives for illness. He finds that though women outlive men however, they report lower subjective well-being as well as lower health-related quality of life (HRQOL) than men (Chin and Goldman 1998).

IV. Theoretical Framework

Basic theoretical framework is based on Finkelstein’s (2011) state dependence model. Finkelstein’s model of health state dependence of marginal utility has been modified to allow for difference by gender, race and ethnicity.

Life time Utility is the sum of:

1. Current period non-health consumption

2. Current period health consumption

3. Expected utility from next period consumption

$$U = \sum_{t=0}^{T} [(1/1-\gamma)(1+ \emptyset_{CS}\, S)C_t^{1-\theta} + (1/1-\gamma)\,(1+ \emptyset_{HS}\, S)H_t^{1-\theta}]^{1-\gamma/1-\theta}$$
$$+ \sum_{t=0}^{T-1} [(1/1-\gamma)(1/1+\delta)E_t(U_{t+1})^{1-\theta/1-\gamma}]^{1-\gamma/1-\theta} \qquad (1)$$

Where Ø = Coefficient of level of sickness

δ = Discount rate

θ = Elasticity of intertemporal substitution

γ = Coefficient of relative risk aversion

S = Level of sickness

C= Non-health consumption

H = Out of pocket Health Consumption

Assumptions:

1. We assume health status/degree of sickness to be in continuum.
2. We adopt Epstein-Zin (1989) and Weil (1990) formulation of preferences to allow intertemporal elasticity of substitution and relative risk aversion to vary independently.
3. Wealth in the sick state is pre-determined i.e. health shocks do not change wealth. Therefore, in empirical analysis we include only those individuals who are no longer in labor market to exclude the first order effect of health shock on income.

Both healthy and sick individuals derive utility from health expenditure. Healthy individuals derive utility from precautionary health expenditure.

4. All have health insurance which finances fraction b of health expenditure. It is financed by tax rate on permanent income.

Simplified Two Period Model:

Suppose an individual lives only two periods.

Period-1 utility is given by:

$$U_1 = [(1/1-\gamma)(1+ \emptyset_{CS}\, S)C_1^{1-\theta} + (1/1-\gamma)(1+ \emptyset_{HS}\, S)H_1^{1-\theta}]^{1-\gamma/1-\theta}$$

$$+ [(1/1-\gamma)(1/1+\delta)E_1(U_2)^{1-\theta/1-\gamma}]^{1-\gamma/1-\theta} \qquad (2)$$

Period-2 utility is given by:

$$U_2 = (1/1-\gamma)(1+ \emptyset_{CS}\, S)C_2^{1-\theta} + (1/1-\gamma)(1+ \emptyset_{HS}\, S)H_2^{1-\theta}]^{1-\gamma/1-\theta} \qquad (3)$$

Subject to inter temporal budget constraint:

$$Y(1-\tau) = C_1 + (1-b)H_1 + \left(\frac{1}{1+r}\right)[C_2 + (1-b)H_2] \qquad (4)$$

Where r is the real interest rate.

$$[C_2 + (1-b)H_2] = W \qquad (5)$$

W is the second period wealth.

Therefore,

$$W = (1+r)(Y(1-\tau) - (C_1 + (1-b)H_1)) \qquad (6)$$

Solving the model backwards:

$$\text{Max } U_2(C_2, H_2)$$

$$= \text{Max}_{C_2,H_2}[(1/1-\gamma)(1+ \emptyset_{CS}\, S)C_2$$

$$+ (1/1-\gamma)(1+ \emptyset_{HS}\, S)H_2]^{1-\gamma} \qquad (7)$$

Subject to:

$$W = C_2 + (1-b)H_2 \qquad (8)$$

Therefore, the optimal non-health consumption expenditure and health consumption expenditure in second period will be:

$$C_2 = \frac{W}{1+(1-b)^{1-1/\gamma}(1+\emptyset_{CS}S/1+\emptyset_{HS}S)^{-1/\gamma}} \tag{9}$$

$$H_2 = \frac{W\,((1-b)^{-1/\gamma}(1+\emptyset_{CS}S/1+\emptyset_{HS}S)^{-1/\gamma})}{1+(1-b)^{1-1/\gamma}(1+\emptyset_{CS}S/1+\emptyset_{HS}S)^{-1/\gamma}} \tag{10}$$

By plugging C_2 and H_2 back in the second period utility we will calculate period-2 utility for all sickness levels, starting from 0 to the highest level of sickness prevailing in the population. Thus, now the second period utility will be a function of second period wealth corresponding to all sickness levels.

$$U_{2,S=1,2,3\ldots} = \frac{1}{1-\gamma}(1+\emptyset_{CS}S)W^{1-\gamma}[1+(1-b)^{1-1/\gamma}\,(\frac{1+\emptyset_{CS}S}{1+\emptyset_{HS}\,S})^{-1/\gamma}]^{\gamma} \tag{11}$$

$$U_{2,S=0} = \frac{1}{1-\gamma}W^{1-\gamma} \tag{12}$$

To calculate expected second period utility, we will take weighted average of second period utilities corresponding to all sickness levels, with weights being equal to probability ‘p’ of sickness level zero and ‘1- p’ for all other non-zero sickness levels combined.(We are assuming additive utility). Then, we calculate C_1 from life time utility function and inter-temporal budget constraint in terms of Y and H_1.

Parameters in terms of proportionality of Income:

$$E_1(U_2) = \frac{p}{1-\gamma} +$$

$$(1-p)\sum_{S=1,2,3\ldots}\left(\frac{1+\emptyset_{CS}\,S}{1-\gamma}\right)[1+(1-b)^{1-1/\gamma}\,(\frac{1+\emptyset_{CS}S}{1+\emptyset_{HS}S})^{-1/\gamma}]^{\gamma}W^{1-\gamma} \tag{13}$$

We can rewrite this as:

$$E_1(U_2) = kW^{1-\gamma} \tag{14}$$

where,

$$k = \frac{p}{1-\gamma} + (1-p)\sum_{S=1,2,3\ldots}\left(\frac{1+\emptyset_{CS}\ S}{1-\gamma}\right)[1+(1-b)^{1-1/\gamma}\,(\frac{1+\emptyset_{CS}S}{1+\emptyset_{HS}S})^{-1/\gamma}]^{\gamma} \tag{15}$$

Now we use inter-temporal budget constraint to express expected second period utility as a function of first period consumption.

Inter-temporal budget constraint is:

$$W = (1+r)(Y(1-\tau) - (C_1 + (1-b)H_1)) \tag{16}$$

$$E_1(U_2) = k[(1+r)(Y(1-\tau) - (C_1 + (1-b)H_1))]^{1-\gamma} \tag{17}$$

Substituting this into first period utility:

$$U_1 = [(1+\emptyset_{CS}\ S)(1/_{1-\gamma})C_1^{\ 1-\theta} + (1+\emptyset_{HS}\ S)\left(1/_{1-\gamma}\right)H_1^{\ 1-\theta}]^{1-\gamma/1-\theta} + \left(\frac{1}{1+\delta}\right)\left(\frac{1}{1-\gamma}\right)k[(1+r)(Y(1-\tau) - (C_1 + (1-b)H_1))]^{1-\gamma} \tag{18}$$

By taking derivative of U_1w.r.t . C_1 and H_1 respectively and equating them to zero, we can express C_1 and H_1 in terms of Y such that:

$$C_1 = c_1Y \tag{19}$$

$$H_1 = h_1Y \tag{20}$$

Hence,

$$W = wY \tag{21}$$

Where $w = (1+r)((1-\tau) - (C_1 + (1-b)H_1))$ (22)

Deriving Indirect Utility Functions:

We can derive indirect utility function $v(Y,S)$ by substituting $W = wY$ into second period utility equations.

Indirect Utility function for S=0:

$$v(Y, S = 0) = \frac{1}{1-\gamma}(wY)^{1-\gamma} \tag{23}$$

Indirect Utility function for S being non-zero:

$$v(Y, S) = \frac{1}{1-\gamma}(1 + \emptyset_{CS}S)(wY)^{1-\gamma}[1 + (1-b)^{1-1/\gamma}\,(\frac{1+\emptyset_{CS}S}{1+\emptyset_{HS}\,S})^{\,-1/\gamma}]^{\gamma} \tag{24}$$

Based on these indirect utility functions, the non-linear regression form will be:

$$v = \beta_{1s}S\,Y^{\beta_2} + \beta_3\,Y^{\beta_2} + \mu \tag{25}$$

Where β_{1s} is the income gradient of utility in different non-zero sickness levels relative to zero sickness level (β_3). Therefore,

$$\beta_{1s} = \frac{w^{1-\gamma}}{1-\gamma}(1 + \emptyset_{CS}S)[1 + (1-b)^{1-1/\gamma}\,(\frac{1+\emptyset_{CS}S}{1+\emptyset_{HS}\,S})^{\,-1/\gamma}]^{\gamma} - \frac{w^{1-\gamma}}{1-\gamma} \tag{26}$$

$$\beta_2 = 1 - \gamma \tag{27}$$

$$\beta_3 = \frac{w^{1-\gamma}}{1-\gamma} \tag{28}$$

By dividing equation (26) by (28) and by plugging in the value derived from dividing equation (9) by equation (10) We can calculate the parameter of health dependent marginal utility of consumption ($\emptyset_{CS}$).

$$(1 + \emptyset_{CS}S) = \frac{\beta_{1s}/\beta_3 + 1}{[1+\frac{H_2}{C_2}(1-b)]^{\gamma}} \tag{29}$$

Thus, the ratio between β_{1s} and β_3 gives us state dependence. Thus, the estimate of β_{1s} provides us direct test of sign of state dependence. If β_{1s} is negative, it implies marginal utility (in case of happiness as a proxy of utility) declines as the health deteriorates and vice versa if we are using CES-D as a proxy of utility. Positive coefficient indicates positive state dependence, that is, the difference between marginal utility derived at good health and at the poor health is diminishing. Negative coefficient indicates that the difference between marginal utility derived at good health and at the poor health is increasing (See Figure 1). Magnitude of state dependence is measured by $\emptyset_{CS}$ which depends on the ratio of estimated coefficients of β_{1s} and β_3. Since the denominator of equation – (29) is weakly greater than the one if there is no full-insurance, therefore the true magnitude of state dependence will be smaller than the ratio of estimated coefficients of β_{1s} and β_3.

Non-linear Blinder-Oaxaca Decomposition:

Subsequent upon the findings of our first hypothesis where we test whether health dependence of marginal utility varies over gender, race and ethnicity (and we find the strong evidence of existence of gender, race and ethnicity heterogeneity), the next objective is to tease out which variable causes this heterogeneity in health dependence of utility. We use the non-linear Blinder-Oaxaca (B-O) decomposition to achieve this goal. The B-O decomposition teases out the outcome variables between two groups – (1) a part that is explained by differences in observed characteristics, and (2). that part which is attributable to the difference in coefficients of these characteristics in the regression equation (in other words, difference in returns to these characteristics). Oaxaca-Blinder linear decomposition has been widely used in labor literature but if the outcome variable is non-linear, the standard Oaxaca-Blinder linear decomposition is not applicable. Fairlie (1999, 2003) developed decomposition method for binary dependent variables. Recently work has been done on non-linear decomposition by Sinning, Hahn and Bauer (2008). We apply non-linear B-O decomposition by first estimating the logistic regressions separately for whites and blacks and Hispanics and non-hispanics (see equations 30 and 31) and then decomposing the difference between the two into explained and unexplained components.

$$Y_w = f\left(X_w \widehat{\beta_w}\right) \tag{30}$$

$$Y_b = f\left(X_b \widehat{\beta_b}\right) \tag{31}$$

Where the subscript w refers to whites and b refers to blacks. Similarly we estimate equation 30 and 31 for Hispanics and non-hispanics and for males and females.

The difference between equations (30) and (31) is decomposed by rewriting the conventional decomposition equation in conditional expectation form:

$$\begin{aligned}\overline{Y}_b - \overline{Y}_w = {} & \left[E_{\beta w}(Y_{ib}|X_{ib}) - E_{\beta w}(Y_{iw}|X_{iw})\right] + \\ & \left[E_{\beta b}(Y_{iw}|X_{iw}) - E_{\beta w}(Y_{iw}|X_{iw})\right] + \\ & \left[E_{\beta b}(Y_{ib}|X_{ib}) - E_{\beta w}(Y_{ib}|X_{ib})\right] + \left[E_{\beta b}(Y_{iw}|X_{iw}) - E_{\beta w}(Y_{ib}|X_{ib})\right]\end{aligned} \tag{32}$$

V. Data

For the analyses we use data on individuals from the Health and Retirement Survey (HRS). This is a longitudinal survey started in 1992 that is representative for targeted birth cohorts, which WE will discuss below. The core survey is administered every other year, with some additional information collected by mail in some of the off-years.

The primary information we need for our analysis is household income, household wealth, occurrence of health shock, out of pocket medical expenditure. HRS provides this and much more. We are using all the nine waves (1992 - 2008) of HRS data from RAND HRS and Tracker files for our main analysis. We use a sample with age 50+, who have health insurance and who are either retired or not working (in order to avoid the impact of gender gap in labor market on one hand and the impact of labor market income on consumption on the other hand). We include individuals from the original HRS cohort (born in 1931-41), the Children of the Depression Age (CODA) sample (born 1924-30), the War Baby (WB) sample (born 1942-47), and the Early Baby Boomer (EBB) sample (born 1948-53). The CODA and WB samples were added in 1998 and the EBB sample in 2004. The CODA sample will have been sufficiently old that they are unlikely to be working by 1998, which is the first year of the data WE are using logged transformation of HH income (Average of HH income over all waves) + 5% current HH wealth adjusted for HH composition (divided by 1.7 if coupled and by 1 if single).

Corresponding with the literature, we do the analyses for seven diseases hypertension, stroke, arthritis, cancer, diabetes, chronic lung disease, and heart disease. For robustness check, WE repeat the analyses using Activities of Daily Living (ADLs) and Instrumental Activities of Daily Living (IADLs) from wave 2 onwards (1994—2008)[4]. Details on cross-wave difference of ADL and IADL questions can be found in appendix – A.

For utility measures this study uses the questions on happiness. As an alternative, we use CES-D score which is the sum of feelings like depression, sadness, loneliness etc. Details on CES-D score can be found in Appendix. Higher the score, more negative the respondent's feelings are in the past week.

Permanent Income is average of HH income (adjusted for HH composition)[5] across waves 1992 to 2008. WE have taken annual HH Income adjusted for HH composition. WE also add 5% of current HH wealth (excluding housing and automobile) to it. Permanent Income includes wages and salary, business income, dividend, interest income, other asset income, pension, government transfers, other sources. Details on construction of permanent income measure can be found in appendix – B. Household Wealth includes: net values of stock, mutual fund, investment trusts, checking account, saving account, money markets, CD, T-bill, other

[4] We exclude wave – 1 for ADL and IADL based analyses because of inconsistency in the way questions were asked in wave – 1 in the survey.
[5] We use OECD adjustment for HH size: Divide total HH income by 1.7 if respondent is married and living with spouse in same HH in that wave and divide by 1 if single.

savings and assets minus non-housing and non - automobile debts. Average HH wealth is average of wealth over all waves whenever HH enters. Details on construction of wealth measure can be found in appendix – B

VI. Results

We regress subjective happiness (proxy of utility) on health/sickness level, permanent income and interaction term of health/sickness level and permanent income. Time and individual fixed effects, risk attitude, age, census region, marital status, dummy for race, and ethnicity were used as controls but not being reported here in tables. The data is tested for heteroskedasticity (using ado file xttest3). Since heteroskedasticity was present, robust standard errors have been used. Sample was tested for multicollinearity by using stata user written Collin command. We include wave fixed effects in our regression since WE failed to reject the null of time dummies not jointly significant using testparm command. We use probability weights for the analyses.

Equation (24) is empirically calculated by the running the following fixed effects regression:

$$U_{it} = f(\beta_1 S_{it} \times \overline{Y}_i^{\beta_2} + \beta_4 S_{it} + \overrightarrow{A} X_{it} + \alpha_i) \tag{33}$$

The effect of permanent income on utility gets absorbed by individual fixed effects (α_i), in order to capture that, we run the auxiliary regression of the following type to get the coefficient of permanent income:

$$\hat{\alpha}_i = \beta_3 \overline{Y}_i^{\beta_2} + \overrightarrow{A_1} X_{it} + \varepsilon_{it} \tag{34}$$

In our baseline model (Tables-1, 2, and 3), we regress utility proxy on the variable 'number of diseases' which is the sum of seven health conditions (hypertension, stroke, arthritis, cancer, diabetes, chronic lung disease, and heart disease), interaction between permanent income and number of diseases along with other control variables (age, wave fixed effects, individual fixed effects, marital status, risk attitude). The estimates of individual fixed effects derived from this regression are regressed on dummy for gender (or race and ethnicity alternatively), permanent income (adjusted for HH composition), risk attitude, residency and marital status. To estimate the parameter of state dependence, the coefficient of interaction term of diseases and log permanent income are divided by the coefficient of permanent income (adjusted for HH composition). We find that there is gender, race and ethnic heterogeneity in health state dependence of utility as is clear from the coefficients of implied state dependence in table 1, 2 and 3.

Table.1,2,3 insert here

We find that there is heterogeneity in health state dependence of utility among different genders, races and ethnicities also. As mentioned, in the theory section, these state dependence coefficients have been derived from the ratio of the interaction term of permanent income and health state and the coefficient of permanent income itself.

Our second objective was to find out the contributors of this heterogeneity. We use B-O decomposition for the same. The significant contributors towards the explained gap in utility are marital status, number of diseases, log adjusted income, risk attitudes, age, along with race, gender and ethnicity. The geometric means of utility proxy (Happiness) is 2.41 for whites and 2.33 for blacks which amounts to a difference of 3.6 percent. Adjusting black's endowment levels to that of whites would increase black's utility by 3.7%. One hundred percent of the utility gap is explained by the endowment effect. The geometric means of utility proxy (Happiness) is 2.44 for men and 2.37 for women (Mean of happiness is 0.865 for women and 0.892 for men) which amounts to a difference of 2.8 percent. Adjusting women's endowment levels to that of men would increase women's utility by 2.2%. Approximately 79 percent of the utility gap is explained by the endowment effect.

We find similar results for B-O decomposition based on ethnicity also. Robustness checks have been done using alternative specification logit and by using CES-D as an alternative utility proxy. Our study confirms the findings of Halliday (2008) that there may be larger potential gains to identifying as well as targeting factors that influence individual heterogeneity since the health state dependence is mostly driven by individual characteristics, as has been found to be the case in B-O decomposition of utility in the current study.

Tables 4,5and 6 insert here.

Robustness Checks:

Robustness checks have been done using alternative specification logit and by using CES-D as an alternative utility proxy. The results with logit stand our baseline model results. Results with CES-D score as a disutility proxy (opposite to happiness) also stand our baseline results that health state-dependence of utility varies over gender, race and ethnicity.(Results available on request). However, using ADLs and IADLs we find that the results are not consistent with that of objective disease results. One possible explanation is that ADLs and IADLs are subjective health measures and there is possible variation in self-reporting of functional limitations among races and ethnicities. In general, in the literature, African Americans and Hispanics have been found to be reporting worse functional health than whites (Kington and Smith 1997). Keeping in view that it is less explored area, more research is needed in to ascertain these findings.

VII. Conclusion and Discussion

Using happiness as a utility proxy and combined measure as sum total of these seven conditions in our baseline model, we find gender, and racial-ethnic differences in health dependence of utility. By B-O decomposition of utility we find out that the significant contributors to the gender, racial-ethnic utility gap are marital status, number of diseases, log adjusted income, risk attitudes , age and gender.

However when we use self-reported health (IADLs) as a measure of health status, the results are not consistent to the baseline model results where we used objective health condition reports. One of the possible explanations is behavioral difference among race and ethnicities in self-reporting of functional health. African-Americans and Hispanics self-report the functionality hindrances more. Since, health state dependence is being measured as a ratio between the interaction term of self-reported health × permanent income and permanent income, the higher self-report of diseases bias the results for health state dependence.

The existence of gender, race and ethnicity differences in health state dependence of utility has implications for health insurance. Our study confirms the findings of Halliday (2008) that there may be larger potential gains to identifying as well as targeting factors that influence individual heterogeneity since the health state dependence is mostly driven by individual characteristics, as has been found to be the case in B-O decomposition of utility in the current study.

Table 1: Health State Dependence Heterogeneity of utility among male-female by WLS (Probability weights): Health Variable – Number of Diseases

	Utility Proxy : Happiness		Utility Proxy : CESD	
Number of Diseases	**Female**	**Male**	**Female**	**Male**
Num_dis $\times \text{Log}(\bar{Y})\ \beta_1$	-0.004 (0.005)	0.001 (0.004)	-0.009 (0.021)	0.023 (0.021)
$\text{Log}(\bar{Y})\ \beta_3$	0.047*** (0.004)	0.023*** (0.004)	-0.479*** (0.023)	-0.490*** (0.023)
Implied State Dependence (β_1/β_3) with Number of Diseases				
Num_dis 1	1.000*** (0.008)	0.992*** (0.007)	1.160*** (0.045)	1.143*** (0.040)
Num_dis 2	0.974*** (0.008)	0.976*** (0.007)	1.387*** (0.047)	1.343*** (0.041)
Num_dis 3	0.958*** (0.009)	0.959*** (0.008)	1.610*** (0.051)	1.560*** (0.045)
Num_dis 4	0.928*** (0.010)	0.934*** (0.009)	1.981*** (0.060)	1.878*** (0.053)
Num_dis 5	0.899*** (0.016)	0.903*** (0.014)	2.167*** (0.089)	2.168*** (0.076)
Num_dis 6	0.906*** (0.033)	0.844*** (0.027)	2.569*** (0.183)	2.619*** (0.148)
Num_dis 7	0.873*** (0.166)	0.862*** (0.075)	1.649* (0.864)	2.146*** (0.394)
N	26,677	22,721	26,053	22,009
R^2	0.121	0.089	0.084	0.165
Within Person Std Dev of Num_Dis			0.601	0.679
Ratio of margins $\sigma(\beta_1/\beta_3)$				
Num_dis	0.601*** (0.002)	0.678*** (0.002)	0.638*** (0.011)	0.751*** (0.010)

Notes:

1. Regression uses fixed effects OLS in a panel setting using weights and reports robust standard errors for diseases and interaction terms. Time and individual fixed effects, risk attitude, age, census region, marital status, dummy for race, and ethnicity were used as controls but not being reported here.
2. β_3 is estimated from fixed effects estimates of the previous regression.
3. State dependence is estimated from the ratio of interaction term (β_1) and coefficient of permanent income (β_3).

Table 2: Health State Dependence Heterogeneity of utility among Hispanic-Nonhispanic by WLS (Probability weights): Health Variable – Number of Diseases

	Utility Proxy : Happiness		**Utility Proxy : CESD**	
Number of Diseases	**Hispanic**	**Non-Hispanic**	**Hispanic**	**Non-Hispanic**
Num_dis $\times\text{Log}(\bar{Y})\ \beta_1$	-0.013 (0.014)	-0.004 (0.003)	-0.030 (0.084)	0.016 (0.015)
$\text{Log}(\bar{Y})\ \beta_3$	0.063*** (0.013)	0.041*** (0.003)	-0.546*** (0.086)	-0.524*** (0.017)
Implied State Dependence ($\beta_{1/}\ \beta_3$) with Number of Diseases Detailed				
Num_dis 1	0.940 (1.469)	-8.039 (65.620)	0.058 (4.613)	0.927*** (0.422)
Num_dis 2	0.560 (0.830)	17.891 (271.9)	-0.945 (5.625)	1.002*** (0.319)
Num_dis 3	0.945*** (0.183)	3.220 (4.011)	1.339 (0.908)	2.402 (3.960)
Num_dis 4	1.231 (1.160)	0.710*** (0.246)	0.201 (1.927)	1.753*** (0.367)
Num_dis 5	1.066 (0.676)	0.865*** (0.328)	1.654** (0.869)	2.567 (1.709)
Num_dis 6	1.243*** (0.325)	-0.273 (23.680)	1.357*** (0.089)	1.682*** (0.311)
Num_dis 7	-	0.581 (1.141)	-	-0.072 (2.305)
N	3,096	46,216	3,019	45,287
R^2	0.308	0.037	0.064	0.225
Within Person Std Dev	0.633	0.640		
State Dependence $\sigma(\beta_{1/}\ \beta_3\ )$				
Num_dis	0.639*** (0.013)	0.642*** (0.003)	0.701*** (0.077)	0.673*** (0.015)

1. Regression uses fixed effects OLS in a panel setting using weights and reports robust standard errors for diseases and interaction terms. Time and individual fixed effects, risk attitude, age, census region, marital status, dummy for race, and ethnicity were used as controls but not being reported here.
2. β_3 is estimated from fixed effects estimates of the previous regression.
3. State dependence is estimated from the ratio of interaction term (β_1) and coefficient of permanent income (β_3).

Table3: Health State Dependence Heterogeneity of utility among whites-blacks by WLS (Probability weights): Health Variable – Number of Diseases

	Utility Proxy : Happiness		**Utility Proxy : CESD**	
Number of Diseases	**White**	**Black**	**White**	**Black**
Num_dis $\times \text{Log}(\bar{Y})\ \beta_1$	0.001 (0.003)	0.002 (0.010)	0.018 (0.015)	-0.014 (0.047)
$\text{Log}(\bar{Y})\ \beta_3$	0.026*** (0.003)	0.030*** (0.009)	-0.490*** (0.018)	-0.566*** (0.053)
Ratio of Margins with Number of Diseases Detailed				
Num_dis 1	0.525 (2.378)	1.365*** (0.300)	0.084 (6.942)	1.183*** (0.215)
Num_dis 2	0.693*** (0.301)	1.305*** (0.258)	-0.587 (3.176)	1.119*** (0.240)
Num_dis 3	0.988*** (0.337)	-2.556 (28.11)	231.187 (220257)	0.838*** (0.197)
Num_dis 4	0.960* (0.524)	1.114*** (0.195)	0.269 (1.196)	0.842*** (0.166)
Num_dis 5	1.116 (1.046)	-	2.432 (3.403)	-
Num_dis 6	1.430*** (0.516)	-	1.322*** (0.101)	-
N	41,630	6,995	40,532	6,844
R^2	0.030	0.332	0.018	0.007
Within Person Std Dev	0.598	0.623		
Ratio of Margins $\sigma(\beta_{1/}\ \beta_3)$				
Num_dis	0.605*** (0.003)	0.663*** (0.009)	0.633*** (0.015)	0.730*** (0.051)

Notes:

1. Regression uses fixed effects OLS in a panel setting using weights and reports robust standard errors for diseases and interaction terms. Time and individual fixed effects, risk attitude, age, census region, marital status, dummy for race, and ethnicity were used as controls but not being reported here.
2. β_3 is estimated from fixed effects estimates of the previous regression.
3. State dependence is estimated from the ratio of interaction term (β_1) and coefficient of permanent income (β_3).

Table 4: Linear Blinder-Oaxaca Decomposition of Utility Heterogeneity among Men and Women using HRS 1992-2008.

Utility Proxy : CES-D	Male-female utility heterogeneity With number of diseases	Male-female utility heterogeneity With ADLs	Male-female utility heterogeneity With five ADLs	Male-female utility heterogeneity With IADLs	Male-female utility heterogeneity With five IADLs
Total Disparity	-0.393*** (0.018)	-0.393*** (0.018)	-0.394*** (0.018)	-0.394*** (0.018)	-0.391*** (0.018)
Portion due to Difference in Coefficients	-0.205*** (0.008)	-0.221*** (0.009)	-0.237*** (0.009)	-0.198*** (0.008)	-0.244*** (0.009)
Portion due to Difference in Endowments	-0.188*** (0.018)	-0.172*** (0.017)	-0.157*** (0.017)	-0.195*** (0.018)	-0.146*** (0.018)
Health Indicator	-0.011*** (0.003)	-0.032*** (0.004)	-0.057*** (0.053)	0.006*** (0.003)	-0.049*** (0.004)
Log Income	-0.063*** (0.004)	-0.061*** (0.003)	-0.057*** (0.003)	-0.068*** (0.004)	-0.064*** (0.004)
Age	-0.0003 (0.001)	-0.0003 (0.001)	-0.0003 (0.001)	-0.0003 (0.001)	-0.002 (0.001)
Race	-0.0004 (0.0003)	-0.0003 (0.0004)	-0.0002 (0.0004)	-0.0004 (0.0003)	-0.0002 (0.0003)
Risk Attitude	0.005*** (0.001)	0.004*** (0.001)	0.004*** (0.001)	0.004*** (0.001)	0.004*** (0.001)
Region	0.0003 (0.0002)	0.0003 (0.0002)	0.0002 (0.0002)	0.0002 (0.0002)	0.0003 (0.0002)
Marital Status	-0.143*** (0.006)	-0.134*** (0.006)	-0.123*** (0.006)	-0.143*** (0.006)	-0.135*** (0.006)
Ethnicity	0.002*** (0.0007)	0.001*** (0.0005)	0.001*** (0.0005)	0.001*** (0.0005)	0.001*** (0.0005)

Table5: Linear Blinder-Oaxaca Decomposition of Utility Heterogeneity among Blacks and Whites using HRS 1992-2008.

Utility Proxy : CES-D	Black-White utility heterogeneity With number of diseases	Black-White utility heterogeneity With ADLs	Black-White utility heterogeneity With five ADLs	Black-White utility heterogeneity With IADLs	Black-White utility heterogeneity With five IADLs
Total Disparity	-0.492*** (0.027)	-0.492*** (0.027)	-0.492*** (0.027)	-0.492*** (0.027)	-0.478*** (0.028)
Portion due to Difference in Coefficients	-0.471*** (0.012)	-0.501*** (0.014)	-0.511*** (0.014)	-0.457*** (0.012)	-0.462*** (0.013)
Portion due to Difference in Endowments	-0.021 (0.027)	0.008 (0.027)	0.019 (0.026)	-0.035 (0.027)	-0.015 (0.027)
Health Indicator	-0.079*** (0.005)	-0.123*** (0.008)	-0.154*** (0.010)	-0.043*** (0.005)	-0.092*** (0.007)
Log Income	-0.259*** (0.008)	-0.250*** (0.008)	-0.234*** (0.008)	-0.277*** (0.008)	-0.243*** (0.008)
Age	-0.026*** (0.003)	-0.023*** (0.002)	-0.022*** (0.002)	-0.024*** (0.002)	-0.026*** (0.003)
Gender	-0.013* (0.002)	-0.012*** (0.002)	-0.011*** (0.002)	-0.014*** (0.002)	-0.010*** (0.002)
Risk Attitude	-0.010*** (0.001)	-0.009*** (0.002)	-0.008*** (0.001)	-0.008*** (0.002)	-0.007*** (0.001)
Region	0.003*** (0.001)	0.003*** (0.001)	0.002* (0.001)	0.003*** (0.001)	0.002*** (0.001)
Marital Status	-0.103*** (0.005)	-0.097*** (0.005)	-0.093*** (0.005)	-0.103*** (0.005)	-0.096*** (0.005)
Ethnicity	0.017*** (0.003)	0.010*** (0.002)	0.010*** (0.002)	0.010*** (0.002)	0.010*** (0.002)

Table 6: Non-linear Blinder-Oaxaca Decomposition of Utility Heterogeneity among Hispanic and Non-Hispanic using HRS 1992-2008.

Utility Proxy : Happiness	Hispanic, Non-Hispanic utility heterogeneity With number of diseases	Hispanic, Non-Hispanic utility heterogeneity With ADLs	Hispanic, Non-Hispanic utility heterogeneity With five ADLs	Hispanic, Non-Hispanic utility heterogeneity With IADLs	Hispanic, Non-Hispanic utility heterogeneity With five IADLs
Total Disparity	1.09*** (0.011)	1.08*** (0.011)	1.08*** (0.011)	1.08*** (0.011)	1.08*** (0.011)
Portion due to Difference in Coefficients	1.02*** (0.003)	1.03*** (0.003)	1.03*** (0.003)	1.03*** (0.003)	1.03*** (0.003)
Portion due to Difference in Endowments	1.06*** (0.011)	1.05*** (0.011)	1.05*** (0.011)	1.05*** (0.011)	1.05*** (0.011)
Health Indicator	1.000*** (0.001)	1.01*** (0.001)	1.01*** (0.001)	1.00*** (0.0007)	1.01*** (0.001)
Log Income	1.02*** (0.002)	1.02*** (0.002)	1.02*** (0.002)	1.02*** (0.002)	1.02*** (0.002)
Age	1.003*** (0.007)	1.00*** (0.0007)	1.00*** (0.0007)	1.00*** (0.0007)	1.00*** (0.0007)
Race	1.000 (0.001)	-0.10 (0.001)	-0.10 (0.001)	1.000 (0.001)	-0.10 (0.001)
Risk Attitude	1.000*** (0.001)	-0.10*** (0.0003)	-0.10*** (0.0003)	1.000*** (0.0003)	-0.10*** (0.0003)
Region	1.000 (0.001)	-0.10 (0.001)	-0.10 (0.001)	1.000 (0.001)	-0.10 (0.001)
Marital Status	1.000* (0.0005)	1.00 (0.0005)	1.00 (0.0005)	1.001 (0.0006)	1.00 (0.0005)

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Appendix A : Cross Wave Differences in Activities of Daily Living (ADL)
Source: RAND HRS Data Documentation, Version K

Two Activities of Daily Living (ADL) summaries were derived beginning in Wave 2. One uses the ADLs proposed Wallace and Herzog in their paper (Wallace and Herzog, 1995) to define an ADL summary (ADLWA): bathe, dress, and eat. The second includes these and adds getting in/out of bed and walking across a room (ADLA). In all waves the "some difficulty" versions of the individual measures are used to construct these measures, i.e., walk, bed, bath, dress, and eat. Each limitation adds one to the summary measure, that is:

ADLWA = sum (bath, dress, and eat)

ADLA = sum (walk, bed, bath, dress, and eat)

Please see "Activities of Daily Living (ADLs): Recodes for Comparison to Wallace and Herzog" for a description of how these 0/1 variables ([adl]W) are constructed. Note that the Wallace and Herzog variables result in more limitation than the 0/1 recodes for other waves (Rw[adl]A) solely due to measurement differences in the raw data. The R1ADLWW and R1ADLWA variables are not appropriate for comparison to the RwADLA and RwADLWA variables in other waves.

There are other cross wave differences in the way HRS presented these questions in Wave 2H and 2A and the later waves, that may introduce measurement errors in these variables. In addition the criteria used for skipping some questions changed between Wave 3 and later waves, which may also influence the consistency of measurement before Wave 4 for all ADLs except dressing.

CES-D Score:

CES-D is the sum of feeling depressed, everything is an effort, sleep restless, feel lonely, feel sad, feel cannot get going, (1 - you were happy) and (1 - enjoy life). Thus the higher the score, the more negative the respondent's feelings in the past week.

Cross Wave Differences in Original HRS Data

Please see "Cross Wave Differences in Original HRS Data" for the "Activities of daily living (ADLs): Some difficulty

Appendix B : Construction of Permanent Income and Household Wealth Measures

Source: RAND HRS Data Documentation, Version K

Preparing Income data:

1. Permanent Income is average of HH income (adjusted for HH composition)[6] from waves 1992 to 2008.
2. Annual HH Income includes: Wages and salary, Business income, Dividend, Interest income, Other asset income, Pension, Government transfers and welfare income, income from other sources.

Then I add 5% of HH current financial wealth. This is total HH wealth excluding housing.

Income = wage, salary + tip, bonus and commission income + second job income +professional practice and trade income + Business income + Rental income + Dividend income + Bonds income + CDs, Saving bonds, T-bills income + Checking, Saving account income + Other household income which is income from other assets + Any other HH income + Lump sum income for last calendar year from last calendar year from insurance, pension or inheritance + Lump sum income #2 for last calendar year from insurance, pension or inheritance + Lump sum income #3 for last calendar year from insurance, pension or inheritance + Pension # 1 (largest income) + Pension # 2 (2nd largest income) + Pension # 3 (rest income) + Annuity # 1 (largest income) + Annuity # 2 (2nd largest income) + Annuity # 3 (rest income) + Welfare Income If not + Food Stamps + Veteran's Benefits + Respondent or spouse Social Security retirement or survivor's income, set to SS. + Respondent or spouse Social Security disability income and Supplemental Security Income + Unemployment income + Worker's compensation income

HH Wealth includes:

[6] OECD adjustment criterion of dividing total HH income by 1.7 if R is living with spouse in same HH in that wave and divide by 1 if single has been used.

Net values of stock, MF, investment trusts , checking A/c, Saving AC, Money markets, CD, T-bill, other savings and assets minus non-housing and non - automobile debts.

Total non-housing assets less debt

= Other Real estate + Transportation + Business +Individual Retirement Accounts + Stocks, MF + Checking and Saving Account + CDs, Savings Bonds, Treasury Bills + Bonds + Other savings, Assets – Debts