The Evolution of Self-Reported Health

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Abstract

Self-reported health is widely used in economic models to measure general health status. Most major surveys include some form of a question, in which respondents are typically asked to rate their health on a five-point scale from excellent to poor. Despite its widespread usage, we understand little about the process individuals use to postion themselves on the scale. Furthermore, the process itself may have changed over time as knowledge and perceptions about particular health conditions and their medical treatments have evolved. Using the National Health Interview Study, we show that use of the scale has changed substantially over the past X years. We find the change is due not only to changes in underlying health, but also to changes in the way individuals regard their health in relation to the scale.

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1 Introduction

Few measures of health status are as ubiquitous in social science surveys around the world as the global self-reported health question. A typical example, from the U.S. National Health Interview Survey (NHIS), reads: "*Would you say your health in general is excellent, very good, good, fair, or poor*?"[1] The question is remarkably simple in content, offering no particular guidance as to which aspects of health should be considered or how they should be combined. Respondents are free to interpret the question in any way they like, prioritize those health domains they deem most relevant, or evaluate their health relative to a particular point in time or group of peers. Indeed, the cognitive processes underlying response formation to abstract self-assessments are not well understood. Moreover, it has been pointed out that a response to the above survey question may also be related to the sequence of questions that precede this particular question. Consequently, the literature has been struggling to interpret the responses, and posed the question: What does self-reported health really measure?

The most striking result from twenty-five years of epidemiological research on this question has been the consistent finding that self-reported health is highly predictive of subsequent mortality, a highly objective measure of "true" health by any standard (Idler and Benyamini, 1997). The relationship between self-reported health and mortality holds with respect to both long-term and short-term mortality, and persists in the presence of extensive controls for known health risk factors and socioeconomic status (Idler and Benyamini, 1997). Even the dose-response relationship is robust across studies, with mortality risk rising monotonically as health ratings progress from excellent to poor (Idler and Benyamini, 1997). Moreover, its predictive ability is robust to variations in question wording and translation, national origin, the number and labeling of response categories, whether a time frame is specified, or whether a particular reference group is indicated (Idler and Benyamini, 1997).

Although the mortality relationship has been the focus of most studies, self-reported health also predicts future decline in physical functioning (Idler and Kasl, 1995; Lee, 2000). Largely, the conclusion of this literature is that self-reported health is an accurate measure of true health, perhaps more accurate and more inclusive than other measures on account of its apparent ability to tap domains of health that are beyond the reach of other measures (Idler and Benyamini, 1997).

[1] The precise wording varies from survey to survey and four response categories are sometimes used instead of five. For example, a common alternative is "I*n general, would you say your health is: excellent, very good, good, fair or poor*?" In some European countries the convention is to label the five response categories "*very good*" "*good*", "*fair*," "*bad*," and "*very bad*." Some variants ask individuals to rate their health over a particular time period, relative to a point in the past, or compared to a group of peers.

While the vast majority of studies have related baseline levels in self-reported health to subsequent mortality, a related question that has received much less scrutiny is, what do changes in self-reported health measure? Measurement theory seems to indicate that even if the level of self-reported health is correlated with true health, unless that correlation is perfect, there is also an error component that may not be random (Bound, 1991; Currie and Madrian, 1999). Understanding the nature of this error component and its dynamic properties are crucial for interpreting changes in self-reported health over time. This is a salient issue for policy making on account of the fact that the time profile in self-assessments like self-reported health are often used to measure trends in population health, health inequality, and the decline of health over the life-cycle (see e.g., Crimmins, 1990, Kunst et al., 2004; Contoyannis, Jones and Rice, 2004; Case and Deaton, 2005). The conceptual difficulties with trend analysis of health statistics were noted by Drury and Wilson (1984), and more recently, Waidmann, Bound and Schoenbaum (1995). Both studies argue that purported health declines in the 1970s may have in fact been due to changes in other factors, such as disease detection and awareness.

One particularly useful framework for interpreting change over time in self-assessments is that of Golembiewski, Billingsley and Yeager (1979). They posit three types of changes. The first, called *alpha* change, refers to an absolute quantitative change in the construct of interest. In the context of health status, an alpha change would be a change in true health status (typically what we are trying to measure). The second type, called *beta* change, describes change resulting from recalibration of the measuring instrument. For example, a change in the threshold value of latent true health that distinguishes fair from poor health would be a beta change. Beta change is also known as "response shift," whereby the internal standards of measurement or the response criteria change (Howard and Dailey, 1979). Such effects are hypothesized to arise, for example, if individuals beset with illness learn to cope or change their expectations (Bjorner, Fayers and Idler, 2005).

The third type, called *gamma* change, describes a major change in "the perspective or frame of reference within which phenomena are perceived and classified" (Golembiewski, Billingsley and Yeager, 1979, p. 135). In the context of self-reported health status, gamma change would result from a change in the state variables guiding the decision process. Such state variables could include social phenomena, reference groups, public health information, scientific advancements, technological innovations, and economic conditions. Policy interventions themselves can cause gamma change if, for example, individuals change their outlook about a particular issue as a result of an intervention. [2]

[2] Sprangers and Schwartz (1999) offer a revised typology in which the term "response shift" encompasses gamma changes as well as beta changes.

The Golembiewski, Billingsley and Yeager framework reveals a fundamental identification challenge. Does an observed change in self-reported health represent alpha change, or is it confounded by beta or gamma changes? The identification problem exists whether we consider individual-level change or population-level change, and confronts self-assessments generally, not just measures of self-reported health. In many settings, it is not possible to separately identify these three alternative factors. Hence, it makes it almost impossible to directly test for the presence of confounding changes such as these. In health research, only a small group of studies has attempted to test for beta or gamma change in individual-level responses, although many more have documented seemingly inconsistent response patterns that point to the likely presence of either beta or gamma change (see Sprangers and Schwartz (1999) for a short review of the epidemiological literature, and Currie and Madrian (1999) for a review of the economics literature).[3]

Among studies that have tested directly for changes of this nature are Allison, Locker and Feine (1997), who document evidence of reference group change in the measurement of health-related quality of life. Lindeboom and van Doorslaer (2004), find inconclusive evidence of "cut-point shift" (beta change) in self-reported health responses in the Canadian National Population Health Survey.

In this paper, we present an analysis of the extent to which changes in self-reported health reflect beta and gamma changes in addition to true changes in health status. Using 21 years of data from the U.S. National Health Interview Survey (NHIS), we examine the time trend in self-reported health as it relates to changes in body mass index (BMI), a well-defined and relatively objective measure of health (or health risk). First we show that virtually every segment of the population (e.g., stratified by gender, age, socioeconomic status, region) experienced a notable rise in BMI during the period from 1982 to 2002. We interpret this rise in BMI as evidence of a decline in the true underlying health of the U.S. population. During the same period, mean self-reported health declined slightly and there was a reduction in the variance in self-reported health as individuals became less likely to classify their health as excellent and more likely to choose very good; however, this was not all that occurred. We show that the mapping between BMI and self-reported health changed in two important ways. First, the cut points in an ordered response model of self-reported health have changed over time, and second we show that the coefficient defining the relationship between self-reported health and BMI also changed. We interpret the former as evidence of beta change and the latter as evidence of gamma change. We offer support for our interpretation of gamma change by presenting evidence that the variation over time in self-reported health is

[3] A related strand of research has investigated differential use of response scales across countries in order to facilitate cross-country health comparisons (e.g., Jurges, 2007; Kapteyn et al. 2007).

highly responsive to a number of macroeconomic variables. In particular, we find evidence of a strong procyclical relationship—when the economy improves, so does health. This pattern is contrary to previous work that showed a countercyclical relationship between the number of acute and chronic health conditions (self-reported) and the unemployment rate during the 1970s (Ruhm, 2003).

2 The Data

The data for this study comes from the National Health Interview Survey (NHIS). This data set is the principal source of information on the health of the civilian non-institutionalized population living in the United States at the time of the interview.[4] The NHIS was originated by the National Health Survey Act of 1956. The main objective of the NHIS is to monitor the health of the United States population through the collection and analysis of data on a broad range of health topics. The NHIS provides detailed information about health characteristics broken down by many demographic and socioeconomic characteristics. The NHIS is used extensively by the Department of Health and Human Services (DHHS) to monitor trends in illness and disability and to track progress toward achieving national health objectives. It also provides the primary source of information for studies in various disciplines, including public health, epidemiology, sociology, economics, and many others.

The NHIS has been conducted continuously since 1957. However, the content of the survey has been updated from time to time. In particular, in 1996 there was a substantial revision. While the changes introduced in the NHIS dramatically improved the ability of the survey to provide important health information, it also introduced some problems including the inconsistency of some of the variables (including some of those we use in this study) over time.

The NHIS is a cross-sectional household interview survey. Sampling and interviewing are conducted continuously throughout each year. The sampling plan, which was redesigned in 1995, follows a multistage area probability design that permits the representative sampling of households.

The households selected for interview each week in the NHIS are a probability sample representative of the target population. Overall the NHIS data are collected annually from approximately 43,000 households, including about 106,000 individuals. While survey participation is voluntary, the annual response rate of NHIS is greater than 90% of the eligible

[4]Because of logistical problems, several segments of the population are not included in the sample. These include individuals living in long-term care facilities; persons on active duty with the Armed Forces; and U.S. nationals residing abroad.

households.

The content questionnaires have also been changed over the years. The NHIS that was fielded from 1982-1996 consisted of two parts: (1) a set of basic health and demographic items (known as the *core questionnaire*); and (2) one or more sets of questions on current health topics. The core questionnaire remained the same over that time period, but the current health topics changed depending on data needs. The NHIS core provide detailed information on events such as doctor visits and hospitalizations rather than information that would better characterize the individual.

Among other things, these shortcomings led to a comprehensive revision of the NHIS. Since 1997 the NHIS has three parts or modules: a Basic module; a Periodic module; and a Topical module. The Basic module replaced the core questionnaire and remain largely unchanged. It contains three components: the Family Core, the Sample Adult Core, and the Sample Child Core. The Family Core gathers information on everyone in the family. This includes: household composition and sociodemographic characteristics; tracking information; information for matches to administrative databases; and basic indicators of health status and utilization of health care services.

From each family in the NHIS, one sample adult and one sample child, if applicable, are randomly selected and information on each individual is collected with the Sample Adult Core and the Sample Child Core questionnaires. While the two questionnaires differ somewhat, they both collect basic information on health status, health care services, and behavior.

In this study we mainly use information about the individual and family characteristics and a variety of responses, objective and subjective, regarding the health status of each individual. Table 1 provides summary statistics on the extract used in this study. The average age of the individual in the NHIS was 43 in 1982 and has increased to about 46 by 2002. This is partially because of the change in sample design that took place in 1997, but largely it comes from the fact that the U.S. population is aging. About 55% of the sample is women, especially for the sample years from 1997 onward.

An average individual in the sample reports that his/her health is somewhat better than good (where good is the middle point on a scale from 1 to 5). One particularly interesting development is with respect to the *body mass index* (BMI). This index increased substantially over the sample years. Also there are continuous declines over the sample years in the fraction of people having education level of high school or lower and a dramatic increase in the fraction of individuals who are college graduates, or have some college experience.

About 9.5% of the sample was African American in 1982 and the fraction increased in the sample to about 14% by 2002. Reflecting the changes in the family composition in the U.S., we see that the fraction of married individuals declined over the years, while the fraction of those never married increased.

The rest of the extract contains information about various diseases, as well as information about *activity of daily living* (ADL) and *independent activity of daily living* (IADL). This information is used in constructing a health index for individuals in the sample as is explained below.

3 Self-Reported Health Measure

Self- reported health (SRH) measure is commonly provided in many data sets, including the NHIS. It is a self-assessment of the individual regarding his/her health status. The variable is coded in five categories: (a) excellent; (b) very good; (c) good; (c) fair; and (d) poor. The analysis, whose results are provided below, is devoted to looking at this particular variable from various aspects. Most of the analysis is purely descriptive. Nevertheless, it provides a detailed account of the changes in the observed variables over time. Moreover, we link the changes in the underlying health index to changes in a number of variables measuring the level of economic activity. The variables we consider here are: (a) unemployment rate; (b) inflation; (c) GDP growth rate; (d) percent change in real per capita consumption; (e) change in the Gini coefficient; and (f) change in income dispersion.

The first question to ask is: *How did the reporting of the self-reported health measure change over time*? In Table 2 we show the average reported measure over time for the whole population. We also provide the information for several cohorts defined as follows: (a) 20 years old or less; (b) 30 to 55; and (c) 55 and older. In Figure 1 we provide visual representation of these measures along with two of the economic indicators, namely inflation and unemployment. We first depict it for the whole population, and then we depict several graphs for a few specific age groups. As Table 2 indicates the measure remains around 2, i.e., on average a person is in very good health. Also, as expected, we see that older people report that they are less healthy than their younger counterparts. Note that there is a noticeable variation in the mean of self-reported health measure over the sample years for age groups. This variation is demonstrated in Figure 1a for the whole population and is broken down to several age subgroups in Figures 1b–1d. While for all groups there is some variation over time, the pattern is not uniform for all groups, and, in general, there is a larger variation in the mean health measure for the older groups.

The changes in the mean reported health measure are quite different across the various cohorts. In the excellent category there is hardly any change for the youngest age group of individuals (of 20 years old or younger). Generally, there is a sharper decline in the mean reported health in the older cohorts. There might be many reasons for this dramatic trend. While we do not attempt to investigate the underlying reasons for these changes it is consistent with the findings in the literature. This is due to a larger known number of diseases and various illnesses that have been discovered over the past few decades. Also, the fact that with better medical services fewer people die at every age, implies that less healthy individuals can be found in any age group, and more so in the older cohorts.

In all cases the average seems to be correlated with the economic indicators. To evaluate this issue we run a simple OLS regression of the mean self-reported health on a number of economic indicators in the U.S. These include: The unemployment rate, inflation, growth rate of GDP, change in real per capita consumption, change in the Gini coefficient, and change in income dispersion. The results are reported at the bottom of Table 2. Note that, in general, there is a very high correlation between these measures and self-reported health. The individual R^2's by age groups vary between .44 and .71, quite large by any standard. We return to the link between economic activity and self-reported health below, when discussing the effects of various factors on the individuals' health indices. Whatever causes the reported mean to change over time, has less affect on younger individuals. Specifically, we see that there is much less variation of the younger cohorts to changing economic environment. This is also illustrated by the much larger R^2's obtained in the regressions described above for the older age groups.

In the five panels of Table 3 we provide information about the fraction of people reporting each one of the five categories over the sample years, i.e., 1982 to 2002. Figures 2a–2d provide the graphs that correspond to the various columns of Table 3. Finally, Figures 2e–2f provide similar graphs for the female and male populations.

The most visible phenomena revealed by the tables and figures is the systematic decline in the fraction of people reporting they are in excellent health and a systematic increase in those reporting themselves to be in very good health. While there are some changes in fractions of the other three categories, they are a lot less pronounced than those for the first two categories mentioned above. Overall, we can see that for the population as a whole (Figure 2a) there is an overall decline of about 4 percentage points in the excellent category and an increase of above 5 percentage points in the very good category. An interesting observation is that the decline in the fraction of people in the excellent category is sharper for the younger cohorts than for the older cohorts. For example, in the 20 to 30 age group a difference of over 17 percentage points between the excellent and the very good shrunk to about 6 percentage points over the sample period. A similar convergence appears to be the case for the 30 to 50 years old individuals. The absolute changes are somewhat smaller for the older age groups, but percentage-wise they are quite large as well.

Comparing Figure 2e for the female population with Figure 2f for the male population also reveals significant differences. In particular, the fraction of men that report themselves in excellent health far exceeds that of the female population. Nevertheless, the fraction of males in that category declines significantly over time, while the decline for the female population is less pronounced. Note that the fraction of individuals reporting themselves as being in very good health for both male and female is quite similar. Generally, it seems that women tend to be more reserved in reporting themselves as being in good health. Note however that they do not report themselves more than men as being in poor health.

These findings suggest that two things might have changed. First, it might indicate that something major has changed in the way individuals evaluate their health. Second, there might have been a systematic change in the way people report their health. Of course, a combination of these two possible changes is also a valid possibility. As for the first possibility, the availability of more information and the faster transmission of information certainly makes people learn faster about potential health problems that are associated with certain observed characteristics. For example, people are more aware of the potential hazards that are associated with being over-weight, or the long term effects of actions that they have taken in the past, e.g. smoking. Moreover, the advancement of science in general, and of medical science in particular, allows individuals to detect more medical problems over time as well as detecting known problems earlier in one's life.

As for the second possibility, it would be difficult to detect a systematic change in one's attitude toward reporting factual information, including his/her health status. Particularly in a survey such as the NHIS, there is nothing to be gained by strategically answering the questions, including subjective questions such as the one regarding health status. In the remainder of the paper we simply explore changes in what we view as the evaluations of given medical situations, conditional on one's characteristics.

The health literature has generally found substantial differences between women and men in their answers to a variety of survey questions. Hence, it is natural to ask at this point: Are there any differences in the way women and men evaluate and report their health condition? To investigate this question we provide similar information as for the whole population, broken down by gender.

Specifically, in Panels A and B of Table 4 we provide the information about the evolution of the mean self-reported health for women and men, respectively. We also depict the changes in the mean self-reported health for women and males in Figures 3 and 4, respectively. The two figures are organized similarly to Figure 1, that is, in each figure we provide the time series for the unemployment rate and inflation in the U.S. along with the mean self-reported health for the group.

Comparing first Figures 3a and 4a, for females and males we observe that the general patterns of change over time are quite similar for the two groups. However, there is one crucial difference that stands out. Generally, females tend to report they are in worse health than their males counterparts. This is true not only for the two groups as a whole (see Figures 3a in comparison with Figure 3b), but also for each age group within the two groups (see Figures 3b–3d in comparison with the Figures 4b–4d, respectively). Nevertheless, the similar standard deviations of the mean responses over time indicate that they respond similarly to factors affecting their self-reported health (see the standard deviation reported at the bottom of Panels A and B of Table 4). Differences do exist nonetheless between specific age groups within each gender group and between women and men. In particular, we see in the two panels of Table 4 that the R^2's from the regression of the group mean on a set of economic indicators are, generally, larger for the older groups, for which the economic indicators can be associated with over 60% of the variation in the data. Also, while for the younger groups there is an upward trend in the way they evaluate, on average, their health (i.e., providing worse evaluation), this trend is a lot less pronounced for the older groups for whom there seems to be more direct connection to the underlying economic variables.

Several differences in the pattern of changes for the two groups are worth noting. In particular, we note the differences in the pattern of changes between males and females in the younger age groups. In general we see that the mean of self-reported health has a more pronounced increasing trend for males than for females, indicating that males becomes more similar to women in the way they assess their health, at least for those between the ages of 30 and 50. For the older cohorts, men seem to be more similar to women throughout the sample period.

All the results so far indicate that there are significant difference in individuals' evaluations of their own health. These differences are most pronounced between women and men, but there are certainly significant differences also across the various cohorts.

We have also conducted comparisons between other important sub-populations such as between whites and blacks, between various geographical regions, between individuals in different marital statuses and between individuals working in different occupations. All these analyses reveal two important features. First, there are significant differences in the magnitude of the self-reports between all these groups, that is, some groups are distinctly more optimistic than others in the evaluation of their health status. Furthermore, there are significant differences in the patterns of change in self-reporting their health status over time. All these features are taken into account in the regression results reported below. One phenomenon that is common to all subgroups is that their self-reported health seems to be highly correlated with the trends in key economic indicators.

4 The Model

4.1 The Ordered-Probit Model

What are the factors affecting the individuals' self-reported health status? Do these factors have the similar weights on all individuals reporting? To analyze that we estimate a simple ordered-probit model using all available data from 1982 through 2002. We allow the coefficients to vary across years and estimate the model for each year separately. We also estimate the model separately for the male and female populations, allowing the coefficients to change across these two populations in each sample year. While, for brevity, we do not report all the individual coefficients from our estimation, it is worthwhile noting that the very large data sets we use allows us to estimate the coefficients very precisely.

As noted above, the model we use here is a simple ordered-probit model. Without loss of generality we assume that there exists a latent health index given by

$$I_{it}^{*} = x_i'\beta_t + \varepsilon_{it},$$

where x_{it} is the vector of individual specific health objective health measures, that is, the determinants of the individual's overall health index. The vector β_t is a vector of unknown parameters. These parameter are to be interpreted as the weights that an individual assigns to each of the corresponding health measures. Finally, ε_{it} is an idiosyncratic error term, uncorrelated with x_{it}, that is

$$\varepsilon_{it}|x_{it} \sim N\left(0, \sigma_{\varepsilon}^2\right).$$

For identification purposes we assume that $\sigma_{\varepsilon}^2 = 1$. We assume that when an individual is asked to report his/her SRH described above he/she will report the health condition according to following classification:

$$d_{it}^{SRH} = \begin{cases} 1 & \text{if } I_{it}^{*} \leq c_{1t} \\ 2 & \text{if } c_{1t} < I_{it}^{*} \leq c_{2t} \\ 3 & \text{if } c_{2t} < I_{it}^{*} \leq c_{3t} \\ 4 & \text{if } c_{3t} < I_{it}^{*} \leq c_{4t} \\ 5 & \text{if } I_{it}^{*} > c_{4t} \end{cases},$$

where $d_{it}^{SRH} = 1$ corresponds to *poor* health, $d_{it}^{SRH} = 2$ corresponds to *fair* health, etc. The parameters in $c_t = (c_{1t}, ..., c_{4t})'$ are the thresholds that determine the individual's classification of his/her health. It follows immediately that

$$P_{ij}(x_{it}) = \Pr\left(d_{it}^{SRH} = j|x_{it}\right) = \begin{cases} \Phi\left(c_1 - x_{it}'\beta_t\right) & \text{for } j=1 \\ \Phi\left(c_2 - x_{it}'\beta_t\right) - \Phi\left(c_1 - x_{it}'\beta_t\right) & \text{for } j=2 \\ \Phi\left(c_3 - x_{it}'\beta_t\right) - \Phi\left(c_2 - x_{it}'\beta_t\right) & \text{for } j=3 \\ \Phi\left(c_4 - x_{it}'\beta_t\right) - \Phi\left(c_3 - x_{it}'\beta_t\right) & \text{for } j=4 \\ 1 - \Phi\left(c_4 - x_{it}'\beta_t\right) & \text{for } j=5 \end{cases}.$$

Note that all parameter vectors β_t as well as c_t are indexed by t, so that they are allowed to change over time. Consequently, the reporting of the SRH can change depending both β_t and c_t. One of the main goals of the current paper is to explore the potential links between the actual reporting of SRH and changes in these parameters. Another goal is to examine the potential links between the changes in the model's parameters and changes in the economic environment.

4.2 Variance Decomposition of the Health Index

Consider the deterministic part of the health index, that is

$$I_{it}^{D*} = x_{it}'\beta_t = \sum_{k=1}^{K} x_{kit}\beta_{kt}.$$

In the results reported below we decompose the overall variance of I_{it}^{D*}. To do that note that

$$\begin{aligned} Var\left(I_{it}^{D*}\right) &= Var\left(\sum_{k=1}^{K} x_{kit}\beta_{kt}\right) \\ &= \sum_{k=1}^{K}\left(Var\left(x_{kit}\beta_{kt}\right) + \sum_{j=1,j\neq k}^{K} Cov\left(\left(x_{kit}\beta_{kt}\right),\left(x_{jit}\beta_{jt}\right)\right)\right). \end{aligned}$$

Hence, the contribution of a particular component of the health index, i.e., $x_{kit}\beta_{kt}$, is $s_k = Var\left(x_{kit}\beta_{kt}\right)+\sum_{j=1,j\neq k}^{K} Cov\left(\left(x_{kit}\beta_{kt}\right),\left(x_{jit}\beta_{jt}\right)\right)$. We define then the fraction of the variance due to the kth component by

$$f_k = \frac{s_k}{\sum_{j=1}^{K} s_j}. \tag{1}$$

4.3 The Control Variables

In the regression we use a number variables that control for both general individual characteristics, as well as specific objective measures of health. The demographic variables include:

income, age„ four dummy variables for four possible levels of deduction (9-11, 12, some college education, 4+ years of college education), three regional dummy variable (North East, Mid-West and South), a dummy variable for being African American, two martial status variables (married and never married), Number of children under 5 years old, number of children under 15 years old and six occupational specific dummy variables. For the objective measures of health we use: BMI and its squared term, four dummy variables for # of bed days (0 to 7, 8 to 30, 31 to 180, and more than 180 bed days), two dummy variables for having problems with ADL and IADL. We also account for having a number of specific chronic diseases, namely Arthritis, asthma, bronchitis, any type of cancer, diabetes, emphysema, chronic headaches,. hearing problems, ulcer, hypertension, , heart disease, vision problems, sciatica, and sinusitis.

5 The Results

One of the main findings that seems to be consistent is that all coefficients' estimates are changing, and in very particular patterns over the sample years. Moreover, for at least some of the variables, the levels have changed significantly over time. An example of this is the case the of BMI as indicated above and will be further discussed below. For brevity we restrict our analysis to only some of the key factors affecting the latent health index. Further, we decompose the overall change in each of these factors to those that stem from changes in the individuals' evaluation of their own health (i.e., changes in the coefficients' estimates) and changes in the level of the corresponding variables. We first analyze the changes of some of the key variables that determine the individuals' health indices, namely: (a) age; (b) BMI; (c) cancer; (d) emphysema; (e) hypertension; (f) ulcer; and (g) income.

Figures 9 through 13 below provide the results for these factors. In each figure we provide the results for the coefficient, the portion of the health index that is explained by the specific variable, namely $I_k^* = x_k' \beta_k$, for $k = 1, ..., K$, the change in I_k^* that is due to changes in the corresponding coefficient β_k, and the change in I_k^* due to changes in the corresponding variable x_k. Also, since the sampling frame of the NHIS has changed in 1997, we separate our presentation of the results to the two-sample periods, namely 1982 through 1996 and 1997 through 2002.

In Table 5 we report the fraction of the variation in latent index, i.e., $I_{it}^* = x_i' \beta_t + \sigma_{x'\beta}^2$, that is explained by the deterministic part of the index, namely $x_i' \beta_t$. We denote that fraction by $f_D = \sigma_{x'\beta}^2 / \left(\sigma_{x'\beta}^2 + 1 \right)$, where 1 is simply the normalized variance for ε_{it}. The findings are generally similar for both men and women in the population. We see that while there is some variation in the fraction explained by the deterministic part, it is generally around

40%. That is, about 60% of the variation in the health index is due to the idiosyncratic part ε_{it}.

In Table 6 we report the results from a simple OLS regression of various statistics on the set of economic variables described above. In particular, we see that the fraction explained by the deterministic part (i.e., each column of Table 5) is predicted extremely well by variation in the economic variable, which explain about 80% of f_D. Note also that the mean of the predicted index (row 2 of Table 6) indicates that the economic variables better explain the variation in the estimated index for men where the R^2 is relatively high, at .69, while that for women, although high, is only about .35.

Finally, Table 7 reports the results for the R^2 from a set of simple OLS regressions of the estimated coefficients on the set of economic indicators described above. Generally, the economic indicators explain a relatively large fraction of their variation over time, with some of the regressions yielding an R^2 of over .90.

5.1 The Effect of Age

In Figure 5 we present the results for the age variable. While the distribution of age in the population has not changed dramatically, the effect of age on the health index has changed significantly over the sample period. Note first that, in absolute term, the effect of age has decreased dramatically over the sample period for both women and men. Nevertheless, the effect for men is larger in absolute terms than that for women. A comparison of the change in the portion of the index attributed to age (Figure 5b) with the portion of the change that is due to changes in the coefficient (Figure 5c) indicates that the decrease in the impact of age is almost entirely due to changes in the coefficients over time. This is true for both women and men. Nevertheless, while there a very clear trend in the effect of age on the health index, there is also significant variation over the sample period, and more so for men than for women.

Note also that, if anything, the changes in the age composition has opposing effect to that of the coefficient on the age variable. That is, the aging population causes the index to be somewhat lower over time. Finally, note from Table 7 that the regression of the estimated coefficients on the set of economic indicators yields quite high R^2 for both female ($R^2 = .83$) and men ($R^2 = .86$). This seems to indicate that the economic situation has an effect on the way people evaluate their health conditions. Specifically, age seem to have a more pronounced negative effect on what individuals think their health conditions are, when the economy is in a downturn. In other words, individuals know how to cope better with their age in a better economic environment.

5.2 The Effect of BMI

The effect of BMI on health measure has changed dramatically over the past few decades. The effect can be decomposed into two factors. First, as we establish below, there were enormous changes in the BMI distribution in the population. These changes apply to virtually all segments of the population: For women and men, for blacks and whites, for young and old individuals. Second, there were considerable changes in the individuals' valuation of their health status at any given level of BMI. That is, people perceive a BMI level of, say, 30, differently in 2002 as compared with their perception of that level of BMI in 1982. Below we document the contribution of the changes in the distribution of BMI to changes in the overall health measure during the period from 1982 through 2002. We then discuss the effects of changes in the individuals' valuation over the same period on the health index.

The high BMI among children and adolescents continues to be of particular public health concern. It is been well documented that children with high BMI tend to also be obese adults who are at risk for having severe chronic conditions such as diabetes, cardiovascular disease, and certain types of cancers.

The results for the effect of BMI on the health index are provided in Figure 6. Unlike the results for the age variable, since we include in the regression squared term for BMI as well as the linear term we present the changes in both coefficients over the years. In Figure 7 we depict the empirical cumulative distribution function of BMI for three selected years: 1982, 1992, and 2002. Finally, Figure 8 provides few selected quantiles and the mean of the BMI distribution for few selected age groups.

Starting with Figure 7 we note that there has been enormous change in the BMI distribution in the population, with a clear shift toward my higher BMI in the population. We note that the BMI distribution in 1982 first-order stochastically dominates the distributions in 1992 and 2002. In fact, that is a clear order in the change of the distributions across all years of the sample. It is somewhat puzzling that even though individuals become more aware of the long-term adverse impact of weight, there is sharp increase fraction of the population with relatively very high BMI. This is illustrated more clearly in Figure 8 and especially for the younger age group, i.e., the group of individuals age 30 or less (Figure 8b). This figure clearly illustrates that there is much longer right tail for the distribution of BMI. In fact, the .90 quantile increases from 28 to over 32 from 1982 to 2002. The increases at the lower quantile of the distribution are smaller, but are still quite pronounced. Note also that the increases for the older groups are not as sharp as for the youngest age group represented here. Nevertheless, even for the individuals who are age 55 and more (Figure 8d) there is a substantial rightward shift of the entire BMI distribution.

Clearly, there have been dramatic changes in the BMI distributions. The six panels of Figure 6 provide the results regarding the changing effects of BMI on the latent health index. First note the changes in the coefficients for both BMI and BMI squared. Generally women seem to give larger negative weight of their BMI to their overall health index relative to men. In general larger BMI is interpreted by men as better for their health status as indicated by the positive, and relatively large, coefficients for BMI over all sample years (Figure 6a). Nevertheless, the curvature of the effect is stronger for men than for women as can be seen from Figure 6b. One noticeable result is the large year-to-year variation in the estimated coefficients, especially for men. The changes from year to year are sometime enormous. To see the overall effect of BMI on the health measure we depict in Figure 6c the average marginal effect of BMI on the health index, this is simply given by the average of the derivatives of the health index with respect to BMI, i.e., $\beta_{BMI} + 2\beta_{BMI^2}\,(BMI)_i$, for all individuals in a particular subsample. The figure indicates that the overall effect for women is larger in absolute terms in each of the sample years. That is, women's valuation of having higher BMI is much more negative than that of men. It also seem that men's valuations are more sensitive to changes in the economic factors as is seen from lines 8 and 9 of Table 7. The R^2 from the regressions of they coefficients for BMI and BMI squared on the set of economic indicators are .61 and .62, respectively, for men, but only .40 and .43, respectively, for women.

Figure 6c indicates two important findings. First, the portion of BMI of the health index is relatively large for both men and women. Moreover, the portion changes more frequently for men than for women. Overall, the increase in BMI tends to reduce individuals valuation of their health, and more pronouncedly so for women, as is clearly seen from Figure 6d.

Finally, Figures 6e and 6f indicate that changes in the impact of BMI on the health index come largely from changes in the individuals' valuation, i.e., changes in the coefficients that correspond to BMI. The impact of the composition of BMI in the sample is very smooth, representing consistent downward shift of the health index.

5.3 The Effect of Cancer

Here we consider all types of cancers as one group. Of course, the prevalence of cancers differs substantially among the various parts of the population. Also, with the advancement of various cancer treatments the impact of having cancer may have differing long-term effects, depending on the type of cancer one may have. Thus having different types of cancers may affect individuals differently when coming to evaluate their health status. Nevertheless, as a first approximation we treat all types of cancers as one group.

The results for cancer are presented in Figures 9a–9d. First note that because of the change in the way the NHIS administered their questionnaire the data for years from 1997 onward are not directly comparable to data before 1997. This is the reason we separate the graphs corresponding to years after 1997 from the graphs that correspond to the years from 1982 through 1996. From the results reported in row 32 of Table 7 it is clear that the valuation of the cancer's effect on the health index is closely related to the economic situation. The R^2 from the regression of the time series of coefficients on the set of economic indicators is quite high for both female ($R^2 = .91$) and male ($R^2 = .85$). This might be indicative of one of a few alternative interpretations. It may well be that it is easier for individuals to cope with having cancer in good times than in bad times. Alternatively, it may simply indicate that in bad times individuals have more time on hand to find out about diseases such as cancer. Another interpretation is that the psychological effect of being in bad times weakens the body and thus individuals are more likely to contract all kinds of diseases.

Note from Figure 9a that unlike the effect of the other variables discussed so far, the effect of having cancer on the health index is very similar for both male and female. In fact, it seems that the changes in the coefficients are almost identical for much of the sample period, and especially during the 1982-1996 period. Nevertheless the overall effect of having cancer on the health index is relative small as can be seen from Figure 9b.

Figures 9c and 9d indicate that most of the changes in the effect of having cancer on the health index come from changes in the valuation of the cancer rather than from the prevalence of cancer in the data. Note that the trend in the valuation of having cancer generally declines over the sample period, as the coefficient on the dummy variable of having cancer converges toward zero (see Figure 9c), this may be because given the success in cancer treatments the implication of having cancer become less severe over time. In contrast, the prevalence of cancer has negative and increasing effect, generally worsening the health index (see Figure 9d).

5.4 The Effect of Emphysema

The results for emphysema are provided in Figures 10a–10d. The prevalence of emphysema has been steadily declining over the years, especially for the older age groups for which the rates were the highest. The rates for women were always far below those for men, but over the years there has been convergence in these rates to approximately the same levels. Note that the effect of emphysema is larger than that of cancer on one's health index, even though there is a substantial decline in the effect of emphysema, especially for women (see Figure 10c). Furthermore, note that the changes in the coefficients are a lot more erratic for women than for men. As row 34 of Table 7 indicates the economic fluctuations explain a huge portion of these changes; the R^2 from the regression of the time series of these coefficients on the set of economic indicator is $R^2 = .85$ for women, and is even higher for men, $R^2 = .95$. That is, for the latter group changes in the economic indicators explain almost entirely the fluctuations in the men's evaluation of emphysema on their health index. This is nothing short of a remarkable findings.

As for the other s discussed above, most of the changes in the contribution of emphysema to the health index come from changes in the coefficients and not due to changes in the prevalence of emphysema in the population. Also, it is important to note that the effect of emphysema on the health index is much larger for men than for women.

Changes in the sampling design that was introduce by the NHIS makes it impossible to compare the results for the year before 1997 and from 1997 onward. However, the general pattern of changes in the coefficients remains similar.

5.5 The Effect of Hypertension

The prevalence of hypertension has increased enormously over the sample years. The age-adjusted prevalence rate increased from about 24% in the early 1980s to about 29% by 2002, with the largest increase among non-Hispanic women. Nevertheless, there has also been significant increases in hypertensive awareness, especially for men. In addition there have been significant improvements in treatment through new and better medications, as well as nutrition adjustment and exercises. In fact, among all disease that individuals suffer from, hypertension is relatively easy to control. It is therefore interesting to examine the effect of such a problem on the general health index. The results for hypertension are presented in Figure 11.

Noticeably, the pattern of changes in the coefficients for men is very different for that for women (see Figure 11a). For the latter we see continuous reduction in the negative effect on the health measure, while for the former this general trend is not as pronounced, perhaps because men become more aware on the problem associated with having high blood pressure later than women.

Overall, the portion of the health index that is due to the prevalence of hypertension is rather small, certainly in comparison with other leading diseases (see Figure 11b). Note from Figure 11c that the changes in the portion of the health index explained by hypertension vary significantly over the sample years. Also, until 1989 the portion of the health index declined in absolute term, it remained stable, and even increased at times thereafter. The potion for the years after 1997 is much larger, but this is solely because of the change in the sampling design introduced by the NHIS.

For a problem that can be largely controlled by medication one would expect that changes in the economic situation may not have an effect on the valuation of having this problem. Row 38 of Table 7 indicates otherwise. The R^2 from the regression of the coefficient on hypertension on the set of economic indicators is quite large for both female ($R^2 = .85$) and male ($R^2 = .78$). This is remarkable since it is a defect that can be easily controlled. One possible explanation for this is that while individuals may take their appropriate medications, they would be less inclined to do all the other things needed to keep blood pressure under control in bad times, and hence view hypertension as bigger problem that it needs to be.

5.6 The Effect of Ulcers

Having an Ulcer is quite a common disease that affects more than 6 million Americans every year. Over the last two decades there have been important changes in diagnostic and treatment methods. This has contributed enormously to improving the clinical outcomes and potentially decreasing the long-term health care costs, which are estimated at around 10% of all health care costs. The results for ulcers are presented in Figure 12a–12d.

Interestingly the effect of ulcers on the health index has an inverted u-shape, for the years from 1989 to 1996, with no clear trend in the effect before 1996. Overall, the changes in the coefficient over time are explained extremely well by economic factors. Note from row 37 of Table 7 that the R^2 from the regression of the coefficient on ulcers on the set of economic indicators is quite large for both female ($R^2 = .90$) and male ($R^2 = .90$).

Note that just like the other cases, the changes in the affect on the overall health index come solely from changes in the coefficient and not by the prevalence of ulcers in the population (see Figure 12c in comparison with Figure 12d). As expected, due to the nature of the disease and the relative ease by which it can be controlled, the overall effect on the health index is rather small.

5.7 The Effect of Income

The United States has gone through major changes over the past few decades that have enormously affected the wage structure, the return to schooling and experience and the likelihood of unemployment. Clearly, income is a key factor affecting each and every aspect of our life. Interestingly it seems to also directly affect the valuation of our health as can be seen from the results presented in Figures 13a–13d.

Note first from Figure 13b that income has a large effect relative to other variables on the health index, and more so toward the latter years of the sample. Moreover, it seem to have greater effect on men's health index than on that of women. This is true even though the valuation of income seems to be surprisingly similar for men and women (see Figure 13a). This is largely explained by the fact that men tend to have, on average, higher income than women as can be seen from Figure 13d. This may stem simply because men have traditionally felt the pressure to earn money. What is especially important is the steep rise in the evaluation of income and its affect on the health index. These results clearly indicate the importance that individuals attribute to income, for women and men alike, when evaluating their health status. Consequently, small changes in income can change the self-reported health status enormously, as indeed we see over the sample year.

Figure 13d specifically indicates that changes in income, holding the valuation of income constant, contribute substantially to people's view of their health. In particular we can see that the years of downturn in the economy during the early 1990's significantly reduce individuals' valuation of their well-being.

Row 1 of Table 7 also indicates that the macro environment in general affects the specific valuation of individuals' own income. The R^2 from the regression of the coefficient on income on the set of economic indicators is quite higher, even though not as high as for some of the other variables discussed here. For women the R^2 is $R^2 = .69$, while for men it is $R^2 = .70$.

5.8 Changes in the Health Index's Thresholds

So far we have discussed variation in the contribution's factor to changes in the overall health index. Nevertheless, individuals may have the same valuation of their specific health index over time, and yet report differently when asked about their SRH. One way to interpret this is that there are perceived standards as to what level of the health index constitutes excellent health, very good health, etc. The threshold of the order-probit model are these standards, and they may change over time. It is therefore worthwhile analyzing how changes in the threshold affect individuals' reporting of the SRH, holding the level of their health index I_{it}^* constant. Furthermore, it would be worthwhile decomposing the over all reporting of the SRH into the part that stems from changes in the individual coefficient vectors β_t, and the part the stems from change in the thresholds c_t. We provide the analysis of the latter below. In this subsection we merely analyze changes in c_t over time, and relate these to changes in the set of economic indicators.

Figures 14a–14c provide the results for the changes in c_t. In Figure 14a we provide the results for the whole population, while in Figures 14b and 14c we provide the results for the female and male populations, respectively. Note first that for both men and women there is a general downward trend in all thresholds. This simply means that the same value of the health index I^*_{it} would lead individuals to report better SRH. Nevertheless, the thresholds' estimates for men are a lot more variables than those for women. As rows 43 through 46 of Table 7 indicate, men are more sensitive to changes in the economic environment than women. Specifically, the R^2's from the regressions of the four thresholds on the set of economic indicators for women are .57, .53, .47, and .20, respectively, while the corresponding R^2's for men are .75, .72, .70, and .63. A common feature to both men and women is that the lower thresholds are more sensitive to changes in the economic environment than the higher thresholds. That is, the economic environment seems to change individual's perception when evaluating their health, when their health is not particularly good. In contrast, the reporting of excellent health is less sensitive to changes in the economic environment, especially for women.

5.9 The Distribution of the Health Index

In Figures 15a and 15b we report density estimates for the deterministic part of the health index, i.e., $x'_{it}\beta_t$ for few selected years; the density of the error term is, by definition the same every period, that is $\varepsilon_{it} \sim N(0,1)$. Both figures indicate that the entire distribution shifts from one year to the next over the sample period. However, the shifts in the distribution is much more pronounced for the men than for the women as can be seen from a comparison of Figure 15b with Figure 15a. Moreover, the shifts of the distribution for women do not align with the shift for the men. For example, the distributions for 1990 and 1994 for men are further away from each other, while this is clearly not the case for the distribution in these two years for women. Given the results presented above for the individual variables affecting the health index, this is not surprising. However, one might think that the overall differences should not be that large. While investigating this aspect is beyond the scope of this paper, it certainly deserves serious examination.

In Figures 16a and 16b we present the estimates for the mean of the deterministic part of the health index for the female and male populations, respectively, along with the standard deviation of that part of the health index. Indeed, we see that the greater variation in the estimated individual parameters for men than for women is translated in differences in the mean estimated index. That is, the health distributions for females tend to have larger spreads. Nevertheless, the standard deviations for both men and women change very little over the sample years, indicating that the distribution tends to preserve its shape. Hence, changes in the reporting of SRH represent largely location shifts of the entire distribution over the sample years, while the shape of the distributions remains largely unchanged.

How much do the various variables contribute to the overall variance in the deterministic part of the health index? To investigate this important question we use the decomposition described above in (1). We aggregate the various variables into seven main categories, representing different general elements determining the health index. These are: (1) income; (2) age; (3) BMI; (4) education; (5) demographic variables; (6) ADL, IADL, and number of bed days; and (7) chronic diseases. In the seven panels of Figure 17 we present the results for both women and men for the seven aggregate categories defined above. Note again that the results for the years 1982 through 1996 cannot be directly compared with the results for the years from 1997 onward because of the change in the sampling scheme introduced by the NHIS. While the new sampling scheme does not seem to affect the results for the first five categories, they have huge "level effect" on the results regarding all chronic disease, ADL, IADL, and the measurement of the number of bed days.

Interestingly, the distribution of the shares across the various categories are very different for men and women, even though there are a few categories that explain the same fraction of the overall variance in the health index. In the latter group are income and education (Figures 17a and 17d, respectively). Nevertheless, for everything else there are stark differences between men and women. While age and the other demographic variables seem to account for a larger fraction of the overall health index variance for men, the rest seems to account for more of the variance for women, in particular, direct objective measures of health. These include BMI, ADL, IADL, and bed days, and all the indicators for the existence of some chronic disease. While, as indicated above, explaining why women behave differently than men is beyond the scope of this paper, it would be important to investigate this issue in the future, for us to be able to write meaningful models in which SRH is an endogenous variable.

Even though the share of the various categories of the total variance is different for men and women, the general pattern of changes over the years is very similar. In particular, income becomes a more important factor accounting for a larger share of the overall variance, as does BMI. In contrast, age and education account for smaller fractions of the variance.

5.10 Implication for Reporting of SRH

In this section we discuss several implications of the model's results. In particular we examine a few alternative counterfactuals. This is done in order to identify what has led to the vast changes in reporting of SRH in the NHIS. We first present the model's predictions, largely in order to establish that it does an incredibly good job in replicating what is observed in the data. The three panels of Figure 18 present the model's predictions for the five categories of the SRH variable. Comparing Figure 18a with Figure 2a shows that for the population as a whole the model does a very good job in predicting the exact distribution across the five SRH's categories. This is also the case when we compare the subsamples of females (see Figure 18b in comparison with Figure 2e) and males (see Figure 18c in comparison with Figure 2f).

Having established the usefulness of the model, we now consider three alternative counterfactual exercises. In the first exercise we ask: What would the reporting of SRH be if the observed variables had remained fixed. To do that we fix the vector x at the average level over the years and then use the year-specific β_t and c_t to compute the model predictions of the probabilities reporting each of the five SRH categories. We refer to this experiment as the *constant x's experiment*. In the second experiment we maintain the assumption of the first experiment and in addition we fix the thresholds c_t at the average levels over the sample year. We refer to this experiment as the *constant x's fixed-standard experiment*. Finally, we fixed all the β_t at their average over the years, but let the c_t and the x be year-specific. In this experiment we examine what would happen if the valuation of the specific factors had remained constant, while the standards for determination (i.e., c_t) of SRH and the x's had not. We refer to this experiment as the *constant β's experiment*.

5.10.1 Constant x's Experiment

The results of this experiment are reported in the three panels of Figure 19. Under constant x's, all that determines the probabilities of being in a particular SRH category are the parameters of the model, namely the β_t's and c_t's. As we documented above, most of the changes in the health index come from changes in the parameters. Hence, the patterns of changes in the fraction in each category are similar to those in Figure 18. Nevertheless, a few major differences are apparent. Particularly, the fraction of individuals in the poor category has been reduced significantly for both men and women, while the fraction of individuals in the fair category has remained relatively constant. At the higher end of the health distribution, a lot less individuals are in the excellent category, while more individuals are predicted to be in the very good category, and even more so for the good category.

Overall, we see that fixing the distribution of the x's gives very different results than those presented in Figure 18. Particularly, the lack of variation in the observed variables causes the distribution of reported SRH to be more condensed around "conservative" values, that is the distribution of SRH are more heavily centered around the average values, largely the good category. The reason is that while the changes in the health index are dominated by changes in the valuation parameters (i.e., β_t's and c_t's) changes in the observed x's do have significant effects on the actual reporting of SRH. Consequently, if one is to incorporate the SRH variable in a model, one certainly needs to account for the changes in the observed variables over time, especially those such as income, education, and BMI, that are determined endogenously.

5.10.2 Constant x's Fixed-Standards Experiment

The results of this experiment are reported in the three panels of Figure 20. Note that if in addition to fixing the observed variables we also fixed the threshold, the predictions of the model change dramatically. First, the parameter vectors β_t and c_t are jointly determined. That is, one's valuation of the various factors affecting the latent health index are not completely independent from setting the standards for evaluation of the current health status. That is, reduced valuation of a particular factor is taken into account when the individual reports his/her value for the SRH variable. This is especially important in the reporting for men as can be seen from Figure 20c in comparison with Figure 18c. Failing to account for this simultaneous process of the individuals' evaluation of their health status generates huge year to year variation in their self-reported health status, especially in the excellent health category, where small changes in the health index induce large changes in reporting excellent as their current health status. In other words, whatever the factors are that affect the valuation parameters β_t's are also affecting the standards parameters c_t. Hence, any model that would try to address the question about how individuals' change their valuation of the factors affecting the health index would also need to be able to explain the process by which the individuals update their standards for evaluation of the health index.

5.10.3 Constant β's Experiment

This experiment is in a way the opposite of the previous experiment, in that here the β_t's are fixed, while the x's and c_t's are allowed to vary across years. The results of this experiment are reported in the three panels of Figure 21. While the changes induced by the experiment significantly alter the results relative to the predictions of the model in Figure 18, they are also quite different from those presented in Figure 20. This result again highlights the need to model the simultaneous changes in all parameters. Even though most of the changes over the sample period were indeed in the β_t's, failing to account for changes in the β_t's and c_t's leads to vastly erroneous conclusions regarding changes in SRH the variable.

6 Summary and Conclusions

A question of the form: "*Would you say your health in general is excellent, very good, good, fair, or poor*?" has become a standard question in all surveys that address some aspect of health, especially in the United States. While the question is remarkably simple in content, little do we know about how respondents interpret this question. Changes over time in the distribution of the responses raise doubts that an answer to this question is a simple objective evaluation of one's true health status. Indeed, the literature has been struggling in interpreting the responses. Yet, the above self-reported health measure is used routinely in the literature, commonly assumed to be an objective assessment of one's health status. In this paper we make an attempt to answer the question: What does self-reported health really measure? In particular we estimate a model that is consistent with the type of question asked in surveys and analyze how changes in economic variable affect the parameters associated with this model. Specifically, we estimate the well-known ordered probit model in which it is assume that there is a latent continuous health index that individuals form. The answer to the categorical question posed above is then interpreted to be a conversion of this latent index into a categorical answer. Using 21 years of data from the U.S. National Health Interview Survey (NHIS), we examine the time trend in self-reported health as it relates to changes in various factors determining the latent health index.

We devote our attention to the examining the distinct changes in the health index for the female and male populations. We document what has already been documented elsewhere in the literature, that self-reported health measure has changed dramatically over time. Moreover, it has changed quite differently for men and women. The estimated model yields parameter estimates that are very different, both across time and across gender. We find that the changes in the parameter estimates are closely related to changes in the underlying economic environment. Indeed when we run a simple OLS regression of the parameter estimates on a set of economic indicators we find, for most cases, very high R^2's. Nevertheless, we find that men are a lot more sensitive to the economic environment than women, in that the R^2's from the regressions for males are considerably higher than those for their female counterparts. Moreover, the various factors seem to affect the two groups very differently. For example the changes in the effect of BMI take very different patterns for men and women, both in terms of its affect on the overall index, and in terms of the fraction of the overall variance of the index that it explains.

The results clearly indicate that the self-reported health measure is all but a subjective measure of one's health status. In fact, the changes in the model's coefficients over time and their close link with the economic variable suggest that self-reported health measure stems from a complex process of evaluation performed by the individuals reporting it. Undoubtedly more work is needed in understanding why and how individual form their evaluation of their own health status. What we intended to provide in this paper is a framework with which one can uncovered part of this complicated structure.

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Table 1: Raw Statistics from the National Health Interview Survey

	1982	1986	1990	1994	1996	1997	2000	2002
1. Self-reported health								
Mean	2.773	2.810	2.843	2.793	2.779	2.773	2.782	2.766
St. Dev.	1.151	1.118	1.099	1.106	1.101	1.077	1.077	1.075
2. Age								
Mean	42.66	43.09	43.46	44.34	43.89	45.36	45.49	45.77
St. Dev.	17.67	17.54	17.31	17.12	16.86	17.46	17.33	17.28
3. Education (9-11 years)								
Mean	0.138	0.130	0.118	0.112	0.113	0.127	0.120	0.104
St. Dev.	0.345	0.336	0.322	0.316	0.317	0.333	0.325	0.305
4. Education (4+ years of college)								
Mean	0.163	0.179	0.200	0.220	0.218	0.218	0.229	0.248
St. Dev.	0.369	0.397	0.405	0.415	0.412	0.451	0.451	0.459
5. BMI								
Mean	24.42	24.81	25.12	25.63	25.90	26.36	26.76	27.09
St. Dev.	4.38	4.61	4.76	5.07	5.04	5.47	5.68	5.81
6. Female								
Mean	0.530	0.532	0.533	0.530	0.524	0.562	0.557	0.551
St. Dev.	0.499	0.499	0.499	0.499	0.499	0.496	0.497	0.497
7. Married								
Mean	0.661	0.644	0.653	0.654	0.655	0.512	0.507	0.506
St. Dev.	0.473	0.479	0.476	0.476	0.475	0.500	0.500	0.500
8. ADL								
Mean	—	0.013	0.014	0.015	0.015	0.014	0.016	0.017
St. Dev.	—	0.113	0.116	0.120	0.122	0.119	0.124	0.128
9. IADL								
Mean	—	0.027	0.027	0.031	0.029	0.041	0.037	0.040
St. Dev.	—	0.162	0.162	0.173	0.168	0.198	0.189	0.196
10. Diabetes								
Mean	0.019	0.020	0.021	0.023	0.024	0.056	0.063	0.069
St. Dev.	0.137	0.141	0.142	0.151	0.154	0.231	0.243	0.254
11. Emphysema								
Mean	0.008	0.006	0.006	0.006	0.004	0.018	0.017	0.016
St. Dev.	0.090	0.080	0.077	0.076	0.066	0.131	0.129	0.127
12. Hyper tension								
Mean	0.057	0.056	0.050	0.051	0.046	0.240	0.240	0.253
St. Dev.	0.231	0.230	0.217	0.219	0.209	0.427	0.427	0.435
13. Ulcer								
Mean	0.008	0.008	0.006	0.006	0.005	0.096	0.078	0.078
St. Dev.	0.087	0.088	0.080	0.079	0.069	0.294	0.267	0.268

Table 2: Mean Self-Reported Health, by Year and Age

Year	Age			
	All	≤ 20	> 30 ≤ 55	> 55
1982	2.106	1.792	2.134	2.875
1983	2.088	1.782	2.118	2.810
1984	2.090	1.790	2.114	2.811
1985	2.098	1.789	2.114	2.827
1986	2.092	1.796	2.102	2.800
1987	2.082	1.781	2.094	2.788
1988	2.085	1.786	2.089	2.773
1989	2.062	1.769	2.072	2.731
1990	2.059	1.772	2.071	2.715
1991	2.084	1.793	2.091	2.750
1992	2.108	1.816	2.136	2.764
1993	2.107	1.815	2.138	2.735
1994	2.105	1.803	2.127	2.746
1995	2.130	1.840	2.172	2.770
1996	2.118	1.835	2.163	2.748
1997	2.080	1.785	2.114	2.749
1998	2.071	1.764	2.118	2.740
1999	2.065	1.753	2.113	2.734
2000	2.084	1.776	2.130	2.761
2001	2.077	1.758	2.143	2.743
2002	2.098	1.766	2.173	2.749
Mean	2.090	1.789	2.120	2.768
St. Dev.	0.018	0.023	0.029	0.039
R_1^2	0.396	0.413	0.360	0.709
R_2^2	0.439	0.559	0.377	0.709

Note: The R_1^2 is from a regression of the mean self-reported health on a set of economic indicator: Inflation rate, unemployment rate, etc. The R_2^2 is from similar regression to R_1^2 only that the regression also include a dummy variable indicating that the year is from 1997 onward.

Table 3: Fraction of Self-Reported Health Categories, by Year and Age

Year	Age: All	≤ 20	> 20 ≤ 30	> 30 ≤ 40	> 40 ≤ 50	> 50 ≤ 60	> 60
Panel A—Poor Health							
1982	0.033	0.004	0.007	0.015	0.038	0.076	0.117
1987	0.029	0.004	0.006	0.014	0.031	0.062	0.098
1991	0.029	0.004	0.008	0.014	0.030	0.064	0.092
1996	0.027	0.005	0.009	0.015	0.031	0.063	0.083
1997	0.023	0.004	0.005	0.011	0.024	0.049	0.081
2002	0.024	0.003	0.006	0.012	0.028	0.049	0.076
Mean	0.028	0.004	0.007	0.014	0.030	0.061	0.091
St.Dev.	0.003	0.001	0.002	0.002	0.004	0.009	0.012
Panel B—Fair Health							
1982	0.081	0.027	0.045	0.057	0.092	0.146	0.220
1987	0.075	0.025	0.040	0.052	0.086	0.127	0.202
1991	0.073	0.026	0.044	0.053	0.080	0.120	0.186
1996	0.078	0.028	0.047	0.064	0.092	0.131	0.194
1997	0.071	0.022	0.039	0.053	0.081	0.123	0.189
2002	0.073	0.021	0.035	0.056	0.087	0.118	0.192
Mean	0.075	0.025	0.041	0.056	0.083	0.126	0.195
St.Dev.	0.004	0.004	0.004	0.004	0.005	0.008	0.010
Panel C—Good Health							
1982	0.238	0.203	0.206	0.213	0.272	0.307	0.308
1987	0.233	0.182	0.215	0.213	0.249	0.299	0.325
1991	0.234	0.187	0.205	0.220	0.250	0.292	0.323
1996	0.243	0.195	0.237	0.235	0.259	0.286	0.325
1997	0.238	0.185	0.221	0.227	0.251	0.288	0.341
2002	0.242	0.175	0.216	0.231	0.268	0.299	0.355
Mean	0.236	0.187	0.212	0.223	0.255	0.293	0.328
St.Dev.	0.004	0.009	0.009	0.008	0.007	0.008	0.014

Table 3: (Continued)

Year	Age						
	All	≤ 20	> 20 ≤ 30	> 30 ≤ 40	> 40 ≤ 50	> 50 ≤ 60	> 60
Panel D—Very Good Health							
1982	0.254	0.255	0.291	0.283	0.259	0.230	0.194
1987	0.276	0.273	0.312	0.308	0.292	0.252	0.213
1991	0.283	0.282	0.319	0.312	0.283	0.260	0.234
1996	0.289	0.286	0.321	0.322	0.302	0.264	0.231
1997	0.300	0.283	0.332	0.331	0.327	0.301	0.247
2002	0.303	0.287	0.338	0.345	0.326	0.299	0.238
Mean	0.284	0.276	0.320	0.315	0.298	0.268	0.227
St.Dev.	0.017	0.012	0.018	0.020	0.025	0.025	0.017
Panel E—Very Good Health							
1982	0.394	0.512	0.452	0.432	0.339	0.241	0.160
1987	0.388	0.516	0.427	0.412	0.342	0.260	0.162
1991	0.382	0.502	0.424	0.401	0.356	0.265	0.165
1996	0.363	0.487	0.387	0.364	0.316	0.257	0.167
1997	0.368	0.507	0.402	0.378	0.318	0.239	0.143
2002	0.360	0.514	0.404	0.356	0.292	0.235	0.139
Mean	0.378	0.508	0.420	0.392	0.333	0.253	0.160
St.Dev.	0.013	0.010	0.020	0.023	0.021	0.014	0.013

Table 4: Mean Self-Reported Health, by Gender, Year and Age

Year	Age: All	≤ 20	> 20 ≤ 30	> 30 ≤ 40	> 40 ≤ 50	> 50 ≤ 60	> 60
Panel A—Females							
1982	2.170	1.777	1.956	2.017	2.314	2.638	2.939
1985	2.161	1.770	1.947	2.049	2.259	2.590	2.883
1988	2.150	1.762	1.954	2.029	2.223	2.534	2.847
1991	2.145	1.762	1.983	2.031	2.199	2.510	2.820
1994	2.169	1.770	2.009	2.085	2.234	2.512	2.821
1996	2.179	1.801	2.047	2.106	2.291	2.524	2.822
1997	2.133	1.736	1.965	2.041	2.225	2.492	2.847
2000	2.126	1.722	1.942	2.016	2.234	2.480	2.856
2002	2.142	1.707	1.939	2.067	2.291	2.492	2.846
Mean	2.149	1.754	1.968	2.049	2.242	2.529	2.844
St.Dev.	0.022	0.031	0.037	0.033	0.033	0.046	0.034
R^2	0.579	0.598	0.522	0.480	0.287	0.757	0.666
Panel A—Males							
1982	2.036	1.735	1.762	1.856	2.142	2.525	2.939
1985	2.029	1.729	1.781	1.883	2.088	2.496	2.884
1988	2.014	1.714	1.808	1.897	2.064	2.398	2.808
1991	2.017	1.732	1.791	1.896	2.085	2.402	2.787
1994	2.035	1.736	1.819	1.935	2.113	2.358	2.792
1996	2.052	1.756	1.887	1.975	2.140	2.430	2.758
1997	2.023	1.729	1.859	1.927	2.104	2.384	2.776
2000	2.040	1.733	1.840	1.951	2.133	2.405	2.805
2002	2.051	1.716	1.858	1.973	2.170	2.400	2.807
Mean	2.026	1.727	1.816	1.914	2.110	2.413	2.813
St.Dev.	0.019	0.019	0.040	0.044	0.032	0.047	0.049
R^2	0.328	0.216	0.591	0.586	0.618	0.624	0.731

Table 5: Fraction of Latent Index Explained by Deterministic Part (Latent Index: $I^* = x'\beta + \varepsilon$, Deterministic Part: $x'\beta$)

	Population		
Year	**All**	**Female**	**Male**
1982	0.40	0.39	0.41
1983	0.39	0.38	0.39
1984	0.38	0.38	0.39
1985	0.40	0.40	0.39
1986	0.39	0.40	0.38
1987	0.38	0.38	0.38
1988	0.37	0.38	0.37
1989	0.37	0.38	0.37
1990	0.36	0.37	0.36
1991	0.37	0.37	0.37
1992	0.38	0.38	0.38
1993	0.37	0.37	0.36
1994	0.37	0.38	0.36
1995	0.37	0.38	0.36
1996	0.36	0.38	0.35
1997	0.40	0.42	0.37
1998	0.40	0.41	0.38
1999	0.38	0.39	0.39
2000	0.40	0.42	0.38
2001	0.40	0.41	0.38
2002	0.40	0.41	0.39

Table 6: OLS Regression of Health Index Estimates on Economic Variables

No.	**Variable**	**All**	**Female**	**Male**
1.	Fraction of index explained by $x'\beta$	0.807	0.812	0.830
2.	Mean predicted index	0.761	0.347	0.690
3.	St. deviation of predicted index	0.808	0.814	0.832

Table 7: OLS Regression of Coefficient Estimates on Economic Variables

No.	Variable	All	Female	Male
Demographic Variables				
1.	Income	0.702	0.692	0.643
2.	Age	0.862	0.834	0.855
3.	African American	0.799	0.782	0.680
4.	Married	0.450	0.463	0.528
5.	Not Married	0.758	0.666	0.618
6.	Children age less than 5	0.578	0.471	0.465
7.	Children between 5 and 15	0.694	0.569	0.847
Leading Indices				
8.	BMI	0.662	0.403	0.614
9.	$\text{BMI}^2/100$	0.667	0.431	0.617
10.	ADL	0.976	0.935	0.924
11.	IADL	0.849	0.740	0.686
Education				
12.	Less than High School	0.587	0.531	0.407
13.	High School	0.714	0.597	0.700
14.	Some College	0.844	0.677	0.742
15.	College	0.763	0.539	0.541
Geographical location				
16.	North-East	0.511	0.566	0.451
17.	Mid-West	0.436	0.389	0.468
18.	South	0.548	0.445	0.584
Occupation				
19.	Occupation 1	0.839	0.670	0.793
20.	Occupation 2	0.611	0.385	0.692
21.	Occupation 3	0.551	0.621	0.368
22.	Occupation 4	0.414	0.357	0.459
23.	Occupation 5	0.730	0.606	0.521
24.	Occupation 6	0.460	0.498	0.500
Bed Days				
25.	0-7	0.916	0.912	0.885
26.	7-30	0.902	0.883	0.839
27.	30-180	0.935	0.906	0.821
28.	180+	0.913	0.899	0.808

Table 7: (Continued)

No.	Variable	All	Female	Male
Chronic Diseases				
29.	Arthritis	0.928	0.908	0.933
30.	Asthma	0.959	0.959	0.908
31.	Bronchitis	0.733	0.616	0.517
32.	Cancer	0.933	0.907	0.852
33.	Diabetes	0.381	0.322	0.741
34.	Emphysema	0.974	0.845	0.947
35.	Headache	0.896	0.808	0.880
36.	Hearing problems	0.572	0.529	0.563
37.	Ulcer	0.941	0.903	0.901
38.	Hypertension	0.884	0.852	0.783
39.	Heart disease	0.942	0.895	0.937
40.	Vision problems	0.726	0.333	0.860
41.	Sciatica	0.552	0.479	0.520
42.	Sinusitis	0.958	0.952	0.807
Ordered-Probit thresholds				
43.	First	0.845	0.569	0.754
44.	Second	0.812	0.529	0.716
45.	Third	0.795	0.466	0.697
46.	Fourth	0.678	0.200	0.628

Figure 1: Mean of Self-Reported Health and Economic Indicators, by Age

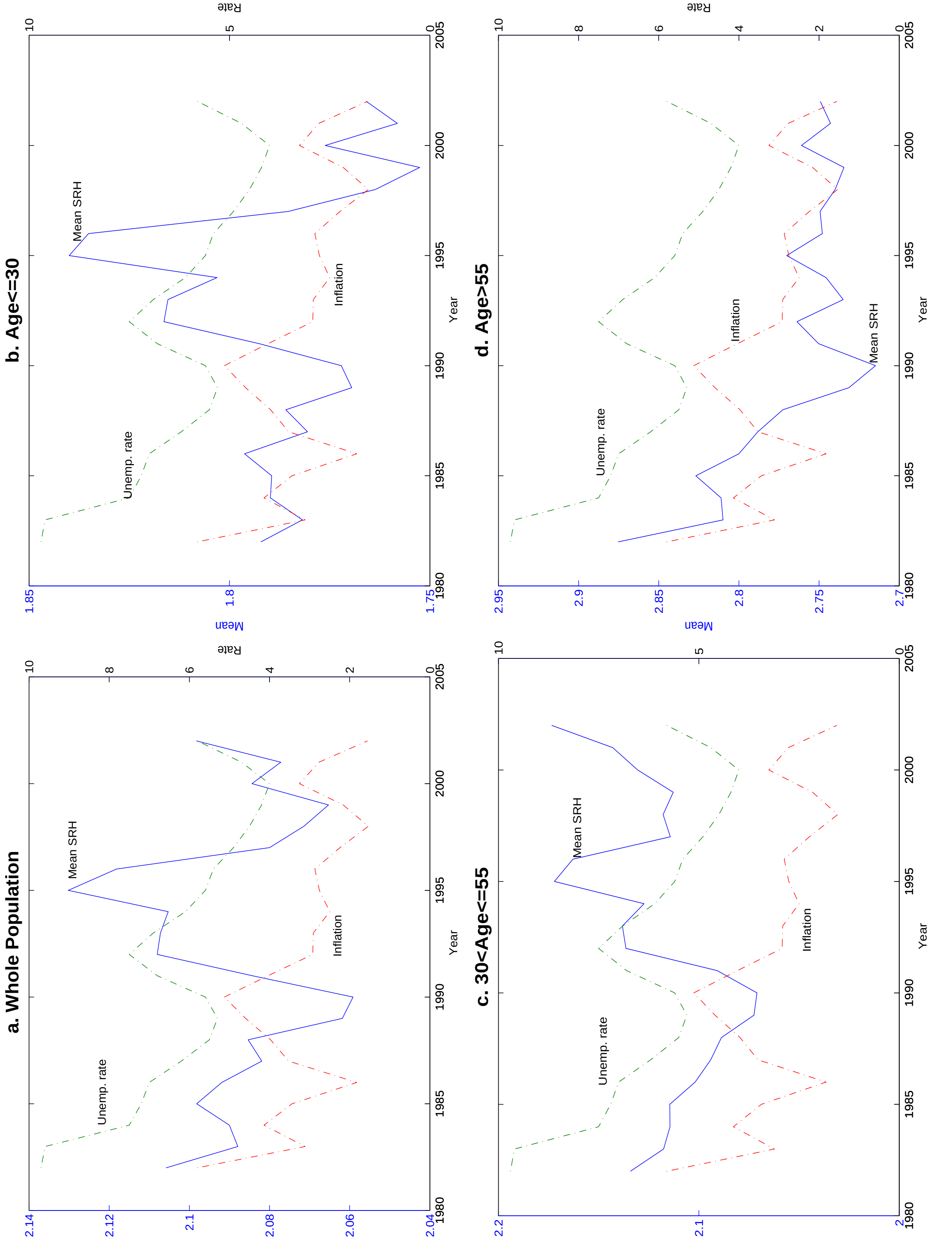


Figure 2: Fraction of Individuals in Health Categories, by Age and Gender

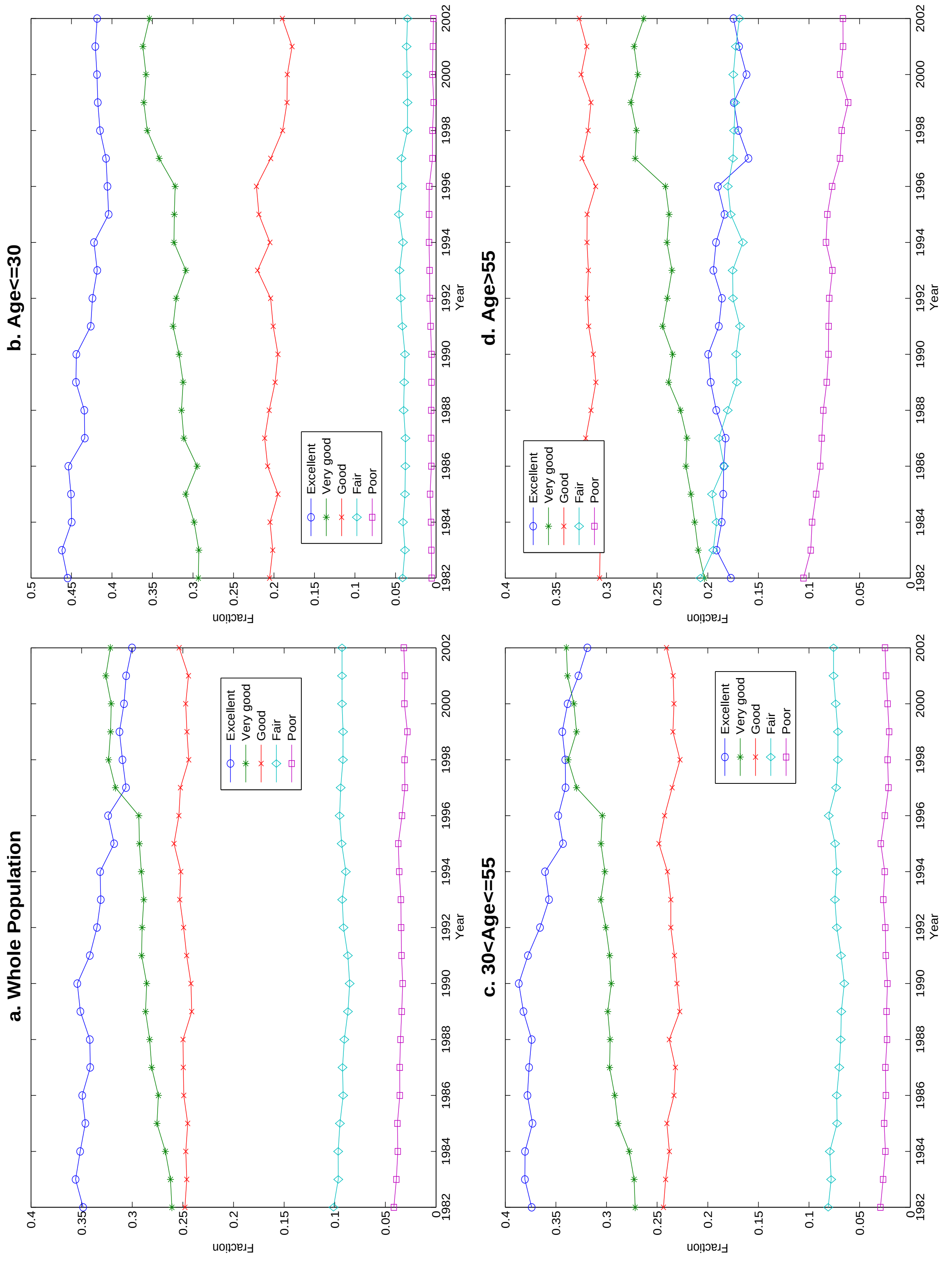


Figure 2: (Continued)

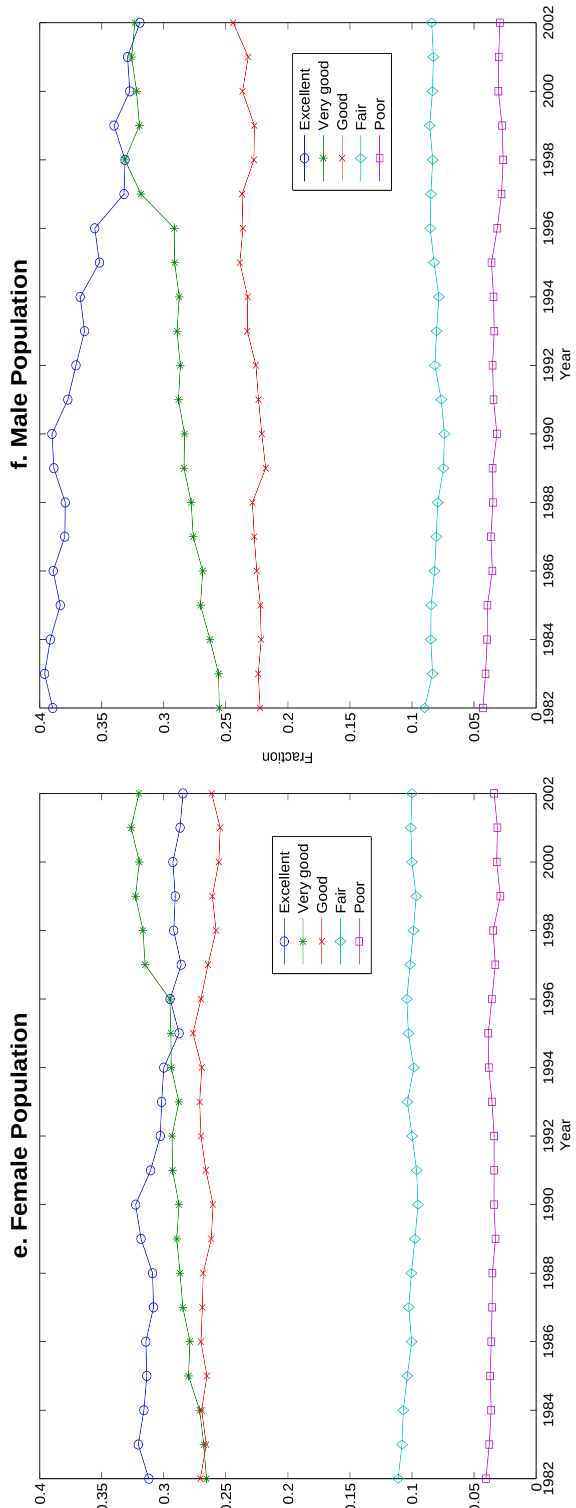


Figure 3: Mean of Self-Reported Health and Economic Indicators for Females

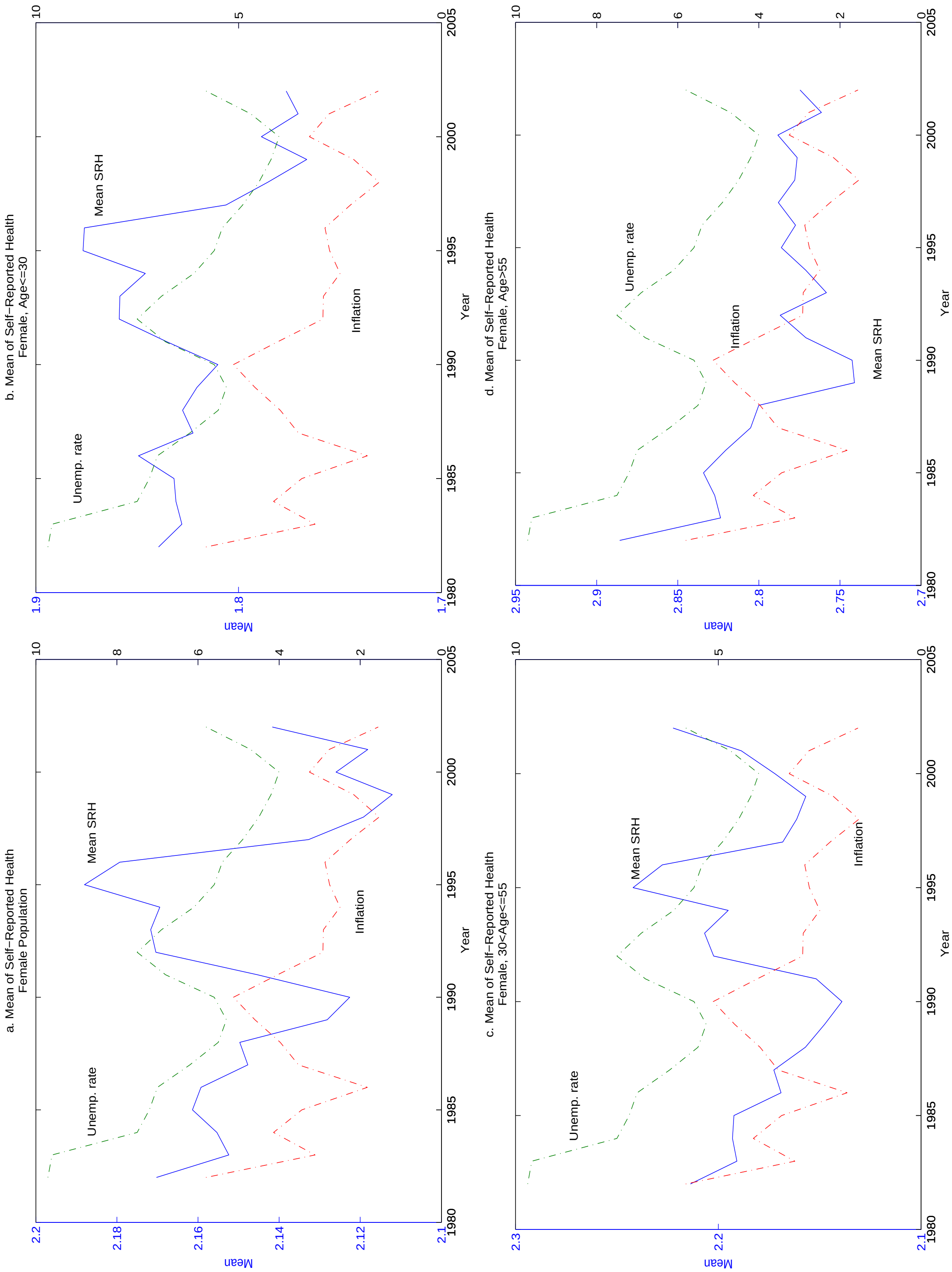


Figure 4: Mean of Self-Reported Health and Economic Indicators for Males

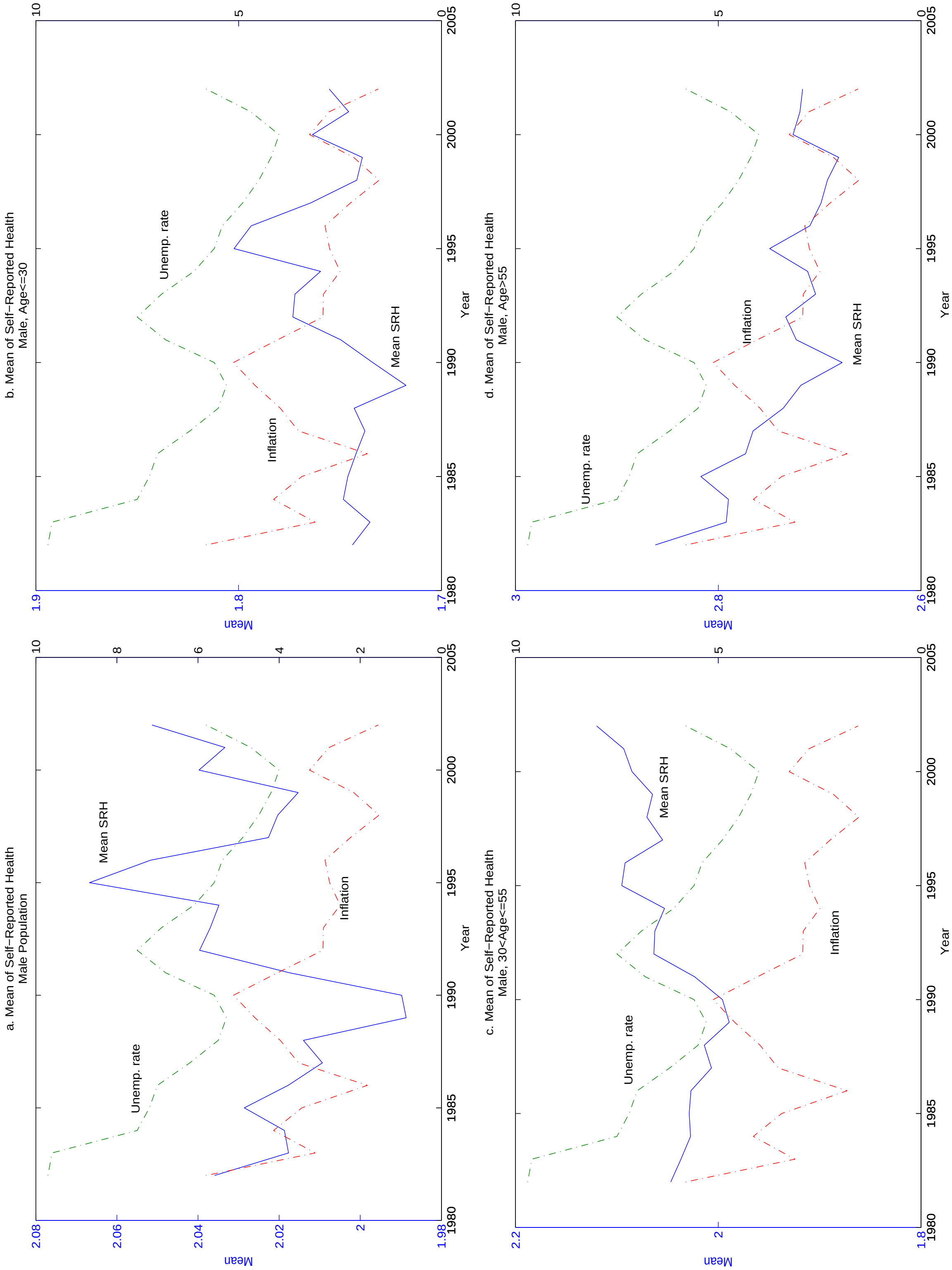


Figure 5: Changes in Health Index Due to Age

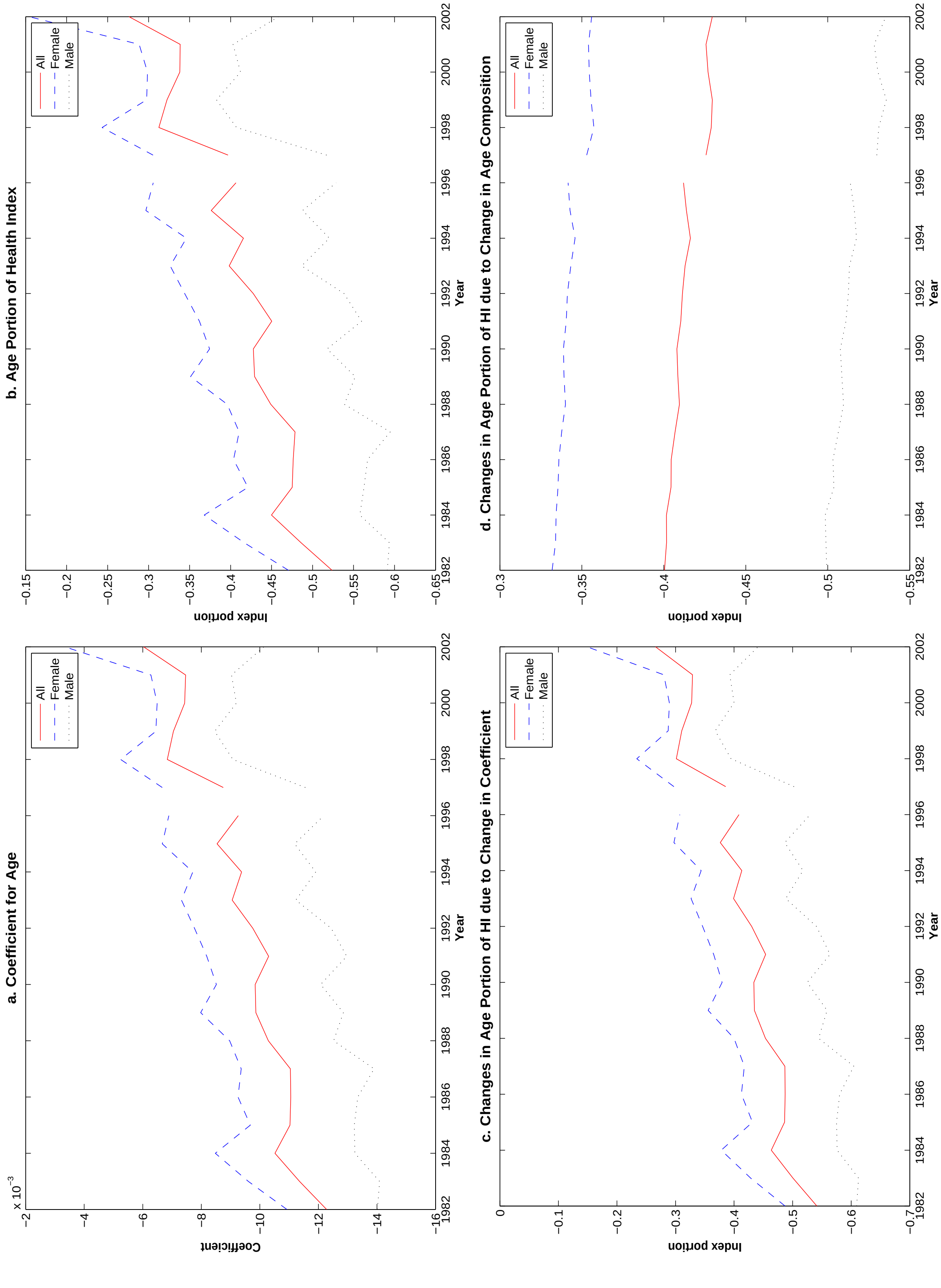


Figure 6: Changes in Health Index Due to Body Mass Index (BMI)

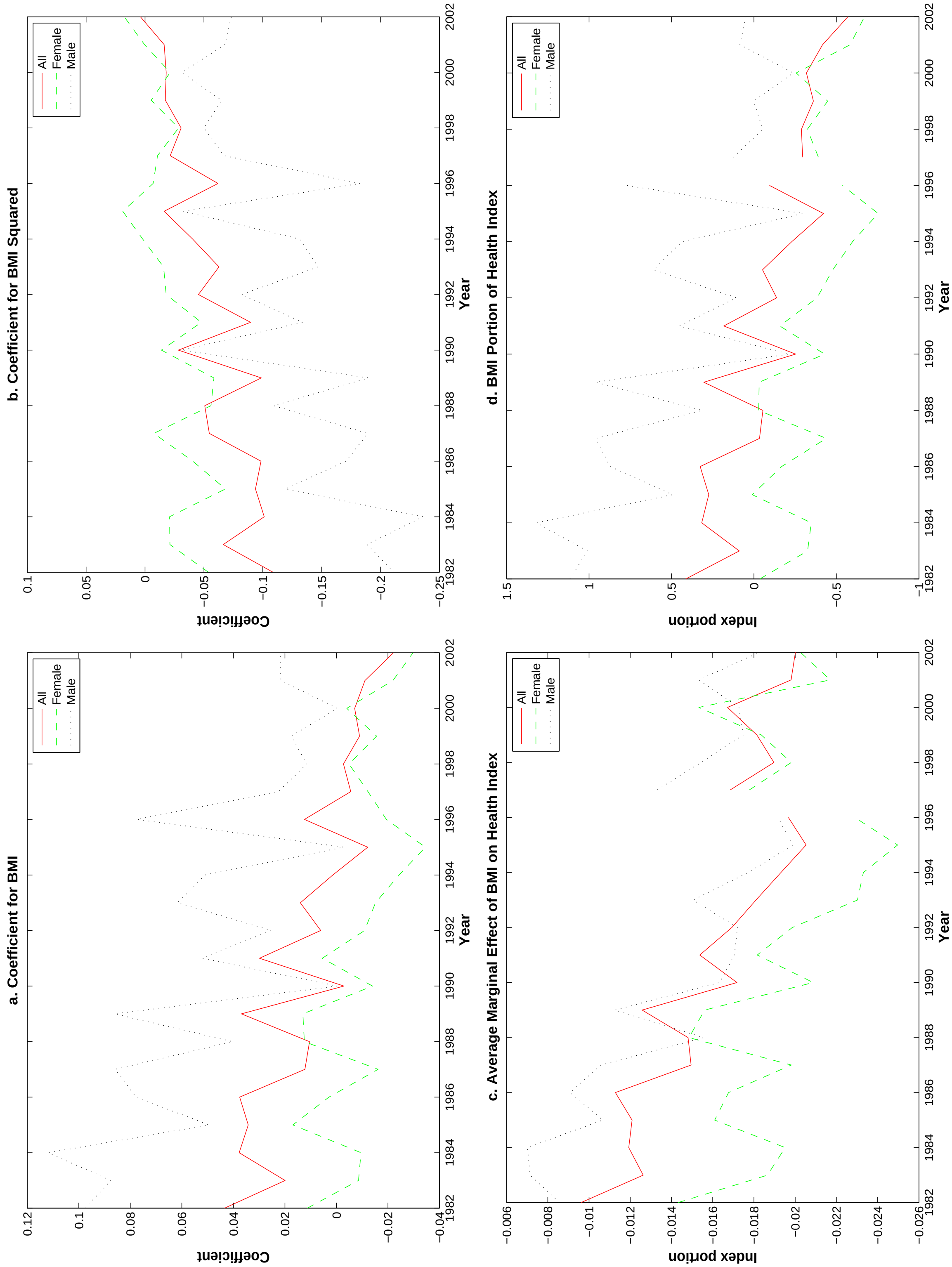


Figure 6: (Continued)

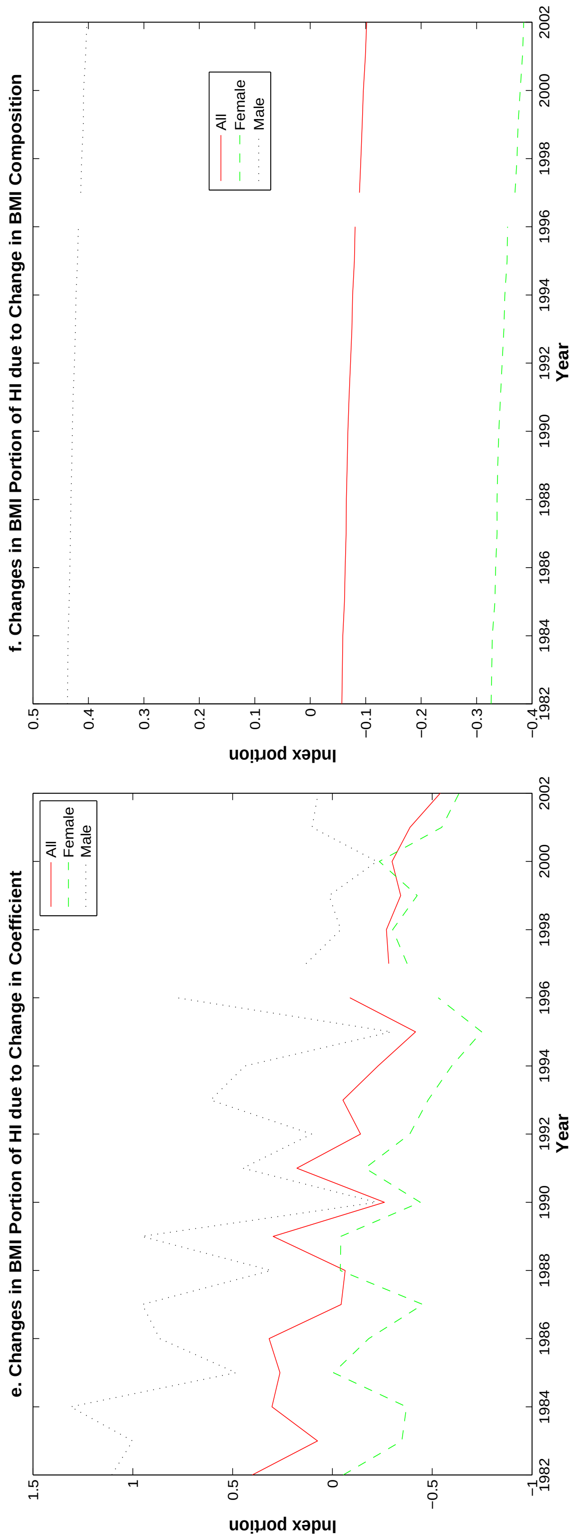


Figure 7: cdf of BMI for Selected Years, Whole Population

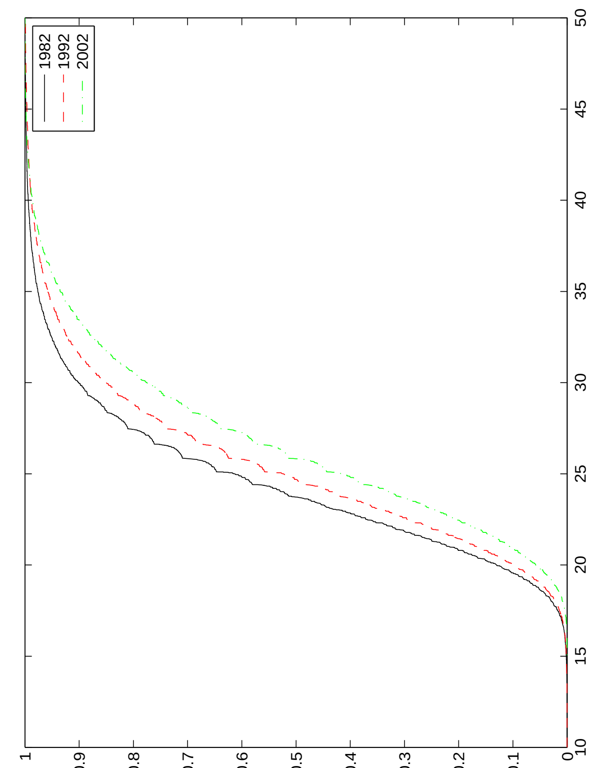


Figure 8: Distribution of BMI, by Age Group

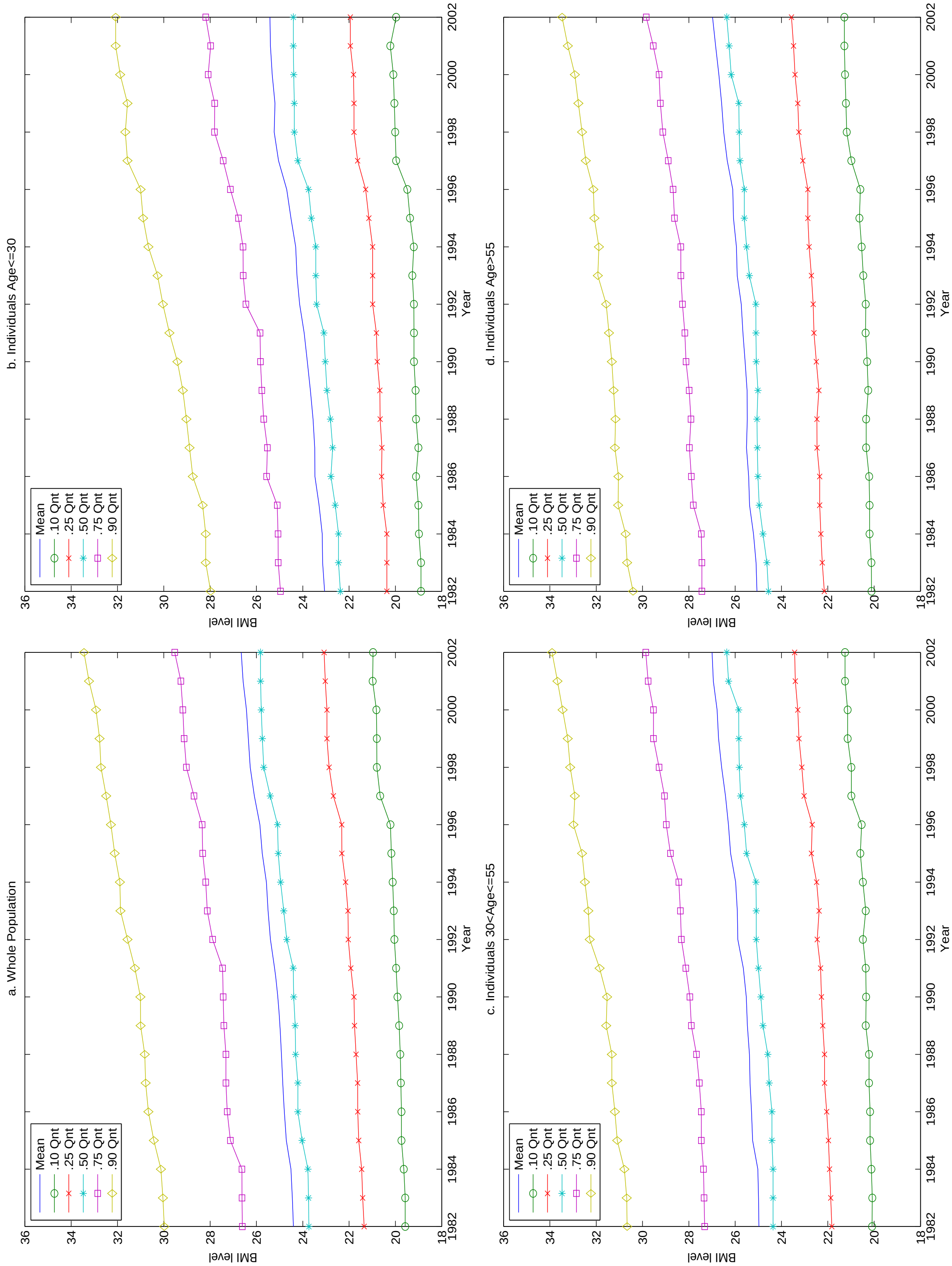


Figure 9: Changes in Health Index Due to Cancer

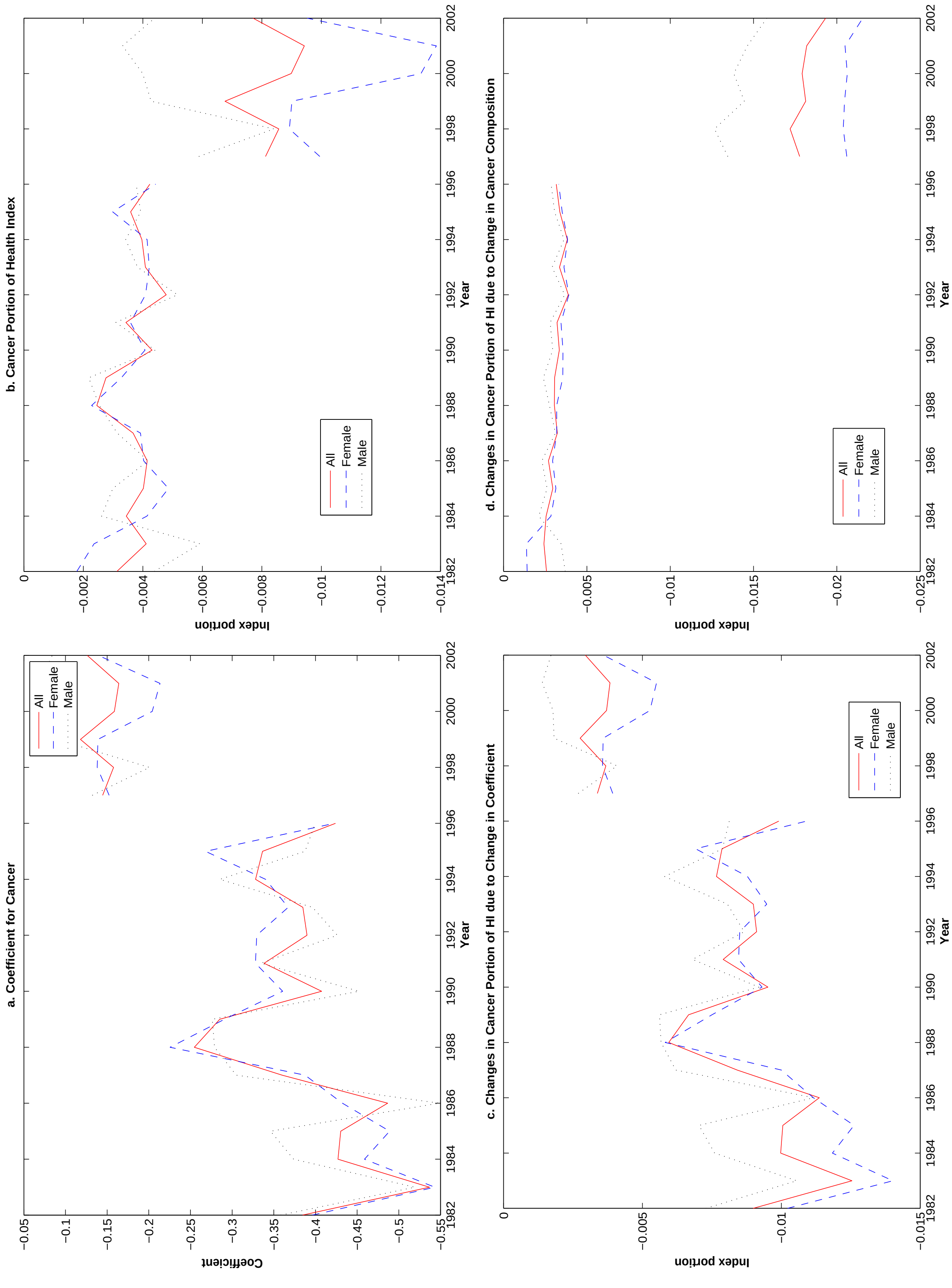


Figure 10: Changes in Health Index Due to Emphysema

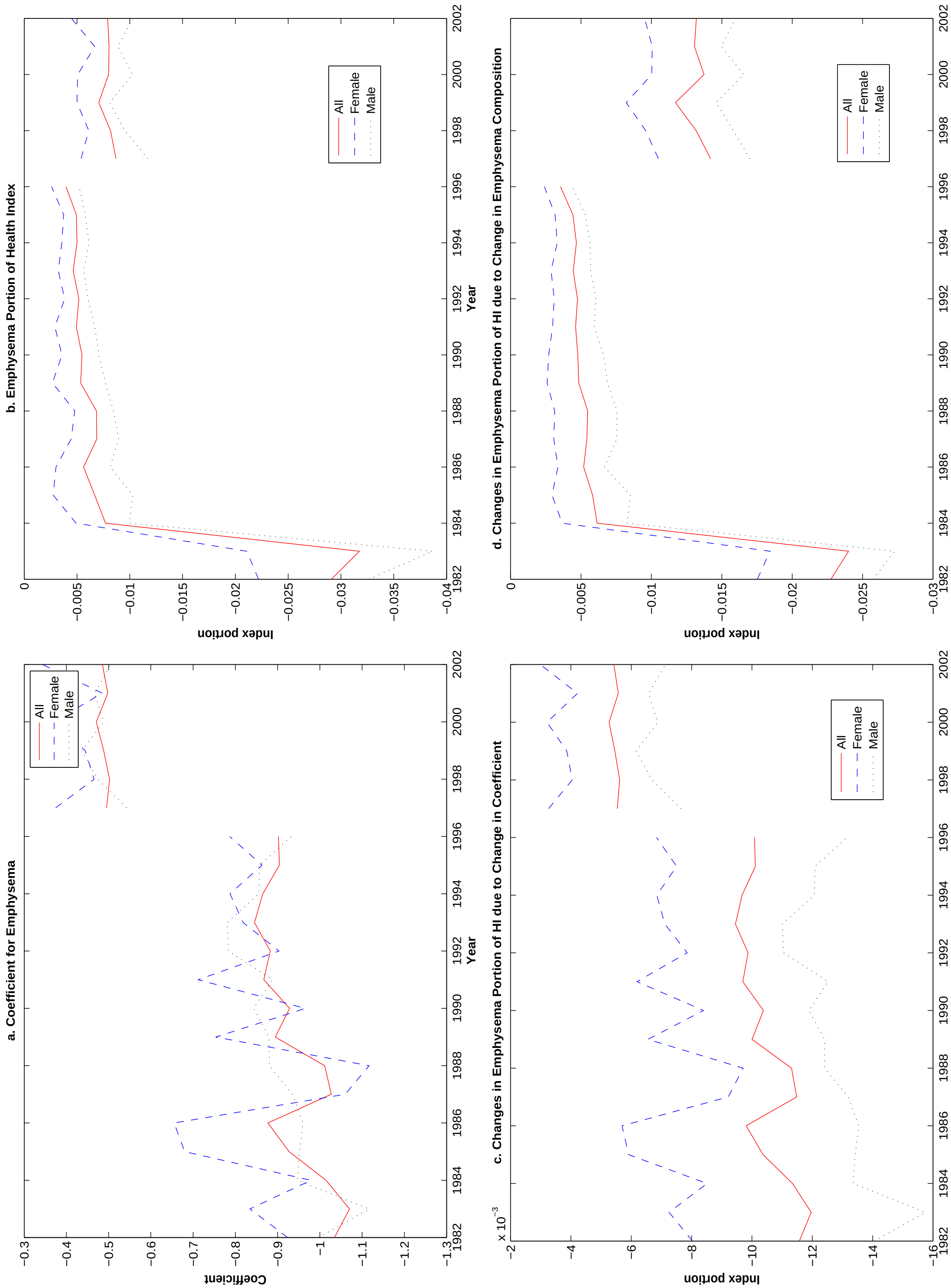


Figure 11: Changes in Health Index Due to Hypertension

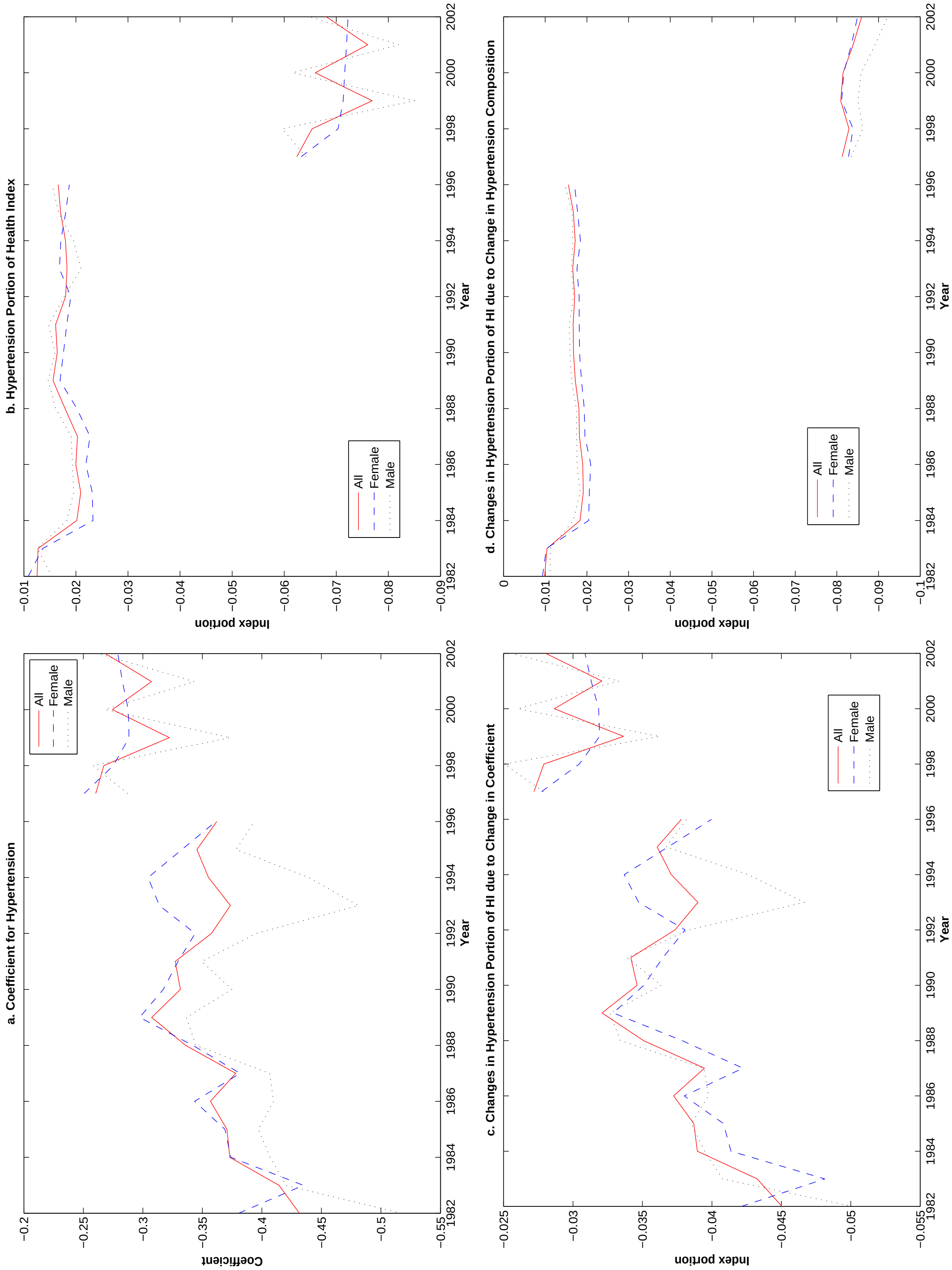


Figure 12: Changes in Health Index Due to Ulcer

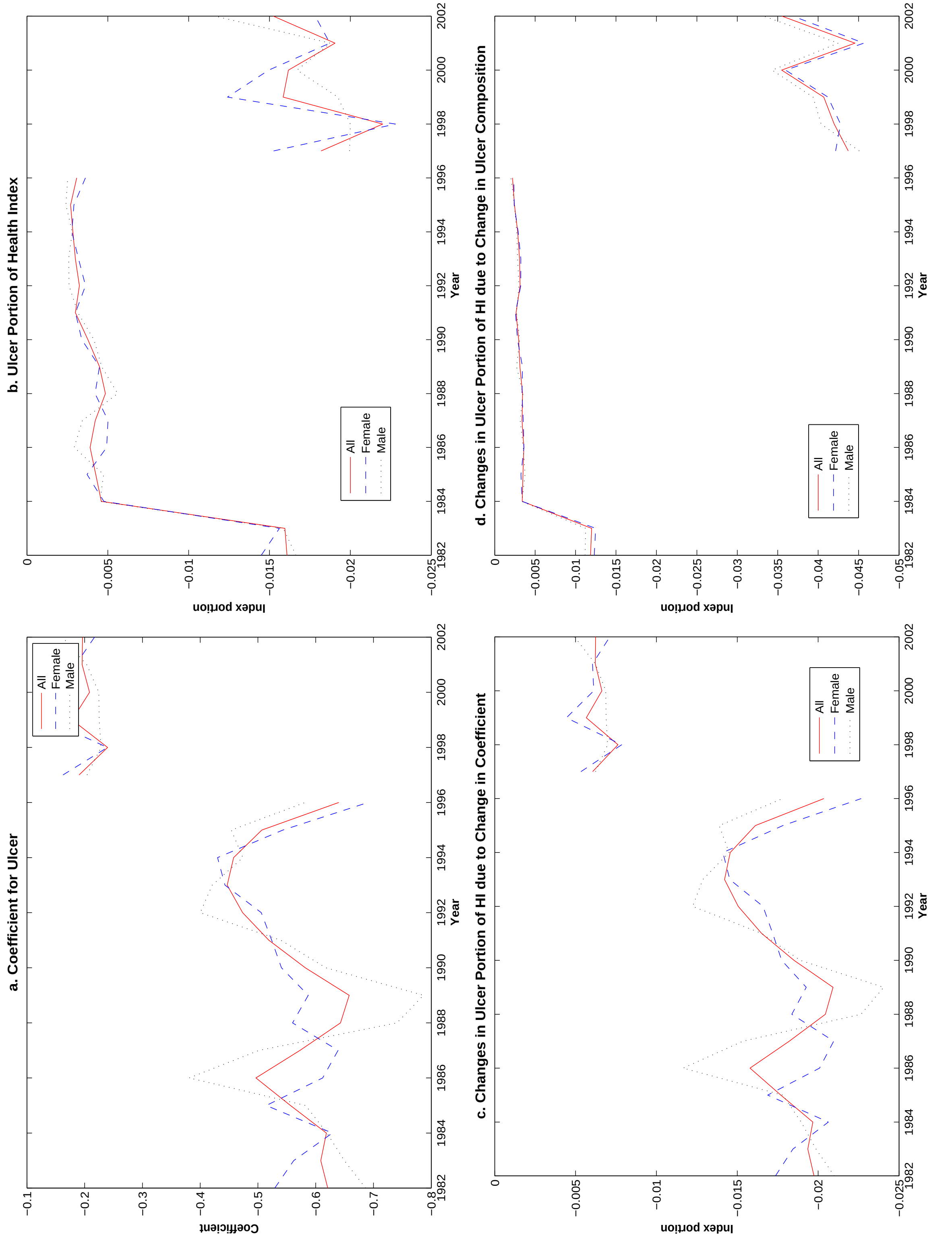


Figure 13: Changes in Health Index Due to Income

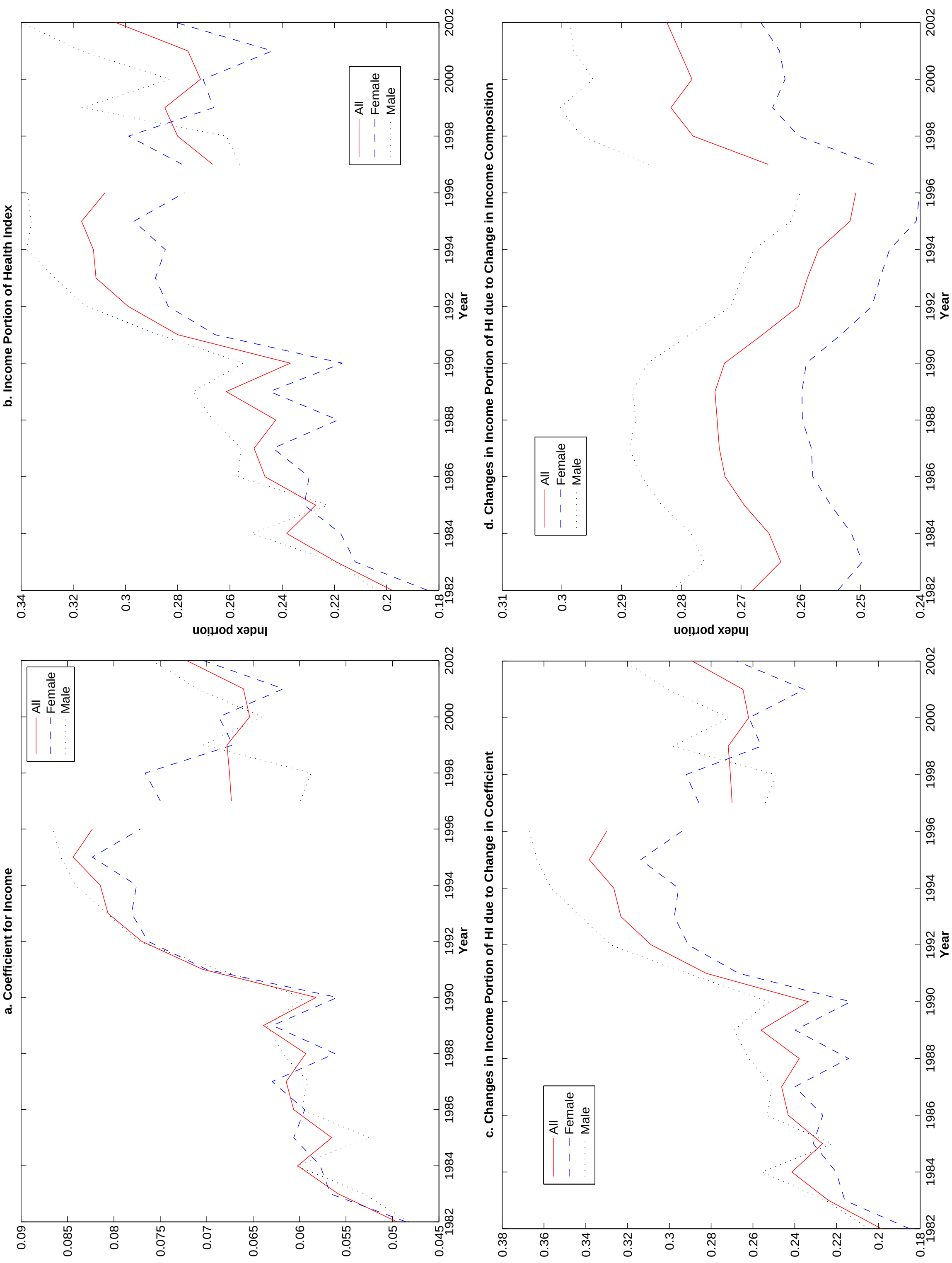


Figure 14: Changes in Thresholds

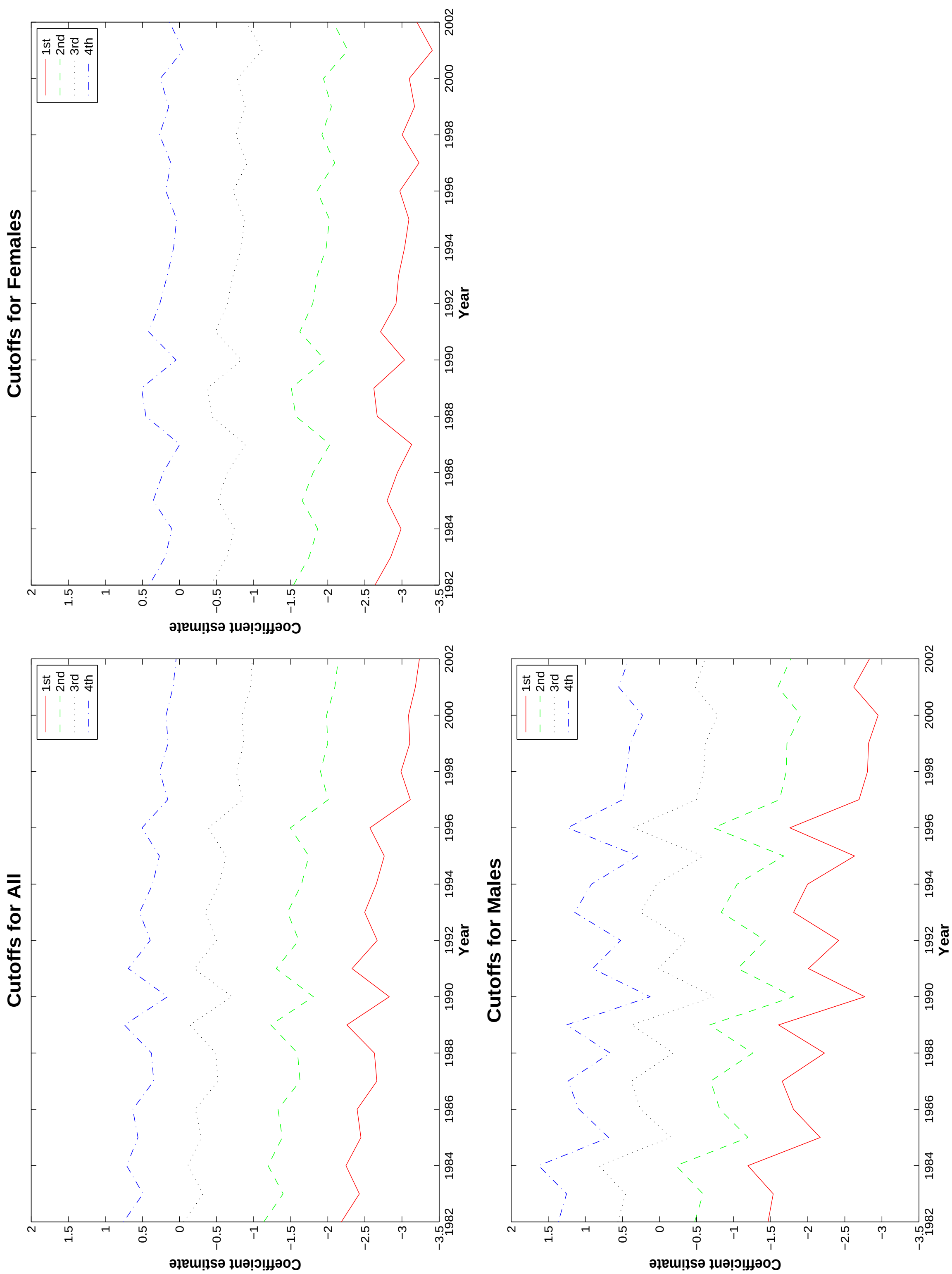


Figure 15: Health Index Density, by Gender, for Selected Years

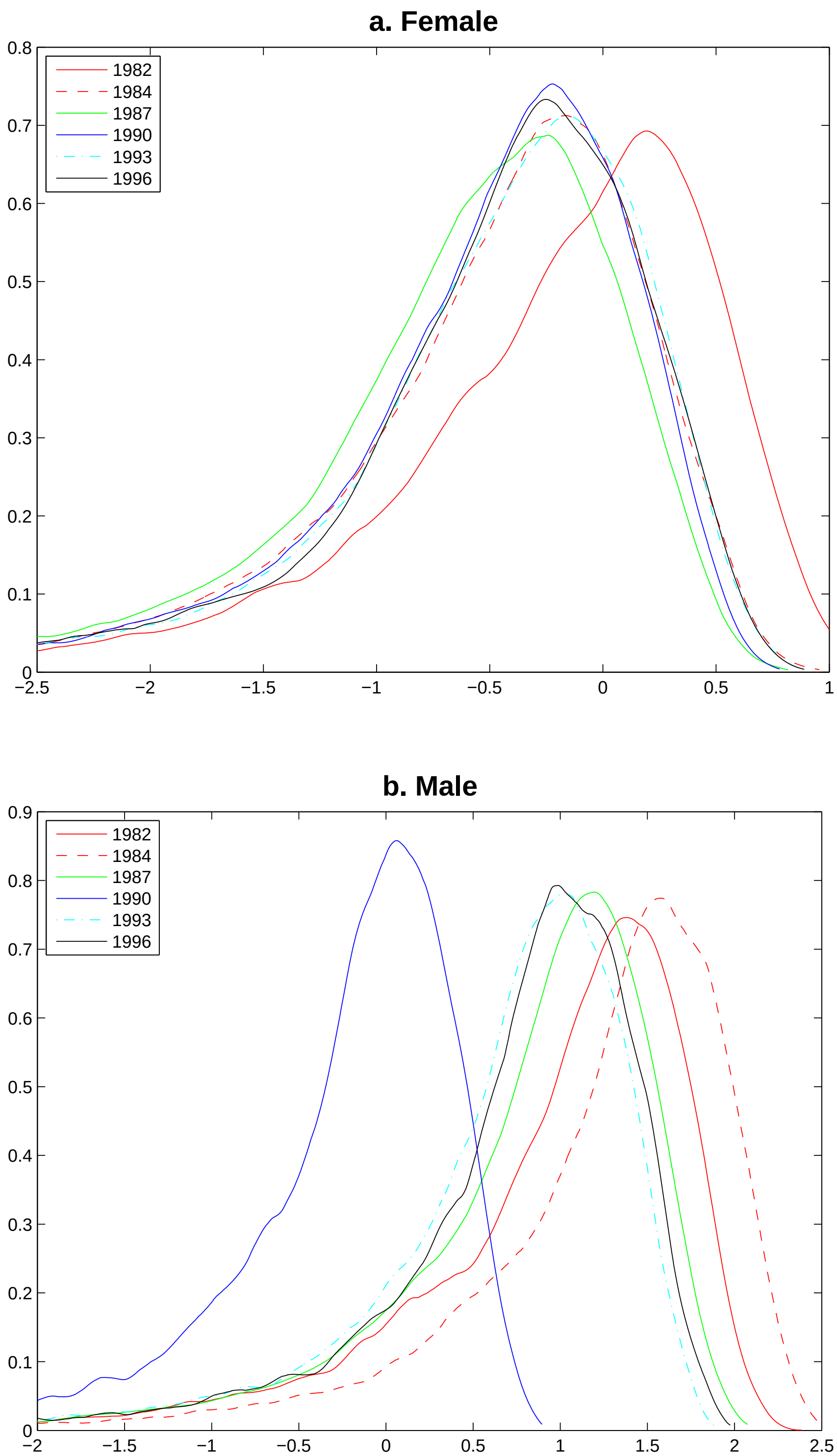


Figure 16: Mean Health Index, by Gender

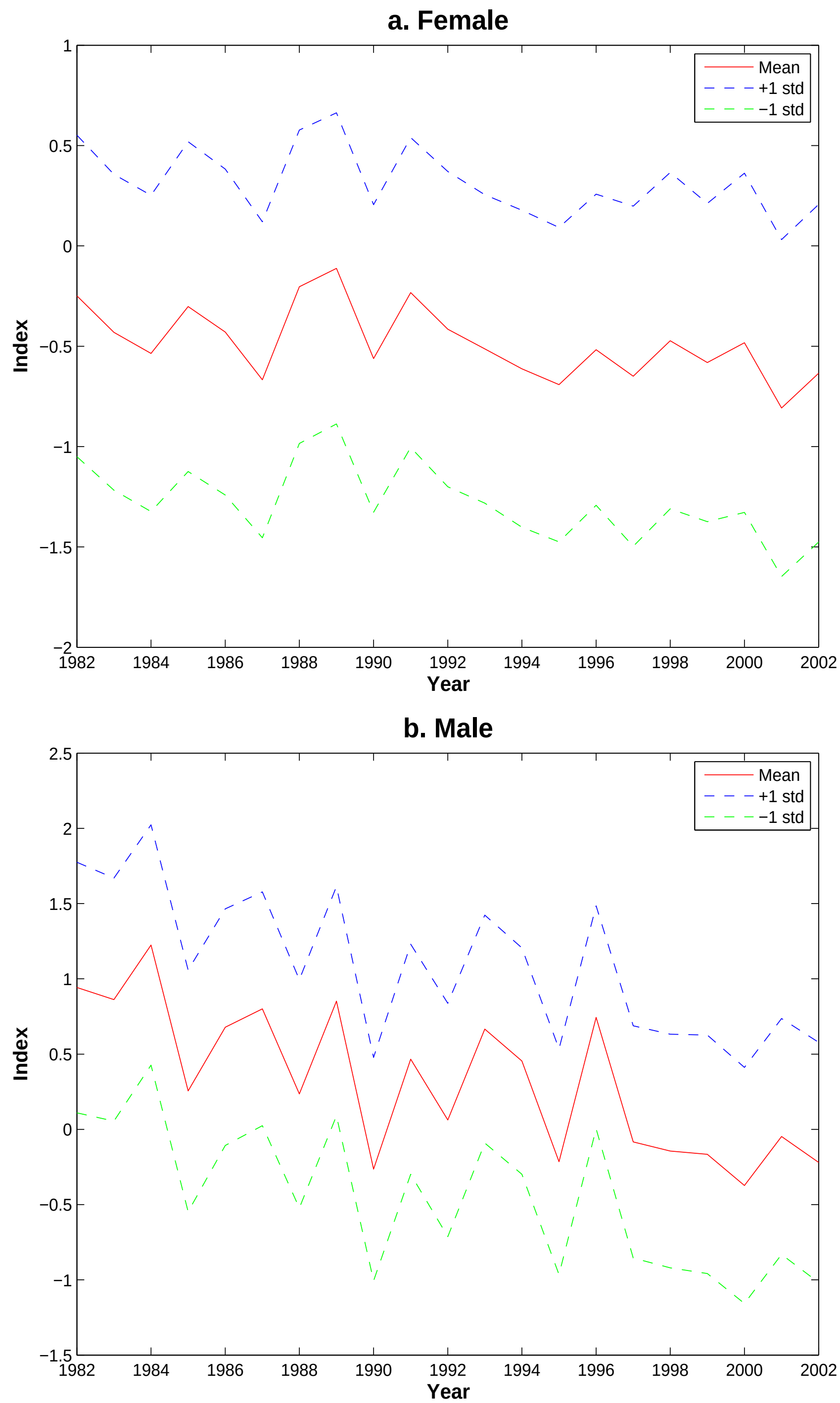


Figure 17: Health Index Variance Decomposition, by Year and Gender

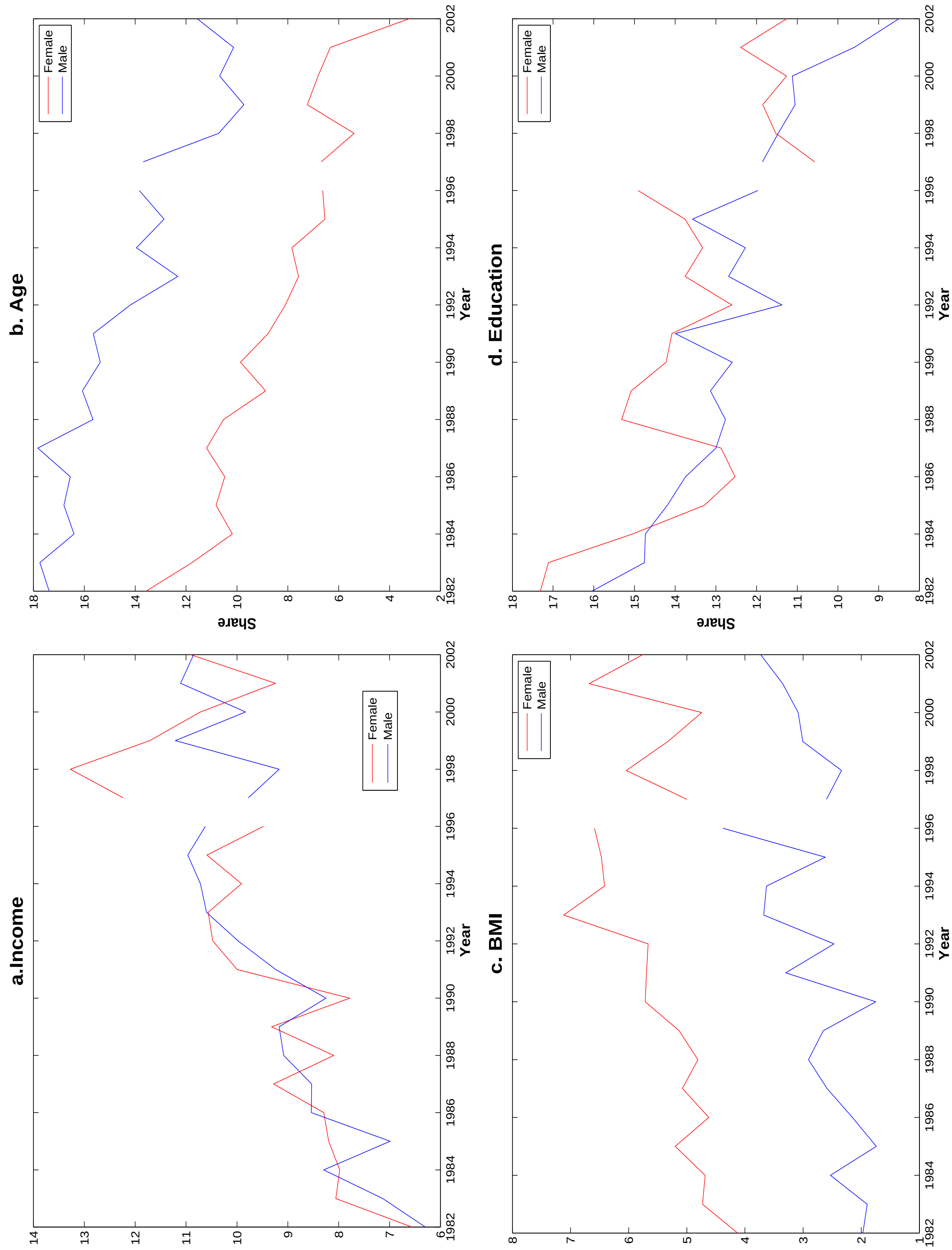


Figure 17: (Continued)

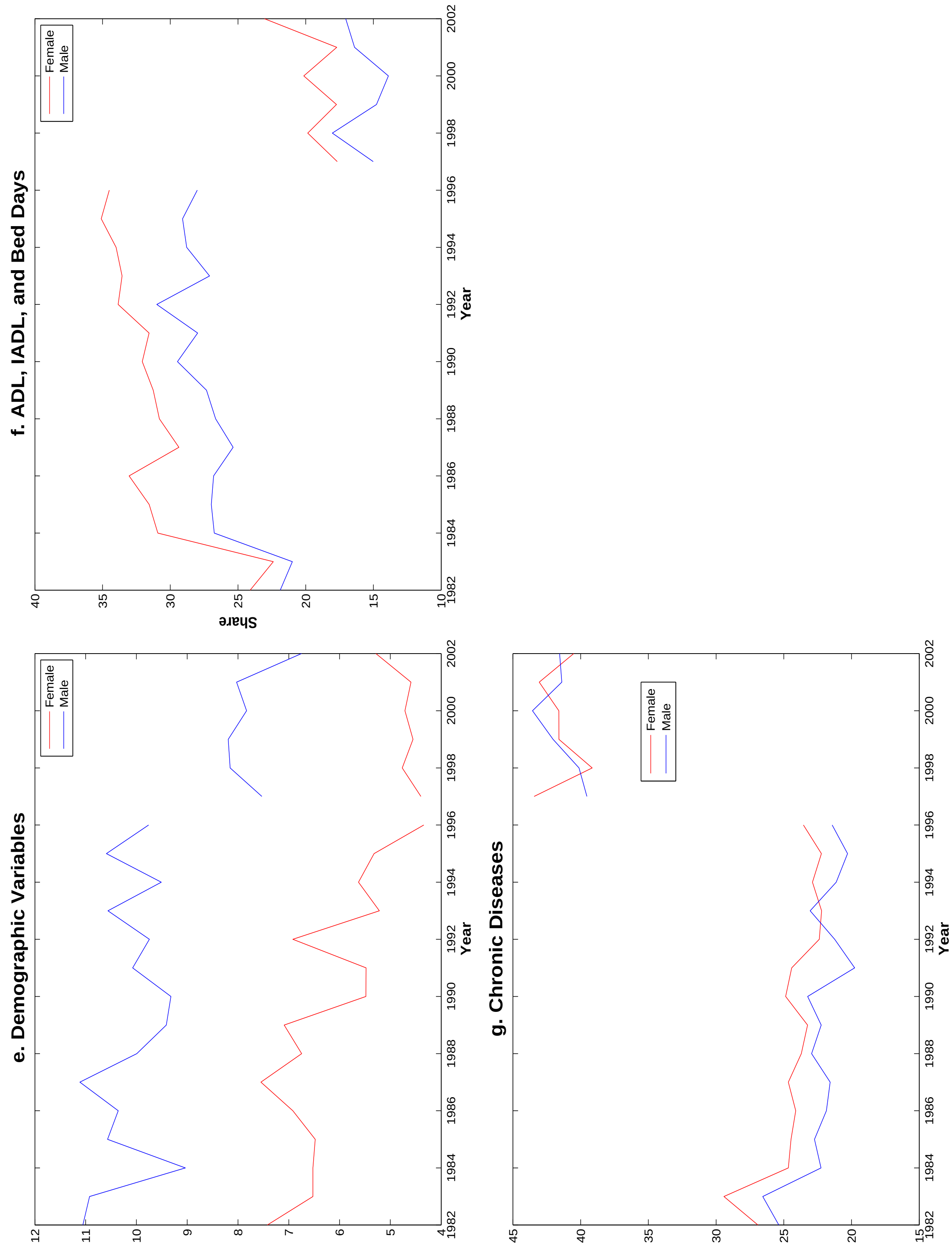


Figure 18: Model Predictions of Health Categories

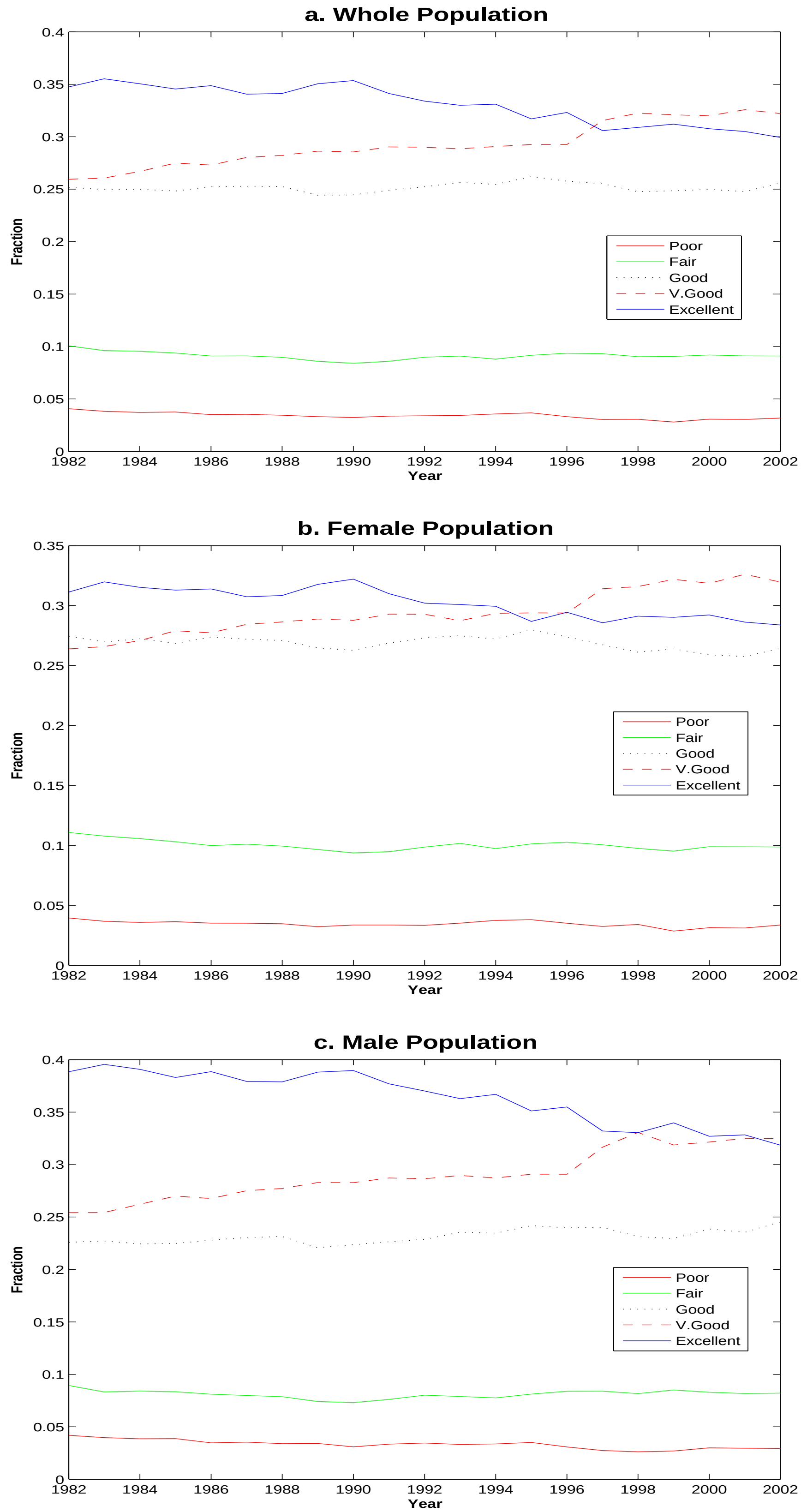
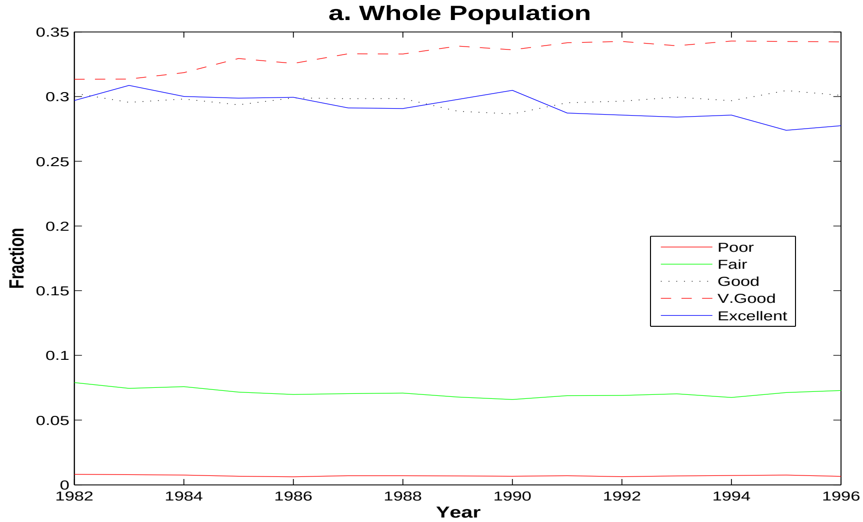
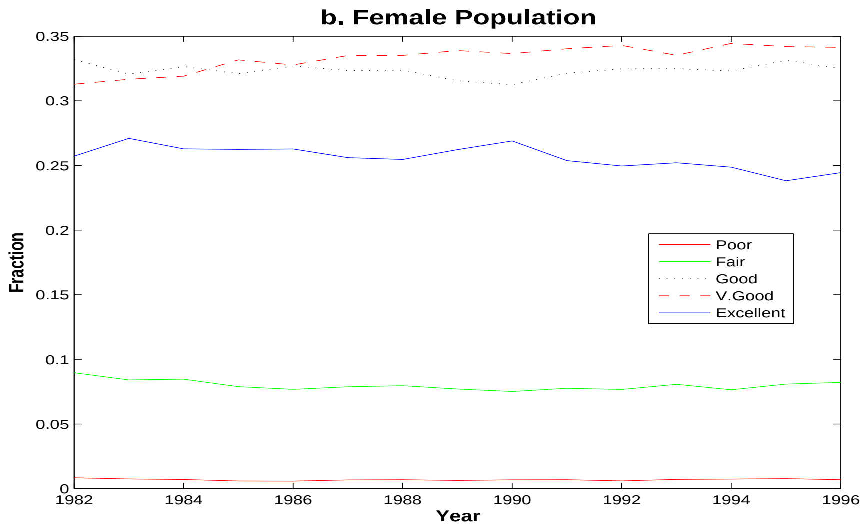


Figure 19: Model Counterfactuals
Constant x's, Year-Specific β's and c's





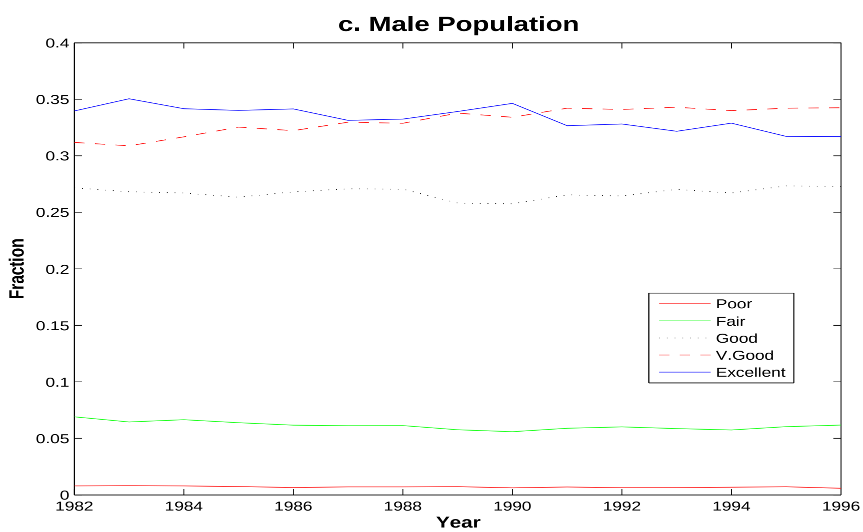


Figure 20: Model Counterfactuals
Constant x's and c's, Year-Specific β's

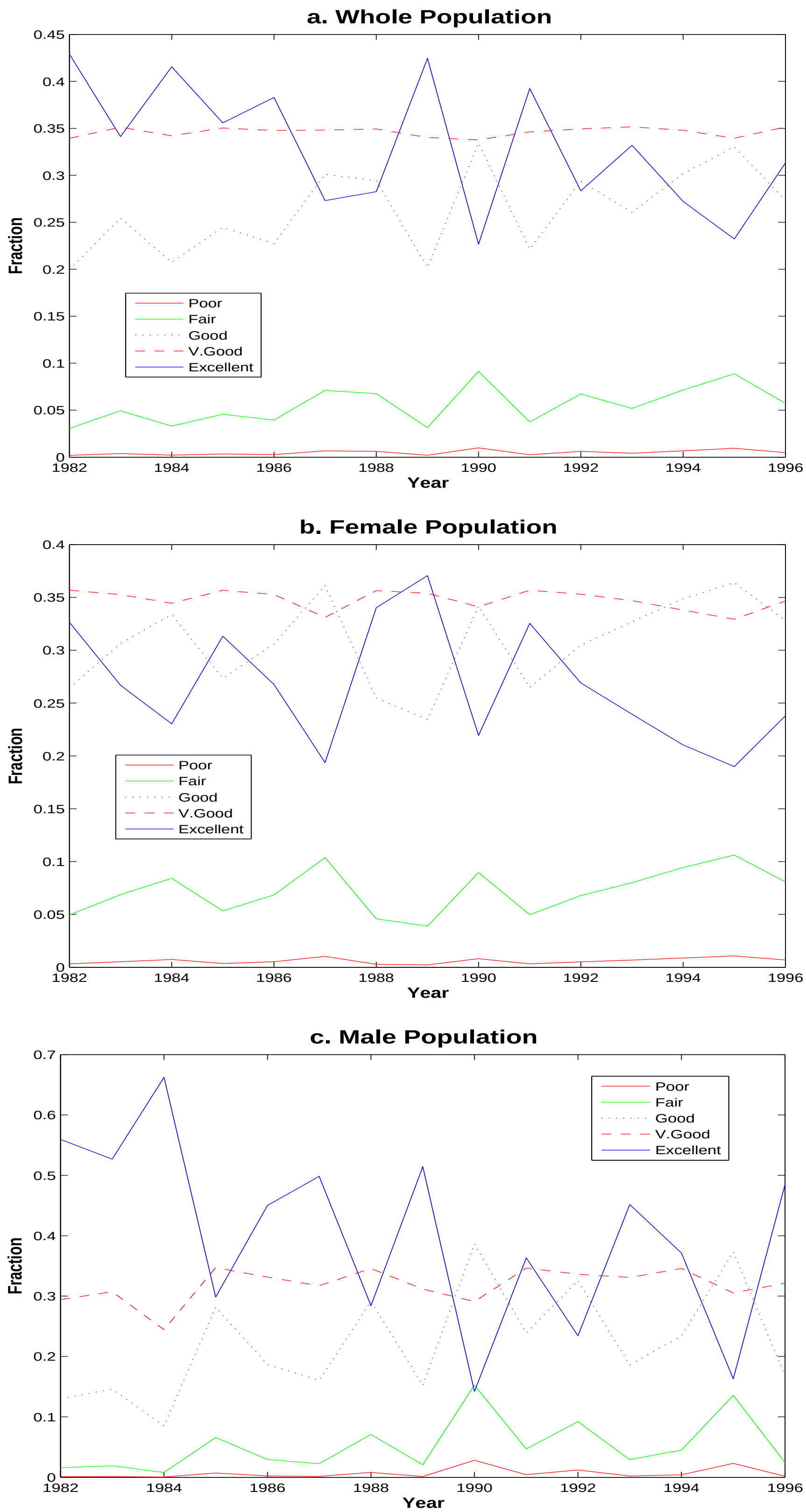


Figure 21: Model Counterfactuals
Constant β's, Year-Specific x's and c's