THREE ESSAYS ON HEALTH CARE SPENDING

By

MINKYOUNG YOO

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ABSTRACT OF THE DISSERTATION

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Dissertation Director:
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This dissertation is composed of three essays that consider the determinants and persistence of health care spending and how policies that control increasing health care costs affect the distribution of health care spending in the U.S. In the first essay, I study the association between education and health care spending for a set of health conditions amenable to self-management. Empirical findings from estimated health expenditure models reveal strong inverse relationships between education and health care spending among elderly adults with hypertension and/or asthma. Additionally, I find that greater educational attainment is associated with a reduced likelihood of being in the top 5% of health care spenders for elderly adults with hypertension and nonelderly adults with diabetes, and also with less severe conditions.

The second essay assesses how the distribution of family out-of-pocket health care spending has been affected by changes in recent cost-sharing to understand the effectiveness of the risk protection function of private health insurance against high medical care expenses. The results suggest that families who rely more on health care because of one or more their member's existing health conditions are most affected by changes in cost sharing during the period 2001-2005 and the increased exposure to out-

of-pocket spending occurrs primarily for families at higher percentiles of the out-of-pocket spending distribution, thus reducing the "return" to risk protection from holding private health insurance.

The final essay examines the dynamics of out-of-pocket health care spending by looking at the persistence of such spending among Medicare beneficiaries. The findings suggest that having a certain chronic condition or a health shock clearly increases the probability of out-of-pocket health care spending persistence. Additionally, having an existing health insurance that supplements Medicare coverage or the acquisition of a new supplementary health insurance has a significant impact on the probability of persistence.

To my beloved parents,

Yangjun Yoo and Haesook Jeong

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Chapter 1

Does Increased Education Lower Health Care Spending? Findings for Self-Managed Health Conditions

1.1. Introduction

There is substantial evidence indicating that higher educational attainment is causally related to improved health (Cutler and Lleras-Muney 2006, Grossman and Kaestner 1997). The theoretical basis for this relationship is found in the Grossman (1972a, 1972b) model of health production. This model posits that increased educational attainment improves individual health through greater productive efficiency: more highly educated individuals are able to produce more health from a given amount of medical care inputs and their own time. Alternatively, others have argued that greater education leads to improved health through greater allocative efficiency: more highly educated individuals are better informed about the true effects of inputs on health and thus able to make more efficient input choices compared to those with less education (Rosenzweig and Schultz 1983a, 1983b). For example, such individuals may possess more knowledge about the effectiveness of medical care and may have better communication with their providers.

Both interpretations of the role of education in the health production process are also consistent with the notion that increased education leads to reductions in the cost of producing a *given level* of health. More highly educated individuals may manage their use of health care resources more efficiently than those with less education and are thus able to produce a given level of health using fewer inputs. Savings in the use of inputs then leads to reduced health care spending. In this paper, I formally present and empirically test the implications of increased education for health care spending. I focus on health conditions amenable to self-management - hypertension, diabetes, and asthma - to test the cost saving effects of increased educational attainment. Using data from

Medical Expenditure Panel Survey (MEPS) for a period from 2002 to 2006, I estimate a two-part generalized linear models (GLM) of health spending focusing on the role of education. My findings suggest that increased education may reduce health care spending to produce a given level of health by more efficient use of health care inputs and time in the production of health. Although I generally find the education – health spending gradient to be negative for these self-managed conditions, the findings are not precisely measured. However, findings for individuals with asthma and/or hypertension support the underlying theory.

The structure of this paper is as follows. I introduce theoretical framework and hypothesis of the paper in section II and III. In section IV, I describe the data and in section IV, I briefly describe each self-managed health condition. I then state the research approach and construction of the health care spending model and variables in section VI. Finally, I present empirical findings in section VII and concluding remark in section VIII.

1.2. Theoretical framework

To provide a framework for my subsequent analysis, I draw upon Grossman's (1972) interpretation of the role of education in health production. I consider the health product0ion function $\mathrm{I} = \mathrm{I}(\mathrm{M}, \mathrm{T}; \mathrm{Edu})$, where I is gross investment in health, M is the amount of medical care inputs, T is the time used in the production of health, and Edu is education, an "environmental" variable that affects the efficiency of the health production process. The cost of producing health is $\mathrm{C} = \mathrm{P}_{\mathrm{M}} \cdot \mathrm{M} + \mathrm{P}_{\mathrm{T}} \cdot \mathrm{T}$, where P_{M} is the price of medical care inputs and P_{T} is the price of time. For a given level of health (assuming a static one-period model), costs are minimized when $\frac{P_T}{MP_T} = \frac{P_M}{MP_M}$ where MP_T is the marginal product of time and MP_M is the marginal product of medical care inputs. As noted by Grossman (1972)'s assumption of neutral "technical change" due to increased education, education increases the marginal products of these inputs equally, and for given input prices, results in a reduction in the total cost of producing a given level of health. [1] Put differently, more highly educated individuals are expected to use fewer resources – both health care and time – to produce a given level of health compared to those with less education, and this will lead to lower spending on medical care and reduced time costs. In this paper, I focus on the implications of increased education for spending on medical care.

The impact of education on the health production process in a given period, from the perspectives of production, cost, and allocative efficiency can be illustrated using a standard isoquant diagram for the production of a given level of health ($\overline{H}$) using inputs of medical care and time. In figure 1.1, I illustrate the cost-minimizing input mix for a given level of health production for two individuals with different levels of education. Each isoquant is derived from a production function of health with medical care and time (figure 1.2).[2] The corresponding isoquant curve for highly educated person is $\overline{H}_{EDU_{high}}$ and that for less educated person is located to the northeast of $\overline{H}_{EDU_{high}}$, i.e., $\overline{H}_{EDU_{low}}$.To produce a given level of health, a less educated person needs to consume more of both medical care and time $(M_{EDU_{low}}, T_{EDU_{low}})$ than more educated person $(M_{EDU_{high}}, T_{EDU_{high}})$. Note that both point A and B produce same level of health and are

[1] If non-neutral technical change due to education increased the marginal product of medical care relative to the marginal product of time, individuals would, in fact, increase their use of medical care in producing a given level of health and spending on medical care would increase.

[2] The production function of health with time is not displayed, but analogous with a production function of health with medical care.

allocatively efficient while point A reflects greater productive efficiency since it produces the same level of health as point B but uses less of both medical care and time as illustrated in figure 1.2. That is, a person with more education, regardless of the input combinations selected, incurs lower medical care and time costs to produce a given level of health. With medical care and time input prices held constant, the associated higher isocost line for a person with low education, $C_{EDU_{low}}$, reflects the higher level medical care spending even if cost minimizing point B is attained.

Alternatively, a person with less education may be allocatively inefficient in the production of health rather than technically or productively inefficient. Such a case is illustrated at point C or D where a person with less education is an inefficient producer of health not because he/she is technically or productively inefficient but because he/she is allocatively inefficient in selecting the least cost combination of medical care and time to produce a given level of health. As a result, a person with less education faces a higher iso-cost curve, which resides the northeast of the initial iso-cost line $C_{EDU_{high}}$, incurring higher cost to produce the same level of health. Finally, points E and F on isoquant $\overline{H}_{EDU_{low}}$ represent both productive and allocative inefficiencies in the production of health and input allocations incurring even higher costs to produce the same level of health.[3]

Although underlying theory supports the notion that higher education may lead to lower medical care spending, the impact of educational attainment on such spending has

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[3] Individuals at allocatively inefficient points such as a point D or F (to the left of cost-minimizing point) use more medical care services and less time than individuals at a point A or B. This requires higher overall spending to produce a given level of health as well as increased spending for medical care. Individuals at points C or E (to the right of cost-minimizing point) use more time and less medical care yielding requiring lower spending on medical care but higher overall costs of producing health. Hence the some of the association between higher educational attainment and reduced health care spending can be offset by allocative inefficiency.

not been explicitly studied. In this paper, I address this issue by examining a set of health conditions in which individuals are able to influence the amount of medical care resources used through their own self-management of care. While I do not distinguish between the productive and allocative efficiency hypotheses that may underlie the production of health, I consider the logical consequences of such efficiency for health care expenditures and time – that more highly educated individuals will be more efficient producers of health and thereby economize on the medical care resources and time utilized in producing given levels of health.[4] I consider the empirical relationship between educational attainment and health care spending focusing specifically on three health conditions amenable to self-management: hypertension, diabetes, and asthma. By comparison, I also consider whether education has an impact on overall health spending for all health conditions.

1.3. Educational attainment and health care expenditure: the role of self-management of care

A number of factors have been identified as contributing to health inequalities across different educational attainment groups, although disagreement remains as to the precise way in which education affects health. Proposed factors include improved economic status, better access to timely health care, individual preferences that favor investments in health, safer occupations and better working conditions, access to better medical information, and improved cognitive ability (Cutler and Lleras-Muney 2006).

[4] This paper focuses on the efficiency for medical care spending. I cannot empirically study the efficiency for time because data for time use is not available.

These differences may be associated with greater educational attainment and yield a positive relationship between education and health status.

I hypothesize that more years of schooling lead to reductions in medical care expenditures for a given level of health through better self-management of care. The self-management of care includes the ability to comprehend and adhere to a treatment procedure, improved decision making ability regarding health treatments, and knowledge about advanced technology. Goldman and Smith (2002) showed that highly educated individuals with diabetes and HIV are more likely to observe treatment protocols. Such compliance requires them to understand the necessity of medical care, comprehend treatment requirements, and then to choose the most suitable treatment. Individuals are then required to implement their treatment correctly and persistently. Those with more education are more likely to possess these characteristics and skills and then to lead significant health disparities.

Another mechanism Goldman and Smith (2002) identified is different decision making abilities across educational groups. Treatment often requires critical independent judgment and adjustment. For example, type 1 diabetics need to decide their insulin intake based on constant monitoring their levels of blood glucose. Additionally, they have to be able to understand how they react to insulin in different circumstances, which allow them to adjust their further treatment. In the similar context, literacy is also a crucial skill for decision making. A study by Williams, et al. (1998) showed that lower literacy level could lead poor understanding about asthma and its medical treatment. Finally, more educated individuals are better able to take benefits from advanced technologies than the less educated. For example, highly educated individuals tend to know and understand more about new medical advances and health care treatments, and hence can more readily seek out and obtain access to such advances. Glied and Lleras-Muney (2003) tested this hypothesis by analyzing different education gradients among diseases that are at different stages of technical progress. They found that those with greater education were more likely to take advantage of these innovations and to have better health outcome.

I examine this hypothesis by health condition, age group, and gender. By focusing on individuals with particular health problems, I can assess how increased education affects health care spending for specific conditions that are amenable to self management and thus likely to be influenced by differences in education. I also expect that I can capture the differences in health production by health conditions. Next, I consider individuals who are age 24 or above have completed their education (are non-students). I do so because for some current students, poor health may have impeded their educational progress and led to greater health spending, and this could over state any relationship between lower education and higher health spending. Additionally, I consider two age groups, nonelderly adults (ages 24-64) and elderly adults (age 65 or above). A major difference between these two groups is their health insurance status. Many nonelderly adults have private health insurance that is obtained from their own employment or that of a spouse, while most of the elderly population has publicly provided Medicare. In addition, I expect that these groups differ with regard to unobserved tastes or preferences for health care as well as by unobserved health care “needs.” Finally, I study the education – health spending relationship by gender since it is well-known that women use more health services than men.

1.4. Data

The data used in this study is the household component of the Medical Expenditure Panel Survey (MEPS-HC) conducted by the Agency for Healthcare Research and Quality (AHRQ). The MEPS is a nationally representative household 2-year panel survey that provides national estimates of health care use, sources of payment, health insurance coverage, and demographic and socioeconomic characteristics for the U.S. civilian non-institutionalized population. It also contains information on medical conditions and medical care expenditures associated with each medical event during the survey year. For this study, I merge the following MEPS-HC data files: the Full Year Consolidated household data file; the Medical Condition file; and the Medical Event Files for the years of 2002 to 2006. By pooling multiple years, I am able to obtain a sufficiently large number of observations for the condition categories that I consider (discussed below). The total sample size is 171,878 individuals consisting of 153,560 nonelderly adults and 18,318 elderly adults.

For the analysis, I consider three health conditions amenable to patient self-management reported by respondents in the Medical Condition file: hypertension, diabetes, and asthma. These conditions are defined by the MEPS summary data table[5] which categorizes conditions using Clinical Classification System (CCS) categories. In the MEPS, only individuals with a "priority condition", a prior designated condition due to its prevalence, expense, or relevance to policy, had been interviewed about the severity of their conditions. I, therefore, consider only individuals with priority condition in order

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[5] Available at
http://www.meps.ahrq.gov/mepsweb/data_stats/tables_compendia_hh_interactive.jsp?_SERVICE=MEPSSocket0&_PROGRAM=MEPSPGM.TC.SAS&File=HCFY2005&Table=HCFY2005%5FCNDXP%5FC&_Debug=
. Last accessed on Aug. 20th, 2010.

to include measures of the severity of conditions in the model. By holding severity constant, I can reduce variation in condition-specific health status.

The MEPS-HC Event files[6] report detailed medical expenditure data for each condition. Specifically, for each condition, these files include information on prescribed medicines, hospital inpatient stays, emergency room visits, outpatient visits, and office-based medical provider visits in separate files. Each file also provides information on medical care payments made for each service used in the treatment of a condition. Total annual medical care expenditures for this analysis are defined as the sum of payments for health care received for each event, including out-of-pocket payments made by the individual as well as payments made by private insurance, Medicaid, Medicare and other sources. Total medical care expenditures for each condition are then defined as total annual medical care expenditures associated with that condition. [7]

1.5. Self-managed Health Conditions

1.5.1. Hypertension

Hypertension, often called as high blood pressure, is a medical condition in which the blood pressure is chronically elevated. In 2005, more than 4.5 million individuals were diagnosed with hypertension and total health care spending for hypertension exceeded $485 billion, making hypertension sixth in the ranking of spending for medical conditions.[8] Treatment for hypertension starts with lifestyle modifications and may also

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[6] All conditions are linked to the MEPS event-level files by the MEPS Condition-Event Link File (CLNK) and the Prescribed Medicines-Event Link File (PLNK).
[7] All data on medical care costs are expressed in 2006 dollars.
[8] Tabulations from the Medical Expenditure Panel Survey available at http://www.meps.ahrq.gov/mepsweb/data_stats/tables_compendia_hh_interactive.jsp?_SERVICE=MEPSSocket0&_PROGRAM=MEPSPGM.TC.SAS&File=HCFY2005&Table=HCFY2005%5FCNDXP%5FC&_Debug=. Last accessed on Aug. 20th, 2010.

involve the use of prescription medications to control blood pressure. Lifestyle changes such as diet, physical exercise, and weight control have been shown to reduce blood pressure significantly. Taking medication on a regular basis is also an important part of treating hypertension and keeping blood pressure within a healthy range.

Self-management is crucial to the treatment of hypertension. The close relationship between educational attainment and good lifestyle is well-known: more educated individuals tend to have a healthy diet, exercise regularly, and maintain a healthy weight (Cutler and Lleras-Muney 2006). In addition, one needs to have knowledge about the nature of the condition and the appropriate use of medication, and to have the discipline to take medicines regularly and the ability to do so as directed. Additionally, those with more education are more likely to recognize hypertensive symptoms earlier, go to doctor’s office sooner, acquire and assimilate knowledge about the condition and treatment, and adhere to treatment regimens. To the extent that such behavior leads to fewer medical encounters and a reduction in the severity of hypertension, I expect total medical expenditure on hypertension to decline with greater educational attainment.

1.5.2. Diabetes

Diabetes mellitus is a chronic health condition caused by high blood sugar (glucose) levels that result from either insufficient production of insulin (type 1 diabetes), or inability of body cells to respond to the insulin (type 2 diabetes). Although both types of diabetes are treatable due to the availability of insulin beginning in 1921, it is a serious illness that usually cannot be completely cured. Diabetes without proper treatments can cause many serious, long-term complications such as heart disease, hypoglycemia (a low level of blood glucose), diabetic ketoacidosis (a complication resulting from an absolute shortage of insulin), or hyperosmolar nonketotic state (HNS: a type of metabolic derangements with a high mortality seen in diabetes mellitus type 2 patients). Adequate medical treatment of diabetes is thus crucial along with efforts to control blood pressure and address lifestyle factors such as smoking, alcohol consumption, lack of regular exercise, unhealthy diet, and unhealthy body weight.

While appropriate medication (insulin) is necessary in the case of type 1 diabetes, lifestyle modification is the crucial part of treatment for type 2 diabetes, which accounts for nearly 90% of diabetes cases. Unfortunately, considerable knowledge deficits in self-management exists in 50% to 80% of diabetic people and more than half of diabetic people fail to manage appropriate glycemic control (Clement 1995). This suggests that education may play an important role in patient understanding of the nature of the condition, its treatment, and thus, in the appropriate management of this health problem. It is also known that the diabetes self-management education (DSME), the process of teaching people to manage their diabetes, is effective in improving glycemic control (Norris et.al. 2002). Thus to the extent that individuals with higher education are better able to assimilate information regarding appropriate self-management of care than those with lower education, their use of formal medical care, and thus their medical care expenditures may be lower.

1.5.3. Asthma

Asthma is a chronic lung disease that inflames the airways causing recurring symptoms (wheezing, coughing, chest tightness, and shortness of breath), airflow obstruction, and bronchospasm (a sudden constriction of the muscles in bronchioles). About seven percent of the population in the U.S. suffers from asthma and nearly one in thirteen children in the U.S. has asthma (President's Task Force on Environmental Health Risks and Safety Risks to Children, 1999). Although asthma is caused by both environmental and genetic factors, researches indicate that the genes that are associated with asthma do not solely trigger asthma under every condition, indicating the crucial role of environmental risk factors. Environmental risk factors such as tobacco smoke, especially maternal cigarette smoking for children and low air quality from traffic pollution or high ozone levels are associated with high risk of asthma prevalence. Additionally, viral respiratory infections, caesarean sections, psychological stress, and antibiotic use early in life are the leading triggers of asthma.

Although asthma can be controlled, it cannot be accomplished without patient education and involvement in management strategies. Patients can learn to identify triggers and avoid them, and educate themselves about medications and self-monitoring. On this basis, the more knowledge a patient with asthma has, the better asthma can be controlled. To the extent that individuals with more education can effectively identify and avoid circumstances that trigger an occurrence of asthma and are more disciplined and knowledgeable about medications and condition management, those with higher educational attainment may incur lower monetary treatment expenditures compared to those with lower educational attainment.

1.6. Econometric Analysis

1.6.1. Model Specification

To model health care expenditures for each of the conditions, I must account for two important characteristics of the health expenditure distribution. First, the distribution of health spending is characterized by a non-trivial and potentially large number of individuals with zero expenditure. Next, expenditures for individuals with positive spending are highly positively skewed. To address these issues, I apply the widely used two-part expenditure model in which I first model the likelihood that an individual incurs health care expenditures and then model the level of spending conditional on an individual having positive expenditures. Using the two-part model also recognizes that the decision to incur health care spending may differ from the decision regarding the amount of such spending reflecting the fact that the common covariates may have different effects in each equation. The predicted estimates from each part of the model are combined to obtain expected health expenditures for each person in the sample (i.e., the predicted probability that an individual will incur health spending multiplied by predicted expenditures for each person). I use a logit model for the first part of the model characterizing a person's decision to incur any medical expenditure and use a generalized linear model (GLM) specification for the second part of the decision process representing the level of medical care spending conditional on any use of services.

As noted, health care spending is highly positively skewed. As a result, it has become a standard practice to transform expenditures into natural logarithm in order to reduce the skewness of the expenditure distribution and then to estimate a log-linear model of health spending conditional on incurring an expenditure. The predicted log expenditures from such a model are then re-transformed to a natural scale whose expected value depends on the variance from the log regression (Manning 1998). In general, if the error term from the log-linear regression is not normally distributed, the re-transformed expenditure predictions are obtained by multiplying predicted natural expenditures by a non-parametric "smearing" factor.[9] However, recent methodological works point to important shortcomings of this approach. In particular, Manning (1998), Manning and Mullahy (2001), and Buntin and Zaslavsky (2004) have noted that if the residuals from the estimated model are heteroskedastic, the re-transformed expenditure predictions will be biased. Should this be the case, separate smearing estimates are required for each class of right-hand side variables correlated with the error term, and this can be a cumbersome and difficult process to implement. To avoid this potential problem, I follow recent research on expenditure modeling and estimate conditional expenditures by applying GLM models. Based on tests described below, I use a GLM model with a logarithmic link function and specify the variance to be either proportional to the mean squared (a Gamma distribution) or proportional to the conditional mean (a Poisson distribution). An additional advantage of the GLM model is that it assumes a variance function that models heteroskedasticity and that the estimation method retains the original scale and thus requires no retransformation.

Finally, to examine the protective effect of educational attainment on incurring very high medical spending, I also model the relationship between higher educational attainment and the likelihood of being in top 5% of medical spending for each health condition. For this analysis, I apply a logit specification. My expectation is that higher

[9] The smearing factor is the average of the exponentiated residuals from the log regression (Manning 1998).

educational attainment will be associated with a reduced likelihood that a person's health care spending will fall above this spending threshold.

1.6.2. Functional form

The first part of the expenditure model predicts the probability of any health care use, specified as a logit function:

$$(1)\ \ \Pr(\text{spending}_i > 0) = \frac{e^{X'\alpha}}{1 + e^{X'\alpha}}$$

with explanatory variables (the vector X') described below. Next, as noted above, I apply GLM specifications to model the level of health care spending conditional on positive health care spending. To identify the appropriate functional form for the GLM model, I perform several tests applied to groups stratified by condition, gender, and age categories. Since the GLM model requires specification of a variance function, I apply the modified Park test to estimate the relationship between the mean and the variance of the conditional expenditure. This test is based on regressing the squared residuals from a GLM on predicted expenditures (Manning and Mullahy 2001). The Park test indicates that most of the conditional variances are proportional to the square of the conditional mean (coefficient is close to 2) which corresponds to the Gamma function, while some of GLM models indicate a conditional variance that is proportional to the conditional mean (coefficient is close to 1), which corresponds to the Poisson function. I apply the corresponding variance function that is appropriate for modeling health spending for the specific self-managed health condition.

Next, I compare mean expenditure estimates from two-part GLM models to those obtained from alternative one-part GLM models. In general, the mean expenditure estimates of the two-part model are closer to the actual sample mean values than those obtained from an unconditional GLM model. Finally, I employ the Hosmer-Lemeshow test to examine the goodness-of-fit of the two-part models. I regress the errors of predicted expenditure on dichotomous variables for the deciles of the prediction. The coefficients for the decile indicator variables are not jointly significant for every model of health care expenditure, indicating that the functional form fits the data well across the distribution of predicted expenditure.

To sum up, the basic conditional expenditure model is:

(2) $\ln\big(\mathrm{E}(spending|spending > 0; \mathrm{X})\big) = \mathrm{X}\beta + \delta\mathrm{Sev} + \varepsilon$

with a variance function specified either as a Gamma function: $\mathrm{v(spending|X)} = \lambda(\mathrm{E(spending|X)})^2$ or a Poisson function: $\mathrm{v(spending|X)} = \lambda\mathrm{E(spending|X)}$ where $\lambda > 0$. In these specifications, X is a vector of covariates that should include factors governing variation in spending, including factors associated with the price of health care and the price of time, an individual's demographic characteristics, general health status, and educational attainment and ε is a stochastic error term. SEV is a categorical variable indicating how seriously the health condition affected the person's overall health and well-being since it began. Finally, expected health care spending is obtained by combining predictions from the logit model of likelihood of use (equation 1) and the second part of the model (the conditional expenditure model equation 2):

(3) $\mathrm{E(spending_i|X_i)} = \mathrm{pr(spending_i} > 0|\mathrm{X_i}) \cdot \mathrm{E((spending|X, spending} > 0))$

1.6.3. Explanatory Variables

As described above, theory predicts that education increases the marginal products of medical care and time inputs equally, and with input prices constant, leads to a reduction in the total cost of producing a given level of health. On this basis, as illustrated in the isoquant diagram, individuals with higher educational attainment are more likely to choose an allocativly efficient and cost-minimizing input mix for a given level of health production that will yield lower medical care spending compared to individuals with less education. Testing this hypothesis thus requires that I control for variation in the level of health for the conditions examined in the sample, an adjustment which is admittedly difficult to implement.

To approximate this constraint, I model health care spending separately by self-managed health conditions and include a severity measure of each condition along with variables indicating health status. As regards the severity measure, respondents were asked a question of how seriously the specific health condition affected the person's overall health and well-being in terms of four categories: very serious, somewhat serious, not very serious, and not at all serious (in the model, the latter response represents the reference group). The general health status variable is also included in the model to control for the level of health, indicating whether an individual reports health status as poor or fair perceived health status in the model (those in good, very good, or excellent health represent the reference group). Finally, having multiple health conditions other than a major health condition may also influence health care expenditures for a given health condition by adding to treatment complexity and hence spending. On this basis, I include variables indicating the number of self-managed health conditions and the number of non-self-managed health conditions (trauma-related disorders, cancer, mental disorders, COPD, Osteoarthritis and other non-traumatic joint disorders, normal birth, back problems, or circulatory conditions[10]).

Since medical care prices will vary by geography based on variation in input prices and cost of living more generally, and because I cannot directly observe such prices, I control for differences in medical care prices using a respondent's region of residence and whether she resides in a metropolitan statistical area (MSA). I also include the health insurance status of an individual since those with health insurance may face lower prices due to insurer negotiation with providers. Additionally, having reduced out-of-pocket prices with health insurance and having higher income will likely increase the demand for medical care compared to those without coverage or with lower incomes, so I control for these factors. The number of children[11] and employment status are included in the model as proxies of the price of time, since those with children and those employed face greater demands on their time. I include marital status to capture the influence on medical spending of having a spouse who may provide his/her time to care for a partner who is ill. Accessibility to health care is captured by including a dummy variable indicating whether an individual has a usual source of care.

The key variable in the analysis is a person's educational attainment. This variable is defined using the following classification: completed less than 12 years of schooling; completed 12 years of schooling (high school graduate); completed 13-15 years of schooling (some post-secondary education); and completed 16 or more years of

[10] The first seven conditions along with three self-managed health conditions are responsible for the highest aggregate health spending in 2005 according to tabulations by the Agency for Healthcare Research and Quality. I also include circulatory conditions since this also yields a high level of aggregate spending and affects large number of health care users.
[11] Three dichotomous variables of whether a parent has at least one child age 0-6, age 7-12, and age 13-18.

schooling (college graduate and beyond). For the analysis, individuals who completed less than 12 years of schooling are considered as the reference group. Finally, an individual's demographic characteristics include age, gender, race and ethnicity are also included.

1.6.4. Condition Severity, Education, and Health Spending

As noted above, I include a severity measure of each health condition in the model (along with measures of self-reported health and comorbidities) since the underlying model considers variation in medical spending for a given level of health, and holding severity constant helps to reduce variation in condition-related health status. Another reason I include this variable is that condition severity itself may be associated with educational attainment: it may represent a pathway through which education affects health spending, thus picking up some of the impact of education on health spending.

To assess whether education does, in fact, have an impact on illness severity, I present the findings in table 1.1 (coefficients and standard errors) from a logit model[12] describing the relationship between condition severity and educational attainment. In this model, the outcome measure for severity is defined as either very severe or somewhat severe (zero if either not very sever or not at all severe). I observe that the likelihood of reporting a severe condition decreased as the years of schooling increased for both nonelderly and elderly adults with hypertension. Although mostly negative correlations between increased educational attainment and the likelihood of reporting a severe condition exist for people with diabetes and/or asthma, a few such relationships are

[12] The results from a ordered Logit model are fairly consistent with the results form a Lotgit model.

statistically significant. Hence, the influence of education on condition severity has to be addressed when I study the effect of education on health care spending.

I characterize this indirect influence of education on spending through the association between education and condition severity as a “pathway (indirect)” effect. In other words, the pathway effect recognizes that increased education leads to reduction in the level of condition severity and this, in turn, leads to reduction in health care spending. Thus, I model the education-health care expenditure relationship by first controlling for the self-reported degrees of severity of each condition. By doing so, I can isolate the pure (direct) effect of education on health spending apart from the total association between education and medical spending that includes both the direct effect and the pathway effect. Next I eliminate the severity measure in these models and obtain the “total” effect of education on health spending which includes the indirect impact of education on condition severity.

1.6.5. Potential Endogeneity of Educational Attainment

Up to now, I consider educational attainment to be a strictly exogenous factor in determining health spending. However, education may be correlated with unobserved factors such as prior health status (e.g., as a child) that could determine both educational attainment and current health spending. If this is the case, such endogeneity will yield an upward bias in the education-medical care spending gradient.[13] Unfortunately, I cannot observe prior health status in childhood or adolescence, nor is there a convenient natural experiment (e.g., such as variation in compulsory schooling laws or changes in

[13] For example, unobserved prior poor health may reduce educational attainment and also be associated with high current health spending.

government spending for education) that would yield exogenous variation in educational attainment since I have no information on a survey respondent's prior location of residence when in school or the respondent's health status at that time. Additionally, I lack a readily available instrument for prior health status, which may be applied to obtain the causal relationship. Thus, my analysis can best be interpreted in identifying an association between education and health care expenditures.

1.6.6. Addressing the MEPS Complex Survey Design

Since data collected in the MEPS are not obtained from a simple random sample, but rather from a stratified and clustered sampling design which over-samples population groups of specific interest, I need to consider such factors in obtaining descriptive estimates of health care spending and parameter estimates of the expenditure models along with their standard errors. I thus apply sampling weights to adjust for the disproportionate sampling and non-response in MEPS and to obtain population estimates for descriptive statistics and for underlying econometric relationships. I also adjust standard errors in recognition of the complex and clustered MEPS sample design using the SVY commands in STATA. In addition, since estimates of the predicted expenditures from the two-part model are derived from complex, non-linear models, I obtain standard errors via Fay's modified balanced repeated replication (BRR) (Judkins 1990). The modified BRR procedure creates replicate half-samples with the adjusted weight by 50%[14] from which a distribution of standard errors is derived and in doing so (in contrast

[14] Robert Fay suggested to adjust the weights by $\pm 100\varepsilon\%$ where $0<\varepsilon<1$ to manage the problem of undefined replicate estimates of BRR method (Judkins 1990). Rao and Shao (1999) shows that the relative bias and variance are the smallest for the modified BRR with $\varepsilon=.5$.

to other estimating procedures) preserves the distribution of the underlying MEPS sample.

1.7. Empirical Results

1.7.1. Mean Health Care Spending

For each of the health conditions noted above and for total health care spending, I first examine the mean health expenditures by educational attainment. These data are displayed in table 1.2 by health condition and educational attainment for nonelderly adults ages 24 to 64 and elderly adults ages 65 or above.[15] As the table reveals, I find some evidence of an inverse relationship between education and health spending for each self-managed condition. The inverse education – health expenditure gradient is evident among nonelderly adults with hypertension. Compared with nonelderly adults who did not complete high school education, high school graduates spent $1,218 less; those with 13-15 years of education spent $1,115 less; and individuals with 16 years of schooling or more spent $1,702 less. For diabetes, nonelderly adults with some post-secondary education and those who are college graduates and beyond spent much less on health care than individuals who did not complete 12 years of education ($1,452 less for those with post-secondary education and $2,208 less for those with a college education or higher). Similarly, health care spending decreased as education increased for nonelderly adults with asthma, particularly those who completed high school and those who educated for 16 years or more. Consistently, medical expenditures by elderly adults decreased as

[15] Significant variation in mean expenditures exists across self-managed conditions. Overall, nonelderly adults having diabetes mellitus incurred the highest mean medical expenditures average $4,030 while those having asthma spent $2,081 and those with hypertension spent the least, about $1,897.For elderly adults, asthma caused the highest mean medical expenditures ($5,029), followed by diabetes ($4.335) and hypertension ($2,201).

education increased for hypertension. For diabetes and asthma, I observe consistent inverse gradients, and these relationships are stronger for elderly adults with asthma.

In addition to mean health expenditures, I examine the likelihood of being in the top 5% of medical expenditures by educational attainment for each of the self-managed conditions (table 1.3). The findings suggest that the mean probability of being in the top 5% generally declines as education increases for nonelderly adults. I also find evidence of such an inverse education – health spending gradient for individuals age 65 or over although this relationship is smaller in magnitude than that observed for nonelderly adults. By contrast, the data in table 1.2 and 1.3 show very different results when I consider everyone in the sample regardless of whether health conditions are amenable to self-management or not. Mean health care spending increased with years of schooling among the nonelderly, while it is mostly constant among the elderly population. Similarly, the likelihood of being a high spender is fairly constant over the educational groups.

1.7.2. Econometric Results

Theory predicts that individuals with higher educational attainment require less medical care and time to produce a given level of health than individuals with lower educational attainment and thus incur lower medical care expenditures. The results from a two-part GLM model and a model of the likelihood of being a high spender (in the top 5% of spenders) partially support this expectation. The findings vary across health conditions and for specific levels of education. Tables 4 and 5 display predicted medical expenditures, while tables 6 and 7 display the predicted probability of being a top spender from these models.[16] The results are displayed by educational groups: high school graduates, individuals with some post-secondary education, and individuals with 16 years or more schooling, using individuals with less than 12 years of schooling as the reference group.

I begin by including a severity measure for each condition in the models for medical care spending and for being a top spender. As noted earlier, educational attainment also may affect the severity of health conditions. As such, the severity measure acts as a pathway through which educational attainment operates. By including severity in the expenditure models, I capture the direct effect of education on health spending and better approximate spending variation for a given level of health. I then estimate models without a severity measure in order to obtain the total effect of education on health spending capturing both the direct effects (due to technical and/or allocative efficiency) and the indirect effect of education (through the impact on the severity) on spending. The latter results yield larger inverse education-medical expenditure gradients in a number of the conditional expenditure models and in models for the likelihood of being a high spender, reflecting the fact that the effect of education on condition severity is dominating the education-health spending relationship.

1.7.2.1. Self-managed health conditions: Predicted health care spending

Nonelderly adults

When I consider the sample with self-managed health conditions, the association between health care spending and educational achievement yields some findings that are

[16] The coefficients of the two-part expenditure model and the model predicting the likelihood of being a high spender for several different specifications are presented in appendix 1-4.

consistent with the inverse education-health spending gradient relationship (i.e., lower predicted spending as education increases). However, the statistical significance of the estimated education coefficients in both parts of the model (the likelihood of incurring spending and conditional spending models) and the relationship between predicted medical care expenditures and education vary across health conditions. The predicted health spending for nonelderly adults from a two-part expenditure model is displayed in table 1.4. The only statistically significant association I observe is for health care expenditures for nonelderly females with hypertension. The predicted average medical expenditure for nonelderly females who have completed high school education is $501 less (average spending of $1,958) than those who did not complete high school (average spending of $2,459). While I also find reduced spending for females with higher educational attainment, these findings are not precisely estimated and thus, are not statistically significant. I find no evidence of the inverse spending relationship for males with hypertension and both females and males with diabetes and/or asthma.

Elderly adults

The most apparent inverse relationships are observed among elderly adults with hypertension and/or asthma (table 1.4). For hypertension, predicted average spending for elderly adults who had 12 years of schooling is $296 less (average spending of $2,213) when they are compared to those with less than 12 years of schooling (average of $2,509). This saving in medical expenditure is observed mainly by women. When I fit the model excluding a severity measure, I find a strong gradient of education: compared to those who did not complete high school (average of $2,782), predicted average medical expenditure for elderly female with hypertension who have completed high school education is $450 less (average of $2,333), $545 less for those with some college (average of $2,237), and $848 less for those with at least a college education (average of $1,935). For asthma, the only statistically significant inverse relationships between educational attainment and medical expenditure for elderly adults appear for those who had some college education. As expected, I observe larger total effect when a pathway effect is considered in the model and I hold condition severity constant (table 1.5). I find that spending is $3,424 less for individuals who had some college (average spending of $3,150) and $3,345 less for those who attained four or more years of college (average spending of $3,229) compared to those who did not (average spending of $6,574). These findings reflect the fact that increased education of elderly adults with hypertension and/or asthma is associated with less severe conditions (as shown in table 1.1) and thus results in lower health care spending. Results for all other groups of elderly individuals yield mostly negative relationships, but these are not statistically significant.

1.7.2.2. Self-managed health conditions: Predicted probability of being in top 5% of spenders

Nonelderly adults

The model prediction the likelihood of being in the top 5% of spender examines the protective effect of education on incurring very high health care spending. Results from this model reveal that the inverse education-health care spending association is statistically significant among nonelderly adults having diabetes (table 1.6). For example, when I consider the direct effect of education (top panel), diabetic adults with 16 years or more schooling show a 2.4% of probability of being a top spender, about 3 percentage point less than those who did not finish high school. When I consider men and women separately, the predicted probability of being in the top 5% of medical spending for women with hypertension who complete high school (probability of 5.3%) is 1.8 percentage points less than that for those who did not complete high school (probability of 7.2%). By contrast, I consistently do not find any statistically significant effect of education on the probability of being a high spender among nonelderly adults with asthma, and find even a positive total effect of education on health care spending for male with some college education.

Elderly adults

I observe little association between the likelihood of being in top 5% of medical expenditure and educational attainment for elderly adults (table 1.7). Findings for a few groups of elderly adults exhibit statistically significant relationships: elderly adults having hypertension with 16 years or more schooling had a 3% of probability of being a top spender, which is 1.9 percentage point lower than those with less than 12 years of schooling. This negative relationship extends to elderly women in the highest education group (probability of a 1.8%), 2.9 percentage points less than the comparison group (probability of 4.5%). The total effect of education remains consistent with the direct effect (bottom panel of table 1.7).

1.7.2.3. Predicted health care spending and probability of being in top 5% of spenders: Full sample

As a comparison, I provide the predicted health spending and probability of being a high spender for everyone in the sample regardless of whether or not they had any of the three self-managed health conditions (table 1.8). In contrast to findings for self-managed condition, the MEPS data generally reveal a positive association between medical care spending and educational attainment. This finding is also obtained for estimates of the likelihood of being in the top 5% of spenders although results for elderly adults show only a weak positive association between education and this probability. These results may reflect the fact that when conditions less amenable to self-management are included, the benefits of increased education on health spending may be less apparent. In this regard, medical care use becomes more important than self-management of care and individuals with more education recognize the importance health care use and as a result spend more on care when ill.

1.8. Conclusions

The theory underlying health production suggests that increased education can lead to reduced health care spending through greater productive and allocative efficiency in the use of medical care compared to individuals with low educational attainment. Although a large volume of research has examined the influence of educational attainment on health, impact of education on spending for health care has not been considered. The primary contribution of this study is to explicitly investigate the relationship between educational attainment and health care expenditures for people who have health conditions amenable to self-management where higher educational attainment would be expected to yield greater efficiency in health care use.

The results from a two-part GLM health care expenditure model and a model of likelihood of being in top spender provide some limited support for the underlying theory. I see clear evidence of an inverse education health spending gradient when I consider the sample of having self-managed health conditions although many of the results are imprecisely measured. In contrast, when I consider all individuals regardless of their health condition, I observe mostly a positive association between health care spending and educational attainment, reflecting that highly educated individuals are more likely to spend more on preventive care, care when ill, and follow-up care than less educated individuals, and the fact that education may have less of an impact for many severe illnesses.

One of the key findings from the health expenditure model is the significant inverse gradient of the effects of education among individuals with hypertension, particularly for elderly adults. The total effects of education on health spending including both direct and pathway effects strengthen the relationship and are most evident among elderly adults with hypertension and/or asthma. This reflects the fact that increased education is associated with less severe conditions among elderly adults having hypertension and/or asthma, and thus reduced health care expenditures. For example, the predicted annual health care expenditures of female adults with hypertension who completed at least 12 years of schooling are each about $450 to $850 less than those who completed less than 12 years of schooling. Similarly, those with asthma who completed at least 12 years of schooling spent more than $3,000 less on health care than those who did not. In contrast, only a few results provide evidence of a negative relationship between education and health care spending for elderly adults with diabetes and for nonelderly adults with any self-managed health conditions. This may reflect the fact that educational attainment does not impart cost-efficient self-management of these health conditions for nonelderly adults.

While increased education associates with reduced health care spending mainly for elderly adults, increased education is associated with a reduced probability of being in the top 5% of expenditure. I find that elderly adults with hypertension or nonelderly adults with diabetes are less likely to be in the top 5% of health care spenders; however, I find little evidence of the expected inverse education – high health expenditure relationship for individuals with asthma. The predicted probability of being in top 5% of elderly adults having hypertension with 16 years or of schooling or more is about 2 percentage points lower than those who did not finish high school. Additionally, nonelderly diabetics who had 16 years of schooling or more have about 3 percentage points lower probability of being a high spender. These inverse associations are primarily for estimates of the education-health spending gradient including both direct and pathway effects, while only a few direct effects are statistically significant. Although these relationships extend to elderly adults, I observe far less evidence of an association between educational attainment and the probability being a top spender.

Although the results indicate expenditure savings from increased educational attainment for a specific group of individuals with self-managed health conditions, they cannot be interpreted a causal relationships because of possible endogeneity of education in models of health production. Educational attainment may be correlated with unobservable factors such as prior health status that could affect both educational attainment and current health care spending, which can yield an upward bias in estimates of the expenditure savings from increased education. Unfortunately, I lack the data for prior health status or a suitable instrument to address this issue. Hence my empirical results can best be interpreted as identifying an association between educational attainment and health care expenditure.

The findings reported in this paper suggest that increased education can lead to reduced health care spending both through a more efficient uses of health care resources and through reduced severity of illness. Although the finding that savings in health care expenses were obtained for individuals with specific self-managed health conditions, they suggest that economies in health spending can be achieved with greater education, especially with the completion of high school education. If these efficiencies in health care use persist with more complex conditions, then policies that promote greater education in the U.S. may have the indirect effect of helping to control rising health care expenditures.

Figure 1.1. Isoquant diagram for the production of health

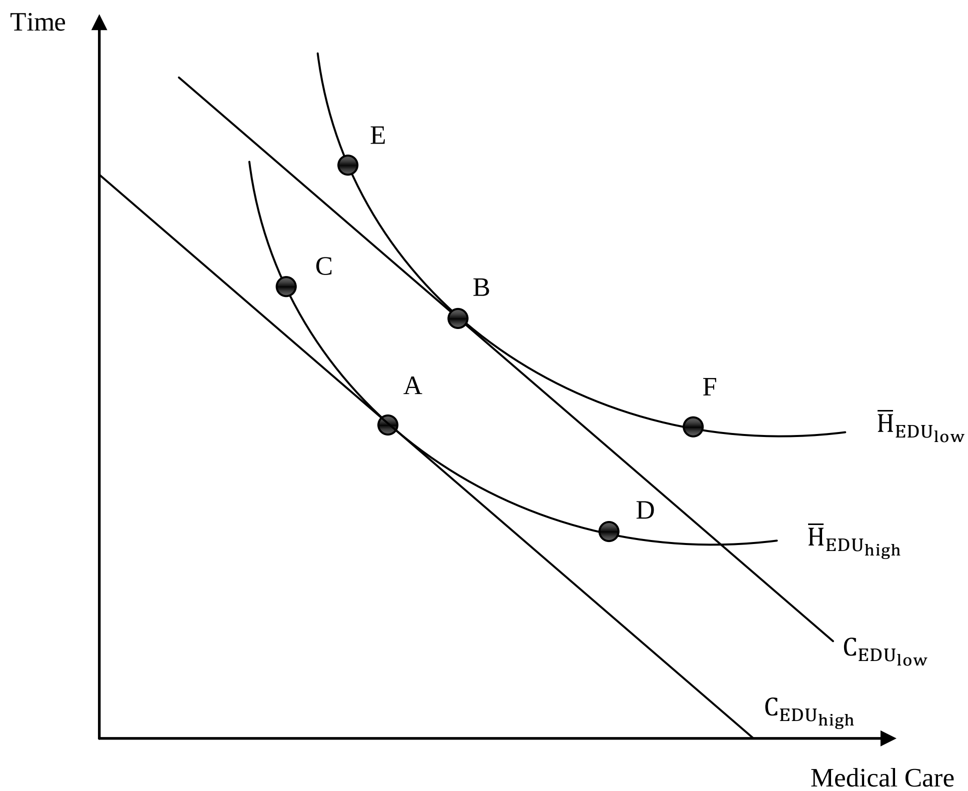

Figure 1.2. Production function of health

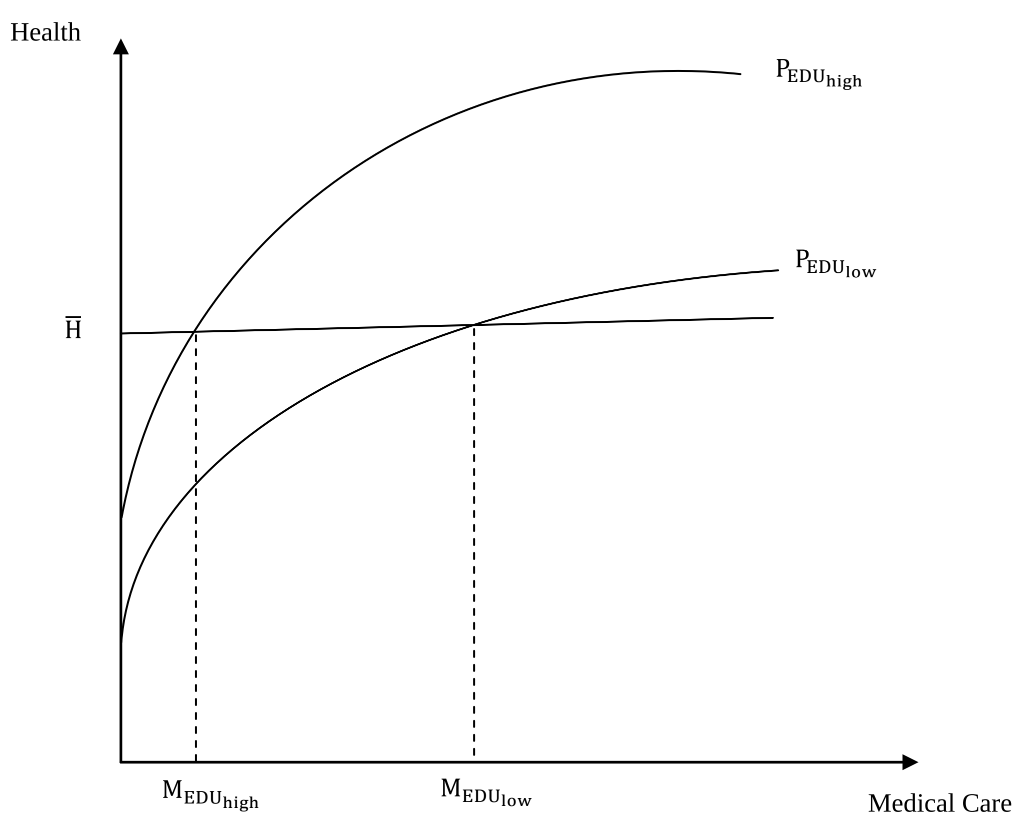

Table 1.1. Relationship between severity and educational attainment (Coefficient form a logit model)

		Hypertension	Diabetes	Asthma
NONELDERLY ADULT (age 24-64)				
ALL				
	High School Graduate	-0.196**	-0.125	-0.067
		(0.090)	(0.135)	(0.164)
	Some College	-0.379***	-0.111	-0.148
		(0.092)	(0.150)	(0.170)
	4yr College +	-0.470***	-0.024	-0.536***
		(0.111)	(0.172)	(0.192)
FEMALE				
	High School Graduate	-0.121	0.024	-0.371*
		(0.143)	(0.184)	(0.193)
	Some College	-0.290**	-0.083	-0.236
		(0.130)	(0.202)	(0.211)
	4yr College +	-0.251	-0.219	-0.658***
		(0.156)	(0.257)	(0.240)
MALE				
	High School Graduate	-0.265***	-0.283	0.752**
		(0.112)	(0.200)	(0.344)
	Some College	-0.456***	-0.104	0.233
		(0.138)	(0.217)	(0.366)
	4yr College +	-0.691***	0.210	-0.221
		(0.143)	(0.229)	(0.369)
ELDERLY ADULTS (age 65+)				
ALL				
	High School Graduate	-0.377***	-0.233*	-0.628*
		(0.090)	(0.137)	(0.324)
	Some College	-0.475***	-0.500***	-0.784**
		(0.106)	(0.181)	(0.373)
	4yr College +	-0.246**	-0.109	-1.288***
		(0.118)	(0.194)	(0.382)
FEMALE				
	High School Graduate	-0.348***	-0.168	-0.632*
		(0.116)	(0.177)	(0.385)
	Some College	-0.425***	-0.199	-0.962***
		(0.131)	(0.256)	(0.389)
	4yr College +	-0.197	-0.126	-1.249***
		(0.164)	(0.289)	(0.447)
MALE				
	High School Graduate	-0.402***	-0.287	-0.551
		(0.138)	(0.208)	(0.532)
	Some College	-0.562***	-0.839***	-0.459
		(0.174)	(0.266)	(0.859)
	4yr College +	-0.350*	-0.174	-1.560*
		(0.183)	(0.285)	(0.869)

Not shown: age, race, region, health insurance, marital status, health status, income, usual source, number of self-managed health conditions, number of non-self-managed health conditions, and year dummies

BRR Standard errors in parentheses.

* = statistically significant at the 10%

** = statistically significant at the 5%

*** = statistically significant at the 1%

Table 1.2. Average medical expenditures by health condition and educational attainment

	Hypertension				Diabetes			
	Mean	Obs. #	S.E.	Diff.	Mean	Obs. #	S.E.	Diff.
NONELDERLY ADULT (age 24-64)								
All Nonelderly Adults	1,897	11,489	105		4,030	5,027	224	
Less Than High School	3,012	2,801	253		5,042	1,641	446	
High School Graduate	1,795	3,970	105	-1,218†	4,259	1,702	402	-783
Some College	1,897	2,413	320	-1,115†	3,590	988	304	-1,452†
4yr College +	1,310	2,235	85	-1,702†	2,834	659	276	-2,208†
ELDERLY ADULTS (age 65+)								
All Elderly Adults	2,075	8,659	102		3,994	3,401	236	
Less Than High School	2,763	3,424	182		4,589	1,555	346	
High School Graduate	1,835	2,705	136	-0,928†	3,391	964	273	-1,199†
Some College	1,913	1,281	198	-0,850†	4,344	426	579	-246
4yr College +	1,412	1,156	158	-1,350†	3,470	408	821	-1,119

	Asthma				All Conditions			
	Mean	Obs. #	S.E.	Diff.	Mean	Obs. #	S.E.	Diff.
NONELDERLY ADULT (age 24-64)								
All Nonelderly Adults	2,081	2,736	204		3,113	86,623	65	
Less Than High School	3,721	685	887		2,862	19,970	103	
High School Graduate	1,672	861	182	-2,049†	3,256	27,896	138	394†
Some College	2,112	645	349	-1,609	3,118	18,593	71	256†
4yr College +	1,398	539	276	-2,322†	3,093	19,555	118	231
ELDERLY ADULTS (age 65+)								
All Elderly Adults	3,526	747	459		8,044	18,300	131	
Less Than High School	5,509	300	1,062		8,470	6,634	251	
High School Graduate	2,988	212	606	-2,521†	7,698	5,765	246	-773†
Some College	2,732	119	1,043	-2,777	8,207	2,690	293	-263
4yr College +	1,785	108	706	-3,723†	7,953	2,983	313	-517

† = statistically significant at the 5%

Table 1.3. Likelihood of being in the top 5% of medical expenditure by health condition and educational attainment

	Hypertension	Diabetes	Asthma	All Conditions
	Probability	Probability	Probability	Probability
NONELDERLY ADULT (age 24-64)				
All Nonelderly Adults	4.1	4.6	3.7	5.1
Less Than High School	8.1	7.4	6.7	5.4
High School Graduate	4.0	4.5	3.4	5.4
Some College	3.4	4.2	4.3	5.2
4yr College +	2.2	1.5	1.4	4.6
ELDERLY ADULTS (age 65+)				
All Elderly Adults	3.9	4.4	5.0	4.9
Less Than High School	5.3	5.2	7.9	5.9
High School Graduate	3.7	3.9	3.9	4.5
Some College	3.7	6.0	5.0	5.0
4yr College +	2.0	2.1	2.0	4.3

Table 1.4. Predicted total medical expenditure by health condition and educational attainment for nonelderly adults (age 24-64)

		Hypertension		Diabetes		Asthma	
		Predicted Expenditure	Diff.	Predicted Expenditure	Diff.	Predicted Expenditure	Diff.
FULL MODEL (DIRECT EFFECT)							
ALL							
	Less Than High School	2,212		4,428		2,454	
	High School Graduate	2,091	-121	4,385	-43	2,049	-405
			(240)		(468)		(326)
	Some College	2,287	75	4,389	-39	2,335	-119
			(614)		(610)		(517)
	4yr College +	2,124	-88	3,803	-626	2,292	-162
			(519)		(1189)		(501)
FEMALE							
	Less Than High School	2,459		4,277		2,938	
	High School Graduate	1,958	-501**	4,556	278	2,384	-554
			(217)		(672)		(495)
	Some College	2,081	-378	5,292	1,015	2,239	-699
			(522)		(1099)		(472)
	4yr College +	2,226	-233	4,171	-106	2,792	-146
			(638)		(1924)		(749)
MALE							
	Less Than High School	2,029		4,458		1,339	
	High School Graduate	2,113	84	3,955	-503	1,324	-15
			(274)		(641)		(357)
	Some College	2,295	266	3,812	-646	3,377	2,038
			(683)		(730)		(1399)
	4yr College +	1,963	-66	3,805	-653	1,247	-92
			(376)		(839)		(478)
MODEL WITHOUT SEVERITY MEASURES (TOTAL EFFECT)							
ALL							
	Less Than High School	2,312		4,361		2,679	
	High School Graduate	2,102	-210	4,349	-12	2,034	-645
			(260)		(449)		(439)
	Some College	2,232	-80	4,472	112	2,340	-339
			(625)		(668)		(459)
	4yr College +	2,051	-261	3,904	-457	2,145	-533
			(562)		(1235)		(642)
FEMALE							
	Less Than High School	2,485		4,255		3,258	
	High School Graduate	2,047	-438	4,582	327	2,294	-964
			(269)		(553)		(622)
	Some College	2,047	-438	5,221	966	2,270	-988*
			(465)		(904)		(526)
	4yr College +	2,182	-304	4,059	-196	2,636	-623
			(675)		(1,877)		(931)
MALE							
	Less Than High School	2,096		4,427		1,233	
	High School Graduate	2,108	13	3,902	-524	1,475	242
			(329)		(638)		(312)
	Some College	2,252	156	3,891	-535	3,059	1,826
			(732)		(809)		(1,535)
	4yr College +	1,932	-164	3,955	-471	1,067	-166
			(446)		(872)		(431)

Note: An alternative model including spouse's level of education for male adults shows similar results.
BRR Standard errors in parentheses.
* = statistically significant at the 10%
** = statistically significant at the 5%
*** = statistically significant at the 1%

Table 1.5. Predicted total medical expenditure by health condition and educational attainment for elderly adults (age 65+)

		Hypertension		Diabetes		Asthma	
		Predicted Expenditure	Diff.	Predicted Expenditure	Diff.	Predicted Expenditure	Diff.
FULL MODEL (DIRECT EFFECT)							
ALL							
	Less Than High School	2,509		4,522		5,862	
	High School Graduate	2,213	-296*	3,935	-587	4,145	-1,717
			(170)		(471)		(1220)
	Some College	2,378	-131	5,167	645	3,248	-2,614**
			(240)		(771)		(1230)
	4yr College +	2,171	-338	3,646	-876	3,569	-2,293
			(255)		(779)		(1521)
FEMALE							
	Less Than High School	2,691		4,900		6,739	
	High School Graduate	2,425	-266	4,318	-582	2,726	-4,013*
			(288)		(565)		(2117)
	Some College	2,446	-246	5,465	565	4,181	-2,558
			(298)		(1517)		(2581)
	4yr College +	1,752	-940**	3,886	-1,015	3,609	-3,130
			(378)		(2065)		(3853)
MALE							
	Less Than High School	2,190		4,016		3,792	
	High School Graduate	1,979	-210	3,581	-435	6,491	2,699
			(232)		(867)		(3365)
	Some College	2,455	265	4,595	579	2,295	-1,497
			(350)		(1133)		(3267)
	4yr College +	2,251	62	3,232	-784	1,833	-1,959
			(276)		(721)		(5541)
MODEL WITHOUT SEVERITY MEASURES (TOTAL EFFECT)							
ALL							
	Less Than High School	2,608		4,592		6,574	
	High School Graduate	2,159	-449**	3,735	-858	4,715	-1,859
			(190)		(527)		(1,364)
	Some College	2,224	-384	5,095	503	3,150	-3,424***
			(265)		(705)		(1,270)
	4yr College +	2,060	-548*	3,887	-705	3,229	-3,345**
			(297)		(900)		(1,444)
FEMALE							
	Less Than High School	2,782		5,016		7,011	
	High School Graduate	2,333	-450*	4,247	-770	2,896	-4,115*
			(232)		(655)		(2,278)
	Some College	2,237	-545*	5,659	642	3,531	-3,480
			(326)		(1,336)		(2,686)
	4yr College +	1,935	-848**	3,950	-1,067	3,132	-3,880
			(357)		(2,317)		(3,484)
MALE							
	Less Than High School	2,312		4,034		4,417	
	High School Graduate	1,905	-407	3,279	-755	7,153	2,736
			(276)		(748)		(4,221)
	Some College	2,285	-27	4,272	238	1,785	-2,632
			(383)		(1229)		(3,359)
	4yr College +	2,099	-213	3,333	-700	2,162	-2,255
			(348)		(747)		(3,487)

Note: An alternative model including spouse's level of education for male adults shows similar results.
BRR Standard errors in parentheses.
* = statistically significant at the 10%
** = statistically significant at the 5%
*** = statistically significant at the 1%

Table 1.6. Predicted probability of being in top 5% of medical expenditure by health condition and educational attainment for nonelderly adults (age 24-64)

		Hypertension		Diabetes		Asthma	
		Predicted Expenditure	Diff.	Predicted Expenditure	Diff.	Predicted Expenditure	Diff.
FULL MODEL (DIRECT EFFECT)							
ALL							
	Less Than High School	0.053		0.055			
	High School Graduate	0.047	-0.006	0.047	-0.008	.	-0.015
			(0.005)		(0.010)		(0.013)
	Some College	0.047	-0.006	0.056	0.001	.	0.008
			(0.009)		(0.012)		(0.015)
	4yr College +	0.044	-0.009	0.024	-0.031**	.	-0.005
			(0.014)		(0.014)		(0.014)
FEMALE							
	Less Than High School	0.072		0.075		-	
	High School Graduate	0.053	-0.018**	0.050	-0.025	-	-0.014
			(0.008)		(0.016)		(0.015)
	Some College	0.059	-0.012	0.065	-0.010	-	0.010
			(0.010)		(0.021)		(0.018)
	4yr College +	0.056	-0.016	0.032	-0.043	-	-0.002
			(0.011)		(0.027)		(0.018)
MALE							
	Less Than High School	0.067		0.055		-	
	High School Graduate	0.076	0.008	0.053	-0.002	-	-0.009
			(0.010)		(0.025)		(0.021)
	Some College	0.068	0.000	0.057	0.002	-	0.026
			(0.014)		(0.020)		(0.032)
	4yr College +	0.074	0.006	0.035	-0.021	-	0.004
			(0.020)		(0.020)		(0.026)
MODEL WITHOUT SEVERITY MEASURES (TOTAL EFFECT)							
ALL							
	Less Than High School	0.054		0.054		0.048	
	High School Graduate	0.047	-0.006	0.047	-0.007	0.035	-0.014*
			(0.005)		(0.010)		(0.008)
	Some College	0.046	-0.008	0.056	0.002	0.058	0.010
			(0.009)		(0.012)		(0.018)
	4yr College +	0.042	-0.011	0.024	-0.030**	0.035	-0.013
			(0.013)		(0.013)		(0.016)
FEMALE							
	Less Than High School	0.058		0.063		0.048	
	High School Graduate	0.040	-0.017**	0.041	-0.022	0.033	-0.015
			(0.008)		(0.024)		(0.011)
	Some College	0.044	-0.014	0.054	-0.009	0.059	0.011
			(0.010)		(0.021)		(0.012)
	4yr College +	0.040	-0.018	0.024	-0.039	0.039	-0.009
			(0.011)		(0.027)		(0.025)
MALE							
	Less Than High School	0.064		0.056		0.036	
	High School Graduate	0.070	0.006	0.053	-0.002	0.041	0.004
			(0.010)		(0.027)		(0.011)
	Some College	0.063	-0.001	0.060	0.005	0.090	0.053***
			(0.013)		(0.024)		(0.021)
	4yr College +	0.066	0.002	0.037	-0.018	0.028	-0.008
			(0.018)		(0.020)		(0.021)

Note: An alternative model including spouse's level of education for male adults shows similar results.
BRR Standard errors in parentheses.
* = statistically significant at the 10%
** = statistically significant at the 5%
*** = statistically significant at the 1%

Table 1.7. Predicted probability of being in top 5% of medical expenditure by health condition and educational attainment for elderly adults (age 65+)

		Hypertension		Diabetes		Asthma	
		Predicted Expenditure	Diff.	Predicted Expenditure	Diff.	Predicted Expenditure	Diff.
FULL MODEL (DIRECT EFFECT)							
ALL							
	Less Than High School	0.049		0.050			
	High School Graduate	0.049	0.000	0.048	-0.002	.	-0.017
			(0.007)		(0.012)		(0.025)
	Some College	0.051	0.002	0.083	0.033	.	-0.011
			(0.009)		(0.028)		(0.029)
	4yr College +	0.030	-0.019*	0.033	-0.018	.	-0.005
			(0.012)		(0.021)		(0.027)
FEMALE							
	Less Than High School	0.047		0.042		-	
	High School Graduate	0.051	0.003	0.047	0.004	-	0.004
			(0.008)		(0.018)		(0.034)
	Some College	0.045	-0.002	0.108	0.066	-	0.014
			(0.017)		(0.067)		(0.040)
	4yr College +	0.018	-0.029**	0.035	-0.007	-	0.027
			(0.014)		(0.039)		(0.044)
MALE							
	Less Than High School	0.055		0.052		-	
	High School Graduate	0.042	-0.013	0.040	-0.012	-	0.017
			(0.011)		(0.019)		(0.053)
	Some College	0.051	-0.003	0.060	0.008	-	-0.064
			(0.016)		(0.030)		(0.048)
	4yr College +	0.044	-0.010	0.062	0.009	-	-0.064
			(0.015)		(0.025)		(0.048)
MODEL WITHOUT SEVERITY MEASURES (TOTAL EFFECT)							
ALL							
	Less Than High School	0.051		0.051		0.068	
	High School Graduate	0.046	-0.004	0.047	-0.004	0.052	-0.017
			(0.007)		(0.013)		(0.028)
	Some College	0.048	-0.003	0.078	0.026	0.052	-0.016
			(0.009)		(0.022)		(0.033)
	4yr College +	0.029	-0.022*	0.031	-0.020	0.043	-0.025
			(0.012)		(0.020)		(0.030)
FEMALE							
	Less Than High School	0.048		0.044		0.057	
	High School Graduate	0.048	-0.001	0.045	0.002	0.057	0.000
			(0.008)		(0.018)		(0.030)
	Some College	0.043	-0.006	0.099	0.056	0.045	-0.012
			(0.018)		(0.059)		(0.038)
	4yr College +	0.018	-0.030**	0.035	-0.009	0.069	0.012
			(0.013)		(0.040)		(0.062)
MALE							
	Less Than High School	0.057		0.051		-	
	High School Graduate	0.040	-0.018	0.040	-0.012	-	0.014
			(0.012)		(0.018)		(0.052)
	Some College	0.047	-0.011	0.060	0.009	-	-0.064
			(0.018)		(0.038)		(0.048)
	4yr College +	0.040	-0.017	0.063	0.011	-	-0.074*
			(0.019)		(0.026)		(0.044)

Note: An alternative model including spouse's level of education for male adults shows similar results.
BRR Standard errors in parentheses.
* = statistically significant at the 10%
** = statistically significant at the 5%
*** = statistically significant at the 1%

Table 1.8. Predicted medical expenditure and probability of being in top 5% of expenditure for everyone in the sample by educational attainment and gender

		Two-part Expenditure Model		Likelihood model of being in top 5% of spender	
		Predicted Expenditure	Diff.	Predicted Probability	Diff.
NONELDERLY ADULT (age 24-64)					
ALL					
	Less Than High School	3,137		0.047	
	High School Graduate	3,507	370	0.054	0.007
			(237)		(0.008)
	Some College	3,591	455	0.055	0.008
			(289)		(0.008)
	4yr College +	3,706	570**	0.056	0.009
			(265)		(0.009)
FEMALE					
	Less Than High School	3,395		0.044	
	High School Graduate	3,743	349**	0.053	0.010
			(139)		(0.009)
	Some College	3,838	443***	0.053	0.009
			(149)		(0.011)
	4yr College +	4,112	718***	0.058	0.015
MALE					
	Less Than High School	8,193		0.050	
	High School Graduate	7,956	-238	0.046	-0.004
			(458)		(0.008)
	Some College	8,556	363	0.052	0.002
			(522)		(0.008)
	4yr College +	8,898	705	0.040	-0.010
ELDERLY ADULTS (age 65+)					
ALL					
	Less Than High School	7,803		0.049	
	High School Graduate	7,983	180	0.047	-0.002
			(353)		(0.007)
	Some College	8,667	865**	0.052	0.004
			(391)		(0.007)
	4yr College +	9,073	1,271***	0.046	-0.002
			(473)		(0.010)
FEMALE					
	Less Than High School				
	High School Graduate	2,743		0.045	
		3,083	339	0.055	0.009
	Some College		(365)		(0.007)
		3,129	386	0.057	0.012*
	4yr College +		(423)		(0.007)
		2,975	232	0.056	0.010
			(356)		(0.009)
MALE					
	Less Than High School	7,237		0.044	
	High School Graduate	7,970	733*	0.049	0.005
			(387)		(0.009)
	Some College	8,800	1,563**	0.054	0.010
			(610)		(0.011)
	4yr College +	9,134	1,896**	0.051	0.007
			(746)		(0.013)

Note: An alternative model including spouse's level of education for male adults shows similar results.
BRR Standard errors in parentheses.
* = statistically significant at the 10%
** = statistically significant at the 5%
*** = statistically significant at the 1%

Appendix 1.1. Results from two-part GLM model by health condition, educational attainment, and gender (full model)

		Hypertension		Diabetes		Asthma	
NONELDERLY ADULT (age 24-64)							
ALL		1st part	2nd part	1st part	2nd part	1st part	2nd part
	High School Graduate	-0.09	-0.04	0.02	-0.03	0.00	-0.08
		(0.07)	(0.07)	(0.12)	(0.11)	(0.15)	(0.18)
	Some College	-0.20**	0.09	0.14	-0.06	0.04	-0.09
		(0.09)	(0.10)	(0.13)	(0.11)	(0.17)	(0.19)
	4yr College +	-0.07	-0.04	0.32**	-0.25**	0.15	-0.12
		(0.09)	(0.09)	(0.17)	(0.12)	(0.20)	(0.19)
FEMALE							
	High School Graduate	-0.01	-0.22*	0.01	0.02	-0.07	-0.05
		(0.06)	(0.11)	(0.18)	(0.10)	(0.17)	(0.21)
	Some College	-0.03	-0.16	0.04	0.15	-0.11	-0.19
		(0.07)	(0.14)	(0.18)	(0.13)	(0.18)	(0.22)
	4yr College +	0.05	-0.16	0.39*	-0.16	0.13	-0.07
		(0.07)	(0.13)	(0.22)	(0.16)	(0.21)	(0.23)
MALE							
	High School Graduate	-0.17	0.09	0.01	-0.13	0.38	-0.22
		(0.11)	(0.12)	(0.09)	(0.14)	(0.30)	(0.21)
	Some College	-0.34***	0.21	0.14	-0.21	0.61*	0.57***
		(0.13)	(0.14)	(0.12)	(0.17)	(0.35)	(0.22)
	4yr College +	-0.20	0.05	0.15	-0.26	0.39	-0.35
		(0.13)	(0.12)	(0.13)	(0.17)	(0.39)	(0.33)
ELDERLY ADULTS (age 65+)							
ALL		1st part	2nd part	1st part	2nd part	1st part	2nd part
	High School Graduate	-0.11	-0.11	-0.01	-0.20**	-0.06	-0.70***
		(0.08)	(0.08)	(0.14)	(0.10)	(0.28)	(0.24)
	Some College	0.02	-0.10	-0.15	0.07	0.13	-0.98***
		(0.10)	(0.10)	(0.19)	(0.13)	(0.30)	(0.27)
	4yr College +	-0.18*	-0.09	-0.03	-0.23	-0.04	-0.82**
		(0.10)	(0.11)	(0.20)	(0.16)	(0.35)	(0.35)
FEMALE							
	High School Graduate	-0.06	-0.03	-0.18	-0.10	-0.42	-0.86***
		(0.06)	(0.10)	(0.21)	(0.11)	(0.35)	(0.25)
	Some College	-0.02	-0.06	-0.28	0.19	0.26	-0.59**
		(0.08)	(0.12)	(0.26)	(0.17)	(0.35)	(0.28)
	4yr College +	-0.12	-0.31**	0.21	-0.18	-0.31	-0.56
		(0.09)	(0.14)	(0.37)	(0.22)	(0.48)	(0.40)
MALE							
	High School Graduate	-0.09	-0.16	0.09	-0.23	1.17*	-0.16
		(0.12)	(0.13)	(0.14)	(0.15)	(0.62)	(0.69)
	Some College	0.10	-0.09	-0.04	-0.06	-0.46	-0.71
		(0.15)	(0.15)	(0.15)	(0.19)	(0.62)	(0.81)
	4yr College +	-0.18	0.00	-0.03	-0.32*	0.58	-1.40**
		(0.14)	(0.16)	(0.15)	(0.18)	(0.63)	(0.66)

Not shown: age, race, region, health insurance, marital status, health status, income, employment status, number of kids, usual source, number of self-managed health conditions, number of non-self-managed health conditions, and year dummies

* = statistically significant at the 10%

** = statistically significant at the 5%

*** = statistically significant at the 1%

Appendix 1.2. Results from two-part GLM model by health condition, educational attainment, and gender (model without severity measures)

		Hypertension		Diabetes		Asthma		All Conditions	
NONELDERLY ADULT (age 24-64)									
ALL		1st part	2nd part	1st part	2nd part	1st part	2nd part	1st part	2nd part
	High School Graduate	-0.12*	-0.07	0.00	-0.04	-0.01	-0.15	0.28***	0.12***
		(0.07)	(0.07)	(0.12)	(0.11)	(0.15)	(0.18)	(0.04)	(0.04)
	Some College	-0.25***	0.03	0.11	-0.04	-0.03	-0.13	0.63***	0.10***
		(0.09)	(0.10)	(0.13)	(0.10)	(0.16)	(0.19)	(0.04)	(0.04)
	4yr College +	-0.13	-0.10	0.31*	-0.24**	-0.03	-0.19	0.94***	0.13***
		(0.09)	(0.09)	(0.16)	(0.11)	(0.19)	(0.20)	(0.05)	(0.04)
FEMALE									
	High School Graduate	-0.04	-0.21**	0.00	0.01	-0.12	-0.14	0.20***	0.10*
		(0.09)	(0.10)	(0.17)	(0.10)	(0.17)	(0.21)	(0.06)	(0.05)
	Some College	-0.11	-0.16	0.00	0.13	-0.16	-0.23	0.52***	0.07*
		(0.11)	(0.12)	(0.18)	(0.14)	(0.18)	(0.22)	(0.07)	(0.04)
	4yr College +	0.01	-0.22*	0.34	-0.18	-0.03	-0.16	0.75***	0.10**
		(0.11)	(0.13)	(0.22)	(0.15)	(0.21)	(0.24)	(0.08)	(0.05)
MALE									
	High School Graduate	-0.19*	0.06	-0.02	-0.13	0.48*	-0.16	0.24***	0.12*
		(0.11)	(0.12)	(0.16)	(0.15)	(0.27)	(0.25)	(0.05)	(0.06)
	Some College	-0.37***	0.18	0.21	-0.19	0.53*	0.49*	0.54***	0.10**
		(0.13)	(0.14)	(0.20)	(0.17)	(0.31)	(0.27)	(0.06)	(0.05)
	4yr College +	-0.25**	0.01	0.30	-0.24	0.22	-0.40	0.80***	0.06
		(0.13)	(0.12)	(0.24)	(0.16)	(0.34)	(0.39)	(0.07)	(0.06)
ELDERLY ADULTS (age 65+)									
ALL		1st part	2nd part	1st part	2nd part	1st part	2nd part	1st part	2nd part
	High School Graduate	-0.16*	-0.16**	-0.06	-0.25**	-0.15	-0.60**	0.31**	0.04
		(0.08)	(0.08)	(0.14)	(0.10)	(0.27)	(0.24)	(0.15)	(0.04)
	Some College	-0.05	-0.20**	-0.24	0.06	0.01	-1.03***	0.61***	0.12***
		(0.10)	(0.10)	(0.19)	(0.13)	(0.28)	(0.27)	(0.23)	(0.04)
	4yr College +	-0.22**	-0.17	-0.07	-0.19	-0.29	-0.76**	0.88***	0.17***
		(0.10)	(0.11)	(0.20)	(0.19)	(0.32)	(0.34)	(0.21)	(0.05)
FEMALE									
	High School Graduate	-0.15	-0.08	-0.23	-0.13	-0.47	-0.73***	0.09	-0.02
		(0.10)	(0.09)	(0.20)	(0.11)	(0.34)	(0.25)	(0.21)	(0.05)
	Some College	-0.08	-0.17	-0.34	0.18	0.09	-0.74***	0.23	0.04
		(0.12)	(0.11)	(0.26)	(0.17)	(0.33)	(0.26)	(0.31)	(0.06)
	4yr College +	-0.22	-0.26**	0.17	-0.18	-0.45	-0.46	0.35	0.09
		(0.15)	(0.13)	(0.37)	(0.24)	(0.45)	(0.38)	(0.33)	(0.07)
MALE									
	High School Graduate	-0.15	-0.25*	0.11	-0.26*	0.83	-0.39	0.42*	0.13**
		(0.12)	(0.13)	(0.24)	(0.15)	(0.53)	(0.71)	(0.23)	(0.06)
	Some College	0.02	-0.22	-0.19	-0.05	-0.54	-0.58	0.91***	0.22***
		(0.15)	(0.15)	(0.26)	(0.19)	(0.58)	(0.88)	(0.34)	(0.07)
	4yr College +	-0.24*	-0.12	-0.10	-0.28	0.01	-0.91	1.27***	0.26***
		(0.14)	(0.16)	(0.27)	(0.19)	(0.58)	(0.69)	(0.29)	(0.08)

Not shown: age, race, region, health insurance, marital status, health status, income, employment status, number of kids, usual source, number of self-managed health conditions, number of non-self-managed health conditions, and year dummies

* = statistically significant at the 10%

** = statistically significant at the 5%

*** = statistically significant at the 1%

Appendix 1.3. Results from likelihood model by health condition, educational attainment, and gender (full model)

		Hypertension	Diabetes	Asthma
NONELDERLY ADULT (age 24-64)				
ALL				
	High School Graduate	-0.17	-0.20	-0.01
		(0.14)	(0.23)	(0.01)
	Some College	-0.17	-0.08	0.01
		(0.17)	(0.28)	(0.01)
	4yr College +	-0.23	-1.09**	-0.01
		(0.21)	(0.46)	(0.01)
FEMALE				
	High School Graduate	-0.41**	-0.58*	-0.01
		(0.20)	(0.31)	(0.01)
	Some College	-0.31	-0.25	0.01
		(0.22)	(0.36)	(0.02)
	4yr College +	-0.46	-1.12	0.00
		(0.29)	(0.70)	(0.02)
MALE				
	High School Graduate	0.14	-0.01	-0.01
		(0.23)	(0.28)	(0.02)
	Some College	-0.01	-0.07	0.02
		(0.30)	(0.43)	(0.03)
	4yr College +	0.20	-0.65	-0.01
		(0.34)	(0.52)	(0.02)
ELDERLY ADULTS (age 65+)				
ALL				
	High School Graduate	0.04	-0.05	-0.01
		(0.15)	(0.28)	(0.02)
	Some College	0.10	0.58**	-0.01
		(0.20)	(0.32)	(0.03)
	4yr College +	-0.29	-0.34	0.00
		(0.29)	(0.46)	(0.02)
FEMALE				
	High School Graduate	0.15	0.15	0.00
		(0.22)	(0.37)	(0.03)
	Some College	-0.01	1.08***	0.01
		(0.27)	(0.40)	(0.04)
	4yr College +	-0.91**	-0.17	0.03
		(0.45)	(0.68)	(0.04)
MALE				
	High School Graduate	-0.30	-0.32	-0.04
		(0.28)	(0.44)	(0.04)
	Some College	-0.05	0.02	-0.06
		(0.31)	(0.54)	(0.04)
	4yr College +	-0.12	-0.05	-0.07*
		(0.35)	(0.46)	(0.04)

Not shown: age, race, region, health insurance, marital status, health status, income, employment status, number of kids, usual source, number of self-managed health conditions, number of non-self-managed health conditions, and year dummies

* = statistically significant at the 10%

** = statistically significant at the 5%

*** = statistically significant at the 1%

Appendix 1.4. Results from likelihood model by health condition, educational attainment, and gender (without severity measures)

		Hypertension	Diabetes	Asthma	All Conditions
NONELDERLY ADULT (age 24-64)					
ALL					
	High School Graduate	-0.20	-0.19	-0.25	0.18***
		(0.14)	(0.23)	(0.27)	(0.07)
	Some College	-0.22	-0.08	0.24	0.20**
		(0.17)	(0.29)	(0.30)	(0.08)
	4yr College +	-0.32	-1.08**	-0.49	0.19**
		(0.21)	(0.47)	(0.51)	(0.08)
FEMALE					
	High School Graduate	-0.44**	-0.53*	-0.31	0.20**
		(0.20)	(0.31)	(0.35)	(0.09)
	Some College	-0.37	-0.27	0.25	0.17
		(0.23)	(0.38)	(0.36)	(0.10)
	4yr College +	-0.58**	-1.13	-0.33	0.24**
		(0.29)	(0.71)	(0.57)	(0.10)
MALE					
	High School Graduate	0.10	-0.04	0.30	0.26***
		(0.23)	(0.30)	(0.45)	(0.09)
	Some College	-0.05	-0.02	1.43*	0.31***
		(0.29)	(0.46)	(0.79)	(0.11)
	4yr College +	0.11	-0.59	-0.38	0.27**
		(0.33)	(0.52)	(1.31)	(0.11)
ELDERLY ADULTS (age 65+)					
ALL					
	High School Graduate	-0.06	-0.10	-0.42	-0.04
		(0.16)	(0.29)	(0.51)	(0.12)
	Some College	0.01	0.47	-0.43	0.13
		(0.20)	(0.30)	(0.42)	(0.13)
	4yr College +	-0.37	-0.38	-0.17	0.00
		(0.29)	(0.46)	(0.71)	(0.15)
FEMALE					
	High School Graduate	0.06	0.09	-0.02	-0.11
		(0.22)	(0.37)	(0.67)	(0.14)
	Some College	-0.08	0.95**	-0.13	0.03
		(0.26)	(0.39)	(0.72)	(0.18)
	4yr College +	-0.92**	-0.17	0.73	-0.23
		(0.47)	(0.69)	(1.02)	(0.20)
MALE					
	High School Graduate	-0.40	-0.33	-0.05	0.21
		(0.29)	(0.42)	(0.04)	(0.18)
	Some College	-0.23	0.02	-0.06	0.37*
		(0.31)	(0.56)	(0.04)	(0.22)
	4yr College +	-0.27	-0.06	-0.08**	0.20
		(0.37)	(0.49)	(0.03)	(0.24)

Not shown: age, race, region, health insurance, marital status, health status, income, employment status, number of kids, usual source, number of self-managed health conditions, number of non-self-managed health conditions, and year dummies

* = statistically significant at the 10%

** = statistically significant at the 5%

*** = statistically significant at the 1%

Chapter 2

Private Health Insurance and Risk Protection: Changes in Out-of-pocket Medical Spending, 2001 and 2005

2.1. Introduction

Over the past decade, US health care expenditures continued to rise reaching 17.6 percent of gross domestic product (GDP), or almost $2.5 trillion in 2009, up from 14 percent of GDP, or $1.4 trillion in 2001.[17] The sustained increase in health care costs has been a particular concern of employers who are the largest source of private health insurance in the U.S. In response, beginning in the first half of the past decade, many employers restructured the health insurance plans offered to employees by raising maximum out-of-pocket spending limits, and increasing deductibles and coinsurance provisions. For example, the portion of employees enrolled in plans with high maximum out-of-pocket spending limits, e.g., a $5,000 out-of-pocket spending limit for family plans, increased significantly, from about 17 percent to 25 percent during the period of 2001 and 2003. [18] Average annual deductibles with family coverage were $1,192 in 2005, an increase from $708[19] in 2001.[20] In addition, the average co-payment per physician office visit rose from $15 in 2002 to $19 in 2005 and the coinsurance percentages for an office visit to a physician stood at 17.4 percent in 2002, and increased to 18.3 percent in 2005.[21] During the same period, the annual premiums for employer-sponsored health insurance (ESI) continued to increase at a much faster rate than overall inflation and

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[17] National Health Expenditure Tables from *Centers for Medicare & Medicaid Services in the U.S. Department of Health & Human Services*

[18] Taylor, Amy. K, Beth L. Crimmel, Alice. M. Zawacki. Changes in Out-of-Pocket Maximum Limits for Employer-Sponsored Health Insurance Plans 1999-2003, *Agency for Healthcare Research and Quality*, Statistical Brief #128

[19] Expressed in 2005 dollars and adjusted for inflation using the CPI for medical care services

[20] Employer Health Benefits: 2005 Annual Survey "Employee Cost Sharing", *The Kaiser Family Foundation and Health Research And Educational Trust*

[21] Crimmel, B. L., A. K. Taylor, A. M. Zawacki. Co-pays and coinsurance percentages for an office visit to a physician for employer-sponsored health insurance in the private sector, by firm size classification, 2002-2005, *Agency for Healthcare Research and Quality*, Statistical Brief #189

wage earnings, reaching to $4,024 for single coverage and $10,880 for family coverage.[22,23]

These changes in ESI may discourage overuse of nonessential health care and thus help to slow the growth in health care expenditures and health insurance premiums. However, as a result of these changes, individuals and families covered by ESI are now responsible for paying more out-of-pocket for their medical care. For example, the aggregate annual out-of-pocket spending for individuals having private insurance was $237 billion[24] in 2001 and rose to $248 billion in 2005. There are also concerns that such provisions may differentially affect those families who have greater health care needs and may be less able to pay for medical care, and that access to ESI will favor the healthiest and wealthiest of employees (Fronstin, 2004). While there have been several studies measuring the financial burden on covered individuals (See for example Banthin and Bernard, 2006 and Schoen, Doty, Collins, and Holmgren, 2005), there has been less work on determining which groups were differentially affected by such changes in cost-sharing. To answer which families bear the heaviest financial burden from recent changes in cost-sharing provisions, this paper explores not only the mean change in the family's out-of-pocket burden of medical spending over the study period, but also the distributional change in this financial burden using quantile regressions.

In this chapter, I focus on the non-elderly working population and their families covered by ESI and examine the change in the financial burden of out-of-pocket medical care over the 2001 to 2005 period in order to draw implications about the impact of

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[22] Employer Health Benefits: 2005 Summary of Findings, *The Kaiser Family Foundation and Health Research And Educational Trust*
[23] The average percentage of premium paid by employers did not increase during this period.
[24] Expressed in 2005 dollars and adjusted for inflation using the CPI for medical care services

changes in ESI provisions noted above. I focus my analysis on these two years since over this time period, much attention was directed to the shift in employee responsibility for health care spending. The structure of the chapter is as follows. In section II, I describe the data used in my analysis, construction of my key measures of out-of-pocket spending, and the research approach. In section III I present empirical findings, and in section IV I summarize key findings and identify the key implications of the analysis.

2.2. Data and Research Framework

2.2.1. Data

The data source for this analysis is the Medical Expenditure Panel Survey (MEPS), a nationally representative household panel survey conducted by the Agency for Healthcare Research and Quality (AHRQ) since 1996. The MEPS provides detailed data on the health care use, medical expenditures, health insurance status and sources of payment for medical care, health status, demographic characteristics, employment status, and family income (among other factors) for the U.S. civilian non-institutionalized population. The main data are from the Full Year Consolidated Household data file, the Person Round Plan public use file (PRPL) and Medical Condition file of MEPS Household Component (MEPS-HC) in 2001 and 2005.[25]

The Full Year Consolidated Household data file is a person-level file and provides information on individual and family demographic characteristics and on total and out-of-pocket medical expenditures. For families with a member who holds ESI coverage, health insurance status and out-of-pocket premium expenses are obtained using

[25] As noted, significant changes in health insurance provision were made during 2001-2005 period and at the time of my analysis, 2005 MEPS data were the most currently available data set. The information on health insurance status is from PRPL and health condition variables are from the medical condition file.

the Person Round Plan (PRPL) file, a complex, hierarchical file of privately insured persons and their private health insurance plans. As the PRPL is a person-round[26]-policyholder[27]-establishment[28]-level file, it is transformed to a person-level file for the study. The PRPL provides information on monthly health insurance status, the characteristics of the corresponding establishment providing coverage, and out-of-pocket premium expenditures, which enable precise computation of annual out-of-pocket premiums for each insured individual and for the family. Finally, the Medical Condition file identifies the medical condition reported by respondents to the household survey. I use ten health conditions which are responsible for the highest aggregate health spending in 2005 according to tabulations by the Agency for Healthcare Research and Quality. They include heart conditions, trauma-related disorders, cancer, mental disorders, chronic obstructive pulmonary Disease (COPD)/asthma, hypertension, diabetes mellitus, osteoarthritis and other non-traumatic joint disorders, back problems, and normal birth. I also include circulatory conditions (arteries, veins, and lymphatics) since this also yields a high level of aggregate spending and affects large number of health care users.

This paper uses separate cross-sections of non-elderly individuals (younger than age 65) who are privately insured with ESI throughout the year in 2001 and 2005. I consider families in which all members are covered by ESI as the unit of observation and as discussed below, develop measures of the family's out-of-pocket medical spending to assess the economic burden of such spending on family income. I include the out-of-pocket premium expense among such spending since many families with ESI will incur

[26] The MEPS-HC is based on an overlapping panel design in which data covering a two year period are collected through a preliminary contact followed by a series of five rounds of interviews over a two and a half year period.
[27] Information on dependents is linked to the policyholder's job providing insurance, rather than their own job.
[28] "Establishment" in MEPS refers to the organization through which the policyholder obtains ESI.

such spending to obtain access to health care services. In using the family as the unit of analysis, individuals are aggregated up to a family level following the definition of family in MEPS: A family generally consists of two or more persons living together in the same household who are related by blood, marriage, or adoption, as well as foster children. On this basis, I define the outcome variable of interest as family out-of-pocket medical spending (FOOPSPD) which is the aggregation of each family member's out-of-pocket medical spending. Total family income is also defined as the aggregated amount of each family member's total income.[29] Unless otherwise noted, the analyses employ population weights and adjust standard errors for the complex and clustered sampling design of the MEPS.[30]

Out-of-pocket spending can be defined in two ways. The first is limited to the total amount of medical spending paid out-of-pocket by a family excluding any premiums paid directly by employees; the second measure of out-of-pocket spending includes family payments for ESI premiums. While many studies of out-of-pocket spending burden consider medical out-of-pocket spending and out-of-pocket premiums separately, this paper uses the second measure of medical spending (out-of-pocket spending and family premium payments) for a more precise estimate of the burden of medical spending faced by insured families because a family will typically be responsible for some portion of ESI premiums and this will enter into its medical care decision making regarding desired access to specific health care services.

[29] FOOPSPD and family income in 2001 are inflated to 2005 dollars.
[30] The policyholder's weight is applied to obtain family-level estimates. In families with multiple adult policyholders, I use the average policyholder weight.

2.2.2. Empirical Approach

Descriptive Analysis

To identify specific types of families experiencing changes in FOOPSPD between 2001 and 2005, I examine the out-of-pocket spending experience of families with non-elderly persons who are continuously insured with ESI. I develop a measure of financial burden to illustrate how the proportion of families with FOOPSPD in excess of 10% of income has changed between 2001 and 2005. Since a financial burden of 10% is generally viewed as excessive health care expenditures for families (Short and Banthin 1995; Banthan and Bernard 2006; Schoen, Doty, Collins and Holmgren 2005), this threshold is also often used as measures of underinsurance. FOOPSPD burden is defined as the ratio of total out-of-pocket medical spending to total family income where the numerator and denominator are summed over *i* individuals (*i*= 1 to *k*) in each family:

$$\frac{\sum_{\mathrm{i}} \text{Out of Pocket Spending}_{\mathrm{i}}}{\sum_{\mathrm{i}} \text{Income}_{\mathrm{i}}}$$

Such a measure of out-of-pocket spending burden is less sensitive to measurement error found in most of survey data on health spending and family income than the average of the ratio of out-of-pocket spending to income defined for each individual (Goldman and Smith, 2001). The change in burden over the study period provides information on how the health-related financial risk has been changing among families with ESI over the study period. I provide estimates of FOOPSPD and its burden according to the characteristics of the family and the employment characteristics of ESI policyholder in the family.

Econometric Analysis

I next apply econometric models to identify factors that help to explain the variation in FOOPSPD by families having ESI and to identify which families have borne the increase in FOOPSPD over time. The cumulative distribution of FOOPSPD has a spike of observations at zero when the family out-of-pocket premium is not considered as a part of FOOPSPD because a substantial portion of families do not use any health care services during the year. On the other hand, most families are not free from paying at least some part of premiums and thus the typical mass at zero spending in the health expenditure distribution is far less of a problem when the broader definition of FOOPSPD is used. Apart from this characteristic the distribution of FOOPSPD also is highly skewed to the right and heteroskedastic. That is, the variability among families' medical expenditures increases as expenditures get larger often proportional to the square of the mean expenditure (Blough, Madden, and Hornbrook, 1999). As a result, the dependent variable is log-transformed to accommodate the skewness. As discussed below, I apply semi-log regression model.

The model takes the following form:

$$\log FOOPSPD_i = \alpha_0 + \alpha_1 X_i + \varepsilon$$

where X_i is a $k \times 1$ vector of explanatory variables and $i = 1,\ldots,n$ denotes families in the sample. Explanatory variables used in the model of FOOPSPD include family's poverty status and family size along with policyholder's[31] age, gender, race/ethnicity and education. Region and information on family policyholder's current main job, industry type, and firm size are included to control the area-specific differences in medical care

[31] In case of multiple policyholders in a family, the characteristics of the oldest policyholder are used.

costs and health insurance benefit and payment provisions, respectively, since such measures are not available on the MEPS public use files. Other key variables are health status and health conditions. Family level health status is a dichotomous variable indicating at least one family member is reported to be in fair or poor health. Each family-level health condition variable (obtained from the 11 health conditions noted earlier) is also a dummy variable defined as having at least one family member with such a condition in an interview year. The model also includes interaction effects between a dummy variable for year (value of 1 for 2005 and 0 for 2001) and family and policyholder characteristics to discern how FOOPSPD changed over time for families with specific characteristics.

Since the econometric model of FOOPSPD is limited to providing indications of changes in the mean level of out-of-pocket spending over time, I also use a quantile regression model to describe how family out-of-pocket spending has changed throughout the out-of-pocket spending distribution over my study period, and thus, to assess the effectiveness of risk protection from holding ESI. Recent changes in cost-sharing provisions not only have led to an increase in the average level of FOOPSPD but also may have changed the distribution of FOOPSPD by policyholder and family characteristics over time. Figure 2.1 describes the average FOOPSPD at five different FOOPSPD quantiles in 2001 and 2005. Although the average FOOPSPD has increased over time at all quantiles, the extent of increases significantly differs by quantile: the higher the FOOPSPD quantile (where increasing magnitudes of the quantiles are associated with greater levels of FOOPSPD), the bigger the change in out-of-pocket spending. Meanwhile, the median of FOOPSPD is constantly greater than the mean of FOOPSPD in both years demonstrating the right skewed distribution of FOOPSPD.

The quantile regression technique, first introduced by Koenker and Bassett (1978), is especially useful when the entire shape of the distribution changes over time in that it estimates conditional quantile functions – models in which quantiles of the conditional distribution of the dependent variable are expressed as functions of explanatory covariates. The quantile regression model of FOOPSPD is written as:

$$FOOPSPD^{i} = x_i^{'}\beta_\theta + u_\theta,\ Quant_\theta(FOOPSPD_i \mid x_i) = F^{-1}(x_i^{'}\beta_\theta)$$

where x_i is a $k \times 1$ vector of explanatory variables, u_θ is an error term for the θ^{th} quantile, $0 < \theta < 1$, and $i = 1,...,n$ represents a family in the sample. $Quant_\theta(FOOPSPD_i \mid x_i)$ denotes the θ^{th} quantile of FOOPSPD conditional on x_i consisting of dollar amount of total family health expenditures, family' and policyholder's characteristics, geographical location, and interaction between time and family' and policyholder's characteristics. The θ^{th} quantile regression solves the following minimization problem:

$$\min_{\beta \in R^k} \{ \sum_{i: y_i \geq x_i\beta} \theta \mid FOOPSPD^{i} - x_i^{'}\beta_\theta \mid + \sum_{i: y_i < x_i\beta} (1-\theta) \mid FOOPSPD^{i} - x_i^{'}\beta_\theta \mid \}$$

A key assumption of this regression is $Quant_\theta(u_i \mid x_i) = 0$ even though the distribution of the error term u_θ is unspecified. Standard errors of estimates are obtained by the bootstrap method with 20 replications. In this paper, I focus on the characterization of changes at five different points of the conditional FOOPSPD distribution, i.e., 10^{th}, 25^{th}, 50^{th}, 75^{th}, and 90^{th} percentiles.

The quantile regression is also used to decompose the changes in FOOPSPD between 2001 and 2005 into a component that is the contribution due to differences in policyholder and family characteristics over this period and the contribution due to differences in the structure of the model that are characterized by the changes in the regression coefficients. These “structural” changes reflect changes in unobserved tastes, behavioral responses, and responses to policy interventions including the changes in health insurance provisions over the study period. Families who have greater health care needs and are less able to pay for health care may respond differently to changes in health insurance provisions.

I use the Oaxaca-Blinder decomposition technique by identifying the two components of changes between these periods at each quantile of distribution. A decomposition of the difference between the θ^{th} quantile of 2001 and 2005 distribution is given by:

$$q_{\theta}(2005) - q_{\theta}(2001) = \{q_{\theta}(2005) - q_{\theta}(c)\} + \{q_{\theta}(c) - q_{\theta}(2001)\}$$

where $q_{\theta}(t)$ is the θ^{th} quantile of the distribution in year t and $q_{\theta}(c)$ is the θ^{th} quantile of the counterfactual distribution, which is the distribution of FOOPSPD that would result if families in 2001 had been endowed with 2005 characteristics but exhibited 2001 behavioral responses (i.e., coefficients) associated with those characteristics. The Machado and Mata approach is used to construct the counterfactual distribution.[32] The first term on the right-hand side represents the effect of structural changes, i.e., changes in the distribution of behavioral responses and the second term represents the effect of changes in the distribution of characteristics over the study period

[32] STATA ado file is provided by Melly (2006).

2.3. Findings

2.3.1. Descriptive Findings

Table 2.1 provides mean values of FOOPSPD[33] among families with ESI according to the characteristics of the family's policyholder and the family. Between 2001 and 2005, there was a significant increase in mean FOOPSPD on medical services, from $2,476 to $3,010 in 2005 dollars or by 22%. In general, families with older policyholders and those with more highly educated policyholders tended to spend more on medical care out-of-pocket and experience larger increases in FOOPSPD over the study period compared to families with younger policyholders and those whose policyholders have lower educational attainment. In both years, families with female policyholders spent slightly more than those with male policyholders and families with white or Asian policyholders had the highest level of FOOPSPD among racial/ethnic groups. Middle income and high income families experienced larger increase in FOOPSPD between 2001 and 2005 than poor or near poor families with incomes up to 200% of the federal poverty level (FPL).

The close relationship between FOOPSPD and health status and the presence of high-cost health conditions is also observed. Families with at least one member in poor or fair health incurred much higher levels of FOOPSPD and experienced a much larger increase in FOOPSPD over the study period (a $1,047 increase) compared to those without any member in poor or fair health (a $478 increase). Similarly, having a high-cost health condition played a crucial role in triggering the increase in FOOPSPD during the study period. FOOPSPD in families with at least one member having one or more high-cost health condition ($2,713) exceed that of families without any health conditions

[33] Several extreme outliers with FOOPSPD greater than $80,000 are dropped for the analysis.

($1,670) in 2001. The former group experienced a larger change in FOOPSPD ($636) compared to for the latter ($118). Among these conditions, the conditions associated with large changes in FOOPSPD between 2001 and 2005 were cancer and circulatory conditions (arteries, veins, and lymphatic system).

In appendix 1 and 2, I examine the change in FOOPSPD by its components of average out-of-pocket medical spending excluding premiums and average out-of-pocket premiums. Briefly, this analysis reveals the important role played by family out-of-pocket premiums for ESI in increasing FOOPSPD between 2001 and 2005. For example, mean family out-of-pocket medical spending excluding premiums increased by only $114 (from $1,083 to $1,197). By contrast, mean out-of-pocket premiums increased by $418 (from $1,426 to $1,844). In general, similar findings appeared by family characteristics and medical conditions.

2.3.2. Likelihood of High Out-of-Picket Expenditure Burdens

Table 2.2 shows that 10% of families with ESI had FOOPSPD burdens exceeding 10% of their income in 2001 and this increased to 14% of families in 2005. In both years, families with older policyholder, poorer families, and/or families with less educated policyholder were more likely to have higher risk of incurring high financial burden. The largest increases occurred among non-white families (9% in 2001 to 15% in 2005 for Hispanics, and 9% to 14% for African Americans), high income families (3% to 6%), and families with policyholders with a four-year college or higher education (7% to 11% for college graduates and 6% to 10% for individuals with more than 16 years of schooling).

Financial burdens exceeding 10% of family income also varied widely by family health status. Those families with one or more members in poor or fair health status, with a high-cost health condition, or with greater use of medical care were more likely to have an FOOSPD burden in excess of 10% of family income compared to families in better health. During the study period, the probability of having a 10% FOOSPD burden became larger for families with members in poor or fair health status (from 17% to 26%). Financial burdens also varied by health conditions and increased over the study period. Families with at least one person with heart conditions (17% with FOOSPD burdens exceeding 10% of family income in 2001; 22% in 2005) and/or diabetes mellitus (19% in 2001; 23% in 2005) had the highest probabilities of having high financial burden in both years. By contrast, families with at least one member having cancer, COPD/asthma, osteoarthritis, or other circulatory conditions experienced the largest increases in the likelihood of having financial burdens exceeding 10% of family income over the study period (13% in 2001to 20% in 2005; 10% to 17%; 13% to 20%; and 14% to 23% respectively).

The likelihood of incurring FOOPSPD burdens exceeding 10% of family income also differed by policyholders' current job characteristics. Families with policyholders who worked in large firms (50 or more employees) were much more likely to be at risk for a high financial burden than those who worked in small firms (less than 50 employees) in both years. 8.7% of families with ESI policyholders at small firms had FOOPSPD in excess of 10% of family income in 2001, and this increased to 12.3% of such in 2005. By comparison, 22% of families with a policyholder in a larger firm were exposed to such risk in 2001, and this increased to 34% of such families in 2005.

Financial burdens changed over the study period for families with policyholders in specific industries. For example, between 2001 and 2005 families with policyholders who worked in construction, wholesale/retail trade, or other service sectors experienced increases in expenditure burdens between 2001 and 2005: from 10% to 19% of family income; from 5% to 14%; and from 4% to 20%, respectively.

2.3.3. Econometric Findings

Regression Model of FOOPSPD

Table 2.3 displays the result for the semi-logarithmic regression model of FOOPSPD, pooling the 2001 and 2005 data. Overall, families with male and/or older policyholders tended to incur greater levels of FOOPSPD than those with female or younger policyholders, while families with Hispanic or African-American policyholders were much more likely to incur lower levels of FOOPSPD than those with white policyholders. As regards heath status and health conditions, families with at least one person who was in poor or fair health and/or with one or more medical conditions were expected to spend more on medical care and thus to exhibit greater FOOPSPD. This expectation is confirmed by the regression model. Additionally, compared to families with a policyholder who did not attend college, those with four or more college post-graduate education had higher level of FOOPSPD.

Next I consider the interaction between time and policyholder and family characteristics to assess the contribution of these factors over time to FOOPSPD. The key finding is that having one or more health conditions actually raised the FOOPSPD by about 7% to 11% between 2001 and 2005. For example, over the study period, families with at least one member having COPD or asthma experienced an increase in FOOPSPD by 6%; with hypertension by 15%; with a normal birth by 8% and with any circulatory conditions (arteries, veins, and lymphatics) by 11%. Another important finding is that families with policyholders who completed more than a four-year college education experienced an increase in FOOPSPD by 21% over time compared to those with high school education.

Quantile Regression and Decomposition

In Table 2.4, I use quantile regression to consider how the out-of-pocket burden of health care spending changed over time for families at different points in the out-of-pocket spending distribution described in terms of five different percentiles of the FOOPSPD distribution (10^{th}, 25^{th}, 50^{th}, 75^{th}, and 90^{th}). An important and consistent finding in the analysis is that having major health conditions played a significant role in raising FOOPSPD over the study period and its impact varied according to where families are with regard to the distribution of FOOPSPD between 2001 and 2005. For several health conditions, the changes in FOOPSPD were concentrated at higher quantiles of FOOPSPD distribution and the magnitudes of the changes are greater at the higher quantiles of FOOPSPD distribution. In other words, families who spent the least and the most out-of-pocket for medical care experienced greater increases in FOOPSPD during the study period. In contrast, a few conditions led families to experience an increase in FOOPSPSD at lower quantiles, such as COPD or asthma and back problems.

More specifically, families who experienced large increases in FOOPSPD during the study period were those with certain chronic health conditions. Having cancer triggered an increase in FOOPSPD at most of quantiles: by \$385 at the 75th percentile, by \$89 at the 25th percentile, and by \$160 at the bottom (10th) percentile. Cancer, hypertension, and circulatory conditions (arteries, veins, and lymphatics) were main sources of increased FOOPSPD for families in higher quantiles, i.e., an increase of \$865 at the 75th percentile for those with cancer, \$366 at the 75th percentile and \$884 at the top (90th) percentile for those with hypertension, and \$1668 at the top percentiles for those with circulatory problems. In contrast, families with at least one person with back problems experienced an increase of \$172 in FOOPSPD at the lower quantile (25th).

The result from the quantile regression also revealed that families with an ESI policyholder with four or more years of college experienced a greater increase in FOOPSPD at the median of the FOOPSPD than families with policyholders without any college (high school education or less). This finding may reflect the fact that more educated policyholders had access to jobs with better insurance, and that their employers were among those more likely to increase the cost-sharing provisions of their health plans. On the other hand, having at least one family member with fair or poor self-reported health decreased FOOPSPD by almost \$300 at the median over the study period. Other characteristics such as the family's poverty status and the policyholder's firm size where the policyholder was employed did not affect the level of FOOPSPD between 2001 and 2005.

The results from the decomposition analysis using quantile regression reveal that that major portion of differences in FOOPSPD between 2001 and 2005 was due to structural changes. Last two rows of table 2.5 indicate that the differences in FOOPSPD over the period were not primarily due to changes in family or policy holder characteristics.[34] Instead, the change in the medical care spending burden were driven by a set of structural factors which likely may capture behavioral responses to unobserved changes in specific health insurance benefit provisions that changed over the study period. This residual or structural factor was responsible for more than 85% of the total differences. This contribution is fairly consistent through the FOOPSPD distribution: accounting to 88% of the change at the top quantile and about 85% at other quantiles. Thus, the findings indicate that an increase in FOOPSPD over the study period may have resulted primarily because of changes of health insurance plan requirements regarding employee premium contributions, benefits, and payment provisions for families whose members had major health conditions, rather than through changes in the characteristics of these families. That is, during this period, they became more vulnerable to changes in health insurance plan contribution requirements, benefits, and cost-sharing provisions.

The findings from the quantile regression and decomposition analyses are consistent with changes in cost-sharing provisions over this time period. As noted earlier, the number of enrollees in private health insurance with high deductibles, high rate of co-payment and/or a higher limit on out-of-pocket expenses has increased consistently across these years. As a result, families likely to incur higher medical expenditures due to major health conditions had to pay more out-of-pocket for their medical care in 2005 than in 2001. Thus, very high spenders experienced an increase in risk of incurring more FOOPSPD over time. Put differently, they experienced a decline in the “return” (i.e., the

[34] Indeed, I would not expect the characteristics of families with ESI or policyholders to change dramatically over the period.

benefits of risk protection) to holding private health insurance. Interestingly, the same patterns are observed for some families in the bottom of the out-of-pocket spending distribution as well as those with more educated policyholders. This implies that increased family payments for health insurance premiums rather than out-of-pocket spending for medical care *per se* imposed more of a financial burden on families who are less likely to be high health risks.

2.4. Conclusion

In response to rising health care costs and health insurance premiums over the past decade, many employers adopted greater cost-sharing provisions so that enrolled workers and their families would be more responsible for their health care spending and thereby reduce the overuse of unnecessary health care. These efforts to reduce the growth in health care costs, however, may also differentially add to the burden of out-of-pocket spending borne by families with greater health care needs. To address this issue, this chapter examined the changes in FOOPSPD between 2001 and 2005 and which groups of families have borne the increase in FOOPSPD over time.

Between 2001 and 2005, average FOOPSPD had significantly increased by 22% for families with non-elderly individuals who were covered by employer-sponsored health insurance (from nearly$2,500 annually to more than $3,000.) Families with at least one member having one or more serious health conditions were particularly likely to experience considerable increases in both FOOPSPD and in the risk of incurring a financial burden of medical care exceeding 10% of family income over the study period. Both descriptive statistics on mean annual out-of-pocket spending and financial burden suggest that the increase in family out-of-pocket premiums was the key factor to raise the FOOPSPD.

After controlling for other potential family and policyholder characteristics that may be associated with family decisions to use medical care, estimates from a regression model reveal that having at least one family member suffering from COPD/asthma, hypertension and/or having a normal birth had greater increases in the likelihood of paying more out-of-pocket for medical care between 2001 and 2005 (than families without such conditions) as did families having policyholders with at least a college education (compared to policyholders with lower educational attainment).

During this period, not only the mean FOOPSPD but also the whole distribution of FOOPSPD changed. The quantile regression analysis captures this change by estimating the conditional distribution of FOOPSPD. Consistent with the regression model, having one or more health conditions significantly raised the burden of paying out-of-pocket on medical spending over time, but patterns differ according to where a family is located in the FOOPSPD distribution and by health conditions. Overall, the biggest increase in FOOPSPD occurred among families who are in the top quantiles of the FOOPSPD distribution with certain health conditions, indicating that, in part, the changes in health insurance premiums, benefit, and payment provisions during the study period were felt by families who spent the most out-of-pocket. Among 11 major high-cost health conditions, having COPD or asthma and/or hypertension were the two key conditions that triggered the biggest increases in family out-of-pocket expenditure burdens, and having cancer, circulatory condition and/or back problems were other conditions that caused significant increases in FOOPSPD over time. Other than health conditions, having a higher level of education raised the FOOPSPD at the median similar to what was observed in the regression model. In addition, more than 80% of these changes in FOOPSDP were associated with the structural changes, rather than changes in the characteristics of the policyholder and his/her family, and may reflect behavioral responses to the unobserved changes in ESI payment provisions.

While I cannot measure changes in specific health insurance provisions directly, this study showed that over a period in which cost sharing changed, families who needed more health care because of one or more family members' existing health conditions were most affected by changes in cost sharing. In addition, decreases in the "return" to risk protection from holding private health insurance, in terms of increased exposure to out-of-pocket spending, occurred primarily for families at higher parts of the FOOPSPD distribution. One possible implication from this study is that if vulnerable groups found health insurance to be of less value in terms of risk protection, some families during the last decade may have declined offers of employment-sponsored health insurance and became uninsured or sought to enroll in public coverage. Provisions of the Patient Protection and Affordable Care Act (ACA), enacted in March 2010, may address some of these concerns regarding high out-of-pocket medical care costs. In particular, the ACA provides cost-sharing subsidies to families with income between 100% and 400% of federal poverty line (FPL). Additionally, the ACA provides income-related premium credits to those with income up to 400% of FPL. Finally, beginning in 2014 the ACA prohibits health plans from placing annual limits on the dollar value of coverage.[35]

This study has a two notable of limitations. First, pre-tax family-level total income was used for the analysis in this paper. Although it might be more proper to use

[35] "Summary of New Health Reform Law", The Kaiser Family Foundation. Apt. 2011

disposable income, pre-tax total family income was the best available option due to data limitations on data regarding the tax obligations by families. Second, we do not have direct information on health plan characteristics. Use of such data would help to clarify the impact of specific cost-sharing provisions on family financial burden by directly examining the impact of changes in specific cost-sharing provisions.

Figure 2.1. Average FOOPSPD at each quantile in 2001 and 2005

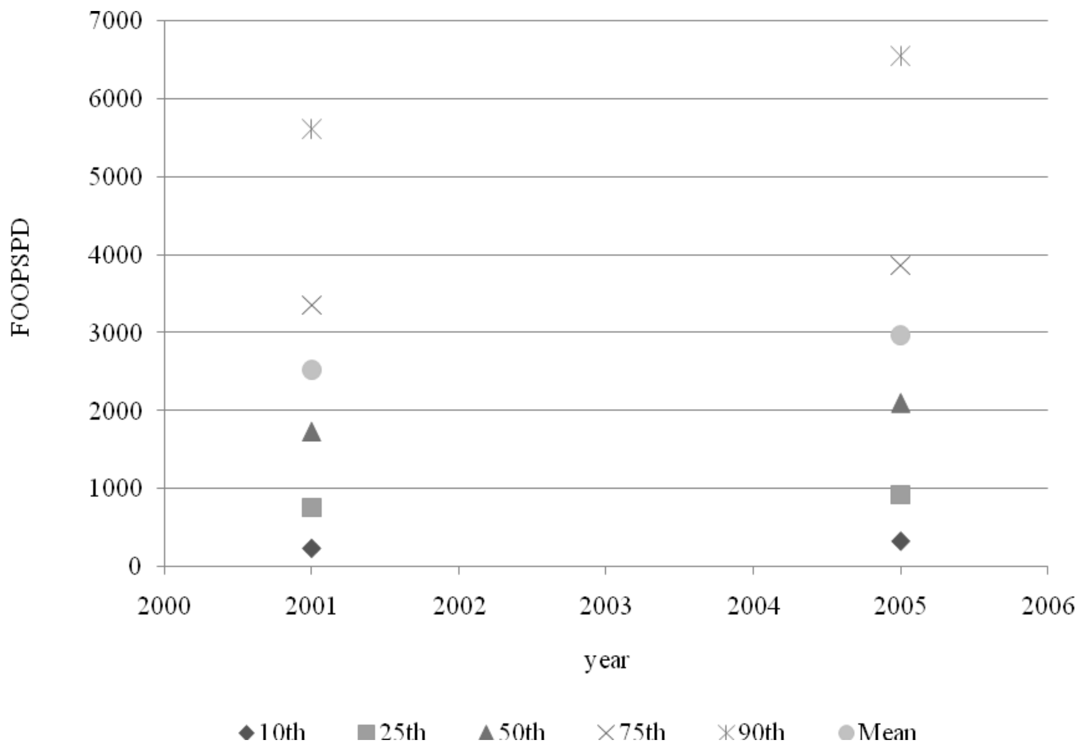

Table 2.1. Descriptive Statistics

		FOOPSPD					
		2001			2005		
		Estimate	Std.Err.	Obs	Estimate	Std.Err.	Obs
	TOTAL	2,476	39	5,979	3,010	54	5,185
Age	18 - 34	1,689	57	1,417	1,915	73	1,165
	35 - 54	2,662	54	3,498	3,218	72	2,959
	55 - 64	2,993	99	1,064	3,684	145	1,061
Gender	Female	2,310	56	2,483	2,793	82	2,150
	Male	2,589	53	3,496	3,154	72	3,035
Race	White/Asian/Others	2,620	46	4,234	3,204	65	3,567
	Hispanic	1,975	95	950	2,366	110	809
	Black	1,818	95	795	2,167	101	809
Poverty Status	Poor/Near Poor (< 200% of FPL)	2,183	91	807	2,401	133	757
	Middle Income (200% ≤ < 400% of FPL)	2,307	62	2,205	2,798	88	1,842
	High Income (≥ 400% of FPL)	2,629	56	2,967	3,244	77	2,586
Education	High School or less	2,046	97	669	2,348	125	565
	2 Year College	2,355	52	3,122	2,805	68	2,613
	4 Year College	2,535	80	1,347	3,185	115	1,233
	4 Year College +	2,970	118	820	3,696	175	749
Region	Northeast	2,397	90	1,046	3,154	166	897
	Midwest	2,425	74	1,418	2,966	94	1,161
	South	2,673	66	2,180	3,078	86	1,905
	West	2,287	88	1,335	2,825	103	1,222
Marital Status	Single	1,588	46	2,259	1,843	63	1,972
	Married	3,096	55	3,719	3,816	75	3,213
Number of family member being in Poor or Fair Health	0	2,384	41	5,250	2,862	53	4,569
	At Least One	3,267	113	727	4,314	257	610
Number of Health Conditions	0	1,670	74	1,313	1,788	71	1,130
	At Least One	2,713	45	4,666	3,349	65	4,055
Health Conditions	Heart Condition	3,483	165	510	4,349	251	472
	Trauma-Related Disorder	2,923	75	1,938	3,651	117	1,585
	Cancer	3,215	150	357	4,790	387	279
	Mental Disorder	3,279	96	1,249	3,860	130	1,247
	COPD, Asthma	2,908	64	2,173	3,768	106	1,798
	Hypertension	2,992	81	1,194	3,791	128	1,283
	Diabetes Mellitus	3,588	165	437	4,098	264	463
	Osteoarthritis and Other Non-Traumatic Joint Disorders	3,133	101	934	3,900	153	793
	Back Problems	3,022	102	952	3,813	159	915
	Normal Birth/ Live Born	2,911	151	344	3,491	272	313
	Other Circulatory Conditions Arteries, Veins, and Lymphatics	3,296	203	226	4,762	481	192
Industry	Natural Resources/Mining	3,285	434	100	2,456	369	75
	Construction	2,168	151	312	3,430	268	292
	Manufacturing	2,153	73	1,175	2,771	114	833
	Wholesale/ Retail Trade	2,209	124	525	3,024	163	574
	Transportation/ Utilities	2,626	112	783	2,694	157	340
	Financial Activities	2,717	173	333	3,245	201	343
	Professional and Business Services	2,141	266	169	2,992	104	1,600
	Other Services	2,318	116	441	3,190	324	117
	Public Administration	–	–	–	2,800	156	418
	Unclassifiable Industry/Military	2,606	74	1,884	2,845	225	370
Firm Size	Small (employees < 50 & single location)	2,441	40	5,502	2,953	55	4,843
	Large (employees ≥ 50)	2,874	144	477	3,851	277	342

Table 2.2. Probability of incurring FOOPSPD exceeding 10% of income

		Probability Incurring FOOPSPD Burden Exceeding 10% of Family Income			
		2001		2005	
		Estimate	Std.Err.	Estimate	Std.Err.
	TOTAL	9.83	0.42	13.70	0.53
Age	18 - 34	6.90	0.70	9.62	0.95
	35 - 54	8.77	0.52	12.74	0.69
	55 - 64	17.49	1.31	20.81	1.35
Gender	Female	11.14	0.68	14.97	0.85
	Male	8.93	0.53	12.86	0.68
Race	White/Asian/Others	9.98	0.48	13.53	0.61
	Hispanic	9.00	1.02	14.54	1.57
	Black	9.36	1.13	14.22	1.32
Poverty Status	Poor/Near Poor (< 200% of FPL)	34.99	1.96	39.35	2.21
	Middle Income (200% ≤ < 400% of FPL)	13.22	0.84	19.00	1.05
	High Income (≥ 400% of FPL)	3.26	0.34	6.09	0.50
Education	High School or less	16.08	1.70	21.12	2.18
	2 Year College	11.20	0.62	15.05	0.78
	4 Year College	7.20	0.74	11.26	0.95
	4 Year College +	6.31	0.87	10.06	1.16
Region	Northeast	8.87	1.01	12.09	1.15
	Midwest	9.07	0.80	13.08	1.05
	South	12.58	0.76	16.29	0.96
	West	7.08	0.74	11.78	1.06
Marital Status	Single	7.82	0.61	10.43	0.74
	Married	11.23	0.57	15.96	0.73
Number of family member being in Poor or Fair Health	0	8.99	0.43	12.30	0.54
	At Least One	16.98	1.53	25.87	2.00
Number of Health Conditions	0	6.99	0.81	10.15	1.03
	At Least One	10.66	0.49	14.69	0.61
Health Conditions	Heart Condition	17.40	1.84	22.07	2.05
	Trauma-Related Disorder	10.80	0.75	13.97	0.94
	Cancer	12.80	1.91	19.66	2.65
	Mental Disorder	13.70	1.06	17.55	1.16
	COPD, Asthma	10.29	0.70	16.56	0.96
	Hypertension	14.67	1.10	18.61	1.21
	Diabetes Mellitus	19.06	2.11	23.49	2.25
	Osteoarthritis and Other Non-Traumatic Joint Disorders	13.16	1.15	19.99	1.53
	Back Problems	11.62	1.10	16.75	1.33
	Normal Birth/ Live Born	9.16	1.65	12.26	2.01
	Other Circulatory Conditions Arteries, Veins, and Lymphatics	14.38	2.50	22.63	3.25
Industry	Natural Resources/Mining	16.90	4.45	9.68	3.59
	Construction	9.80	1.77	18.53	2.60
	Manufacturing	7.45	0.81	10.40	1.15
	Wholesale/ Retail Trade	4.96	1.03	14.22	1.69
	Transportation/ Utilities	12.18	1.35	9.36	1.71
	Financial Activities	9.71	1.77	14.84	2.13
	Professional and Business Services	9.10	2.40	11.72	0.87
	Other Services	4.30	1.02	19.94	4.03
	Public Administration	–	–	8.90	1.46
	Unclassifiable Industry/Military	9.51	0.72	11.46	1.86
Firm Size	Small (employees < 50 & single location)	8.75	0.41	12.33	0.52
	Large (employees ≥ 50)	22.09	2.05	34.05	2.85

Table 2.3. Results for the regression model of FOOPSPD

Variables		Coef. (Robust S.E.)
Year 2005		0.13
		(0.50)
Age		0.02***
		(0.00)
Gender	Male	0.05***
		(0.02)
Poverty Status	Near Poor (100% ≤ < 200% of FPL)	-0.15
		(0.10)
	Middle Income (200% ≤ < 400% of FPL)	-0.03
		(0.11)
	High Income (≥ 400% of FPL)	-0.03
		(0.11)
Race	Hispanic	-0.12***
		(0.02)
	Black	-0.21***
		(0.04)
Education	2 Year College	0.03
		(0.07)
	4 Year College	0.10
		(0.09)
	4 Year College +	0.17***
		(0.08)
Region	Midwest	-0.01
		(0.04)
	South	0.09***
		(0.04)
	West	-0.03
		(0.05)
Family Size	Small family (2 ≤ family members < 5)	0.56***
		(0.03)
	Large family (family members ≥ 5)	0.75***
		(0.03)
Number of family member being in Poor or Fair Health	At Least One	0.15***
		(0.03)

Note: Reference group for gender is female; for poverty status is poor (<100% of FPL); for race is White/Asian/Others; for education is less than 12 years of schooling; for region is east, for family size is single family, and for firm size is middle size (employees < 50 & multiple location)

Robust Standard errors in parentheses.

* = statistically significant at the 10%

** = statistically significant at the 5%

*** = statistically significant at the 1%

Table 2.3. Results for the regression model of FOOPSPD (Cont.)

Variables		Coef. (Robust S.E.)
Health Conditions	Heart Condition	0.12***
		(0.03)
	Trauma-Related Disorder	0.09***
		(0.04)
	Cancer	0.02
		(0.05)
	Mental Disorder	0.19***
		(0.03)
	COPD, Asthma	0.09***
		(0.03)
	Hypertension	-0.04
		(0.04)
	Diabetes Mellitus	0.19***
		(0.04)
	Osteoarthritis and Other Non-Traumatic Joint Disorders	0.07***
		(0.03)
	Back Problems	0.09***
		(0.03)
	Normal Birth/ Live Born	0.17***
		(0.03)
	Other Circulatory Conditions Arteries, Veins, and Lymphatics	0.11***
		(0.03)
Industry	Natural Resources/Mining	0.07***
		(0.03)
	Construction	-0.15***
		(0.03)
	Wholesale/ Retail Trade	0.02
		(0.03)
	Transportation/ Utilities	0.10
		(0.07)
	Financial Activities	-0.09***
		(0.03)
	Professional and Business Services	-0.07*
		(0.04)
	Other Services	-0.13***
		(0.05)
	Public Administration	0.00
		(0.04)
Firm Size	Small (employees < 50 & single location)	0.05
		(0.17)
	Large (employees ≥ 50)	0.02
		(0.19)

Note: Reference group for gender is female; for poverty status is poor (<100% of FPL); for race is White/Asian/Others; for education is less than 12 years of schooling; for region is east, for family size is single family, and for firm size is middle size (employees < 50 & multiple location)

Robust Standard errors in parentheses.

* = statistically significant at the 10%

** = statistically significant at the 5%

*** = statistically significant at the 1%

Table 2.3. Results for the regression model of FOOPSPD (Cont.)

Interacted With Year 2005		Coef. (Robust S.E.)
Age		0.00
		(0.00)
Poverty Status	Near Poor (100% ≤ < 200% of FPL)	0.10
		(0.09)
	Middle Income (200% ≤ < 400% of FPL)	0.14
		(0.11)
	High Income (≥ 400% of FPL)	0.17
		(0.14)
Education	2 Year College	0.12
		(0.11)
	4 Year College	0.18
		(0.10)
	4 Year College +	0.19***
		(0.08)
Family Size	Small (2 ≤ family members < 5)	-0.01
		(0.05)
	Large (family members ≥ 5)	0.04
		(0.05)
Number of family member being in Poor or Fair Health	At Least One	-0.03
		(0.04)
Health Conditions	Heart Condition	0.00
		(0.04)
	Trauma-Related Disorder	-0.01
		(0.04)
	Cancer	0.15
		(0.09)
	Mental Disorder	-0.04
		(0.04)
	COPD, Asthma	0.06***
		(0.03)
	Hypertension	0.15***
		(0.03)
	Diabetes Mellitus	-0.01
		(0.08)
	Osteoarthritis and Other Non-Traumatic Joint Disorders	0.03
		(0.04)
	Back Problems	0.03
		(0.05)
	Normal Birth/ Live Born	0.08***
		(0.04)
	Other Circulatory Conditions Arteries, Veins, and Lymphatics	0.11***
		(0.05)
Firm Size	Small (employers < 50 & single location)	-0.21
		(0.31)
	Large (employers ≥ 50)	-0.21
		(0.31)
Constant		6.42***
		(0.33)

Note: Reference group for gender is female; for poverty status is poor (<100% of FPL);
for race is White/Asian/Others; for education is less than 12 years of schooling; for region is east,
for family size is single family, and for firm size is middle size (employees < 50 & multiple location)

Robust Standard errors in parentheses.

* = statistically significant at the 10%

** = statistically significant at the 5%

*** = statistically significant at the 1%

Table 2.4. Results for Quantile Regression model of FOOPSPD

Variables		q10	q25	q50	q75	q90
Year 2005		-24.6	177.8	188.5	-492.5	50.2
		(-0.06)	(0.29)	(0.35)	(-0.58)	(0.03)
Age		4.9***	10.2***	19.2***	29.5***	54.8***
		(4.58)	(7.84)	(9.19)	(9.47)	(8.72)
Gender	Male	7.7	20.7	102.1***	305.7***	480.9***
		(0.31)	(0.75)	(2.65)	(4.75)	(2.75)
Poverty Status	Near Poor (100% ≤ < 200% of FPL)	-19.0	88.7	52.6	-205.5	-550.7
		(-0.21)	(0.52)	(0.20)	(-0.45)	(-0.91)
	Middle Income (200% ≤ < 400% of FPL)	63.5	208.4***	263.6	-41.8	-561.0
		(0.65)	(1.47)	(1.03)	(-0.09)	(-0.98)
	High Income (≥ 400% of FPL)	42.4	223.7***	270.9	-43.0	-407.4
		(0.42)	(1.67)	(1.05)	(-0.08)	(-0.71)
Race	Hispanic	-67.8***	-155.0***	-249.6***	-315.4***	-576.0***
		(-1.94)	(-3.10)	(-3.15)	(-3.14)	(-3.15)
	Black	-169.1***	-201.5***	-409.4***	-555.4***	-866.1***
		(-5.34)	(-3.70)	(-7.04)	(-7.81)	(-5.22)
Number of family member being in Poor or Fair Health	At Least One	132.2***	249.8***	414.1***	539.5***	567.9***
		(2.46)	(3.04)	(4.21)	(3.95)	(2.71)
Health Conditions	Heart Condition	289.9***	248.9***	278.0*	469.9***	386.0
		(2.86)	(2.03)	(2.63)	(2.73)	(0.86)
	Trauma-Related disorder	136.8***	233.0***	277.4***	330.1***	580.3***
		(4.40)	(4.88)	(5.18)	(3.47)	(2.87)
	Cancer	283.3***	277.5***	251.4***	174.9	366.1
		(2.53)	(3.10)	(1.74)	(0.83)	(0.96)
	Mental Disorder	275.4***	367.1***	475.6***	676.5***	653.9***
		(6.29)	(5.91)	(5.76)	(6.05)	(3.45)
	COPD, Asthma	159.0***	264.8***	366.4***	352.3***	283.1
		(4.37)	(5.26)	(6.54)	(3.34)	(1.34)
	Hypertension	178.4***	170.5***	124.3	-3.5	-253.8
		(7.00)	(2.79)	(1.68)	(-0.03)	(-1.10)
	Diabetes Mellitus	186.4***	368.8***	606.8***	740.4***	938.0***
		(2.43)	(3.31)	(4.81)	(4.00)	(2.78)
	Osteoarthritis and Other Non-Traumatic Joint Disorders	102.1***	215.2***	244.4***	320.2***	547.8***
		(2.02)	(3.62)	(3.66)	(2.01)	(2.01)
	Back Problems	77.2*	113.3	244.7***	386.1***	391.4
		(2.76)	(2.32)	(3.66)	(2.69)	(1.83)
	Normal Birth/ Live Born	205.8***	403.5***	371.5***	531.5***	851.3***
		(1.83)	(3.51)	(2.08)	(1.92)	(2.31)
	Other Circulatory Conditions Arteries, Veins, and Lymphatics	182.6	106.3	232.6	199.6	40.1
		(0.92)	(0.98)	(1.07)	(0.49)	(0.09)
Family Size	Small (2 ≤ family members < 5)	156.6***	407.0***	858.6***	1449.5***	1926.6***
		(9.21)	(13.68)	(20.35)	(20.97)	(15.07)
	Large (family members ≥ 5)	212.0***	610.9***	1383.3***	2077.8***	2990.1***
		(5.99)	(10.70)	(12.24)	(18.89)	(15.31)

Note: Reference group for gender is female; for poverty status is poor (<100% of FPL); for race is White/Asian/Others; for education is less than 12 years of schooling; for region is east, for family size is single family, and for firm size is middle size (employees < 50 & multiple location)

Robust Standard errors in parentheses.

* = statistically significant at the 10%

** = statistically significant at the 5%

*** = statistically significant at the 1%

Table 2.4. Results for Quantile Regression model of FOOPSPD (Cont.)

Variables		q10	q25	q50	q75	q90
Education	2 Year College	41.4	108.4*	142.7	262.0	528.3***
		(1.28)	(2.15)	(1.62)	(1.51)	(2.47)
	4 Year College	120.7***	264.7***	376.4***	495.8***	1016.0***
		(2.63)	(3.11)	(3.59)	(3.16)	(3.62)
	4 Year College +	108.1*	171.1***	325.8***	866.7***	2152.0***
		(1.98)	(1.77)	(3.77)	(3.26)	(4.15)
Region	Midwest	40.4	142.1***	107.8***	32.8	-317.1
		(1.41)	(3.61)	(1.79)	(0.34)	(-1.51)
	South	166.5***	301.4***	351.3***	421.5***	258.6
		(4.16)	(6.46)	(5.25)	(3.81)	(1.13)
	West	-28.7	-52.8	-27.8	66.9	-131.5
		(-0.78)	(-1.57)	(-0.46)	(0.64)	(-0.78)
Firm Size	Small (employers < 50 & single location)	72.5	97.9	-262.6	-100.2	-21.7
		(0.42)	(0.24)	(-0.93)	(-0.22)	(-0.03)
	Large (employers ≥ 50)	97.9	217.5	-195.2	-171.0	-456.3
		(0.51)	(0.56)	(-0.68)	(-0.37)	(-0.71)
Industry	Natural Resources/Mining	-141.8***	-113.3*	-76.8	422.7*	1313.9***
		(-2.57)	(-1.55)	(-0.75)	(2.24)	(3.62)
	Construction	-1.9	11.3	-120.9*	-94.5	-272.6
		(-0.05)	(0.26)	(-1.96)	(-0.99)	(-1.02)
	Wholesale/ Retail Trade	76.6***	111.1***	199.4***	300.0***	246.8
		(1.66)	(1.76)	(2.24)	(2.25)	(0.89)
	Transportation/ Utilities	83.4	131.6	290.9***	607.9***	1023.5***
		(1.65)	(1.71)	(2.27)	(2.78)	(2.00)
	Financial Activities	-54.7	-82.2**	-126.2	78.1	-45.2
		(-1.20)	(-1.57)	(-1.45)	(0.62)	(-0.15)
	Professional and Business Services	-6.4	-35.2	-9.6	25.3	-157.8
		(-0.14)	(-0.48)	(-0.10)	(0.19)	(-0.60)
	Other Services	-64.5	-112.4	-182.9	-260.5	-237.8
		-0.92	-1.05	-1.15	-1.36	-0.6
	Public Administration	13.59608	38.77538	82.0592	386.6927	432.6036
		(0.36)	(0.66)	(1.26)	(3.55)	(1.64)

Note: Reference group for gender is female; for poverty status is poor (<100% of FPL); for race is White/Asian/Others; for education is less than 12 years of schooling; for region is east, for family size is single family, and for firm size is middle size (employees < 50 & multiple location)

Robust Standard errors in parentheses.

* = statistically significant at the 10%

** = statistically significant at the 5%

Table 2.4. Results for Quantile Regression model of FOOPSPD (Cont.)

Interacted With Year 2005		q10	q25	q50	q75	q90
Poverty Status	Near Poor (100% ≤ < 200% of FPL)	55.7	-81.5	-75.9	171.4	649.9
		(0.53)	(-0.40)	(-0.29)	(0.27)	(0.83)
	Middle Income (200% ≤ < 400% of FPL)	20.8	25.2	110.3	373.4	1131.9
		(0.18)	(0.14)	(0.40)	(0.56)	(1.43)
	High Income (≥ 400% of FPL)	49.7	39.9	138.6	635.0	1317.7
		(0.42)	(0.23)	(0.47)	(0.96)	(1.70)
Number of family member being in Poor or Fair Health	At Least One	-68.3	-144.0	-296.7***	-174.8	153.4
		(-0.76)	(-1.10)	(-2.09)	(-0.68)	(0.36)
Health Conditions	Heart Condition	59.8	261.7	258.6	221.9	505.9
		(0.52)	(1.70)	(1.32)	(0.79)	(0.76)
	Trauma-Related disorder	-35.2	-90.3	8.1	114.5	27.9
		(-0.69)	(-1.17)	(0.08)	(0.72)	(0.11)
	Cancer	132.2	129.2	416.5	864.9***	68.9
		(0.88)	(0.82)	(1.71)	(2.29)	(0.11)
	Mental Disorder	-111.5	52.3	-9.8	-185.7	-170.3
		(-1.90)	(0.60)	(-0.08)	(-1.23)	(-0.45)
	COPD, Asthma	159.4***	88.8*	110.7	384.8***	446.1
		(3.44)	(1.27)	(1.02)	(2.45)	(1.95)
	Hypertension	120.9	119.4	149.3	366.0*	883.8***
		(2.02)	(1.56)	(1.40)	(1.44)	(2.85)
	Diabetes Mellitus	113.4	75.1	-140.4	-192.5	-548.6
		(0.74)	(0.37)	(-0.74)	(-0.56)	(-0.99)
	Osteoarthritis and Other Non-Traumatic Joint Disorders	27.6	-203.0*	-65.4	4.6	671.4
		(0.37)	(-1.86)	(-0.39)	(0.01)	(1.30)
	Back Problems	32.7	172.1**	21.5	-94.2	133.0
		(0.39)	(1.86)	(0.21)	(-0.46)	(0.46)
	Normal Birth/ Live Born	-79.4	-77.1	138.2	-145.1	-189.2
		(-0.51)	(-0.41)	(0.66)	(-0.42)	(-0.22)
	Other Circulatory Conditions Arteries, Veins, and Lymphatics	53.9	286.9	323.1	239.2	1668.0*
		(0.20)	(1.27)	(1.07)	(0.64)	(2.07)
Education	2 Year College	9.8	-38.4	106.2	63.6	-109.8
		(0.14)	(-0.39)	(0.81)	(0.32)	(-0.36)
	4 Year College	-65.3	-13.7	241.7	285.9	293.2
		(-0.77)	(-0.12)	(1.46)	(1.06)	(0.55)
	4 Year College +	36.7	206.5*	424.4*	371.1	110.0
		(0.45)	(1.44)	(2.43)	(1.07)	(0.15)
Firm Size	Small (employers < 50 & single location)	50.5	-13.1	-170.8	173.8	-1036.5
		(0.15)	(-0.02)	(-0.37)	(0.28)	(-0.80)
	Large (employers ≥ 50)	97.1	-78.8	-214.6	202.0	-516.5
		(0.32)	(-0.13)	(-0.51)	(0.27)	(-0.38)
Constant		-461.7***	-849.8***	-596.8	-556.4	-182.2
		(-2.08)	(-2.15)	(-1.42)	(-0.89)	(-0.16)

Note: Reference group for gender is female; for poverty status is poor (<100% of FPL); for race is White/Asian/Others; for education is less than 12 years of schooling; for region is east, for family size is single family, and for firm size is middle size (employees < 50 & multiple location)

Robust Standard errors in parentheses.

* = statistically significant at the 10%

** = statistically significant at the 5%

*** = statistically significant at the 1%

Table 2.5. Oaxaca-Blinder decomposition of the changes in FOOPSPD between 2001 and 2005

$	q10	q25	q50	q75	q90
Raw difference	94.3	214.9	399.1	626.0	997.3
Characteristics	14.4	30.7	61.2	90.2	118.8
Coefficients	80.0	184.2	337.8	535.8	878.6
%					
Characteristics	0.15	0.14	0.15	0.14	0.12
Coefficients	0.85	0.86	0.85	0.86	0.88

Appendix 2.1. Descriptive Statistics of Out-of-Pocket Spending

		OUT-OF-POCKET SPENDING					
		2001			2005		
		Estimate	Std.Err.	Obs	Estimate	Std.Err.	Obs
	TOTAL	1083	23.4	5979	1197	29.5	5185
Age	18 - 34	591	26.1	1417	619	32.6	1165
	35 - 54	1171	32.5	3498	1271	36.1	2959
	55 - 64	1498	65.2	1064	1646	92.0	1061
Gender	Female	1034	33.9	2483	1177	49.5	2150
	Male	1116	31.9	3496	1210	36.5	3035
Race	White/Asian/Others	1204	27.9	4234	1318	35.7	3567
	Hispanic	658	60.2	950	751	58.8	809
	Black	536	27.6	795	704	46.8	809
Poverty Status	Poor/Near Poor (< 200% of FPL)	858	51.6	807	933	81.3	757
	Middle Income (200% ≤ < 400% of FPL)	961	39.0	2205	1044	44.2	1842
	High Income (≥ 400% of FPL)	1196	33.2	2967	1335	42.8	2586
Education	High School	774	59.3	669	767	66.8	565
	2 Year College	1022	31.9	3122	1137	37.5	2613
	4 Year College	1121	47.0	1347	1222	50.4	1233
	4 Year College +	1383	69.3	820	1554	111.1	749
Region	Northeast	1110	63.5	1046	1218	97.2	897
	Midwest	1167	49.4	1418	1261	53.1	1161
	South	1105	36.7	2180	1160	42.6	1905
	West	916	39.4	1335	1164	51.5	1222
Marital Status	Single	663	28.5	2259	735	44.0	1972
	Married	1376	33.3	3719	1515	37.8	3213
Number of family member being in Poor or Fair Health	0	999	23.9	5250	1091	24.9	4569
	At Least One	1798	84.0	727	2119	185.7	610
Number of Health Conditions	0	467	36.6	1313	439	31.2	1130
	At Least One	1264	27.6	4666	1407	35.8	4055
Health Conditions	Heart Condition	1858	112.9	510	2123	172.6	472
	Trauma-Related Disorder	1387	48.8	1938	1648	73.6	1585
	Cancer	1690	95.3	357	2405	291.7	279
	Mental Disorder	1720	64.3	1249	1863	81.3	1247
	COPD, Asthma	1417	39.4	2173	1669	64.4	1798
	Hypertension	1504	50.2	1194	1771	79.7	1283
	Diabetes Mellitus	1863	110.3	437	2129	196.8	463
	Osteoarthritis and Other Non-Traumatic Joint Disorders	1593	56.8	934	1896	82.3	793
	Back Problems	1519	63.3	952	1840	102.3	915
	Normal Birth/ Live Born	1026	71.1	344	1125	79.5	313
	Other Circulatory Conditions Arteries, Veins, and Lymphatics	1739	132.1	226	2543	369.0	192
Industry	Natural Resources/Mining	1168	189.8	100	811	156.0	75
	Construction	833	70.8	312	1124	115.6	292
	Manufacturing	974	49.1	1175	1127	61.0	833
	Wholesale/ Retail Trade	993	75.9	525	1074	76.6	574
	Transportation/ Utilities	1036	58.8	783	1321	112.2	340
	Financial Activities	1121	93.6	333	1174	79.5	343
	Professional and Business Services	1035	213.6	169	1193	60.9	1600
	Other Services	1092	77.8	441	1269	162.4	117
	Public Administration				1195	92.3	418
	Unclassifiable Industry/Military	1160	44.3	1884	1099	97.3	370
Firm Size	Small (employees < 50 & single location)	1060	24.0	5502	1161	29.1	4843
	Large (employees ≥ 50)	1346	95.9	477	1725	172.5	342

Appendix 2.2. Descriptive Statistics of Out-of-Pocket Premium

		OUT-OF-POCKET PREMIUM					
		2001			2005		
		Estimate	Std.Err.	Obs	Estimate	Std.Err.	Obs
	TOTAL	1426	29.5	5851	1844	41.3	5093
Age	18 - 34	888	39.5	1397	1237	58.6	1150
	35 - 54	1203	33.6	3369	1888	57.7	2877
	55 - 64	1195	60.9	1031	1928	95.3	1026
Gender	Female	1036	35.8	2411	1549	55.6	2101
	Male	1180	32.6	3386	1869	56.2	2952
Race	White/Asian/Others	1149	27.6	4099	1816	48.5	3477
	Hispanic	1015	57.9	930	1511	87.2	795
	Black	1002	77.0	768	1398	79.9	781
Poverty Status	Poor/Near Poor (< 200% of FPL)	1099	57.4	797	1442	89.0	750
	Middle Income (200% ≤ < 400% of FPL)	1090	37.6	2157	1707	68.3	1810
	High Income (≥ 400% of FPL)	1145	35.4	2843	1815	57.0	2493
Education	High School	983	60.8	656	1496	93.7	556
	2 Year College	1076	32.6	3011	1597	50.8	2545
	4 Year College	1136	47.9	1306	1880	94.3	1201
	4 Year College +	1291	74.9	804	2095	112.8	728
Region	Northeast	1046	50.6	1016	1888	123.6	872
	Midwest	1027	40.3	1360	1666	67.0	1127
	South	1246	43.2	2126	1817	64.4	1868
	West	1101	61.7	1295	1574	78.5	1186
Marital Status	Single	722	27.7	2247	1062	39.3	1966
	Married	1413	35.6	3549	2227	61.2	3087
Number of family member being in Poor or Fair Health	0	1120	26.3	5090	1699	42.4	4457
	At Least One	1135	57.0	705	2123	135.5	590
Number of Health Conditions	0	974	52.6	1290	1303	60.7	1111
	At Least One	1165	27.2	4507	1864	48.7	3942
Health Conditions	Heart Condition	1287	84.4	492	2106	130.0	460
	Trauma-Related Disorder	1243	43.2	1871	1915	72.5	1533
	Cancer	1211	87.6	344	2307	212.7	272
	Mental Disorder	1267	54.3	1213	1930	81.3	1215
	COPD, Asthma	1206	38.8	2089	2020	72.5	1747
	Hypertension	1218	52.3	1141	1934	84.0	1236
	Diabetes Mellitus	1412	112.6	415	1861	132.9	446
	Osteoarthritis and Other Non-Traumatic Joint Disorders	1275	68.9	904	1996	114.7	765
	Back Problems	1231	66.7	910	1923	104.0	884
	Normal Birth/ Live Born	1494	107.8	330	2281	271.0	298
	Other Circulatory Conditions Arteries, Veins, and Lymphatics	1210	117.8	217	2167	256.2	185
Industry	Natural Resources/Mining	1570	260.5	100	1513	266.8	72
	Construction	1089	114.8	297	2163	221.9	287
	Manufacturing	944	39.8	1135	1555	89.0	812
	Wholesale/ Retail Trade	990	85.9	506	1864	132.7	562
	Transportation/ Utilities	1292	77.3	761	1336	100.3	332
	Financial Activities	1269	106.7	323	2036	170.9	332
	Professional and Business Services	825	94.5	164	1732	68.8	1560
	Other Services	994	68.0	426	1863	263.8	117
	Public Administration				1548	115.0	409
	Unclassifiable Industry/Military	1162	44.7	1840	1669	187.2	360
Firm Size	Small (employees < 50 & single location)	1112	25.2	5338	1719	41.3	4725
	Large (employees ≥ 50)	1233	86.5	459	2073	190.1	328

Chapter 3

Persistence in Out-of-pocket Health Care Expenditures among Medicare Beneficiaries

3.1. Introduction

U.S. health care spending is heavily concentrated in the top percentiles of its health care spending distribution. Although half of the population spends little or nothing on health care, about five percent of the population accounts for almost half of total expenditures. This skewness in the health care expenditure distribution has been relatively consistent over time. Berk and Monheit (1992) showed that the concentration of health expenditures among the U.S. population has remained fairly stable from the1970s to the mid-1990s, while Zuvekas and Cohen (2007) have demonstrated some attenuation of the expenditure concentration since 1996 due to increased use of prescription drugs. Many studies also have examined the dynamics of concentrated health expenditures by determining whether an individual with high health expenditures continues to incur high health care expenditures over time (Eichner et al. 1997; Garber et al. 1997; Goodman et al. 1991; Russell and Chaudhuri 1992). However, we know little about the persistence of health care expenditures that an individual or a household pays out-of-pocket for medical care.

This study will be the first to examine the dynamics of out-of-pocket health care spending by looking at the persistence of such spending among elderly adults. It will provide insight into how long high health care out-of-pocket spending persists, its association with certain health conditions and health shocks, and identify the determinants of the likelihood that an individual will be a persistent high health care spender. Expenditure persistence could depend on individual characteristics, health-related factors associated with an individual's prior position in health care expenditure distribution, or random health shocks apart from ongoing health conditions.

Understanding the factors that could lead out-of-pocket payments for health care to persist over long periods will help to evaluate the economic implications of cost-sharing provisions and thus, how effective Medicare and other supplementary health insurance are in protecting elderly adults from possible catastrophic out-of-pocket expenditures (Monheit, 2003). Therefore, such information can be used to develop policies or insurance programs that reduce the burden of high and persistent out-of-pocket spending on individuals and families.

In this paper, I first examine the distribution of out-of-pocket spending and how long high out-of-pocket spending persists over the study period. I then study the likelihood that an elderly adult who was in the top 10% or 20% of out-of-pocket spending in the first observation period continuously remains in the same position of the distribution over the study period. The Health and Retirement Study (HRS), a biannual household panel survey of the elderly in the United States, is able to support an analysis of persistence in out-of-pocket health care spending over a lengthy period. This paper focuses elderly adults who are 65 years old or older from 2001 to 2010. The paper first begins by describing the data sources that are used in this study, the RAND HRS, in section 2. In section 3, I discuss the model I used to predict the likelihood of persistently being in the top percentiles of out-of-pocket distribution and issues that can arise in the model. In section 4, I present the results from the analysis: first I describe the concentration of out-of-pocket health care spending and how individuals in the top percentiles remain in such a position over ten years, and then I examine results from the logit model that predicts the likelihood of out-of-pocket health care expenditure persistence. Finally, in the last section, I summarize and discuss the main results from the study.

3.2. Data

The RAND Health and Retirement Study (HRS) Data File and the RAND Enhanced Fat Files are the main data sources for this study. The HRS is a national panel survey of the American older adults, designed for research regarding policies and programs on health, health insurance, and retirement. The RAND HRS Data files are a cleaned and processed version of the HRS for the easy use, although it contains a subset of the HRS data. It includes information on medical care out-of-pocket expenditures, health conditions, health insurance status, health care utilization, and wealth. For additional sensitivity checks, I merge variables on out-of-pocket expenditure by utilization and variables indicating expectations of future health and risk averseness from the RAND Enhanced Fat Files. The Enhanced Fat Files were developed to provide a respondent-level dataset of the original HRS and hence it includes all variables in the unrefined HRS.

The HRS provides more complete profiles of out-of-pocket health care spending, total income, and wealth than the Medicare Current Beneficiary Survey (MCBS). Goldman and Smith (2001) demonstrated that measurement error in income in the MCBS results in significant bias in estimates. The RAND HRS provides comprehensive information on wealth and income while the MCBS only asks a single question on total income. I use total wealth rather than total income because decision on medical care is more like to depend on total wealth than total income for elderly adults. Total wealth in the RAND HRS includes a comprehensive set of wealth components: the value of the primary residence; net value of real estate (not primary residence); net value of vehicles; net value of business; net value of IRA and Keogh accounts; net value of stocks, mutual funds, and investment trusts; net value of checking, savings, or money market accounts; value of CD, government savings bonds, and T-bills; net value of bonds and bond funds; net value of all other savings, less all debt; the value of all mortgages/ land contracts (primary residence); the value of other home loans (primary residence); and the value of other debts.

The target sample for this study includes elderly adults who are age 65 years or older and who were alive throughout the study period.[36] I also restrict the sample to individuals who are covered by Medicare. Less than 5% of people or 415 elderly adults in the sample are not enrolled in Medicare but covered by other health insurance or uninsured. Such individuals, for example, are likely to be new immigrants who may exhibit different behavior regarding the use of health care. Therefore, four categories of health insurance status in this study are considered: Medicare only, Medicare and any federal government health insurance programs such as Medicaid, CHAMPUS, VA, or other military programs, and Medicare and other private health insurance such as private Medigap policies and retiree policies that can supplement Medicare coverage.

Since 1992, the HRS surveyed participants biannually, collecting information for previous two years. Although the HRS is available from 1992, it provides a consistent estimate on total out-of-pocket health care expenditure from the wave 6[37] and hence wave 6, wave 7, wave 8, wave9, and wave10, which contain respondents' previous two-year

[36] The mortality rate is about 13%. 1,752 observations were dropped because of the death.
[37] Wave 6 contains information in 2001 and 2002: wave 7 in 2003 and 2004: wave 8 in 2005 and 2006: wave 9 in 2007 and 2008: wave 10 in 2009 and 2010.

information corresponding to the years 2002, 2004, 2006, 2008, and 2010, and these time periods are used in this paper. The total out-of-pocket health care spending includes payments for hospital use, nursing home, doctor visits, dentist visits, outpatient survey, prescription drug, home health care and special facilities use. All dollar amounts are expressed in 2010 dollars. The total sample size is 39,398, including about 6,500 to 9,000 observations in each wave. For the econometric analysis, I consider individuals who were continuously interviewed for 3 consecutive waves, accounting for 9,541 elderly adults. 81% of people have responded in 6, 7, and 8 waves (group 1); about 19% of people were not interviewed in wave 6, but interviewed in wave 7,8, and 9 (group 2); and remaining 9% were first interviewed in wave 8 and continuously followed up until wave 10 (group 3). I combine these groups into one data set and call the first wave period 1, the second wave period 2, and the last wave period 3. For example, wave 6 from group 1, wave 7 from group 2, and wave 8 from group 3 comprise period 1; wave 7 from group 1, wave 8 from group 2, and wave 9 from group 3 comprise period 2; wave 8 from group 1, wave 9 from group 2, and wave 10 from group 3 comprise period 3. I study three waves because the descriptive statistics shows that the distribution of out-of-pocket spending tends to regress to the mean after the 3 waves or 6 years. Detailed statistics are discussed in the result section.

3.3. Econometric Methods

I use the Logistic model to study the likelihood of persistently being in the top percentiles of out-of-pocket health care spending among elderly adults who were initially in the top percentiles. I first assess out-of-pocket expenditure persistence for the top 10^{th}

and 20th percentiles of the out-of-pocket spending distribution considering them as top percentiles of the distribution.[38] The total out-of-pocket health care expenditure in the top 10% or 20% accounts for each about 55% or 70% of total out-of-pocket spending in the sample. An additional analysis considers the likelihood of a sharp reduction in health care spending in the last period, low enough for some observations to fall within the bottom 50% of the distribution, after being in the top 10% in the first period. The analysis thus identifies the factors that lead the reduction in the financial burden on health care.

Explanatory variables include individual characteristics and demographics, health status, and health insurance status. The HRS asks respondents to self-report his/her general health status among five categories, excellent, very good, good, fair, or poor. In this paper, "good health" refers either excellent, very good, or good health status and "poor health" refers either fair or poor health status. These self-reported health status change over periods, and therefore I define dummy variables for self-reported health status as: being in good health for all three periods, starting in poor health but improving to good health in the second or third period, starting in good health but worsening in health status in the later periods, or always being in poor health. The HRS also reports eight chronic health conditions including high blood pressure, diabetes, cancer, lung problem, heart problem, stroke, emotional problem, and arthritis. It asks whether an individual has ever been diagnosed with certain health problems. Similar to health status, the onset of a health condition could occur in the later period. Each health condition is defined by three dummy variables, indicating whether the initial observation period included a health condition, whether the onset of a new health condition in the second or

[38] Small sample size precludes using higher percentiles, such as top 1st or top 5th.

the third period, and whether an individual was without a health condition for the entire observation period. Another variable that helps to control for health status assesses Activities of Daily Living (ADL). ADL in this paper includes five tasks: bathing, eating, dressing, walking across a room, and getting in or out of bed. The ADL dummy variable also indicates whether an individual has difficulty with at least one ADL during the whole interview years, whether he/she face a new difficulty with an ADL in later periods, or whether he/she does not have any difficulty with an ADL through the periods.

Although every individual in this study is enrolled in Medicare, their insurance coverage differs by whether or not they are enrolled any health insurance that supplements Medicare. The majority of elderly adults, more than 40% of them, are enrolled in both Medicare and employer-sponsored health insurance as shown in table 3.5. Among the remaining half, about a quarter of individuals in the sample are covered by Medicare only, while another quarter of them possess supplementary private health insurance other than employer-sponsored health insurance such as Medigap along with Medicare, and about 7% of them are under both Medicare and other government health insurance such as Medicaid, CHAMPUS, VA, or other military programs. To capture the influence of changes in health insurance status since the initial observation period, I also include a variable indicating the enrollment in any supplementary health insurance including government health insurance, employer-sponsored insurance, and other private health insurance, and variables identifying the acquisition or loss of supplementary health insurance during the study periods.

One thing to note is that the health insurance variables and variables indicating acquisition or loss of supplementary health insurance may be endogenous and reflect the anticipation of future high out-of-pocket health care spending. There exists mixed evidence of selection problem in the Medicare supplementary market. Fang et al. (2006) suggested an advantageous selection into Medigap insurance market by healthier elderly, while Lustig (2008) found evidence of adverse selection in privatized Medicare plans. Ettner (1997) and Wolfe and Goddeeris (1991) did not find significant adverse selection, but a strong positive wealth effect on the choice of supplementary health insurance. Marquis (1992) also found lack of evidence of adverse selection in the health insurance market for elderly adults. Although I lack an instrument that would address the source of endogeneity, the following statistics suggest that any bias that could arouse in results from the logit model because of selection will be small. Appendix 1 summarizes individual characteristics by each health insurance status. Although people who have any supplementary health insurance are somewhat more likely to have at least one health condition than those who are covered by only Medicare, I do not observe significant differences in either average out-of-pocket spending or overall health status between those with and without supplementary coverage. Instead, total wealth is much higher among those who are enrolled in any supplementary health insurance. Additionally, an individual's expectation of their future health and their risk aversion do not significantly differ between elderly adults who are persistently in the top 10% and those who are persistently in the bottom 50% of the distribution.[39]

Another issue in modeling the likelihood of out-of-pocket expenditure persistence is that the Medicare Part D became effective beginning in 2006 and out-of-

[39]The variable measuring the expectation on future health reports the chances an individual think his/her health status gets worse in four years; the risk averse measure is from a variable reflecting an individual's preference to a stable job over a risky, but higher-return job. Both variables are drown from the Rand Fat Files. Even so, these two measures are not included in the econometric analysis because of lack of sample size.

pocket spending for the prescription drug clearly declined since 2006. The Fat File from the HRS provides the out-of-pocket health care spending for certain utilization including spending for prescription drugs and it shows that the average out-of-pocket spending for prescription drugs was $3,475 in 2002 and $4,692 in 2004. The data provide a clear evidence of reduction in an individual's financial burden on health care: the average out-of-pocket spending was reduced to $1,940 in 2006, $1,684 in 2008, and $1,790 in 2010 after the introduction of public prescription drug insurance coverage from Medicare Part D. The analysis based on "periods" instead of waves (or years) disables the use of a variable to control for the year of onset of Medicare Part D, because each period includes 2006 data. Therefore, by including a period variable in the model, I try to capture unobserved characteristics of each period, but also the financial protection from the introduction of Medicare Part D.

3.4. Results

3.4.1. Concentration and persistence of out-of-pocket health care spending

Out-of-pocket health care expenditures have an uneven distribution, heavily concentrated at the top of the distribution among elderly adults who were interviewed in the HRS during the study period. This concentration is consistent through the year: the top 5% of out-of-pocket health care spenders account for about half of the total out-of-pocket expenditures on average and the top 10% of spenders account for about 60% of the total on average (Table 3.1). That is, similar to the stable concentration of total medical spending, a few elderly adults are responsible for extremely high out-of-pocket health care spending. Does this high out-of-pocket spending persist over time? The first column of table 3.2 shows the number of elderly adults who are in each percentile of out-of-pocket health care expenditure in the first wave, 2002, and following columns reveal the number of people who remain in the same percentiles in 2004, 2006, 2008, and 2010. Many studies of persistence in total health care spending observe short-term persistence and table 3.2 also suggests that the number of people who remain in the same percentile declines over time. In the HRS, high out-of-pocket spending persists for a short period and then remains fairly stable after about three waves or six years. One thing to note is that the mortality rate is relatively higher at the upper percentiles of out-of-pocket spending and that could significantly reduce the number of elderly adults who incur high out-of-pocket spending for multiple years (table 3.3).

Since the persistence of out-of-pocket fades out after about three waves (or six years), I study individuals for three continuous periods. Table 3.4 describes the persistence of out-of-pocket expenditure for three periods. The first table provides information for each percentile and the second shows the cumulative number of observations up to each percentile. As in table 3.2, the first column displays the number of elderly adults who were in each percentile of out-of-pocket expenditure in the first period and the second and third columns show the number of these individuals remaining in the same percentile. Although the number of people significantly dropped after the first period, partly because of a high mortality rate particularly in the top spender categories, a non-trivial number of people remain in the same or upper percentiles of out-of-pocket spending distribution. For example, 279 out of 793 elderly adults (about 34%) with out-of-pocket spending ranked up to top 10% in the first period continuously spent for health care maintaining their level of spending up to top 10% in the second period and 149 adults (about 19%) of them in the third period.

Table 3.5 summarizes the characteristics of elderly adults in the top 10%, top 20%, and the bottom 50% of out-of-pocket health care spenders during the study period. Characteristics of the full sample are also reported as a comparison in the last column. People who are in top deciles are more likely to be female, white and/or more highly educated. As expected, the probability of being in the top percentiles of the out-of-pocket spending distribution is much higher for people having a health condition in all periods. For example, 30% of elderly adults who are in the top 10% of spending have diabetes while only 10% of people who are in the bottom 50% do. Similarly, people who are in the bottom 50% of out-of-pocket spending are more likely not to have any health condition. Health insurance status also varies over the out-of-pocket health spending distribution. Twice as many high spenders (42% for the top 10%; 41% for the top 20%) are covered by both Medicare and other private health insurance such as Medigap than low spenders (19% for the bottom 50%). In contrast, 15% of elderly adults in the bottom 50% are covered by both Medicare and ESHI while only 2% of them in the top 10% are covered by the same insurance. Average total wealth also differs significantly: elderly adults who are in the top percentiles possess wealth that is about twice that of low spenders (about $1,000,000 versus $530,000).

3.4.2. The likelihood of persistently high out-of-pocket health care expenditure over three periods and its determinants

The logit model in table 3.6 provides estimates of the likelihood of being in the same percentiles in two consecutive periods conditional on being in the top 10% of out-of-pocket health care expenditure in the first period. In HRS, about 20% of people remain in the top 10^{th} of spending distribution among 742 elderly adults who are initially in the top 10^{th} of the distribution. The third and fourth columns of table 3.6 show coefficients from the logit and their standard errors. The marginal effects and their standard errors are provided in the following fifth and sixth columns, and the odds ratio and their linearized standard errors are displayed in the last two columns. The results suggest that having a specific health condition is a crucial determinant of the likelihood of persistently being in the top out-of-pocket spending percentiles. Having diabetes in every period increases the probability of being a persistent high spender by 5 percentage points and an onset of diabetes in either the second period or the third also increases the probability by 9 percentage points. Similarly, having a stroke or an emotional problem raises the likelihood of persistence by about 5 to 6 percentage points. Another important determinant of persistently high spending is health insurance status. Compared to elderly adults who are covered by only Medicare, people having other government health insurance such as Medicaid, CHAMPUS, VA, or other military programs are about 19 percentage point less likely to be a persistently high out-of-pocket spender for three periods or 6 years. By contrast, people who are covered by Medicare and any supplementary health insurance are more likely to be a persistently high spender (by about 9 percentage points).

Table 3.7 provides the result from the logit model of the likelihood that an individual who was in the top 20% of out-of-pocket health care spending in the first period remains in the sample percentile of the spending distribution over the remaining periods. About 30% of people were in the top 20% of the distribution for the whole period. The logit model suggests that being in good health compared to fair or poor health reduces the probability of persistence in high spending by 6 percentage points. Acquisition of any supplementary health insurance other than Medicare also reduces such probably by 10 percentage points. By contrast, having a specific health condition or any difficulties in ADLs increase the likelihood of expenditure persistence. Having diabetes, cancer, lung problem, or stroke increases the chance that an individual remains in the top 20% of out-of-pocket spending distribution persistently by about 6 to 8 percentage points. The onset of a health condition also results in an individual being a persistently high spender: an onset of diabetes or a heart problem increases the probability by each about 8 percentage points. One exception is that the probability of persistent spending is reduced by 13 percentage points for those facing a lung problem in the second or the third period.

The last logit model estimates the likelihood of being in the bottom 50% of the out-of-pocket spending distribution in the last period for elderly adults who were in the top 10% in the first period. The result is displayed in table 3.8. Elderly adults in the top 10% of out-of-pocket spenders who are in good health are 11 percentage points more likely to end up in the bottom 50% than those in fair or poor health, even though their spending put them in the top 10% in the first period. Improvement in ADLs also results in reduced out-of-pocket spending, resulting in an 11 percentage point increase in the likelihood of being in the bottom 50%. Among eight health conditions, having arthritis for the all periods reduces the probability of being in the bottom 50^{th} of the out-of-pocket spending distribution in the last period. Finally, people who acquired any supplementary health insurance in the second or the third period are about 15 percentage points more likely to reduce their out-of-pocket spending to be in the bottom 50% in the last period.

3.5. Conclusion

Understanding patterns of out-of-pocket health care spending and the factors that determine such patterns are crucial to evaluate the spending burden imposed on individuals by the current U.S. health insurance system, and thus to help develop equitable and efficient health insurance programs. This paper focused on the spending patterns of elderly adults who incur high out-of-pocket health care expenditures that account for more than a half of total out-of-pocket spending. I first studied whether an individual who was in the top percentiles of the out-of-pocket health care spending distribution persistently remains in the same percentile in subsequent years. I then identified factors that determine the probability of remaining in the same location of the out-of-pocket spending distribution over time. This study also addressed the issue of whether certain health shocks or changes in health insurance influence the likelihood of out-of-pocket health care spending persistence. By doing so, this study will help to evaluate how well health insurance protects elderly adults from incurring exceptionally high out-of-pocket spending for multiple years. It will also help to identify potentially high cost cases based on an individual's characteristics, health status, and health insurance status.

The summary statistics for out-of-pocket health care spending indicate that about a quarter of elderly adults who were in the top 10% of the distribution in 2002 remains in the same percentile in 2004 and more than 10% of them remained in the same percentile in 2006. I observe that the out-of-pocket health care spending distribution attenuates after two waves, or total of six years. Therefore, I also study individuals for three consecutive periods and the statistics based on the "period" reveal that nearly 20% of elderly adults persistently were in the top 10% of the distribution for all three periods, and about 30% continuously were in the top 20% of the distribution. The findings from the logistic model of the likelihood of being in the top percentiles of the distribution for three consecutive periods suggest that having a certain chronic condition or a health shock clearly increases the probability of out-of-pocket health care spending persistence. For example, having diabetes or an onset of diabetes in later periods increases the probability of high spending persistence by about 5 to 10 percentage points; having stroke also increases such probability by about 7 percentage points.

Another key result of the study is that although the probability of high spending persistence generally did not depend on the health insurance status, having existing health insurance that supplements Medicare coverage or the acquisition of a new supplementary health insurance had a significant impact on the probability of persistence. Interestingly, having any Medicare supplementary health insurance increased the likelihood of persistently being in the top percentiles of the distribution by about 9 percentage points, while an acquisition of a new supplementary coverage decreased the persistence probability by about 10 percentage points. Consistent with this finding, elderly adults who acquired new supplementary coverage were more likely to move to the bottom 50%

of the out-of-pocket spending distribution in the following periods after being at the top percentiles. Put differently, elderly adults who already enrolled in any Medicare supplementary health insurance were more likely to persistently incur high out-of-pocket health care spending for multiple years. By contrast, elderly adults who acquired new supplementary coverage in the middle periods had more chances to reduce their out-of-pocket spending for health care.

Although persistence of out-of-pocket health care spending at the top percentiles appears to decline over time, I observe that a non-trivial number of elderly adults remained in the same upper percentiles of the distribution for multiple years (for six years on average). Furthermore, the persistence in out-of-pocket spending could be underestimated by the fairly high mortality rate especially at the top percentiles. Considering such mortality, the degree of persistence in out-of-pocket spending might in fact be more pronounced and might persist for longer periods of time. The crucial factors that triggered high out-of-pocket spending on health care for several years were having certain chronic health conditions or experiencing the onset of new health condition, even after controlling differences in health insurance coverage.

Persistently high out-of-pocket spending on health care may represent a substantial burden on elderly adults, particularly those who are already retired and are in poor health. Thus, to improve the efficiency and equity with which Medicare provides financial protection for health care spending incurred by the elderly, we need to not only carefully consider how the elderly use health care, but to understand how certain health conditions may impose significant financial burdens. Moreover, to more fully understand the role of health insurance in providing financial protection, especially that obtained from holding supplementary Medicare health insurance, there is a need to carefully identify the role played by advantageous or adverse selection into Medicare supplementary coverage. Although a lack of suitable instruments precluded such analysis, the acquisition of any supplementary coverage clearly helped to reduce an individual's out-of-pocket health care spending.

Table 3.1. Concentration of Out-of-Pocket Health Care Expenditure, 2002 to 2010*

Interview Year	Percent of Elderly Adults Ranked by Expenditure	Sample Size	Expenditure Threshold	Aggregate Expenditure	Percent of Aggregate Expenditure
2002	Top 1%	66	52,896	7,007,432	22.5
	Top 2%	67	30,303	2,656,944	8.5
	Top 5%	201	14,969	4,006,324	12.8
	Top 10%	329	9,688	3,887,572	12.5
	Top 20%	694	5,616	5,082,110	16.3
	Top 30%	649	3,673	2,947,096	9.5
	Top 50%	1,333	1,727	3,508,408	11.3
	Bottom 50%	3,349		2,086,223	6.7
	Total	6,688		31,182,109	
2004	Top 1%	73	63,143	11,600,000	29.0
	Top 2%	73	31,563	3,080,675	7.7
	Top 5%	222	15,743	4,774,869	11.9
	Top 10%	365	9,999	4,567,381	11.4
	Top 20%	734	5,995	5,613,462	14.0
	Top 30%	734	3,951	3,537,068	8.8
	Top 50%	1,474	1,971	4,229,482	10.6
	Bottom 50%	3,663		2,663,482	6.6
	Total	7,338		40,066,419	
2006	Top 1%	80	30,761	5,743,919	18.3
	Top 2%	81	21,138	2,065,576	6.6
	Top 5%	244	12,433	3,835,670	12.2
	Top 10%	402	8,445	4,020,538	12.8
	Top 20%	806	5,111	5,258,609	16.7
	Top 30%	807	3,559	3,443,712	11.0
	Top 50%	1,613	1,838	4,251,187	13.5
	Bottom 50%	4,033		2,801,746	8.9
	Total	8,066		31,420,957	
2008	Top 1%	85	36,327	6,317,775	20.9
	Top 2%	86	21,332	2,341,168	7.7
	Top 5%	258	11,224	3,874,157	12.8
	Top 10%	430	7,158	3,793,514	12.5
	Top 20%	883	4,166	4,765,429	15.7
	Top 30%	859	2,884	2,955,135	9.8
	Top 50%	1,734	1,538	3,699,192	12.2
	Bottom 50%	4,261		2,534,826	8.4
	Total	8,596		30,281,196	
2010	Top 1%	87	52,491	8,852,481	22.7
	Top 2%	87	27,346	3,305,034	8.5
	Top 5%	261	14,556	4,961,190	12.7
	Top 10%	443	8,600	4,881,542	12.5
	Top 20%	873	5,200	5,786,176	14.8
	Top 30%	862	3,574	3,696,659	9.5
	Top 50%	1,745	1,830	4,491,323	11.5
	Bottom 50%	4,352		3,102,574	7.9
	Total	8,710		39,076,979	

* All expenditures are in 2010 dollars

Table 3.2. Persistence in Out-of-pocket Health Care Expenditures by Percentiles, 2002 to 2010

	2002	2004	2006	2008	2010	Died in 2003 or 2004
≥ Top 5%	334	21	6	2	2	154
		(6.3)	(1.8)	(0.6)	(0.6)	(46.1)
Top 5% > & ≥ Top 10%	329	49	13	2	0	65
		(14.9)	(4.0)	(0.6)	(0.0)	(19.8)
Top 10% > & ≥ Top 20%	694	144	45	12	3	110
		(20.7)	(6.5)	(1.7)	(0.4)	(15.9)
Top 20% > & ≥ Top 30%	649	111	21	3	0	94
		(17.1)	(3.2)	(0.5)	(0.0)	(14.5)
Top 30% > & ≥ Top 50%	1,333	405	141	43	13	148
		(30.4)	(10.6)	(3.2)	(1.0)	(11.1)
Bottom 50%	3,349	2,251	1,691	1,278	988	422
		(67.2)	(50.5)	(38.2)	(29.5)	(12.6)

Percentages are in parenthesis

	2002	2004	2006	2008	2010	Died in 2003 or 2004
Up To Top 5%	533	58	27	14	7	283
		(10.9)	(5.1)	(2.6)	(1.3)	(53.1)
Up To Top 10%	663	164	74	30	13	219
		(24.7)	(11.2)	(4.5)	(2.0)	(33.0)
Up To Top 20%	1,357	545	329	179	98	329
		(40.2)	(24.2)	(13.2)	(7.2)	(24.2)
Up To Top 30%	2,006	1,042	678	424	276	423
		(51.9)	(33.8)	(21.1)	(13.8)	(21.1)
Up To Top 50%	3,339	2,231	1,679	1,212	883	571
		(66.8)	(50.3)	(36.3)	(26.4)	(17.1)
Full Sample	6,688	6,306	6,034	5,796	5,425	993
		(94.3)	(90.2)	(86.7)	(81.1)	(14.8)

Percentages are in parenthesis

Table 3.3. Number of Deaths among Elderly Adults who are Persistently High Out-of-pocket Spenders

	2002	2004	2006	2008	2010
≥ Top 5%		154	20	3	2
Top 5% > & ≥ Top 10%		65	16	2	0
Top 10% > & ≥ Top 20%		110	26	4	2
Top 20% > & ≥ Top 30%		94	17	2	2
Top 30% > & ≥ Top 50%		148	28	10	3
Bottom 50%		422	261	174	111

	2002	2004	2006	2008	2010
Up To Top 5%		283	68	26	6
Up To Top 10%		219	77	38	13
Up To Top 20%		329	152	94	32
Up To Top 30%		423	228	142	73
Up To Top 50%		571	385	254	169
Full Sample		993	893	800	693

Table 3.4. Persistence in Out-of-pocket Health Care Expenditures by Percentiles and Periods, Period 1 to 3

	Period1	Period2	Period3
≥ Top 5%	394	42	6
		(17.1)	(2.4)
Top 5% > & ≥ Top 10%	399	65	18
		(16.3)	(4.5)
Top 10% > & ≥ Top 20%	802	165	42
		(20.6)	(5.2)
Top 20% > & ≥ Top 30%	796	109	24
		(13.7)	(3.0)
Top 30% > & ≥ Top 50%	1590	477	151
		(30.0)	(9.5)
Bottom 50%	3808	2679	2092
		(70.4)	(54.9)

Percentages are in parenthesis

	Period1	Period2	Period3
Up To Top 5%	614	117	46
		(29.7)	(11.7)
Up To Top 10%	793	270	146
		(34.0)	(18.4)
Up To Top 20%	1595	788	477
		(49.4)	(29.9)
Up To Top 30%	2391	1366	916
		(57.1)	(38.3)
Up To Top 50%	3981	2851	2189
		(71.6)	(55.0)
Full Sample	7789	7789	7789
		(100.0)	(100.0)

Percentages are in parenthesis

Table 3.5. Characteristics of Elderly Adults in Top Deciles and Bottom 50% of Out-of-pocket Spenders, 2002-2010

		Top 10% of Persistent Spenders	Top 20% of Persistent Spenders	Bottom 50% of Persistent Spenders	Full sample
Number of Observations		108	365	2,304	6,385
Out-of-pocket Spending		21,987	13,995	1,836	4,219
Age		71	71	71	71
Gender	Male	36.1	35.3	42.7	41.5
	Female	63.9	64.7	57.3	58.5
Race/ Ethnicity	White	92.0	93.2	80.9	86.6
	Hispanic	1.8	1.9	7.6	4.5
	Black	4.0	4.2	8.8	7.0
	Other Race	2.2	0.6	2.7	1.9
Region	Northeast	7.9	13.6	19.5	18.1
	Midwest	28.8	27.8	25.8	27.6
	South	38.4	37.7	31.9	33.6
	female	25.0	20.8	22.7	20.7
Education	Less than 12yrs	25.3	20.4	27.7	21.9
	High School Graduate	26.0	28.8	36.9	36.8
	Some College	17.6	22.7	17.9	20.1
	4yr College +	31.1	28.1	17.5	21.1
Married		64.3	65.4	64.5	66.5
Self-Reported Health Status	Good Health, All Periods	34.5	49.4	69.0	65.6
	Better Health	21.6	14.1	9.1	9.9
	Worse Health	17.1	15.7	12.8	13.6
	Poor Health, All Periods	26.8	20.8	9.2	11.0
Any ADL	Any ADL, All Periods	8.6	8.1	3.9	4.2
	Got Any ADL	8.1	9.0	5.2	6.0
	Better ADL	21.3	14.2	10.5	11.5
	No ADL, All Periods	62.1	68.7	80.4	78.3
High Blood Pressure	High Blood Pressure, All Periods	61.4	62.8	43.6	52.3
	New High Blood Pressure	10.7	7.9	8.8	9.5
	No High Blood Pressure	27.9	29.3	47.6	38.1
Diabetes	Diabetes, All Periods	29.9	26.0	10.1	14.2
	New Diabetes	6.3	6.4	4.4	4.8
	No Diabetes	63.7	67.6	85.5	81.0
Cancer	Cancer, All Periods	23.6	19.7	11.2	14.1
	New Cancer	3.0	4.9	3.9	4.6
	No Cancer	73.4	75.3	84.8	81.3
Lung Problem	Lung Problem, All Periods	13.4	10.7	6.3	6.8
	New Lung Problem	1.4	2.1	2.7	2.9
	No Lung Problem	85.2	87.2	91.0	90.3
Heart Problem	Heart Problem, All Periods	40.7	33.3	15.9	21.4
	New Heart Problem	7.0	10.2	5.3	7.6
	No Heart Problem	52.3	56.5	78.8	71.0

Table 3.5. Characteristics of Elderly Adults in Top Deciles and Bottom 50% of Out-of-pocket Spenders, 2002-2010 (Cont.)

		Top 10% of Persistent Spenders	Top 20% of Persistent Spenders	Bottom 50% of Persistent Spenders	All sample
Stroke	Stroke, All Periods	11.4	8.9	4.9	5.8
	New Stroke	3.5	3.5	2.5	3.1
	No Stroke	85.2	87.6	92.6	91.1
Emotional Problem	Emotional Problem, All Periods	20.8	14.7	8.5	9.5
	New Emotional Problem	2.7	3.7	2.8	3.0
	No Emotional Problem	76.5	81.6	88.8	87.5
Arthritis	Arthritis, All Periods	75.1	72.2	56.1	60.4
	New Arthritis	5.3	4.9	8.2	7.7
	No Arthritis	19.6	22.9	35.7	31.9
Total Wealth		988,310	1,059,135	530,698	661,070
Health Insurance Status	Only Medicare	23.4	23.8	25.6	24.9
	Medicare and Medicaid	2.1	1.2	14.8	7.4
	Medicare and ESHI	30.6	32.4	40.0	41.4
	Medicare and Other Private	41.8	41.5	18.7	25.1
Supplementary Health Insurance	No Supplementary HI, All Periods	13.2	15.3	13.6	13.2
	Medicare and Supplementary HI, All Periods	59.2	54.2	56.1	55.7
	Acquisition Supplementary HI	10.2	8.6	12.0	11.6
	Lost Supplementary HI	17.4	22.0	18.3	19.4
Period	Period 1	86.8	83.9	78.7	79.1
	Period 2	5.8	7.7	10.6	10.0
	Period 3	7.4	8.4	10.7	10.9

Table 3.6. The Likelihood of Persistently High Health Out-of-pocket Expenditures in 3 Periods: Top 10% of Spenders in Period 1

Variable		Coef.	Std.Err.	Marginal Effect	Std.Err.
Gender	Male	-0.165	0.296		0.026
Race/ Ethnicity	Hispanic	-1.387	0.962	-0.075***	0.027
	Black	0.039	0.465	0.004	0.044
	Other Race	0.217	0.689	0.022	0.075
Education	High School Graduate	-0.469	0.328	-0.042	0.033
	Some College	-0.378	0.374	-0.036	0.041
	4yr College +	0.297	0.352	0.032	0.034
Age		-0.009	0.023	—	—
Region	Midwest	0.389	0.297	0.027	0.018
	South	0.373	0.366	0.027	0.024
	West	0.757***	0.324	0.055***	0.018
Married		-0.232	0.264	-0.021	0.025
Self-Reported Health Status	Good Health, All Periods	-0.332	0.297	-0.028	0.025
	Better Health	0.476	0.359	0.049	0.033
	Worse Health	0.119	0.347	0.012	0.034
Any ADL	Any ADL, All Periods	0.541	0.443	0.047	0.037
	Got Any ADL	-0.056	0.469	-0.005	0.040
	Better ADL	0.092	0.329	0.008	0.028
High Blood Pressure	High Blood Pressure, All Periods	0.138	0.271	0.012	0.022
	New High Blood Pressure	0.698	0.458	0.058*	0.035
Diabetes	Diabetes, All Periods	0.631***	0.246	0.053***	0.021
	New Diabetes	1.069***	0.449	0.087***	0.039
Cancer	Cancer, All Periods	0.448	0.314	0.040	0.027
	New Cancer	-0.055	0.523	-0.005	0.044
Lung Problem	Lung Problem, All Periods	0.049	0.417	0.004	0.038
	New Lung Problem	-1.027	0.942	-0.090	0.082
Heart Problem	Heart Problem, All Periods	0.477	0.300	0.042*	0.025
	New Heart Problem	0.191	0.416	0.015	0.033
Stroke	Stroke, All Periods	0.655*	0.358	0.058*	0.031
	New Stroke	-0.011	0.496	-0.001	0.042
Emotional Problem	Emotional Problem, All Periods	0.604**	0.288	0.052**	0.024
	New Emotional Problem	0.930	0.623	0.078	0.052
Arthritis	Arthritis, All Periods	0.143	0.276	0.013	0.025
	New Arthritis	-1.006	0.640	-0.083	0.058
Total Wealth		0.000	0.000	—	—
Health Insurance Status	Medicare and Medicaid	-2.554**	1.145	-0.192*	0.102
	Medicare and ESHI	-1.337*	0.753	-0.147	0.105
	Medicare and Other Private	-0.683	0.755	-0.093	0.114
Supplementary Health Insurance	Medicare and Supplementary HI, All Periods	1.148	0.748	0.091*	0.048
	Acquisition Supplementary HI	-0.087	0.531	-0.004	0.024
	Lost Supplementary HI	0.611	0.874	0.038	0.052
Period	Period 2	-0.795*	0.433	-0.059**	0.026
	Period 3	-0.986***	0.443	-0.068***	0.021
Constant		-1.657	1.921		

* = statistically significant at the 10%
** = statistically significant at the 5%
*** = statistically significant at the 1%

Table 3.7. Logit Model of the Likelihood of Persistently High Out-of-pocket Health Expenditures in 3 Periods: Top 20% of Spenders in Period 1

Variable		Coef.	Std.Err.	Marginal Effect	Std.Err.
Gender	Male	-0.165	0.175	-0.029	0.030
Race/ Ethnicity	Hispanic	-0.467	0.298	-0.074*	0.042
	Black	-0.355	0.348	-0.058	0.052
	Other Race	-0.598	0.580	-0.092	0.075
Education	High School Graduate	-0.182	0.167	-0.030	0.029
	Some College	-0.039	0.233	-0.007	0.040
	4yr College +	0.551***	0.196	0.101***	0.033
Age		-0.004	0.011	—	—
Region	Midwest	0.077	0.160	0.013	0.026
	South	0.196	0.187	0.033	0.031
	West	0.356	0.254	0.060	0.043
Married		-0.156	0.170	-0.028	0.031
Self-Reported Health Status	Good Health, All Periods	-0.335**	0.166	-0.060*	0.031
	Better Health	-0.089	0.202	-0.018	0.041
	Worse Health	-0.181	0.236	-0.036	0.048
Any ADL	Any ADL, All Periods	0.614***	0.264	0.107***	0.044
	Got Any ADL	0.217	0.222	0.037	0.039
	Better ADL	0.108	0.210	0.019	0.036
High Blood Pressure	High Blood Pressure, All Periods	0.072	0.126	0.013	0.022
	New High Blood Pressure	-0.007	0.254	-0.001	0.044
Diabetes	Diabetes, All Periods	0.444***	0.151	0.077***	0.026
	New Diabetes	0.50*	0.272	0.085*	0.048
Cancer	Cancer, All Periods	0.342**	0.168	0.060**	0.029
	New Cancer	0.347	0.278	0.060	0.047
Lung Problem	Lung Problem, All Periods	0.399**	0.201	0.071**	0.036
	New Lung Problem	-0.757*	0.388	-0.13*	0.069
Heart Problem	Heart Problem, All Periods	0.195	0.128	0.034	0.022
	New Heart Problem	0.459**	0.219	0.079**	0.037
Stroke	Stroke, All Periods	0.417*	0.228	0.074*	0.040
	New Stroke	-0.096	0.340	-0.017	0.059
Emotional Problem	Emotional Problem, All Periods	0.028	0.187	0.005	0.033
	New Emotional Problem	0.299	0.393	0.053	0.069
Arthritis	Arthritis, All Periods	0.198	0.146	0.035	0.026
	New Arthritis	-0.469	0.291	-0.077	0.050
Total Wealth		0.000	0.000	—	—
Health Insurance Status	Medicare and Medicaid	-0.901	0.897	-0.099	0.097
	Medicare and ESHI	0.391	0.583	0.066	0.092
	Medicare and Other Private	0.769	0.619	0.143	0.104
Supplementary Health Insurance	Medicare and Supplementary HI, All Periods	-0.624	0.663	-0.122	0.138
	Acquisition Supplementary HI	-0.511*	0.263	-0.102*	0.054
	Lost Supplementary HI	-0.593	0.706	-0.117	0.145
Period	Period 2	-0.650***	0.255	-0.104***	0.034
	Period 3	-0.860***	0.246	-0.129***	0.030
Constant		-0.727	0.787		

* = statistically significant at the 10%

** = statistically significant at the 5%

*** = statistically significant at the 1%

Table 3.8. The Likelihood that an Elderly Adult who was in the Top 10% of Out-of-pocket Spenders in the First Period Moves to the Bottom 50% of Spenders in the Last Period

Variable		Coef.	Std.Err.	Marginal Effect	Std.Err.
Gender	Male	-0.173	0.210	-0.033	0.040
Race/ Ethnicity	Hispanic	0.442	0.531	0.093	0.120
	Black	0.320	0.352	0.065	0.076
	Other Race	0.298	0.597	0.061	0.129
Education	High School Graduate	0.288	0.223	0.055	0.042
	Some College	0.499**	0.226	0.095***	0.040
	4yr College +	-0.325	0.258	-0.057	0.048
Age		0.019	0.017	—	—
Region	Midwest	-0.257	0.387	-0.051	0.080
	South	-0.042	0.329	-0.009	0.068
	West	-0.131	0.348	-0.027	0.073
Married		0.280	0.200	0.054	0.037
Self-Reported Health Status	Good Health, All Periods	0.593*	0.351	0.112*	0.065
	Better Health	0.186	0.450	0.029	0.067
	Worse Health	0.303	0.290	0.048	0.041
Any ADL	Any ADL, All Periods	-0.519	0.557	-0.099	0.105
	Got Any ADL	-0.424	0.397	-0.081	0.077
	Better ADL	0.530*	0.311	0.106*	0.062
High Blood Pressure	High Blood Pressure, All Periods	-0.107	0.229	-0.021	0.045
	New High Blood Pressure	-0.318	0.369	-0.064	0.075
Diabetes	Diabetes, All Periods	-0.251	0.300	-0.049	0.060
	New Diabetes	-0.423	0.389	-0.084	0.079
Cancer	Cancer, All Periods	-0.189	0.279	-0.037	0.055
	New Cancer	-0.020	0.477	-0.004	0.094
Lung Problem	Lung Problem, All Periods	0.163	0.386	0.032	0.075
	New Lung Problem	0.348	0.474	0.067	0.093
Heart Problem	Heart Problem, All Periods	-0.246	0.231	-0.048	0.045
	New Heart Problem	-0.036	0.374	-0.007	0.075
Stroke	Stroke, All Periods	-0.172	0.370	-0.034	0.073
	New Stroke	-0.168	0.641	-0.033	0.125
Emotional Problem	Emotional Problem, All Periods	-0.208	0.421	-0.040	0.082
	New Emotional Problem	0.286	0.508	0.056	0.101
Arthritis	Arthritis, All Periods	-0.512**	0.228	-0.100**	0.044
	New Arthritis	-0.076	0.302	-0.017	0.067
Total Wealth		0.000*	0.000	—	—
Health Insurance Status	Medicare and Medicaid	0.590	1.199	0.120	0.237
	Medicare and ESHI	0.376	1.014	0.073	0.188
	Medicare and Other Private	0.005	1.017	0.001	0.179
Supplementary Health Insurance	Medicare and Supplementary HI, All Periods	-0.327	0.988	-0.064	0.200
	Acquisition Supplementary HI	0.638**	0.322	0.148*	0.084
	Lost Supplementary HI	-0.348	0.987	-0.068	0.199
Period	Period 2	0.430	0.326	0.089	0.072
	Period 3	0.246	0.349	0.049	0.073
Constant		-2.422*	1.374		

* = statistically significant at the 10%

** = statistically significant at the 5%

*** = statistically significant at the 1%

Appendix 3.1. Summary Statistics: Mean Values for the Out-of-pocket Spending, Health status, Health conditions, and Total Wealth by Health Insurance Status

		Medicare Only	Medicare and Other Government Covered HI	Medicare and ESHI	Medicare and Other Private HI
	Number of Obs.	24	2	35	45
Out-of-pocket Spending	Period 1	24,631	19,129	23,192	21,248
	Period 2	51,048	59,024	90,535	30,025
	Period 3	15,588	13,440	15,550	23,351
Self-Reported Health Status	Good Health, All Periods	23.9	0.0	36.3	40.0
	Better Health	30.7	28.6	13.1	22.2
	Worse Health	16.2	0.0	25.5	13.1
	Bad Health, All Periods	29.2	71.4	25.1	24.7
Any ADL	Any ADL, All Periods	7.6	0.0	6.6	9.2
	Got Any ADL	6.4	0.0	14.5	4.1
	Better ADL	32.0	71.4	12.6	19.8
	No ADL, All Periods	54.1	28.6	66.4	66.8
High Blood Pressure	High Blood Pressure, All Periods	52.5	100.0	56.1	65.6
	New High Blood Pressure	11.5	0.0	15.3	7.8
	No High Blood Pressure	36.0	0.0	28.6	26.6
Diabetes	Diabetes, All Periods	23.1	71.4	30.3	31.8
	New Diabetes	7.7	0.0	5.5	6.7
	No Diabetes	69.2	28.6	64.2	61.5
Cancer	Cancer, All Periods	27.9	0.0	21.3	26.3
	New Cancer	1.3	0.0	5.8	2.2
	No Cancer	70.8	100.0	72.9	71.5
Lung Problem	Lung Problem, All Periods	27.7	0.0	4.8	12.7
	New Lung Problem	0.0	0.0	4.6	0.0
	No Lung Problem	72.3	100.0	90.6	87.3
Heart Problem	Heart Problem, All Periods	40.6	28.6	37.6	43.6
	New Heart Problem	1.3	0.0	11.9	7.1
	No Heart Problem	58.1	71.4	50.5	49.2
Stroke	Stroke, All Periods	15.6	28.6	9.0	10.3
	New Stroke	6.6	0.0	3.2	0.0
	No Stroke	77.9	71.4	87.8	89.7
Emotional Problem	Emotional Problem, All Periods	32.3	0.0	16.1	17.5
	New Emotional Problem	0.0	0.0	8.7	0.0
	No Emotional Problem	67.7	100.0	75.2	82.5
Arthritis	Arthritis, All Periods	54.5	100.0	94.1	69.5
	New Arthritis	15.6	0.0	1.5	2.8
	No Arthritis	29.9	0.0	4.5	27.7
Any Health Condition	Period 1	91.8	100.0	100.0	100.0
	Period 2	91.8	100.0	100.0	100.0
	Period 3	91.8	100.0	100.0	100.0
Total Wealth	Period 1	627,565	2,093,994	1,068,537	1,096,110
	Period 2	878,059	2,605,611	1,021,327	1,038,808
	Period 3	957,534	3,275,505	923,295	759,717

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