The Health Returns to Medical Expenditures:

Does Age Matter?

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ABSTRACT

Medical expenditures as a percentage of GDP have doubled during the past three decades, reflecting technology advancement and an aging population. Understanding how medical expenditures affect health, and whether this relationship differs by important sociodemographic characteristics such as age, are important for the appropriate allocation of scarce health care resources. Given the current environment of health care reform, further evidence on the health returns to medical investment is both timely and policy-relevant.

This study assesses the relationship between medical expenditures and health-related quality of life. We use both objective (EuroQol) and subjective (rating scale) measures of health. The conceptual point of departure for this study is Grossman's classic model of health investment. We employ two-stage least squares estimation techniques to address the endogeneity of individual medical expenditures (e.g., that sicker people spend more).

Using our objective health measure, we find that the elasticity of medical expenditure with respect to health is approximately 0.26. That is, a 10% increase in medical expenditures increases health by 2.6%. However, the returns to medical expenditures differ by age group and whether we use an objective or subjective health measure. Using our objective measure, the returns to medical expenditure are greatest for the middle-aged group (e.g., 46 to 64 years of age). However, using the subjective measure, we find that the *perceived* returns to health are greatest for seniors (e.g., > 64 years of age) cohort. Moreover, the higher perceived returns for seniors appear to reflect factors that are unrelated to our objective health measure. If objective health measures provide better evidence of actual gains in health, these findings suggest that a reallocation of spending from seniors towards middle-aged cohorts can improve overall health without affecting expenditures. Given the strong perceived benefit for medical expenditures among seniors, however, any attempts at such a reallocation may face considerable opposition.

JEL Classification:

Key Words

I. INTRODUCTION

Growth in health care spending has exceeded overall economic growth in the United States for many years. During the past three decades, the percentage of GDP spent on health care nearly doubled, from 8% 1975 to 14.9% by 2005 (Congressional Budget Office 2007).[1] The increasing cost of health care has been attributed to the development and diffusion of improved health technology (Newhouse 1993) and an aging population (Hartman et al. 2008, Shrestha 2006). Large geographic differences in Medicare spending without evidence of corresponding variations in health outcomes pointed to possible waste in Medicare spending (Fisher et al. 2003a, 2003b). According to the recent Health Care and Education Reconciliation Bill, subsidies to the Medicare Advantage plan will be cut to reduce government spending (H.R.4872, Section 1102).

Understanding how medical care expenditures affect health is important for the proper allocation of health care resources. Given the current environment of health care reform, further evidence on the health returns to medical investment is both timely and policy-relevant. Yet, there is relatively little research on this relationship, and previous studies provide conflicting evidence. Moreover, prior studies have typically been limited to specific groups of individuals (e.g., Medicare beneficiaries), specific treatment settings (e.g., inpatient care), or individual diseases (e.g., heart disease).

To our knowledge, no study has examined the returns to medical expenditures using general health-related quality of life measures. Such evidence would be valuable because this would provide a more comprehensive assessment of the health returns to medical expenditures. To help bridge this gap in the literature, we examine the relationship between medical expenditures and health using both objective and subjective general health measurements. The EuroQol (EQ-5D) is our objective health measure. The EQ-5D is a preference-based health-related quality of life (HRQOL) measure that includes both physical and mental health status components and consists of the following domains: mobility, self-care, usual activities, pain/discomfort and anxiety/depression (Fleishman 2005, Rabin and de Charro 2001, Dolan 2000, McDowell 2006). The EQ-5D is one of the most widely used

[1] This figure is cited from the Congressional Budget Office: The Long – Term Outlook for Health Care Spending 2007. Under plausible assumptions of health care cost growth rates based on historical trends, health care spending is projected to reach 31% of GDP by 2035 and 41% by 2060.

general health utility measures. Self-assessed health status based on a rating scale serves as our subjective health measure.

The conceptual motivation for this study is Grossman's health investment theory (Grossman 1972), where overall health is regarded as a special form of human capital and medical expenditure a key input into health. Because we examine how medical expenditures affect *overall* health, our study provides an empirical test that is more consistent with this model.

It would be useful to know what the actual health returns per dollar of medical expenditure are and how this relationship varies by demographic factors such as age. Studying the health returns to medical investment by age is particularly pertinent, given the changing demographics in the United States toward an older population. The percentage of the population aged 65 and older has risen steadily from 8.1% in 1950 to 12.4% by 2000. It is projected to reach 20.6% of the total population by 2050 (Shrestha 2006). An aging population poses critical challenges to the health care system since older persons typically develop more medical conditions and demand more care.

While the Medicare population is increasing, the percentage of uninsured among the non-elderly population is high. On average, 15% of the non-elderly population is uninsured and these rates are highest among young adults. For example, 35% of people aged 25 are uninsured (CEA report 2009). These rates are projected to grow has health care costs, insurance premiums and out-of pocket costs continue to increase. These patterns suggest that health care access and spending is generous for Medicare beneficiaries relative to many younger persons.

Are health care spending patterns for different age groups efficient? To help answer this question, one needs to investigate how the health returns to medical investment vary by age? Under the assumption that the health depreciation rate increases with age, health investment theory concludes that the marginal cost of health capital rises with age (Grossman 1972, Muurinen 1982). This implies that the returns to medical expenditures would be less for older age groups. That is an empirical question, however, and a focus of this study.

While the question of the empirical relationship between medical expenditures and health seems straightforward, the practical challenges are formidable. Health affects medical expenditures, and failure to address this reverse-causation effect can lead to serious underestimates of the effects of

medical expenditures on health and even a negative estimated relationship. We use instrumental variables (IV) methods to purge medical expenditures of endogeneity and obtain estimates of the effects of medical expenditure on health outcomes.

Simple ordinary least squares (OLS) estimates of medical expenditures and health yield an inverse relationship, likely reflecting that healthier subjects need less health care. After instrumenting medical expenditures, however, we find a positive and significant relationship between medical expenditures and health. Using the EuroQol as our health measure, the elasticity of medical expenditures on health is 0.26: a 10 percent increase in medical expenditures leads to a 2.6% increase in health as measured by the EuroQoL. Using the rating scale, we find very similar results, with an overall elasticity of 0.19.

The most interesting results come from comparing different patterns of the expenditure-health relationship by type of health measure (e.g. objective vs. subjective) and by age group. Using the EuroQol, our objective measure, the returns to medical expenditure are greatest for the middle-aged group (e.g., 46 to 64 years of age). However, using the subjective rating scale measure, we find that the perceived returns to health are greatest for seniors (e.g., > 64 years of age) cohort. Moreover, the relationship between medical expenditures and health differs quite substantially among seniors subjects according to the health measure considered. In particular, we find no statistically significant relationship between medical expenditures and our objective health measure (e.g., the EuroQol) for the senior group, but a positive and significant relationship between medical expenditures and self-assessed health status, with an elasticity of 0.30. These results suggest that seniors may gain significant perceived benefit from more health care spending, but the objective benefits to their health appear to be substantially less. These findings suggest that current health policy initiatives to reduce the Medicare Advantage benefit plan may achieve cost savings without substantively affecting overall objective health outcomes for senior population.

The remainder of this paper is organized as follows: Part II briefly describes the health investment model and part III summarizes previous work on the relationship between medical expenditures and health outcomes. Data sources and variables are presented in part IV and our estimation strategy is described in part V. Part VI reports estimation results including both OLS and IV analyses. Part

VII summarizes the results and their policy implications and briefly considers future extensions of this work.

II. THE HEALTH INVESTMENT MODEL

According to health investment theory, medical care is considered a key element in the production of health and medical service is a derived demand for "good health". The notion of modeling health as a special form of human capital was first introduced in Grossman's (1972) paper. In his model, individuals spend time and money to produce good health. People have incentives to invest in health to increase their utility and market productivity.

Implications are derived from this model for age, education and wealth that are independent of consumers' tastes or preferences for health. The model predicts that the demand for health and medical care will be positively related to the wage rate. Provided that education increases the efficiency of investments in health, more educated individuals would demand a higher optimal health stock. But with relatively inelastic medical demand, the relationship between education and medical outlays would be negative. Of note, the model derives conditions under which the quantity of health capital demanded declines with age even though expenditures on medical care increase with age.

Later extension's of Grossman's work considered the endogeneity of longevity (Ehrlich and Chuma 1990, Ried 1998, Ehrlich 2000, Grossman 1999). Muurinen (1982) expanded Grossman's study and introduced a more generalized model by allowing the health capital depreciation rate to depend not only on age but also on the intensity of use. Individuals working in polluted environments had higher health capital depreciation rates. This led to similar implications as found in the Grossman model.

Other extensions introduced uncertainty into the health investment model (Cropper 1977, Dardanoni and Wagstaff 1987, 1990, Picone et al. 1998). For instance, Dardanoni and Wagstaff (1990) considered uncertainty over the probability of illness and the effectiveness of medical treatment. Picone et al. (1998) studied the effects of uncertainty on disease incidence and medical care demand on health capital and wealth for retired individuals. They found that subjects respond to uncertainty by

smoothing their expected utility over time through their medical spending, and that such spending depends in part on an individual's degree of risk aversion.

III. PREVIOUS EMPIRICAL STUDIES

The health care industry in the United States has been referred to as "flat of the curve" medicine for the past several decades, as marginal spending on health care has been thought to bring little or no improvement in health outcomes (Fuchs 2004, Gruber 2006). Although wide geographic variations in Medicare spending have been reported (Dartmouth Atlas of Health Care 2008), there is no strong evidence that greater expenditures have led to better health outcomes. There are also wide geographic variations in health care spending for the general population. While per capita health spending in 2004 was approximately $4,000 in regions such as Utah and Arizona, it exceeded $6,500 in areas such as New York and Massachusetts (Congressional Budget Office 2008).

Such wide variations in health care spending suggest possible inefficiencies and opportunities to reduce costs without sacrificing quality of care (Skinner and Fisher 1997, Fisher et al. 2003a, 2003b, Skinner et al. 2005). Consistent with this view, Baicker and Chandra (2004) studied the relationship between physician workforce and service quality, finding that states with more specialists have higher costs but *lower* quality. Sirovich et al. (2006) showed that physicians in high expenditure regions find it harder to provide needed services for their patients. Fisher et al. (2003a, 2003b) studied Medicare patients with hip fracture, colorectal cancer and AMI. They found that patients in higher spending areas received 60% more health care services, with no apparent improvement in quality of care. Skinner et al. (2006) combined cross-section and time-series data using a Medicare dataset from 1986-2002 for subjects with acute myocardial infarction (AMI). They presented trends on 1-year survival rates for patients, finding that regions with higher expenditures were not associated with better outcomes.

Other evidence, however, points to benefits from greater medical spending. Cutler and McClellan (2001) studied the costs and benefits associated with technology dispersion over time. The dollar-valued benefits from improved longevity were compared to the greater costs associated with

newer health care technologies. They found that the benefits from technology advances exceeded their costs. The most striking results were for heart disease, where benefits greatly exceeded costs.

Kaestner and Silber (2009) examined the medical effectiveness of inpatient spending for Medicare patients admitted to hospital for surgery. They find that greater inpatient spending is associated with lower mortality and lower "failure to rescue rates".[2] Moreover, the magnitude of the benefit they report is impressive: a ten percent increase in inpatient spending improves the survival rate by 3 to 6 percent. Doyle (2007) conducted a natural experiment to assess the "flat of the curve" medicine hypothesis by studying visitors in Florida who were seeking medical treatments with heart-related emergencies. The results indicate that a 10% increase in medical spending leads to an 8% decrease in the mortality rate, with an estimated cost per statistical year of life gained of approximately $50,000. Previous studies thus provide mixed evidence on the health returns to medical expenditures.

IV. DATA AND VARIABLES

Data

This study uses data from the Medical Expenditure Panel Survey (MEPS) conducted by Agency for Healthcare Quality and Research (AHRQ). The MEPS database includes detailed information on patient's health care utilization, medical expenditures, health status, insurance coverage and sociodemographic characteristics (Cohen 1997, 2003).[3] It is representative of the non-institutionalized civilian population in the United States. We use the MEPS Household Consolidated files from 2000-2003, a time period when information on quality of life measures were included in MEPS. In addition, selected variables in the restricted Area Resource File (ARF) from

[2] Failure to rescue rate is an outcome measurement used in evaluating hospital quality of care. Failure to rescue is defined by the Agency for Health Research and Quality (AHRQ) as deaths per 1,000 discharges in patients undergoing elective surgery. Causes of death included in the definition are pneumonia, deep vein thrombosis/pulmonary embolus, sepsis, acute renal failure, shock/cardiac arrest or gastrointestinal hemorrhage/acute ulcer.

[3] We also included home ownership information from the National Health Interview Survey-Family file. According to the design of MEPS survey, sample individuals and families in MEPS are drawn from a prior year subsample of NHIS. Given this survey feature of MEPS, we used linkage file from AHRQ to merge a home ownership variable to the yearly consolidated file.

AHRQ were incorporated into our study. The ARF provides information on county-level medical resources across the United States, including the supply of health care providers, health facility information, as well as socioeconomic and environmental information.

We excluded individuals under 18 years of age and pregnant women. Respondents who reported a negative health status (worse than death) and zero medical expenditure were also excluded from our sample, leaving us with 54,810 observations for estimation purposes.[4]

Variables

Dependent variables. Our study included both objective and subjective health indices: the EuroQol (EQ-5D) (objective) and self-rated (subjective) health status, respectively. The EuroQol (EQ-5D) is a widely used, general quality of life measure (EuroQol group (2010). The EQ-5D represents an individual's health utility score for a given health state. The MEPS included the EQ-5D on surveys from 2000-2003. The survey first queried respondents about their health status along each of the five domains of the EQ-5D: mobility, self-care, usual activities, pain/discomfort and anxiety/depression. For each category, there are three possible levels ranging from 1-3 (best), and a total of 243 possible health states. Then a time-tradeoff[5] exercise was performed by individuals to assign preference weights for each health status. Incorporating these preference weights for each health state, a cardinal utility score between 1 and 100 was obtained. Self-rated health status, our subjective measure, was based on subjects' responses to a question asking them to rate their health on a scale of 0 (worst) to 100 (best).

[4] We dropped 1,277 cases who reported negative health status values on the EuroQol. According to the design of the EuroQol measure, a health status equal to 100 represents perfect health and 0 represents death. Negative values are derived when individuals reveal a preference for "death" over living in other health conditions. How to measure health states worse than death and whether to include them as valid health measures are controversial issues in quality of life assessment (De Charro et al. 2005). Given this uncertainty, and because the health investment model considers individuals whose health states are better than death, we elected to exclude these subjects from our analysis. We also dropped 10,962 subjects who reported having zero medical expenditures. Because these individuals incurred no medical expenditures, it is impossible to determine the health returns to medical expenditures for them.

[5] In the time trade-off exercise, individual respondents express their preferences towards different health conditions. The U.S. population-based preference weighting system for EQ-5D was developed by AHRQ through a series of time trade-off (TTO) exercises and statistical imputations. See: http://www.ahrq.gov/rice/EQ5Dscore.htm

Explanatory variables. The key predictor for health is total medical expenditures per annum per patient. This measure includes individual out-of-pocket expenditures as well as expenditures made by the insurer, if applicable. Other sociodemographic predictors of health include age, gender, race and educational attainment. Socioeconomic predictors include health insurance, employment status, annual family income and home ownership. We also controlled for preexisting conditions that could affect quality of life. In particular, we control for 15 major chronic diseases and for whether the subject is obese. Regional factors include whether the subject resides in an urban location and Census Region. Year is controlled for using a series of binary indicators, with 2000 serving as the reference year.

All dollar-denominated variables are converted to 2003 dollars. For medical expenditures, we use the Medical Care Component of the Consumer Price Index (CPI). For non-medical items, the general CPI is used.

V. ESTIMATION STRATEGY

Instrumental Variables Estimation

In studying the effects of medical expenditures on health, controlling for the endogeneity of health inputs is essential (Rosenzweig and Schultz 1983). It is intuitively straightforward to recognize that people with better health status should have lower health care spending. Using simple correlations, or standard OLS methods, therefore, one will likely obtain a biased and even a negative relationship between health care spending and health outcomes.

This phenomenon is illustrated in Figure 1, which shows a negative correlation between medical expenditure and quality of life. Similarly, Figure 2 demonstrates a strong positive relationship between medical expenditures and the number of medical conditions. Moreover, the negative relationship between medical expenditures and quality of life persists in ordinary least squares estimation, when we control for the covariates described in part IV above. Finally Hausman-type tests confirm that the medical expenditure variable is endogenous.[6]

[6] See the Appendix for a full description of tests of endogeneity and our instruments.

Thus, it is important to control for endogeneity in order to isolate the effects of medical expenditures on health. Instrumental variables (IV) estimation is a commonly-accepted approach in such situations. In the present application, the objective of IV estimation is to obtain variables that are strongly correlated with health spending but which have no direct effect on quality of life. Previous studies suggest that the wide geographic variations in medical expenditures across the United States reflect differences in treatment intensity and practice style (Wennberg et al. 2002, 2009, Skinner et al. 2006, Dartmouth Atlas of Health Care 2008). While such differences in treatment intensity and practice styles should affect medical expenditures, they may not directly affect health outcomes independent of indirect effects working through health expenditures. Hence, variables indicating geographical variations in treatment intensity and practice style have been used as instruments to control for the endogeneity of expenditures in health outcomes analyses (Skinner et al. 2005, Kaestner and Silber 2009, Stukel et al. 2007, Doyle 2007).

In particular, Skinner et al. (2005) used patients' physician visits during the last six months of life to instrument Medicare spending in 1986-2002, finding no significant relationship between per capita Medicare spending and survival rates for hospital referral regions.[7] Kaestner and Silber (2009) found a negative relationship between inpatient spending and inpatient mortality rate in Medicare patients admitted to hospitals for surgery. End-of-life expenditures in hospital referral regions (HRR) were used to instrument for inpatient spending. Stukel et al. (2007) found 16% decreased mortality rate for Medicare AMI patients because of cardiac catheterization, using the regional catheterization rate as an instrumental variable. Doyle (2007) selected county-level medical spending as an instrumental variable for per patient medical costs following heart-related emergencies, finding that higher spending is beneficial for Florida visitors with a heart emergency.

We followed this approach and chose local health care resource availability as part of our IV set. It is reasonable to argue that regions with different densities of health care providers have different practice styles, which should also affect expenditure levels. Indeed, as Skinner and Staiger (2009) have argued, different regions may exhibit different health production functions. Cutler (2006) has argued that efficiency in health production varies across regions. The literature is clear that regional

[7] Two additional IVs were included in Skinner et al. (2005): the percentage of decedents admitted to the ICU during the last six months of life, and Medicare expenditures for AMI patients during 1993–94.

variation in medical practice exists in the United States. Given these observations, differences in the availability of health care resources should affect the way medical care is produced and, ultimately, medical expenditures. In contrast, there is little reason to expect variation in the supply of health care providers to have a direct effect on an individual's quality of life. Thus our first instrumental variable selected from the Area Resource File is the number of non-hospital based physicians per thousand subjects in the county.[8]

Two additional instruments are selected which reflect respondents' attitudes toward risk. The selection of risk preference variables is motivated by health investment theory (Dardanoni and Wagstaff 1990, Picone et al. 1998), which predicts that risk averse individuals will spend more on their health. In particular, we include a binary variable equal to 1 if the respondent considers himself to be less likely to engage in risk taking behavior and 0 otherwise, and an indicator variable equal to 1 if the respondent always wears a seatbelt when driving and 0 otherwise. It seems reasonable to argue that risk preference does not directly affect quality of life independent of its effects on medical expenditures.

Appendix A summarizes the relationships between attitudes towards risk, health insurance and medical expenditures. Table A1 includes information on levels of risk aversion and the percentage of subjects who consider insurance necessary and average medical expenditure for each category. The risk averse category has the highest percentage of individuals who consider health insurance necessary, compared to the risk lover groups. Table A2 shows the respondent-reported frequency of wearing seatbelts, attitude towards health insurance and medical expenditure. Individuals who report always wearing seatbelts have the highest percentage of subjects that consider health insurance to be necessary and have higher medical expenditures compared to groups who report less frequently wearing seatbelts less regularly, with the exception of subjects who never wear a seatbelt. Subjects who wear seatbelts more regularly are also more likely to believe that it is necessary to have health insurance. Overall, these summary statistics suggest that more risk averse individuals consider health insurance necessary and invest more in their health.

[8] The number of non-hospital based physicians was normalized to the number of non-hospital based physicians per 1,000 population.

Empirical Model

The empirical model to be estimated may be written as:

$$\ln(MEDEXP) = \alpha_0 + \alpha_1 X + \alpha_2 IV + \varepsilon \quad (1)$$

$$\ln(EQ-5D \text{ or } Ratescale) = \beta_0 + \beta_1 ln(MEDEXP) + \beta_2 X + \varepsilon \quad (2)$$

The first equation examines the determinants of medical expenditures. The vector ***X*** represents socioeconomic, demographic, comorbdities, and regional factors affecting both medical expenditures and health, while ***IV*** represents the instruments described above. Equation (2) uses the predicted value from (1) and the vector *X* to predict health outcomes. We conducted separate regression analyses for EQ-5D and the self-assessed rating scale measures. Medical expenditures and both health outcome measures were transformed to natural logarithms to normalize their distributions. Equations (1) and (2) are also estimated separately for three age groups: younger persons (18-45 years of age), middle aged subjects (46 to 64) and seniors (65 and over).

VI. RESULTS

Descriptive Statistics

Summary statistics are provided in Table 1. The dependent variables include both subjective (rating scale) and objective (EQ-5D) health outcomes. Both health outcome measurements were normalized to lie between 0 and 1. The key explanatory variable of interest, annual medical expenditure, is $3,526 on average.

[Insert Table 1]

OLS Results

Table 2 shows the results of ordinary least squares estimation of the association between medical expenditures and our health measures, ignoring the issue of endogeneity. As the table indicates, this relationship is estimated to be negative and significant for each health outcome measure, reflecting endogeneity of the medical expenditure variable.

[Insert Table 2]

First-stage Medical Expenditure Equation

Table 3 presents the first-stage medical expenditure regression results for the two-stage least squares model. Female and married individuals spend more than males and single individuals, respectively. Minority populations spend significantly less compared to Caucasians. Individuals with a college education have higher medical expenditures compared to those with high school education. Uninsured individuals spend significantly less.

All three instrumental variables are highly significant, with risk aversion and wearing a seatbelt significant at 1% level and the physician supply variable significant at 5% level. The number of physicians has a positive effect on medical expenditures. As predicted, people who are more risk averse spend more on medical care. To test the validity of our instruments and the two-stage least squares estimation approach, we conducted a series of tests for endogeneity of medical expenditures, exogeneity of the instrumental variables, and joint over-identification of the instrumental variables. The test statistics confirm that the medical expenditure variable is endogenous and the instrumental variables are exogenous (orthogonal to the health outcome variable). We also tested the joint over-identification test for instrumental variables. The resulting Hansen test statistics failed to reject the null hypothesis and the instrumental variable setting in this study passed over identification test. Appendix B provides further details on the results of these tests.

.

[Insert Table 3]

Second-stage Results

Table 4 shows the second-stage estimates predicting health outcomes. Medical expenditure has a positive and significant effect on both objective and subjective health measurements. The elasticity of health expenditure on health outcome is 0.26 for the objective measure (EQ-5D) and 0.19 for self-rated health scale. The elasticity of 0.26 indicates that a 10% increase in medical expenditures will improve quality of life by 2.6%.

Age has a large negative effect on health outcomes. Men have slightly better health status than women. The ethnic minority variables including Hispanic, African American and other racial ethnicities all exhibit a *positive* relationship to both health measurements. While this pattern seems puzzling, it must be remembered that these race/ethnicity effects are adjusted for differences in medical expenditures. And as the results in Table 3 indicate, racial and ethnic minorities have substantially lower medical expenditures than do Caucasians. Unemployed individuals have worse health status. Individuals with relatively low income have lower health status. All chronic disease conditions have significant negative effects on health status.

[Insert Table 4]

Do the returns to medical expenditures vary by age group? To investigate this issue, we repeated the analysis on sub groups stratified into three age groups; less or equal to 45 years of age, 46 to 64 years of age and > 64 years of age. We estimated separate two-stage least squares models for each age group and health outcome measure. The results are provided in Table 5. Using the EuroQol, our objective health measure, the elasticity of medical expenditure on health is 0.20 for subjects aged less or equal to 45 ($p < 0.05$); 0.34 for subjects aged 46-64 ($p < 0.01$), and 0.23 for subjects aged greater than 64 (p: ns). Clearly, the effect of medical expenditure on health is much greater for the middle-aged cohort than for either of the other groups. Indeed, we find no statistically significant effect of expenditures on health for older subjects.

[Insert Table 5]

In contrast, a different pattern emerges using the rating scale, our subjective measure. In this case, all three groups show a positive and highly significant relationship between medical expenditures and health, with the effect strongest for the senior group.

Thus we see that the health returns to medical expenditure vary by age and by whether the health measure is subjective or objective. When an objective measure was used, middle-aged individuals clearly gained more from medical expenditures than older subjects, who showed little benefit. But medical expenditures strongly increased self-assessed health status among senior subjects. These results suggest that while the middle-age group obtained the highest objective health returns to medical expenditures, the senior population may enjoy higher perceived benefits from health care expenditures.

To gain further insight into the high perceived health benefits from medical expenditures among seniors, we obtained the residuals from a regression of the natural logarithm of the rating scale measure on the natural logarithm of the EQ-5D. These residuals provide variations in the rating scale that are independent of EQ-5D, our objective health measure. We then estimated two-stage least squares models for each of our age groups using these residuals as the second-stage outcome measure. The results, summarized in Tables A3 and A4, indicate that medical expenditures have the strongest associations with the residual measure among seniors, followed by the young cohort. By contrast, medical expenditures are unrelated to the residuals for the middle-aged group. These findings suggest that the source if the positive relationship between the rating scale and medical expenditures among seniors reflects factors that are unrelated to EQ-5D, the general objective measure of health.

V. CONCLUSION

This study is an empirical attempt to test the health investment model and provide estimates of the value of medical expenditures using broader health measures than found in prior studies. Using a nationally representative database, we explored the returns to medical expenditures considering both subjective and objective general measures of health. The objective measure, the EQ-5D, incorporates

multi-dimensional health domains. The subjective health outcome – a self-assessed rating scale--reflects individuals' perceptions of their overall health status.

By applying the two-stage least square technique with valid instrumental variables, we were able to estimate the elasticity of medical expenditure on health outcome for a general population. We also performed further analyses on different age groups, which led to some intriguing results. In particular, while the middle-age group cohort enjoys the highest returns to medical care expenditures in terms of improving objective health, seniors have the highest return on medical expense for the subjective measure of health. This suggests that, among seniors, there may be considerable perceived health benefits from medical expenditures that do not correspond to actual gains in health. An alternative possibility is that there are additional real health benefits to medical expenditures among seniors that are not captured by EQ-5D. It is not clear, however, what these additional benefits might be and why they are apparent among seniors but not among the middle-aged cohort.[9]

The age-specific variation in the returns to medical expenditures we document has potentially important implications for the optimal allocation of scarce health care resources. If seniors achieve less objective health benefit from medical expenditures than do other age cohorts, this suggests that resources should be directed away from this group and toward groups where medical investment will yield greater health gains. However, given the large perceived health benefits from medical expenditures that we find, older individuals and their advocates may be quite resistant to any such changes. Moreover, even if such a reallocation would improve efficiency, considerations of equity are also quite important in prioritizing health care expenditures.

This study represents a first step in quantifying the effects of medical expenditures on general measures of health. In future work, we hope to investigate how these relationships differ by alternative types of health care expenditures, such as pharmaceutical expenditures and physician services. Another important direction for further work is to examine how the relationship between medical expenditures and health outcomes varies by race and ethnicity and across geographic areas. Such efforts will shed light on inefficiencies in the allocation of health care resources and disparities in the benefits from medical investments.

[9] Recall from Table A4 that, for the middle-aged group, medical expenditures were unrelated to variations in the rating scale that do not correlated to variations in EQ-5D.

Appendix A

Table A1 Attitudes towards health risk, health insurance and medical expenditure

Risk averse level					
	1	2	3	4	5
	Risk dislike	Somewhat dislike	Risk Neutral	Somewhat like	Risk lover
Sample N	22,940	13,143	7,768	8,746	2,213
% consider Insurance is Necessary	85%	68%	65%	59%	62%
Std. Dev.	0.35	0.47	0.48	0.49	0.49
Medical Expenditure in 2003 $	$4,076	$3,175	$3,343	$2,848	$3,246
Std. Dev.	$9,201	$7,269	$7,716	$7,506	$8,088

Table A2 Frequency wearing seatbelt, attitudes towards health insurance and medical expenditure

How often wearing seatbelt					
	1	2	3	4	5
	Always	Nearly Always	Sometimes	Seldom	Never
Sample N	43,093	5,487	3,480	1,235	1,515
% consider Insurance is Necessary	74%	70%	69%	68%	71%
Variance	0.44	0.46	0.46	0.46	0.45
Medical Expenditure in 2003 $	$3,552	$3,368	$3,234	$3,160	$4,333
Variance	$8,210	$8,879	$6,870	$8,804	$9,977

Table A3. Second stage results for residual model

	Ordinary least square	
	Natural logarithm	
Variables[1]	Residual from lnratescale=lneuroqol	
Health expenses in 2003 dollars, natural logarithm	0.11	***
Age, natural logarithm	-0.10	***
Male	0.03	***
Married	0.00	
Race		
White, non-Hispanic	Reference	
African American, non-Hispanic	0.04	***
Other races, non-Hispanic	0.01	
Hispanic	0.04	***
Years of schooling		
Less than 9 years	-0.05	***
9-11 years	-0.01	**
12 years	Reference	
13-15 years	0.00	
16 years or more	-0.01	**
Health insurance		
Private Non HMO	Reference	
Private HMO	0.00	
Medicaid Non HMO	-0.13	***
Medicaid HMO	-0.08	***
Medicare	-0.03	***
Uninsured	0.04	**
Unemployed	-0.06	***
Family Income	0.01	***
House ownership		
Own	Reference	
Rent	-0.01	**
Other arrangement	-0.03	***
US region		
Northeast	Reference	
West	0.00	
Midwest	0.00	
South	0.00	
Living in MSA	0.00	
Body Weight Categories		
Underweight BMI<18.5	-0.02	*
Normalweight 18.5<=BMI<25	Reference	
Overweight 25<=BMI<30	0.00	
Obesity 30<=BMI<40	-0.03	***

Morbidly Obesity BMI>=40	0.07	***
Year		
2000	Reference	
2001	0.01	***
2002	0.02	***
2003	0.02	***
Disease Categories		
Diabetes	-0.13	***
Hypertension	-0.07	***
Lipid metabolism disorders	-0.05	***
Anxiety disorders	-0.08	***
Acute myocardial infarction	-0.18	***
Congestive heart failure	-0.22	***
Cerebrovascular diseasevd	-0.22	***
Peripheral vascular diseasevd	-0.12	***
Atherosclerosis	-0.11	***
Chronic obstructive pulmonary disease	-0.06	***
Asthma	-0.08	***
Osteoarthritis	-0.07	***
Osteoporosis	-0.03	***
Affective disorders	-0.16	***
Migraine	-0.07	***
Constant	-0.35	***

*: 10% significant level; **: significant at the 5% level; ***: significant at the 1% level.

[1] Residual is obtained from regression: lnratescale= lneuroqol + resdiual

The coefficient of medical expenditure represents the effect of medical expenditure on health rating scale independent of euroqol.

Table A4: Selected coefficients using 2 stage least square by age groups for residual model

	2 stage least square	
	Natural logarithm	
Variables[1]	EUROQOL[2]	
Health expenses in 2003 dollars, natural logarithm		
Entire sample	0.11	***
By age group		
Less than or equal to 45 years old	0.13	**
Between 46 and 64	0.02	
Greater than 64 years old	0.22	**

: significant at the 5% level; *: significant at the 1% level.

[1] Explanatory variables also include gender, marital status, races, years of schooling, health insurance, employment status, house ownership status, annual family income in natural logarithm, US region, living in MSA, body weight, survey year and current diseases (diabetes, hypertension, hyperlipidemia, acute myocardial infarction, congestive heart failure, cardiovascular disease, peripheral vascular disease, atherosclerosis, chronic obstructive pulmonary disease, asthma, osteoarthritis, osteoporosis, anxiety disease, affective disorder, and migraine).

[2] EUROQOL: quality of life scale.

[3] RATESCALE: self health rating scale.

APPENDIX B: ENDOGENEITY TESTS AND TESTS OF INSTRUMENTS

After estimating our two-stage least squares regression models, we conducted a series of tests to establish endogeneity of the medical expenditure variable and test the validity of our instruments. First, we tested the endogeneity of the medical expenditure variable. We used the STATA 10 command of ivreg2 with "endog" option, finding that the test statistics chi-square p value equals to 0.00. The test result thus rejects the null hypothesis of exogeneity and we conclude that medical expenditure is endogenous.

The first-stage equation is over-identified and the F value for our instruments is 13.68. The test statistic is reported at the bottom of Table 4. Previously, first-stage F>10 is used as a conservative rule of thumb in determining over-identification feature of first-stage equation in 2sls analysis (Staiger and Stock 1997). Later on, new methods were introduced to evaluate the efficiency of the instrumental variables by measuring the relative bias of 2sls coefficients comparing to the bias of OLS regression (Stock and Yogo (2002)). According to the their standards, in 3 instrumental variables case, to yield relative bias less than 5%, the Cragg-Donald Wald F statistics (Cragg and Donald 1993) needs to be be greater than 13.91, and the statistics in our regressions are 18.84, which are greater than the critical value. In addition, we performed an overall exogeneity test of our instruments. The resulting Hansen J statistic tests the hypothesis that the instrumental variables are jointly exogenous. The Hansen J test Chi-square p value is 0.87 in the EQ-5D regression and 0.17 in the rating scale regression, each of which fails to reject the hypothesis of joint exogeneity.[10]

[10] The relative IV tests results are read from STATA command "ivreg2" with "ffirst" options. "gmm2s robust" option was added to the regressions to obtain the two-step feasible efficient GMM estimator. Hansen J test examines the joint exogeneity of instrument variables in the first stage. The original hypothesis is: the IVs in the first stage are jointly exogenous. The chi-square p value is 0.87 for EQ-5D regression and 0.17 for ratescale regression, failed to reject the hypothesis that IVs are jointly exogenous (Reference: Balm 2006, p185-218, Wooldridge 2002, p83-107, Greene 2003, p74-80)

REFERENCES

Baicker K. Chandra A. Medicare spending, the physician workforce and beneficiaries' quality of care. *Health Affairs* 2004 Jan-Jun; Web Exclusives 4:184-w197.

Baum CF. An introduction to modern econometrics Using Stata. *Stata Press* 2006: p185-218.

Calculating the U.S. Population-based EQ-5D Index Score. *Agency for Healthcare Research and Quality*, Rockville, MD, 2005 Available at: http://www.ahrq.gov/rice/EQ5Dscore.htm.

Cohen SB. Sample Design of the 1996 medical expenditure panel survey household component. MEPS Methodology Report No.2 AHCPR Pub. No. 97-0027. Rockville, MD: *Agency for Health Care Policy and Research* 1997.

Cohen SB. Design strategies and innovations in the Medical Expenditure Panel Survey. *Medical Care* 2003; 41(7):III-5-III-12.

Congressional Budget Office. The long-term outlook for health care spending. Washington, DC: *Congress of the United States Congressional Budget Office* 2007.

Congressional Budget Office. Geographic variation in health care spending. Washington, DC: *Congress of the United States Congressional Budget Office* 2008.

Cragg, JG, Donald SG. Testing identifiability and specification in instrumental variable models. *Econometric Theory* 1993; 9: 222–40.

Cropper ML. Health, investment in health and occupational choice. *The Journal of Political Economy* 1977; 85 (6): 1273-1294.

Cutler DM, McClellan M, Is technological change in medicine worth it? *Health Affairs* 2001; 20 (5):11-29.

Cutler DM, Making sense of medical technology. *Health Affairs* 2006; 25(2): w48-w50.

Dardanoni V, Wagstaff A. Uncertainty, inequalities in health and the demand for health. *Journal of Health Economics* 1987; 6: 283-290.

Dardanoni V, Wagstaff A. Uncertainty and the demand for medical care. *Journal of Health Economics* 1990; 9: 23-28.

Dartmouth Atlas of Health Care 2008. Health care spending, quality and outcomes. http://www.dartmouthatlas.org/atlases/Spending_Brief_022709.pdf.

De Charro F, Busschbach J, Essink-Bot, et al. Some considerations concerning negative values for EQ-5D health states. EQ-5D concepts and methods: a developmental history. Editor: Paul Kind, Richard Brooks, Rosalind Rabin. Springer 2005: p171-179.

Dolan P. The measurement of health-related quality of life for use in resource allocation decisions in health care. *Handbook of Health Economics* Culyer AJ, Newhouse JP (Eds) vol.1B. Elsevier, Amsterdam 2000: p1724-1760.

Doyle, J. Returns to local area emergency health care spending: using health shocks to patients far from home. *NBER Working Paper 2007; No. 13301* Cambridge, MA: NBER.

Ehrlich I, Chuma H. A model of the demand for longevity and the value of life extension. The Journal of Political Economy 1990; 98 (4): 761-782.

Ehrlich I. Uncertain lifetime, life protection and the value of life saving. *Journal of Health Economics* 2000; (19): 341-367.

EuroQol Group (EQ-5D) 2010. Accessed at: http://www.euroqol.org/.

Executive office of the president, Council of Economic Advisors. The economic case for health care reform. June 2009.

Fisher ES, Wennberg DE, Stukel TA et al. (a) The implications of regional variations in Medicare spending: part 1, utilization of services and the quality of care. *Annals of Internal Medicine* 2003; 138 (4):273-287.

Fisher ES, Wennberg DE, Stukel TA et al. (b) The implications of regional variations in Medicare spending: part 2, health outcomes and satisfaction with care. *Annals of Internal Medicine* 2003; 138 (4): 288-98.

Fleishman JA. Demographic and clinical variations in health status. Rockville (MD): *Agency for Healthcare Research and Quality* 2005. MEPS Methodology Report No 14. AHRQ Pub. No. 05-0022.

Fuchs V. 2004. More variation in use of care, more flat-of-the-curve medicine. *Health Affairs* 2004; 10(1377):104-7.

Greene W. Econometric analysis. 5th ed. Prentice Hall International, Inc. 2003: p74-80.

Grossman M. On the concept of health capital and demand for health. *The Journal of Political Economy* 1972; 80(2):223-255.

Grossman M. The human capital model of the demand for health. *NBER working paper* 7078 1999.

Gruber J. The role of consumer copayments for health care: lessons from the RAND health insurance experiment and beyond. *Kaiser Family Foundation* 2006.

Hartman M, Catlin A, Lassman D et al. U.S. health spending by age, selected years through 2004. *Health Affairs* 2008; 27(web exclusive 1): w1-w12.

H.R. 4872, The Health Care & Education Affordability Reconciliation Act of 2010. Sec. 1102. Medicare Advantage payments.

Kaestner R, Silber JH. New evidence on the efficacy of Medicare spending. *Manustript* 2009.

McDowell. Measuring health: a guide to rating scales and questionnaires. 3rd ed. Oxford University Press 2006: p694-702.

Muurinen J-M. Demand for health: a generalized Grossman model. *Journal of Health Economics* 1982; (1): 5-28.

Newhouse JP. An Iconoclastic view of health cost containment. *Health Affairs* 1993; 12(suppl. 1): 152–171.

Picone G, Uribe M, Mark Wilson R. The effect of uncertainty on the demand of medical care, health capital and wealth. *Journal of Health Economics* 1998; 17 (2): 171-185.

Rabin R, de Charro F. EQ-5D: A measure of health status from the EuroQol Group. *Annals of Medicine* 2001; 33(5): 337–343.

Ried W. Comparative dynamic analysis of the full Grossman model. *Journal of Health Economics* 1998; (17): 383-425.

Rosenzweig M, Schultz P. Estimating a household production function: heterogeneity, the demand for health inputs and their effects on birth weight. *Journal of Political Economy* 1983; (91): 723-746.

Sirovich BE, Gottlieb DJ, Welch HG, et al. Regional variations in health care intensity and physician perceptions of quality of care. *Annals of Internal Medicine* 2006; 144(9): 641-649.

Shrestha LB. The changing demographic profile of the United States. Congressional Research Service 2006 Report RL32701.

Skinner JS, Fisher ES. Regional disparities in medical expenditures: an opportunity for reform. *National Tax Journal* 1997; (50): 413-425.

Skinner J, Fisher E, Wennberg JE. The efficiency of Medicare. In analyses in the economics of aging edited by David A. Wise. *University of Chicago Press* 2005.

Skinner JS, Staiger DO, and Fisher ES. Is technological change in medicine always worth it? The case of acute myocardial infarction. *Health Affairs* 2006; 25(2): w34-w47.

Skinner J, Staiger D. Technology diffusion and productivity growth in health care. *NBER working paper* 2009; *No.14856* Cambridge, MA: NBER.

Staiger D, Stock JH. Instrumental variables regression with weak instruments. *Econometrica* 1997; 65: 557–86.

Stock JH, Yogo M. Testing for weak instruments in linear IV regression. NBER working paper 2002, No. 284.

Stukel TA., Fisher ES., Wennberg DE, Alter DA, Gottlieb DJ., and Vermeulen MJ. Analysis of observational studies in the presence of treatment selection bias: effects of invasive cardiac management on AMI survival using propensity score and instrumental variable methods. *Journal of the American Medical Association* 2007; 297: 278-285.

Wennberg JE, Bronner KK, Skinner JS, et al. Inpatient care intensity and patients' ratings of their hospital experiences. *Health Affairs* 2009 Jan;28(1):103-112.

Wennberg JE, Fisher ES, Skinner JS. Geography and the debate over Medicare reform. *Health Affairs (Millwood)* 2002; Web Exclusives: w96-w114.

Wooldridge J. Econometric analysis of cross section and panel data. *MIT* 2002: p83-107.

Table 1: Name and descriptive statistics for variables, N=54810

Variables	Mean	S.D.
Health measures		
Quality of life scale (EUROQOL-EQ-5D)	0.83	0.21
Self health rating scale (RATESCALE)	0.80	0.17
Health expenses in 2003 dollars	$3,526.40	$8,270.72
Age	47.07	17.31
Male	0.42	0.49
Married	0.54	0.50
Race		
White, non-Hispanic	0.68	0.47
African American, non-Hispanic	0.12	0.32
Other races, non-Hispanic	0.04	0.20
Hispanic	0.16	0.37
Years of schooling		
Less than 9 years	0.08	0.28
9-11 years	0.14	0.34
12 years	0.32	0.47
13-15 years	0.22	0.41
16 years or more	0.24	0.43
Health insurance		
Private Non HMO	0.34	0.47
Private HMO	0.29	0.45
Medicaid Non HMO	0.05	0.21
Medicaid HMO	0.04	0.20
Medicare	0.17	0.38
Uninsured	0.11	0.32
Unemployed	0.29	0.46
Annual family income in 2003 dollars	$58,626.33	$47,108.20
House Ownership		
Own	0.68	0.47
Rent	0.27	0.45
Other arrangement	0.05	0.21
US region		
Northeast	0.16	0.37
West	0.23	0.42
Midwest	0.23	0.42
South	0.38	0.48
Living in MSA	0.77	0.42
Body Weight Categories		
Underweight BMI<18.5	0.02	0.13
Normalweight 18.5<=BMI<25	0.36	0.48
Overweight 25<=BMI<30	0.36	0.49
Obesity 30<=BMI<40	0.23	0.42
Morbidly Obesity BMI>=40	0.04	0.19
Risk Preference Variable		
Adrisk =1 Self considered less likely taking risk	0.66	0.47
Seatbelt=1 if always wearing seat belt	0.79	0.41
Health Resource Variable		
Dr Number per 1000 population	2.27	1.37
Year		
2000	0.17	0.38
2001	0.26	0.44

2002	0.31	0.46
2003	0.26	0.44
Main Disease Categories		
Diabetes	0.08	0.27
Hypertension	0.21	0.41
Lipid metabolism disorders	0.11	0.31
Anxiety disorders	0.07	0.26
Acute myocardial infarction	0.01	0.08
Congestive heart failure	0.01	0.09
Cerebrovascular diseasevd	0.01	0.09
Peripheral vascular diseasevd	0.00	0.05
Atherosclerosis	0.01	0.12
Chronic obstructive pulmonary disease	0.05	0.22
Asthma	0.05	0.21
Osteoarthritis	0.01	0.10
Osteoporosis	0.02	0.14
Affective disorders	0.01	0.10
Migraine	0.06	0.24

Table 2: Results using ordinary least square

Variables[1]	Ordinary least square			
	Natural logarithm			
	EUROQOL[2]		RATESCALE[3]	
Health expenses in 2003 dollars,				
natural logarithm	-0.04	***	-0.03	***
Age, natural logarithm	-0.10	***	-0.06	***
Male	-0.02	***	-0.02	***
Married	0.01	***	0.01	**
Race				
White, non-Hispanic	Reference		Reference	
African American, non-Hispanic	-0.01	**	0.00	
Other races, non-Hispanic	-0.01		-0.02	***
Hispanic	0.02	***	0.01	**
Years of schooling				
Less than 9 years	-0.07	***	-0.08	***
9-11 years	-0.04	***	-0.03	***
12 years	Reference		Reference	
13-15 years	0.03	***	0.02	***
16 years or more	0.07	***	0.03	***
Health insurance				
Private Non HMO	Reference		Reference	
Private HMO	0.00		-0.00	
Medicaid Non HMO	-0.17	***	-0.13	***
Medicaid HMO	-0.15	***	-0.10	***
Medicare	-0.01		-0.01	
Uninsured	-0.08	***	-0.05	***
Unemployed	-0.07	***	-0.06	***
Family Income	0.02	***	0.02	***
House Ownership				
Own	Reference		Reference	
Rent	-0.01	***	-0.02	***
Other arrangement	-0.02	*	-0.04	***
US region				
Northeast	Reference		Reference	
West	-0.01	**	-0.01	***
Midwest	0.00		0.00	
South	-0.02	***	-0.01	**
Living in MSA	0.01	***	0.01	**
Body Weight Categories				
Underweight BMI<18.5	-0.08	***	-0.05	***
Normalweight 18.5<=BMI<25	Reference		Reference	
Overweight 25<=BMI<30	-0.02	***	-0.00	
Obesity 30<=BMI<40	-0.05	***	-0.04	***

Morbidly Obesity	BMI>=40	-0.15	***	-0.09	***
Year					
2000		Reference		Reference	
2001		0.02	***	0.03	***
2002		0.03	***	0.04	***
2003		0.03	***	0.04	***
Main Disease Categories					
Diabetes		-0.06	***	-0.08	***
Hypertension		0.00		-0.01	***
Lipid metabolism disorders		0.02	***	0.01	**
Anxiety disorders		-0.13	***	-0.07	***
Acute myocardial infarction		-0.08	**	-0.08	***
Congestive heart failure		-0.15	***	-0.18	***
Cerebrovascular diseasevd		-0.16	***	-0.17	***
Peripheral vascular diseasevd		-0.04		-0.07	**
Atherosclerosis		-0.05	**	-0.06	***
Chronic obstructive pulmonary disease		-0.04	***	-0.05	***
Asthma		-0.07	***	-0.04	***
Osteoarthritis		-0.16	***	-0.06	***
Osteoporosis		-0.06	***	-0.01	
Affective disorders		-0.24	***	-0.15	***
Migraine		-0.08	***	-0.05	***
Constant		0.48	***	0.18	***
R-squared		0.16		0.20	

*: 10% significant level; **: significant at the 5% level; ***: significant at the 1% level.

[1] Family income variable is normalized to lie between zero and one in the regressions.

Table 3: First stage results for medical expenditures (EuroQol)

	Ordinary least square	
	Natural logarithm	
Variables	Health expenses in 2003 dollars	
Age, natural logarithm	0.60	***
Male	-0.35	***
Married	0.03	**
Race		
White, non-Hispanic	Reference	
African American, non-Hispanic	-0.30	***
Other races, non-Hispanic	-0.31	***
Hispanic	-0.33	***
Years of schooling		
Less than 9 years	-0.08	***
9-11 years	-0.03	
12 years	Reference	
13-15 years	0.04	**
16 years or more	0.15	***
Health insurance		
Private Non HMO	Reference	
Private HMO	-0.05	***
Medicaid Non HMO	0.49	***
Medicaid HMO	0.27	***
Medicare	0.17	***
Uninsured	-0.55	***
Unemployed	0.21	***
Family Income	0.01	
House ownership		
Own	Reference	
Rent	-0.03	*
Other arrangement	0.00	
US region		
Northeast	Reference	
West	-0.05	**
Midwest	0.04	*
South	0.01	
Living in MSA	0.01	
Body Weight Categories		
Underweight BMI<18.5	0.01	
Normalweight 18.5<=BMI<25	Reference	
Overweight 25<=BMI<30	0.01	
Obesity 30<=BMI<40	0.10	***
Morbidly Obesity BMI>=40	0.20	***
Year		

2000	Reference	
2001	0.11	***
2002	0.10	***
2003	0.11	***
Disease Categories		
Diabetes	0.60	***
Hypertension	0.43	***
Lipid metabolism disorders	0.44	***
Anxiety disorders	0.46	***
Acute myocardial infarction	1.11	***
Congestive heart failure	0.77	***
Cerebrovascular disease	0.79	***
Peripheral vascular disease	0.47	***
Atherosclerosis	0.54	***
Chronic obstructive pulmonary disease	0.27	***
Asthma	0.47	***
Osteoarthritis	0.45	***
Osteoporosis	0.33	***
Affective disorders	0.78	***
Migraine	0.37	***
IV		
MDs per 1000 population	0.12	**
Adrisk	0.05	***
Seatbelt	0.08	***
Constant	4.38	***
R square	0.26	

*: 10% significant level; **: significant at the 5% level; ***: significant at the 1% level.

Table 4: Selected coefficients using 2 stage least square

	2 stage least square Natural logarithm			
Variables	EUROQOL		RATESCALE	
Health expenses in 2003 dollars, natural logarithm	0.26	***	0.19	***
Age, natural logarithm	-0.28	***	-0.19	***
Male	0.09	***	0.06	***
Married	0.00		0.00	
Race				
White, non-Hispanic	Reference		Reference	
African American, non-Hispanic	0.07	***	0.06	***
Other races, non-Hispanic	0.08	***	0.04	**
Hispanic	0.12	***	0.08	***
Years of schooling				
Less than 9 years	-0.04	***	-0.06	***
9-11 years	-0.03	***	-0.02	***
12 years	Reference		Reference	
13-15 years	0.02	**	0.01	
16 years or more	0.02		-0.01	
Health insurance				
Private Non HMO	Reference		Reference	
Private HMO	0.02	***	0.01	*
Medicaid Non HMO	-0.31	***	-0.23	***
Medicaid HMO	-0.23	***	-0.16	***
Medicare	-0.06	***	-0.04	***
Uninsured	0.10	**	0.07	***
Unemployed	-0.14	***	-0.10	***
Family income	0.02	***	0.01	***
House Ownership				
Own	Reference		Reference	
Rent	-0.01		-0.01	*
Other arrangement	-0.02		-0.03	***
US region				
Northeast	Reference		Reference	
West	0.00		0.00	
Midwest	-0.01		-0.01	
South	-0.02	**	-0.01	
Living in MSA	0.01		0.00	
Body Weight Categories				
Underweight BMI<18.5	-0.08	***	-0.05	***
Normalweight 18.5<=BMI<25	Reference		Reference	
Overweight 25<=BMI<30	-0.02	***	-0.01	
Obesity 30<=BMI<40	-0.08	***	-0.06	***
Morbidly Obesity BMI>=40	-0.20	***	-0.13	***

Year				
2000	Reference		Reference	
2001	-0.01		0.01	
2002	0.00		0.02	**
2003	-0.01		0.02	*
Disease Categories				
Diabetes	-0.24	***	-0.21	***
Hypertension	-0.13	***	-0.11	***
Lipid metabolism disorders	-0.11	***	-0.09	***
Anxiety disorders	-0.27	***	-0.17	***
Acute myocardial infarction	-0.42	***	-0.32	***
Congestive heart failure	-0.39	***	-0.35	***
Cerebrovascular disease	-0.40	***	-0.35	***
Peripheral vascular disease	-0.18	***	-0.18	***
Atherosclerosis	-0.22	***	-0.18	***
Chronic obstructive pulmonary disease	-0.13	***	-0.11	***
Asthma	-0.22	***	-0.15	***
Osteoarthritis	-0.29	***	-0.16	***
Osteoporosis	-0.16	***	-0.08	***
Affective disorders	-0.48	***	-0.32	***
Migraine	-0.19	***	-0.13	***
Constant	-0.86	***	-0.79	***

*: 10% significant level; **: significant at the 5% level; ***: significant at the 1% level.

EuroQol regression:

Hansen J statistic (overidentification test of all instruments): Chi-sq(3) P-val = 0.87

First-stage F value = 13.68

Weak identification test (Cragg-Donald Wald F statistic): 18.84

Rating scale regression:

Hansen J statistic (overidentification test of all instruments): Chi-sq(3) P-val = 0.17

First-stage F value = 13.68

Weak identification test (Cragg-Donald Wald F statistic): 18.84

Table 5: Selected coefficients using 2 stage least square by age groups

	2 stage least square			
	Natural logarithm			
Variables[1]	EUROQOL[2]		RATESCALE[3]	
Health expenses in 2003 dollars, natural logarithm				
Entire sample	0.26	***	0.19	***
By age group				
Less than or equal to 45 years old	0.20	**	0.25	***
Between 46 and 64	0.34	***	0.14	**
Greater than 64 years old	0.23		0.30	**

*: 10% significant level; **: significant at the 5% level; ***: significant at the 1% level.

[1]-Explanatory variables also include gender, marital status, races, years of schooling, health insurance, employment status, house ownership status, annual family income in natural logarithm, US region, living in MSA, body weight, survey year and current diseases (diabetes, hypertension, hyperlipidemia, acute myocardial infarction, congestive heart failure, cardiovascular disease, peripheral vascular disease, atherosclerosis, chronic obstructive pulmonary disease, asthma, osteoarthritis, osteoporosis, anxiety disease, affective disorder, and migraine).

[2] EUROQOL: quality of life scale.

[3] RATESCALE: self health rating scale.

Table 6: Selected coefficients in 2sls using different combinations of IV

Variables[1]	2 stage least square							
	Natural logarithm							
	adrisk, seatbelt, #of MDs[4]		adrisk, seatbelt		seatbelt, #of MDs		adrisk, # of MDs	
Health expenses in 2003 dollars,								
EuroQol[2]	0.26	***	0.25	***	0.26	***	0.28	***
Less than or equal to 45 years old	0.20	**	0.19	*	0.10		0.45	**
Between 46 and 64	0.34	***	0.31	**	0.40	**	0.33	**
Greater than 64 years old	0.23		0.20		0.46	*	0.02	
Health expenses in 2003 dollars,								
Rating Scale[3]	0.19	***	0.20	***	0.24	***	0.10	**
Less than or equal to 45 years old	0.25	***	0.29	***	0.14	**	0.27	**
Between 46 and 64	0.14	**	0.14	**	0.30	**	-0.04	
Greater than 64 years old	0.30	**	0.32	*	0.45	*	0.11	

*:10% significant level; **: significant at the 5% level; ***: significant at the 1% level.

[1] Explanatory variables also include gender, marital status, races, years of schooling, health insurance, employment status, house ownership status, annual family income in natural logarithm, US region, living in MSA, body weight, survey year and current diseases (diabetes, hypertension, hyperlipidemia, acute myocardial infarction, congestive heart failure, cardiovascular disease, peripheral vascular disease, atherosclerosis, chronic obstructive pulmonary disease, asthma, osteoarthritis, osteoporosis, anxiety disease, affective disorder, and migraine).

[2] EUROQOL: quality of life scale.

[3] Rating Scale: self health rating scale.

[4] # of MDs: County level number of non-hospital based physicians per 1,000 population.

Table 7: Selected coefficients in 2sls using different combinations of IV

Putting the third IV in the second stage

Variables[1]	2 stage least square							
	Natural logarithm							
	adrisk, seatbelt, #of MDs[4]		adrisk, seatbelt		seatbelt, # of MDs		adrisk, # of MDs	
Health expenses in 2003 dollars,								
EuroQol[2]	0.26	***	0.25	***	0.26	***	0.28	***
Third IV coeff. in second stage					adrisk		seatbelt	
			0.00	ns	0.00	ns	0.00	ns
Health expenses in 2003 dollars,			# of MDs		adrisk		seatbelt	
Rating Scale[3]	0.19	***	0.20	***	0.24	***	0.11	**
Third IV coeff. in second stage			# of MDs		adrisk		seatbelt	
Rating Scale			0.00	ns	-0.01	ns	0.01	**

*:10% significant level; **: significant at the 5% level; ***: significant at the 1% level.

[1] Explanatory variables also include gender, marital status, races, years of schooling, health insurance, employment status, house ownership status, annual family income in natural logarithm, US region, living in MSA, body weight, survey year and current diseases (diabetes, hypertension, hyperlipidemia, acute myocardial infarction, congestive heart failure, cardiovascular disease, peripheral vascular disease, atherosclerosis, chronic obstructive pulmonary disease, asthma, osteoarthritis, osteoporosis, anxiety disease, affective disorder, and migraine).

[2] EUROQOL: quality of life scale.

[3] Rating Scale: self health rating scale.

[4] # of MDs: County level number of non-hospital based physicians per 1,000 population.

Figure 1.

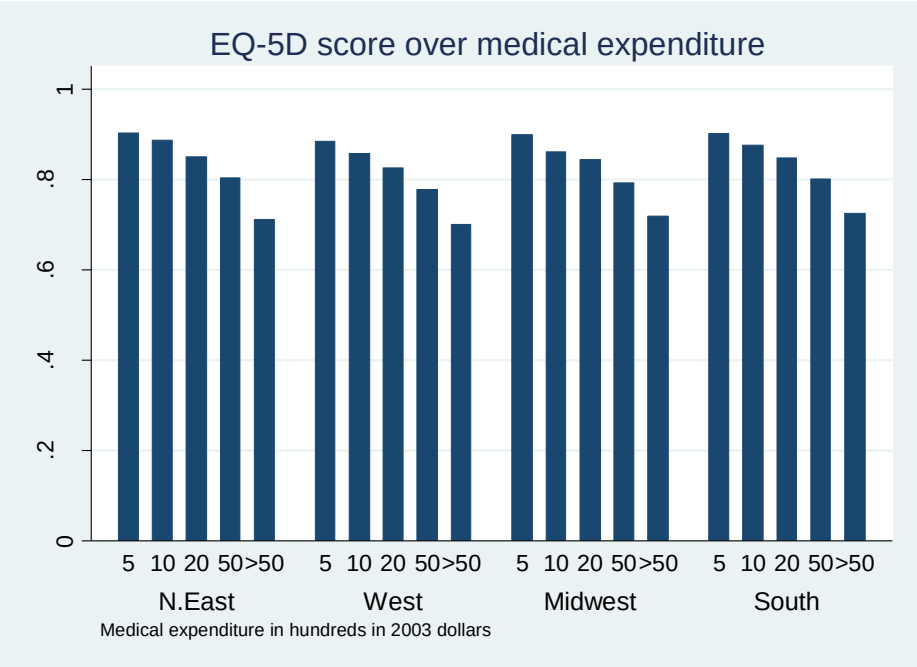
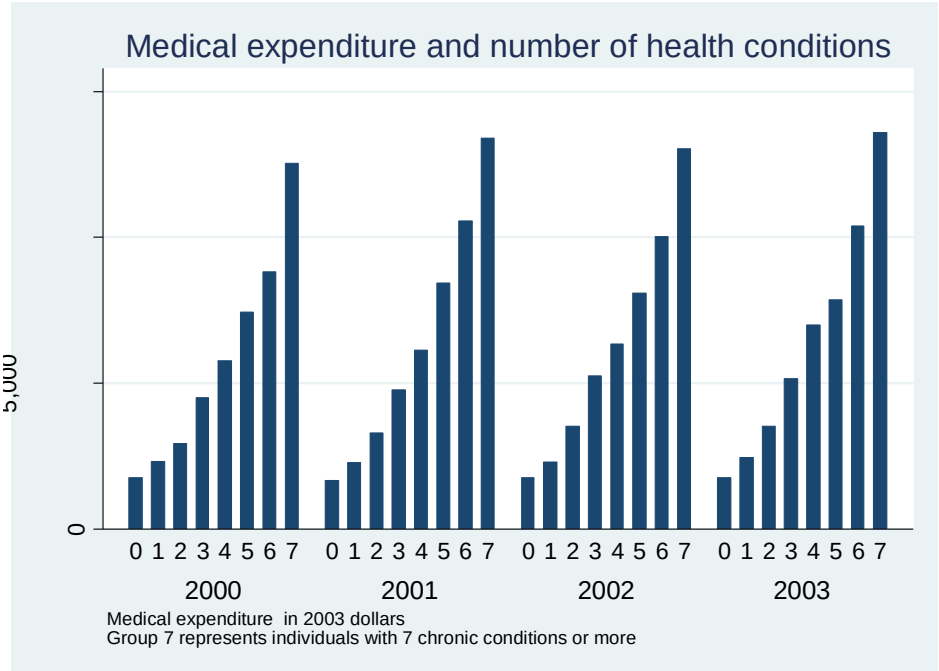


Figure 2.



Survey Questions for Adverse risk and Seatbelt Variables

Source: Medical Expenditure Panel Survey

ADRISK42[1]: MORE LIKELY TO TAKE RISKS 2.0 NUM 2286 2287

-9 NOT ASCERTAINED

-1 INAPPLICABLE

1 DISAGREE STRONGLY

2 DISAGREE SOMEWHAT

3 UNCERTAIN

4 AGREE SOMEWHAT

5 AGREE STRONGLY

SEATBE53[2]: WEARS SEAT BELT

-9 NOT ASCERTAINED

-8 DK

-7 REFUSED

-1 INAPPLICABLE

1 ALWAYS

2 NEARLY ALWAYS

3 SOMETIMES

4 SELDOM

5 NEVER

6 NEVER DRIVES/RIDES IN A CAR

[1] In the regression, we set adrisk=1 if people answered ADRISK42==1 or 2, rest equal to zero.

[2]In the regression, we set seatbelt=1 if people report always wearing seatbelt, rest equal to zero.