The Demand for Preventive Activities among Older Adults and its Association with Medicare Expenditures

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A Dissertation in

Health Care Management and Economics

For the Graduate Group in Managerial Science and Applied Economics

Presented to the Faculties of the University of Pennsylvania

In

Partial Fulfillment of the Requirements for the

Degree of Doctor of Philosophy

2010

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To my parents, Ana and Fernando

ACKNOWLEDGEMENTS

I am grateful to the members of my dissertation committee Drs. Mark Pauly, Dan Polsky, Scott Harrington, Kevin Volpp and Jalpa Doshi for their time, patience, and exceptional mentoring. Without their help, this project would not only have been much harder to complete, if not impossible, but the quality of it would have suffered tremendously. Drs. José Pagán and María Elena Medina-Mora, although not members of my dissertation committee have also played a crucial mentorship role in my education and I owe them enormously for their advice, interest in me, and friendship.

I am also thankful to all the people that I have met in the Wharton's Health Care Management and Economics Department. In particular, to my classmates Amol Navathe, Sean McElligott, Robert Lieberthal, Fred Blavin and Andrew Mulcahy for their constant help, advice, and company throughout my time as a graduate student. They have proven to be an amazing source of coding wisdom, editing help, critical review ability, truthful advice, and most of all, fun camaraderie. In addition, I am fortunate to have counted on Joanne Levy's support and help through the years.

My friend Juan Ramón Martínez-François was not only a great roommate; he was more like a brother for the past 6 years. Without his generosity, helpfulness, trust and friendship, my time in graduate school would have been so much more difficult.

I am infinitely indebted to my parents Ana and Fernando, and my siblings Pablo, Sergio and Natalia for their relentless support, endless love and indefatigable encouragement which have carried and inspired me throughout my life. This milestone is as much theirs as it is mine.

Finally, I am lucky to have Christian as my loudest cheerleader, fiercest critic, longtime partner, dear husband, but most importantly, as my best friend. Needless to say, he played an enormous role in this effort for which I cannot thank him enough.

ABSTRACT

THE DEMAND FOR PREVENTIVE ACTIVITIES AMONG OLDER ADULTS AND ITS ASSOCIATION WITH MEDICARE EXPENDITURES

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In recent years, certain health policy makers have emphasized the need for an increase in preventive services interventions as means to improve health outcomes and cut health care costs. Oftentimes, the debate around the purported benefits of prevention centers on the need to cut the costs of highly costly systems such as Medicare. However, little is known about the factors that might actually influence the demand for preventive services among older adults, neither do we know much about how the dynamic for the demand for prevention plays out among older adults within the context of a household. Moreover, there is little evidence to support the belief that all preventive activities necessarily translate in cost savings. This dissertation examines the theoretical and empirical factors that influence the demand for prevention at the individual and household level. It also analyzes the associations between a diverse set of preventive services and Medicare expenditures in older adults. Using a panel data set from the Health and Retirement study linked to Medicare claims data, I find evidence that while lifestyle prevention such as physical activity, non-smoking and normal weight status maintenance are negatively associated with Medicare expenditures at ages 65-69, clinical preventive activities such as flu shot, cholesterol screening, mammography, Pap smears test and prostate cancer screening have at best no effect on expenditures, at worst they are positively associated; yet these findings may be biased due to uncontrolled unobservables. Also, I find that education, risk aversion, and long term planning are significantly associated with a higher demand for all preventive services. Finally, I find large bargaining effects between household members whereby spouses initiate and terminate preventive activities together. This result leaves room for policy makers to take advantage of spillover effects in the design of interventions designed with the purpose of increasing the demand for prevention.

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INTRODUCTION: THE (HEALTH) ECONOMICS OF PREVENTION

The idea that people invest in health in order to create human capital has long been entrenched in the health economics literature. At the same time, the belief in the old Benjamin Franklin adage of "*a penny saved is a penny earned*" has become a powerful mantra among certain policy makers interested in cutting costs in the health care system. However, despite the enthusiasm about the promise of preventive behavior, the potential for prevention to generate cost savings has quite often been exaggerated. Fewer than 20% of studied preventive options are cost-saving (Russell, 2009, Cohen, Neumann & Weinstein, 2008). The characteristics of those preventive services that save money and those that do not vary so much that it is puzzling to think that all types of prevention programs are all too often expected to have the same effect on a determined outcome.

Few comprehensive studies have been carried out to study what are the factors that make preventive activities different from each other. Little is known about the characteristics that affect the demand for prevention, particularly among the population of older adults whose medical expenditures comprise a sizable portion of most countries' health care budgets. Neither has it been thoroughly studied what role these characteristics play in accounting for selection when the association between prevention and expenditures is explored. The purpose of this dissertation is to shed light in a comprehensive and thorough manner as to these questions.

1. The meaning of prevention

There are several ways to define prevention and the behaviors associated with it. Kenkel (2000) distinguishes among primary, secondary, and tertiary prevention. Primary prevention is understood as actions that reduce the occurrence or incidence of disease. Vaccinations and healthy lifestyles decisions such as regular exercise and smoking cessation are grouped in this category. Secondary prevention involves actions that reduce or eliminate the health consequences of a disease given its occurrence. Examples in this category are preventive screenings for hypertension or cancer. Finally, tertiary prevention encompasses actions that reduce disability associated with a chronic illness (e.g. chronic treatment of diabetes to prevent amputation).

To a large extent, the prevalent threats to health influence what is meant by prevention. In developed countries, the prevalence of serious communicable diseases is low and conditions such as heart disease and cancer are the major causes of death. As a result of this so-called epidemiologic transition, prevention increasingly involves lifestyle changes that reduce risk factors for these conditions. McGinnis and Foege (1993) review evidence on the relative contributions of various external factors linked to the leading causes of death in the U.S. They conclude that the three most prominent contributors to mortality in 1990 were tobacco, diet and activity patterns, and alcohol, which together accounted for almost 40 percent of all deaths. With an increased aged population, health problems associated with chronic but not life-threatening conditions will become more important.

The picture in developing countries is decidedly different where prevention aimed at communicable diseases remains the highest priority. Moreover, prevention is hardly ever directed to older populations. Although prevention in a context of developing countries is interesting in itself, it will not be the focus of this dissertation; hence further discussion will be avoided.

2. Prevention in economic models

Theoretical models provide insights and frameworks for thinking about the economics of prevention. Consumer or household behavior has received most of the attention. Among this kind of studies, Michael Grossman's (1972) human capital model is perhaps the most prominent. In Grossman's seminal work, the individual's health capital stock determines a flow of utility directly and also determines the amount of time available for market and nonmarket production. Gross investment in health capital is produced by combining time, purchased medical care, and other purchased goods according to a household production process. The demand for health inputs, including medical care, is thus derived from the demand for health capital.

A problem with Grossman's basic model in the context of the study of prevention is that it does not really allow for a useful, clear distinction to be made between preventive and curative care. In an extension, Grossman and Rand (1974) distinguish prevention and cure by assuming that groups with low depreciation rates primarily demand preventive care while groups with high depreciation rates primarily demand curative care. The distinction between prevention and cure is not very common in subsequent theoretical studies that build on the Grossman model. Whether or not prevention is distinguished from cure, the health capital framework provides useful insights into the roles schooling, time preference, initial health stock and age play in preventive health demand.

The basic model has, however, been argued to be unduly unrealistic as a description of the inherently uncertain area of health and utilization behavior in that its main part is based on the assumption of complete certainty (Dowie , 1975). Although Grossman (1972, pp. 19-21, especially footnote 18) does give a short discussion of the introduction of uncertainty into the basic framework and its implications, the explicit incorporation of uncertainty remained to be analyzed by others. Dardanoni and Wagstaff (1990) look into the case where the effectiveness of medical care and the incidence of illness are uncertain and derive different expressions of the demand for medical care for different types of uncertainty. In their static version of the Grossman consumption model, Dardanoni and Wagstaff find that, under plausible assumptions, greater uncertainty results in an increase in the demand for medical care.

Cropper (1977) constructs a life-cycle model for the investment in health capital. Her model is, in my view, the most important theoretical development in terms of adapting the Grossman framework to the analysis of prevention while including the element of uncertainty. She considers illness and death to be random, and then studies the individual's investment in health and occupational choice. Comparing the models of Grossman (1972) and Cropper (1977), age may play distinctly different roles in the demand for curative and preventive care. In Grossman's model, because health capital is assumed to depreciate at a higher rate as people get older, if the price elasticity of the demand for health is smaller than one then the derived demand for curative medical care increases with age. Cropper shows that there is an effect working in the opposite direction to Grossman for preventive care. When the length of life is exogenous, because the pay-off period for any human capital investment is shorter for older individuals, use of preventive care tends to decline with age.

In contrast, when Cropper makes the length of life endogenous and assumes the depreciation rate rises with age, she obtains the same results as in Grossman's model.

Another criticism of Grossman's model lies in the fact that his justification of the positive education-health correlation is somewhat unsatisfactory. Grossman (1972) hypothesizes that schooling increases the efficiency of the household production of health. Viewing prevention choices as inputs into the household production of health, Grossman's model yields ambiguous predictions about the relationship between schooling and prevention. Schooling reduces the shadow price of health capital which increases the demand for health capital, but the derived demand for health inputs such as prevention only increases if the price elasticity of the demand for health capital exceeds one.

Muurinen (1972) attempts to formalize the role of schooling better. In her model health stock is not the only durable capital good producing services. In simplified terms, the individual has three different stocks available for service creation in each period of life: firstly his or her stock of health, secondly his or her stock of skills and knowledge (education) - these first two together constituting the human capital of the individual in question, and thirdly his or her stock of wealth, the external financial capital available. In her model, the effect of education affects the demand for prevention via its impact on the use-related rate of depreciation on health. If education reduces the rate of depreciation, health is positively correlated with it. This result conforms to the predictions of Grossman's investment model, but its justification is different.

The estimated relationships between schooling and the health behaviors might be due to unobservable differences across individuals, as Fuchs (1982) and Farrell and Fuchs (1982) suggest. In many conceptual analyses the individual rate of time preference plays an important role in prevention decisions. Fuchs (1982) and Farrell and Fuchs (1982) suggest it as a candidate for the "hidden third variable" behind the link between schooling and health, if people with low rates of time preference are more likely to invest in both schooling and prevention. Becker and Mulligan (1997) challenged this view, arguing that time preference may be endogenous to health. In their model, Becker and Mulligan assume that each person is endowed with an initial level of subjective discount rate, but that rate can be modified by the individual investing time and resources to produce "future-oriented capital" to make the future more salient, allowing one to appreciate the future more and to place more weight on future utility of consumption -- leading to a lower subjective discount rate.

In summary, theoretical models provide insights and frameworks for thinking about the economics of prevention. Consumer or household behavior has received most of the attention. These lines of research have led to some empirical studies with tight links between the theoretical model and empirical specification. Below, I overview some of the empirical studies and their implications. It is important to note, however, that for many of such studies, theoretical models such as Grossman's only provide general guidance for the specification of empirical models of prevention decisions, for example, in terms of explanatory variables to be included in a demand model. This is a result due in part to the generalized and complicated nature of demand models such as Grossman's. In order to analyze specific problems in greater detail, it is necessary to concentrate on particular aspects of the model and to develop these submodels further, possibly at the expense of major simplifications in the rest of the framework. Nevertheless, the underlying conceptual model still remains in force, providing a very general economic explanation of health behavior, which can be seen as a distinct advantage over the practice of utilizing several disconnected ad hoc models as the basis for an economic theory of health.

3. Empirical factors associated with the demand for prevention

As mentioned before, Grossman's theoretical model is a useful framework in which empirical work can be based on. Researchers have used a variety of data sources and empirical methods to determine the effect of some of the variables modeled by Grossman and other authors. Some of the more interesting and tractable results pertain to the study of the effects of age, education, time preferences, and insurance on the demand for preventive services.

Kenkel (1994) finds that annual use of preventive medical services designed for the early detection of breast and cervical cancer decreases with increasing age. Although not the only plausible explanation, the results are consistent with women rationally reducing their use of preventive care as the payoff period to the investment shortens over the lifecycle. In general, the age patterns of the demand for prevention depend on the specific intervention because the risks of different illnesses show different lifecycle patterns.

Schooling is also related to prevention for adult health and safety. For example, Leigh (1990) finds that people with more schooling are more likely to use seatbelts. Kenkel (1991a, 1991 b) finds that more schooling is associated with healthier lifestyle choices regarding smoking, drinking, and exercise. Kenkel (1994) finds that schooling is an important determinant of women's demand for preventive medical services designed for the early detection of breast and cervical cancer. Mullahy (1999) finds that more schooling is associated with a higher propensity to be immunized against the flu. The relationship is estimated to be particularly strong for people over 65, where each year of schooling is associated with a 1.5 percentage point increase in the probability of being immunized. All of the empirical studies listed control for factors such as family income and age, but differ in their ability to control for other differences that might explain the schooling-prevention link.

A crucial aspect, for this study is to investigate whether time preferences correlate with real-world expressions. Particularly, I am interested in investigating whether time preferences are related to the decision to invest in a special kind of future health investments, namely preventive behavior. In this regard, it is only fair to mention that the evidence has been mixed. Chapman and Elstein (1995) and Chapman, Nelson and Heir (1999) found only weak correlations between discount rates for money and health. Fuchs (1982) found no correlation between a prototypical measure of time preference (e.g. "Would you choose $1500 now or $4000 in five years?") and other behaviors that would plausibly be affected by time preference (e.g. smoking, credit-card debt, seatbelt use, and the frequency of exercise and dental checkups). Nor did he find much correlation among any of these reported behaviors. Yet, Chapman and Coups (1999) found that corporate employees who chose to receive an influenza vaccination did have significantly lower discount rates (as inferred from a matching task with monetary loses), but found no relation between vaccination behavior and hypothetical questions involving health outcomes. Munasinghe and Sicherman (2000) found that smokers tend to invest less in human capital (they have flatter wage profiles), and many others have found that for stylized intertemporal choices among monetary rewards, heroin addicts have higher discount rates (e.g. Alvos, Gregson & Ross, 1993; Kirby, Petry, & Bickel, 1999). Picone, Sloan and Taylor (2004) found that individuals with a higher life expectancy and lower time preference are more likely to undergo cancer screening.

Any study that aims to find a relationship between use of preventive services and future health expenditures has to consider the effect that insurance coverage may have in the use of preventive services. A fairly well established arm of the literature has looked into the effect of insurance coverage on the delivery of preventive services. A study looking at cross-sectional data used age 65 as an IV to study the effect of insurance coverage on self-reported access to care, and utilization of medical services (Card, Dobkin & Maestas, 2008). This study found no large or statistically significant jumps in smoking or exercise participation when subjects turn 65. The authors posed that health behaviors evolve smoothly with age, and do not change suddenly at 65. McWilliams, Zaslavsky, Meara and Ayanian (2003) utilized longitudinal HRS data to compare the use of basic clinical services and medications in a nationally representative cohort of previously insured and uninsured near-elderly adults before and after they became eligible for Medicare at age 65 years. They discovered that substantial differences in cholesterol testing, mammography, and prostate examination between continuously uninsured and insured near elderly adults before age 65 years were reduced by half or more after these adults became eligible for Medicare coverage.

4. The value of prevention

Whether prevention does save money has been a running debate for decades. As long ago as 1986, in the book *Is Prevention Better than Cure?*, Rutgers economist Louise Russell argued that prevention rarely reduces costs. The issue resurfaced recently as policymakers embraced prevention as a means for controlling spending. Russell (2007) reiterated her message that prevention rarely saves money in a report for the National Coalition for Health Care. Russell's main point is that prevention does not always reduce medical care costs, because often the intervention is delivered to a large group, only a very small fraction of whom would get the disease without the intervention and thus incur treatment costs. Cohen, Neumann and Weinstein (2008) directed an article to the 2008 presidential candidates, arguing that prevention is inherently no more cost effective than conventional medical care. In April 2008, an article in the same journal described primary prevention as having the "lowest potential" among policy options for cost savings (Mongan, Ferris and Lee, 2008).

4.1. Lifestyle prevention and health expenditures

Perhaps the area where more success has been had in finding the value of prevention is among those activities that modify lifestyle decisions or improve risk factors for chronic conditions. As the literature reveals, lifestyle prevention interventions have shown to be better able to improve health outcomes and/or modify future health expenditures than medical interventions. Nevertheless, the quality of many of the studies in this vein of the literature is very seldom as sound as it should be.

One of the first efforts to assess the effects of multiple behavioral risk factors examined the impact of exercise, weight, smoking, hypertension, alcohol use, cholesterol level, and seatbelt use on health care utilization and costs dates back to the eighties (Brink 1987). This non-peer-reviewed study relied on data collected on Control Data Corporation employees for the period 1981 through 1984. After following 10,000 employees for four years, the auditors concluded that medical care claims were lowest for employees who did not smoke cigarettes, exercised regularly, ate nutritious foods, fastened their seat belts, and were not hypertensive. The analysis was descriptive in nature, and little effort was made to estimate the independent effects of each of the risk factors or other confounding variables.

Using health insurance claims and health risk appraisal (HRA) data collected from 4,782 employees of The Travelers Companies, Golaszewski, Lynch, Clearie and Vickery (1989) estimated the relationship between health expenditures and health index scores (a relatively crude measure of health status/health risk defined as the difference between actual and "appraised" ages). Using a cube-root transformation of medical claims, a significant inverse relationship for age and the health index was identified for men. No relationships were found for women. It was concluded that, for men when age is held constant, a negative relationship exist between retrospective medical claims and a health risk appraisal-generated health status indicator, the health index. In an analysis of the determinants of both medical claims and absenteeism costs, Yen, Eddington and Witting (1992) examined data on 1,284 hourly employees from a manufacturing company. In this study, six of the health-related measures significantly predicted costs in multiple regression models (age, perception of health, personal health problems, self-reported 1984 absences, smoking and drug/medication use). However, the study relied upon a limited time frame (i.e., 2 years) and a relatively small sample size.

One of the most impressive studies (Goetzel, Anderson, Whitmer, Ozminkowski, Dunn, Wasserman, 1998) to date on the link between medical care costs and risk factors was produced through a collaboration of six employers (Chevron, Health Trust, Hoffman-LaRoche, Marriott, the State of Michigan, and the State of Tennessee), which was organized by the Health Enhancement Research Organization (HERO). StayWell, a health promotion vendor, and MEDSTAT, a medical care cost data management organization, had medical care cost data on the six employers (46,026 employees). With the assistance of HERO and the permission of the employers, these two databases were merged to determine the relationship between 10 modifiable risk factors and medical care costs. The strengths of this study include the large sample size, measurement of a wide range of risk factors and the multivariate nature of the analysis. Seven of ten modifiable health risks are associated with significantly higher health care expenditures: those who reported themselves as depressed (70% higher expenditures), at high stress (46%), with high blood glucose levels (35%), at extremely high or low body weight (21%), former (20%) and current (14%) tobacco users, with high blood pressure (12%), and with sedentary lifestyle (10%). These same risk factors were found to be associated with a higher likelihood of having extremely high (outlier) expenditures. A common problem of all of the studies cited above is that the use of employer-based data on interventions can cause selection biases. Decisions to participate in the studies were voluntary. As a result, the study sample may or may not be representative of all of the employees of the organizations that participated in the study, much less the general working population.

Although, there is some evidence of the effect of risk factors in the employer setting, few studies have examined the link between risk factors and expenditures in the public insurance realm. Among the few studies that have used publicly available data, one of them used data from four waves of the HRS to assess the impact of smoking on use of hospital and physicians' services and nursing home care (Picone & Sloan, 2001). The authors uncovered that smoking increased medical utilization and dollar outlays by 5 to 8 percent on average, with substantial variation in incidence by payer. Public payers bore a disproportionate burden. Daviglus et al. (2004) used longitudinal data to find that BMI assessed during young adulthood and middle age was significantly and positively associated with average annual cardiovascular disease-related and total Medicare health care charges in older age as well as with CVD-related and total cumulative charges from age 65 years to death or to age 83 years.

Perhaps the closest study to the one I investigate in this dissertation was done by Daviglus et al. (2005). The study followed participants in the Chicago Heart Association Detection Project in Industry (CHA) study. The sample consisted on men and women aged 32 to 64 years at baseline in 1967 through 1973, who died at ages 66 to 99 years and had Medicare coverage for at least one year in 1984 through 2002. In it, CVD expenditures were obtained for 39,522 adults from Medicare Claims data. Participants were classified as having favorable levels of all major cardiovascular risk factors (low risk), that is, serum cholesterol level lower than 200 mg/dL (>.2 mmol/L), blood pressure 120/80 mm Hg or lower and no antihypertensive medication, body mass index (calculated as weight in kilograms divided by the square of height in meters) lower than 25, no current smoking, no diabetes, and no electrocardiographic abnormalities. The study shows categorically that in the last year of life, average Medicare charges were lowest for low-risk persons.

4.2. Cost-effectiveness analysis and prevention

For clinical preventive interventions, a more useful perspective emerges when the calculation considers the return on investment, such as cost-effectiveness (CE) research. Here, too, studies can reach different conclusions. For example, in three studies, estimates of the CE of various mammography screening protocols ranged from $4,200 per QALY to $140,000 per QALY (Stone, Teutsch, Chapman, Bell, Goldie & Neumann, 2000). Overall assessments of the CE of preventive services also are inconsistent. As noted earlier, Russell, Weinstein, and other economists have questioned whether the average CE of preventive services is any better than for medical treatments. Conversely, groups such as Partnership for Prevention and the Partnership to Fight Chronic Disease (2010) paint a more positive picture and speak of low CE ratios and cost savings for some forms of prevention.

Such disparate findings stem in part from technical variations in how economic evaluations are conducted (Gold 1996). The frame of reference affects inferences about the CE of prevention. For example, it matters whether the analysts have taken a societal perspective or are considering the costs and benefits experienced by a sector (e.g., payers, employers), and the time horizon they are considering (Leatherman, Berwick, Iles, Lewin, Davidoff, Nolan & Bisognano, 2003). Those who benefit from and bear the costs of preventive services are not always the same. It matters whether the study evaluates the CE of the intervention compared to doing nothing, or the marginal (i.e., incremental), CE of option A versus option B.

Nevertheless, in the largest and most comprehensive review of the cost-effectiveness literature on prevention, Cohen, Neumann and Weinstein (2008) analyzed the contents of the Tufts–New England Medical Center Cost-Effectiveness Analysis Registry (www.tufts-nemc.org/cearegistry), which consists of detailed abstracted information on published cost-effectiveness studies through 2005. This study found that cost-effectiveness ratios for preventive measures and treatments are very similar — in other words, opportunities for efficient investment in health care programs are roughly equal for prevention and treatment, at least as reflected in the literature reviewed. Moreover, both distributions of preventive and curative services span the full range of cost-effectiveness. Therefore, just as with curative interventions, it is not reasonable to assume that all preventive interventions are cost-effective just because they may improve health outcomes.

In sum, the literature on the value of prevention is by no means definitive. The review presented above, indicates that those preventive activities that reduce risk factors for chronic diseases such as lower body mass index and non smoking habits might in fact render good value. However, the studies in this class fail to completely surmount selection biases and are not specific in explaining whether the changes in lifestyle are scalable to the general population. Clinical preventive activities, on the other hand, tend to struggle to prove to be cost-effective just as much as other curative interventions. Contrary to popular perception, hardly any clinical prevention has ever shown to be cost saving.

5. Preface

Prevention is a thorny topic to study in the health economics literature. Furthermore, research assessing the relationship between preventive behavior and medical expenditures is accompanied by numerous challenges. People who engage in preventive activities and people who do not differ in many measurable and immeasurable ways, any of which could account for differences in both health outcomes and expenditures that one might otherwise attribute to preventive behavior. Similarly, individuals engaging in preventive activities differ not only in demographic attributes but also in health behaviors, preferences and attitudes toward health and health care, multiple dimensions of health status, and health trajectories. Given the absence of a natural experiment, causal associations relating prevention and expenditures are difficult to establish.

This dissertation attempts to be a comprehensive study of prevention among older adults in four parts. The first chapter focuses on the theoretical models for the demand for prevention. In it, I propose a theoretical model suitable to understand the factors influencing the demand for prevention among older adults for which other theoretical models are not valid. Chapter two uses data from the Health and Retirement Study (HRS) to test empirically the predictions of the theoretical model regarding the factors that affect the demand for prevention. In chapter three, I take a look at the demand for prevention at the household level. In particular, I examine theoretically and empirically using HRS data, the reasons why the demand for prevention among spouses might be correlated. Finally, in the last chapter I describe and analyze how the demand for prevention services among HRS respondents is associated with Medicare expenditures. Different empirical approaches are used to ameliorate and characterize potential biases.

The reader is, of course, advised to read the complete dissertation as a broad and comprehensive study of the topic. However, although there are some natural connections and references between the four chapters, each of them was written to capture a self-contained narrative.

CHAPTER 1: A THEORETICAL STUDY ON THE DEMAND FOR PREVENTIVE ACTIVITIES AMONG OLDER ADULTS

1. Introduction

Grossman’s model of health capital (1972a, 1972b, 2000) is considered a cornerstone in the economics of the derived demand for medical care. In Grossman’s human capital framework individuals demand medical care (e.g., invest time and consume medical goods and services) for the consumption benefits (health provides utility) as well as production benefits (healthy individuals have greater earnings) that good health provides. In this first chapter of the dissertation, I modify Michael Grossman model (1972a, 1972b) in order to generate testable predictions that identify the factors that drive the demand of older adults for prevention. These predictions are later explored empirically in chapter 2.

Several papers on demand-for-health related topics have appeared since Grossman’s seminal work exploring a variety of phenomena related to health, medical care, inequality in health, the relationship between health and socioeconomic status, and occupational choice (Galama and Kapteyn, 2009). Cropper (1977) constructs a life-cycle model for the investment in health capital, where she considers illness and death to be random, and then studies the individual's investment in health and occupational choice. Muurinen (1982) elaborates on Grossman's demand-for-health model and looks at the comparative static results of age, education and wealth effects. Dardanoni and Wagstaff (1990) look into the case where the effectiveness of medical care and the incidence of illness are uncertain and derive different expressions of the demand for medical care for different types of uncertainty. Liljas (1998) develops Michael Grossman’s demand-for-health model by letting the depreciation rate depend upon the level of health, by letting the incidence and size of illness be uncertain, and by investigating how the individual's demand for health would be affected by the introduction of insurance.

In this model, although following the basic Grossman framework, I step away from him in several ways. Firstly, I do not include time inputs into the production of consumption nor in the production of medical care. The reason for that is that Grossman's model uses the wage rate as the best way to establish a price for time. However, my study will focus on studying the demand for preventive services on near-elderly and elderly people, a majority of whom earn no wages since they are already retired. Therefore, my formulation allows for a more general treatment of the costs of health investments. Secondly, I use a more complex depreciation function for health that depends on more factors than Grossman's which depends solely on time. Thirdly, I incorporate the effect of curative care by modeling it as a function that negatively depends on the stock of health. Finally, I consider an extension to Grossman's model by which unhealthy habits enter the utility function. This last consideration helps to dichotomize the different kinds of preventive investments into: those investments that directly affect the stock of health care and those that intervene through the deterioration of the health stock.

2. The theoretical model

2.1. Assumptions

The following assumptions will be made about the individual, her production of health and the environment: (a) all functions are continuous and differentiable and (b) other variables and parameters in the model are unaffected by the defined changes that is, no indirect effects.

2.2. General form

The individual seeks to maximize her lifetime utility. Utility is a function of a composite consumption goods, Z(t), at each time t, and of the services of the stock of health. The services of health are defined as reduced illness in the form of healthy time, h(t):

$$(1)\quad \int_0^T e^{-\theta(t)} U[Z(t), h(t)]dt,$$

where θ is the individual's subjective rate of time preferences. Healthy time h(t) is produced from the stock of health, H(t), according to:

$$(2)\quad h(t) = \phi(H(t)),\ \phi'>0,\ \phi''<0$$

The time of death, T, is defined by the stock of health.

$$(3)\quad T = \min\{t: H(t) \leq \bar{H}(t)\}$$

Following Liljas (1998), health stock changes over time. Further, in this model, as compared to Grossman's original model, the depreciation of health capital is also a function of other environmental exogenous variables, Q_t:

$$(4)\quad \frac{dH}{dt} = \dot{H}_t = f(t) \cdot I(t) - \delta[t, Q(t)] \cdot H,$$

where I stands for investment in preventive measures. Health can be improved through investments I, and deteriorates at the "natural" health deterioration rate δ. f(t) is the input coefficient of preventive activities and satisfies the following condition:

$$(5)\quad f(t)>0 \text{ for all } t,$$

Z, represents investment in other consumption goods.

Curative care can be purchased at price p^M. The amount of curative care is assumed to depend on the state of health which is represented by the stock of health capital H. Thus M=M(H) with:

$$(6)\quad M'(H) < 0, M''(H) > 0$$

Since the decision on the amount of curative care is usually taken by the physician, it is not modeled here; it is simply included in the budget constraint.

Following Muurinen (1982), the second dynamic constraint in the model is similar to equation (4) and expresses the change in the stock of wealth, $\dot{W}_t$, which is a function of W(t), income Y(t), and the costs of investments:

$$(7)\quad \frac{dW}{dt} = \dot{W}_t = rW(t) + Y\big(h(t), R(t)\big) - [p^Z(t) \cdot Z(t) + p^I(t) \cdot I(t) + p^M(t) \cdot M(H(t))],$$

where $p^Z(t)$ and $p^I(t)$ are the exogenous prices of Z(t) and I(t), respectively, r is a constant rate of interest and Y is earned income and Y(h(t), R(t)) meaning that income is a function of health time and other relevant variables, R(t).

(8) $\frac{\partial Y}{\partial h} = Y_h \geq 0$

In other words, the healthier a person is, the more favorable the conditions are for the earning of income.

Let's assume that preventive activities are positive throughout {0,T}. In this case, the optimization requires the following conditions.

(9) $H(0) = H_0$

(10) $W(0) = W_0,$

which are both assumed to be a constant.

(11) $H(T) = H_{min}$

(12) $H(t) > H_{min}\ at\ t < T$

(13) $W(t) \geq 0$

And

(14) $H(t)$, $Z(t)$, $I(t)$, $p^M(t)$, $p^I(t)$, $p^Z(t)$ are non-negative for all t.

Where t is a continuous variable.

Maximization of expression (1), taking into account (2), gives the following Hamiltonian:

(15) $$L = e^{-\theta t} \cdot U[Z(t), \phi(H(t))] + \lambda_1 \cdot \{f(t) \cdot I(t) - \delta[t, Q(t)] \cdot H(t)\} + \lambda_2 \cdot \{r \cdot W(t) + Y[\phi(H(t)), R(t)] - [p^Z \cdot Z(t) + p^I \cdot I(t) + p^M \cdot M(H((t))]\}$$

where λ_1 is the adjoint variable associated with the differential equation (4) for health H(t), λ_2 is the adjoint variable associated with the differential equation (7) for wealth W(t).

The necessary conditions for a maximum require, in addition to (4) and (7) and the boundary conditions, that the following conditions are satisfied:

(16) $$\frac{\partial L}{\partial Z(t)} = e^{-\theta t} \cdot U_Z - \lambda_2 \cdot p^Z \leq 0$$

(17) $$Z(t) \geq 0$$

(18) $$\frac{\partial L}{\partial I(t)} = \lambda_1 \cdot f(t) - \lambda_2 \cdot p^I = 0$$

(19) $$I(t) \geq 0, \text{by assumption}$$

(20) $$\frac{\partial L}{\partial H} = -\dot{\lambda}_1 = e^{-\theta t} \cdot U_h \cdot \phi_H - \lambda_1 \cdot \delta[t, Q(t)] + \lambda_2 \cdot Y_h \cdot \phi_H - \lambda_2 \cdot p^M \cdot M_H$$

(21) $$\frac{\partial L}{\partial W} = -\dot{\lambda}_2 = r \cdot \lambda_2$$

The individual's time of death, T, depends on the individual's investment in health capital in earlier periods and will occur when the level of health is equal to H_{min}. The value of the maximized Hamiltonian at the unspecified final time T, equals zero:

(22) $$\lambda_1 \cdot [H(T) - \bar{H}] = 0$$

(23) $$\lambda_2 \cdot W(T) = 0$$

Meaning that at the time close to the individual's death, T, her gross investments in health capital are smaller than the depreciation of health capital, thus investing in health is of no value for the individual at the moment of death.

The case that the individual never invests in health in t ≤ T may appear, but will not be considered here. Thus since I(t)>0, equation (18) can be set equal to zero by assumption:

$$\lambda_1 = \lambda_2 \frac{p^I}{f(t)} = \lambda_2 \cdot C(t) \tag{24}$$

Differentiating (24) renders:

$$\dot{\lambda}_1 = \dot{\lambda}_2 \cdot C(t) + \lambda_2 \cdot \dot{C}(t) \tag{25}$$

Where,

$$C(t) = \frac{p^I}{f(t)} \tag{26}$$

From (21), and considering that K is a constant, one gets:

$$\lambda_2 = K \cdot e^{-rt}, or\ r = {-\dot{\lambda}_2}/{\lambda_2} \tag{27}$$

Substituting into (20):

(28) $-\dot{\lambda}_1 = e^{-\theta t} \cdot U_h \cdot \phi_H - \lambda_2 \cdot C(t) \cdot \delta + \lambda_2 \cdot Y_h \cdot \phi_H - \lambda_2 \cdot p^M \cdot M_H =$

$-\dot{\lambda}_2 \cdot C(t) - \lambda_2 \cdot \dot{C}(t)$, which reduces to:

$$\left[\frac{e^{(r-\theta)t} U_h}{K} + Y_h\right] \cdot \phi_H = C(t) \cdot \left[\delta + r - {\dot{C}(t)}/{C(t)} + \frac{p^M \cdot M_H}{C(t)}\right] \tag{29}$$

In (28), U_h represent the consumption benefits of health, and Y_h is the effect of healthy time on earned income.

This optimality condition is similar to Grossman's model. In Grossman's investment model, the consumption benefits of health equal zero. In that case, the Y_H in my model would be analogous to the wage rate in Grossman's. The remaining differences between (29) and Grossman's formulation lie the specification of the marginal costs of new health investment, C(t). While in Grossman the costs for investment in health are defined in terms the price away from productive activities such as work, in my model the cost of preventive investments in health is a function of the price of such investments and the productivity of those investments. I have chosen to move away from Grossman's framework mainly because the empirical aspect of the study deals with data extracted from older individuals who are mostly retired. Thus, in this context, the wage rate cannot be seen as the theoretically correct measure of the price of time.

2.3. Comparative statics

2.3.1. Effect of age, t

Following Muurinen (1982), the best way to obtain comparative statics in this is to convert (29) to logarithms. I assume that the proportionate change of health investment over time, $\dot{C}(t)/C\,(t)$ dos not depend on age and equals $\tilde{C}_t$.

(30) $$\ln\left[\frac{e^{(r-\theta)t}}{K}U_h + Y_h\right] + \ln(\phi_H) = \ln\big(C(t)\big) + ln\left[\delta + r - \tilde{C}_t + \frac{p^M \cdot M_H}{C(t)}\right]$$

Differentiation with respect to time yields:

(31) $$\frac{(r-\theta)\cdot e^{(r-\theta)t}.\frac{U_h}{K}}{\frac{e^{(r-\theta)t}.U_h}{K}+Y_h} + \frac{\partial(\phi_H)}{\partial H}\cdot\frac{\partial ln\,(H)}{\partial t} = \frac{\partial \ln\,(C(t))}{\partial t} + \frac{\partial ln\left[\delta+r-\tilde{C}_t+\frac{p^M \cdot M_H}{C(t)}\right]}{\partial t}$$

Using (25), the last term in the last derivative in parenthesis can be written as:

(32) $$\pi = \frac{p^M \cdot M_H}{C(t)} = \frac{p^M \cdot M_H \cdot f(t)}{p^I}$$

Let's assume, for simplicity, that M_H is constant through time. In other words, the marginal amount medical care given a certain level of health stays the same through time. Then:

(33) $$\frac{\partial \pi}{\partial t} = \pi_t = \frac{p^M \cdot M_H}{p^I} \cdot \frac{\partial f}{\partial t}$$

Since by assumption M_H is negative (see equation (6)) and the effectiveness of preventive activities is assumed to decrease with time so f'(t)<0, then π_t is positive. I further assume that all rates are the same, i.e. the rate of depreciation of utility θ, the rate of interest on wealth r, and the rate of depreciation of health investment $\tilde{C}_t$. For simplicity I well denote (δ+π) as φ. Then (31) simplifies into:

(34) $$\frac{\partial \ln(\phi_H)}{\partial H} \cdot \frac{\partial \ln(H(t))}{\partial t} = \frac{\partial \ln(C(t))}{\partial t} + \frac{\partial ln[\varphi]}{\partial t}$$

Following Grossman, $\partial \ln(\phi_H)/\partial H$ is denoted by -1/ε, negative of the inverse of the marginal efficiency of health capital. I will use a tilde above a variable to denote its percentage change over time (i.e.$\frac{\partial \ln(\dots)}{\partial t}$).

(35) $$(-{}^{1}/_{\varepsilon})\widetilde{H}_t = \tilde{C}_t + \tilde{\varphi}_t$$

And

(36) $$\widetilde{H}_t = -\varepsilon \cdot [\tilde{C}_t + \tilde{\varphi}_t]$$

From (26), I can easily solve for $\check{C}_t$

(37) $$\frac{\partial \ln(C(t))}{\partial t} = \tilde{C}_t = -\dot{f}(t)\Big/f(t) = -\tilde{f}_t$$

From the assumption in equation (5), f (t)>0 and assuming that the productivity of investment in health decrease with age: $\dot{f}(t) < 0$. Thus, $\tilde{C}_t$ is positive. To derive the effect of age on investments, equation (4) can be solved for I and written in logarithm form:

(38) $$\ln I = ln\left[\dot{H}_t + \delta[t, Q(t)] \cdot H\right] - \ln\left(f(t) = lnH + \ln\left(\dot{H}_t\big/H + \delta\right) - \ln\left(f(t)\right)\right.$$

Differentiating with respect to time, one arrives to:

(39) $$\frac{1}{I} \cdot \frac{\partial I}{\partial t} = \widetilde{I}_t = \widetilde{H}_t + \frac{\partial \ln(\widetilde{H}_t + \delta)}{\partial t} - \tilde{f}_t = -\varepsilon \cdot \left[\tilde{C}_t + \tilde{\varphi}_t\right] + \frac{-\varepsilon[1 + \tilde{C}_{tt}] + \delta_t}{\delta - \varepsilon \cdot [\tilde{C}_t + \tilde{\varphi}_t]} - \tilde{C}_t$$

So, assuming that $\tilde{\varphi}_t$ is independent of age.

(40) $$\widetilde{I}_t = \left[\frac{\delta\tilde{\varphi}_t(1-\varepsilon) + \varepsilon^2\tilde{\varphi}_t(\tilde{\varphi}_t + \tilde{C}_t)}{\delta - \varepsilon(\tilde{\varphi}_t + \tilde{C}_t)} + \tilde{C}_t \cdot (1 - \varepsilon)\right]$$

The denominator of the first term in equation (40) equals $\delta + \widetilde{H}_t$, which multiplied by H(t) renders $H \cdot \delta + \dot{H}$. Since this is positive, the denominator in (40) is positive too. Hence, the whole expression is positive if ε is less than or equal to one, and negative if ε is greater than one. In other words, the demand for investment in preventive activities depends on the marginal efficiency of health capital in producing healthy days. Therefore, the effect of age on investment for preventive activities is ambiguous. As such, this effect should be tested empirically.

Another observation from equation (40) is that the rate of investment in preventive activities through time augments in magnitude if the rate of depreciation increases. In other words, a higher rate of depreciation would increase the rate at which the demand for preventive investments in health accelerate or decelerate with time.

2.3.2. Effect of education, E

Education effects can be derived by differentiating (38) with respect to education. C, cost of medical care, is not dependent on education in the model.

(41) $$\ln(\mathrm{I}) = ln\left[\dot{H}_t + \delta[t, Q(t)] \cdot H\right] - \ln(f(t) = lnH + \ln\left({}^{\dot{H}_t}/_{H} + \delta\right) - \ln(f(t))$$

(42) $$\frac{\partial I}{\partial E} = \left[\frac{1}{H} \cdot \frac{\partial H}{\partial E} + \frac{1}{\widetilde{H}_t + \delta} \cdot \left[{}^{\delta \widetilde{H}_t}/_{\delta E} + \frac{\delta \delta}{\delta E}\right]\right] \cdot I$$

The effect of education in health is given by:

(43) $$\widetilde{H}_E = \frac{1}{H} \cdot \frac{\partial H}{\partial E} = -\varepsilon \cdot \tilde{\varphi}_E$$

This expression means that if education slows down the rate of depreciation in health (i.e. $\tilde{\varphi}_E < 0$), then health is positively correlated with education. This result is the same as in the Grossman model.

Assuming that $\tilde{\varphi}_t$ is independent of education, and considering (39) and (40), education affects investment in healthy activities in the following way:

$$\frac{\partial I}{\partial E} = \left[\frac{\delta\tilde{\varphi}_E(1-\varepsilon)+\varepsilon^2\tilde{\varphi}_E(\tilde{\varphi}_t+\tilde{C}_t)}{\delta-\varepsilon(\tilde{\varphi}_t+\tilde{C}_t)}\right]\cdot I \qquad (44)$$

Since, the denominator of the term in brackets is positive (see discussion for equation (40)), and since I assume I>0, the sign of the expression depends on the numerator. Thus, a sufficient condition for $\frac{\partial I}{\partial E}$ to be positive is if ε, is less than or equal to one. In this way, the signs of equations (40) and (44) are linked to each other, if demand for preventive activities increases with age, investment in these activities decreases with education, and vice versa. These two conditions can and should be tested empirically.

In sum, education in this model works by reducing the rate of health deterioration, which lowers the user cost of health investments. This is conceptually different from the results in Grossman's model whereby education is positively associated with health, because it increases the general non-market productivity of the individual thus reducing the marginal cost of new investment in health. In this model, an implicit assumption has been that education does not affect the production benefits of health or the income loss caused by using medical care (i.e. Y is not a function of education).

2.3.3. <u>Effect of time preferences</u>

A simplifying assumption in the derivation of (37) was made by assuming that the time preference and interest rate differ (see discussion under equation (31)). Let's assume now that the production benefits of health, Y_H, are zero. The interest rate and the rate of depreciation of health are the same. Therefore, equation (29) reduces to:

$$\left[\frac{e^{(r-\theta)t}U_h}{K}\right]\cdot\phi_H = C(t)\cdot[\delta+\frac{p^M\cdot M_H\cdot f(t)}{p^I}] \qquad (45)$$

Again, denoting φ as the sum of δ and $\frac{p^M \cdot M_H \cdot f(t)}{p^I}$, I can write (45) in logarithmic form:

(46) $$(\mathrm{r} - \theta) \cdot \mathrm{t} + \ln\left(\phi_H\right) = \ln\big(C(t)\big) + \ln\left(\varphi\right)$$

Differentiating equation (43) with respect to time, one arrives to:

(47) $$(r - \theta) + \frac{\partial \ln\left(\phi_H\right)}{\partial H} \cdot \frac{\partial H(t)}{\partial t} = (r - \theta) - \frac{1}{\varepsilon} \cdot \dot{H}_t = \tilde{C}_t + \tilde{\varphi}_t$$

In this case, the equivalent expression for equation (36) becomes:

(48) $$\widetilde{H}_t = -\varepsilon \cdot \left(\tilde{\varphi}_t + \tilde{C}_t + (\theta - r)\right)$$

Equations (33) and (48) equal each other if θ equals r. If the rate of time preference is higher than the rate of interest, the health stock deteriorates more rapidly. So according to this interpretation, an increase in the discount rate of time leads to a lower valuation of future consumption and, thus, decreases the return on prevention. Therefore, the reduction in prevention in order to increase present consumption is a natural reaction. As presented below, this will be another one of the hypothesis that will be tested empirically.

2.3.4. Effect of changes in health deterioration rate

A higher rate of depreciation has two effects. On the one hand, prevention becomes less effective; on the other hand, more prevention is needed in order to retain the current state of health. Nevertheless, equations (40) and (44) show that a higher health depreciation rate should, more directly, decreases the rate of investment in preventive activities.

2.3.5. Effect of prices

If preventive care becomes more expensive, then demand for prevention will decline. In this model, a rise in the price of curative care unambiguously increases the demand for preventive care, which is, of course, plausible. However, in alternative models from the literature the cross-price elasticity of demand for prevention cannot be uniquely derived (Kenkel, 1994; Meier, 1996). The intuitive explanation for the unique results in the current model is that the substitution effect of a changing price always dominates due to absence of an income effect.

2.3.6. Effect of insurance coverage

If insurance covers both preventive and curative care, then changes in insurance coverage would have an ambiguous effect. On the one hand, when an insurance policy covers preventive services, I should expect an increase of the demand for those behaviors. However, insurance could also diminish the demand for prevention by reducing the cost of curative treatment. Therefore, the effect of insurance is ambiguous and should be tested empirically. One way to distinguish the two effects is by noting the difference in the effect of insurance on the demand for preventive activities on activities for which the cost of preventative and curative measurements are covered by insurance, such as cancer screening, versus those activities for which the cost of prevention is not affected by insurance coverage but the cost of treatment is, such as physical activity.

2.4. Model variations

2.4.1. Different kinds of preventive services

One of the advantages of the model as presented above is its capacity to absorb different kinds of preventive investments. One such variation can be done by considering the marginal productivity of health investments, f(t), in equation (4). For instance, the specification of a relationship between use of medical care and new investment in health adopted in the context of this theoretical model may be replaced by a more detailed one. For example, f(t) could be defined as a function of both age and the quantity of medical care consumed, f(t, M), which would allow for the possibility of decreasing marginal productivity of the investment in response to medical care to be taken into account in the model. Also, the heterogeneity of preventive investments could be incorporated into the framework by replacing the simple production relationship $f(t) \bullet I(t)$ by $\varphi(t)[I_1(t), I_2(t), \ldots, I_n(t)]$ or even more complex $\varphi(t)[I_1(t, M), I_2(t, M), \ldots, I_n(t, M)]$, where I_i is the ith type of preventive care. Different kinds of preventive activities like lifestyle preventive activities or clinical preventive activities can be incorporated and distinguished in this framework. For instance, the marginal productivity of health investments might differ widely when they are associated with the use of other medical care, e.g. when prescribed by a doctor than when carried out on one's own initiative.

2.4.2. Useful variation of the model: Level effects on health

Some basic modifications, inspired in Case and Deaxton (2001) can be made to the initial setting to acquire additional insights into the effect of other factors in the demand for health.

Recall equation (4), a modified version of this equation in which health stock is modeled over the life cycle renders:

$$H_{t+1} = f(t) \cdot I_t - \delta[t, Q(t)] \cdot H_t \tag{49}$$

Before, the investment function was modeled in dynamic terms throughout lifetime. Let's assume that one could directly buy these investments in such a way that, instead of a dynamic, one gets a lifetime budget constraint takes the form budget constraint, equation (7) can now be written.

$$\sum_0^T \frac{p^Z \cdot Z}{r^t} + \sum_0^T \frac{p^I \cdot I}{r^t} + \sum_0^T \frac{p^M \cdot M}{r^t} = W_0 + \sum_0^T \frac{y(H,R)}{r^t} \tag{50}$$

Where p^I is the price of the investment in health, p^M is the price of curative health and again T is the time of death. By setting the model this way, I can substitute (49) into (50) and arrive to a single integrated constraint:

$$\sum_0^T \frac{p^Z \cdot Z}{r^t} + \sum_0^T \frac{p^I \cdot}{r^t} \cdot \left[\frac{H_{t+1} + \delta \cdot H_t}{f(t)}\right] + \sum_0^T \frac{p^M \cdot M}{r^t} = W_0 + \sum_0^T \frac{y(H,R)}{r^t} \tag{51}$$

Or

$$\sum_0^T \frac{p^Z \cdot Z}{r^t} + \sum_0^T \frac{p^I \cdot}{r^t} \cdot \left[\frac{\delta \cdot H_t}{f(t)}\right] + \sum_0^T \frac{p^M \cdot M}{r^t} = W_0 + \sum_0^T \frac{y(H,R)}{r^t} - \frac{p^I \cdot r^t}{f(t)} \cdot \left[\frac{H_{T+1}}{r^{T+1}} - H_0\right] \tag{52}$$

Just as before, consumers maximize subject to (50):

$$L = e^{-\theta t} \cdot U[Z(t), \phi(H(t))] + \lambda \cdot \left\{W_0 + \frac{y(H,R)}{r^t} - \frac{p^I \cdot r^t}{f(t)} \cdot \left[\frac{H_{T+1}}{r^{T+1}} - H_0\right] - \frac{p^Z \cdot Z}{r^t} - \frac{p^I \cdot}{r^t} \cdot \left[\frac{\delta \cdot H_t}{f(t)}\right] - \frac{p^M \cdot M}{r^t}\right\} \tag{53}$$

First order conditions are:

(54) $$U_z = \lambda \cdot \frac{p^z \cdot e^{t\theta}}{r^t}$$

(55) $$U_H = \frac{\lambda \cdot e^{t\theta}}{\phi_H \cdot r^t} \cdot \left\{\frac{p^I \cdot \delta}{f(t)} - y_H\right\} = \frac{U_z}{\phi_H} \cdot \left\{\frac{p^I \cdot \delta}{f(t)} - y_H - \frac{p^M \cdot M_H}{r^t}\right\}$$

The Lagrange multiplier λ is the shadow price of lifetime wealth. Following Wagstaff (1986), equations (54) and (55) can be used to examine the life-cycle evolution of consumption and health given that they hold whether or not health is optimally adapted to its user cost. Given the assumptions that there is a diminishing marginal utility of health and consumption as well as diminishing marginal productivity of health on income y_H, I can derive some comparative results about the level of health. The level health stock throughout life will be higher:

a) The lower is the price of health investment, p^I.
b) The higher is the efficiency of health investment in repairing health, f(t).
c) The lower the rate of health deterioration, δ_t.
d) The higher are initial assets, initial health, or lifetime earnings, and the lower are prices over the lifetime, all of which lower λ through lifetime income effects.

2.4.3. Useful variation of the model: The case for investment in healthy lifestyles

In this section, I further modify the model above to accommodate another kind of investment, healthy lifestyle. Oftentimes, preventive activities encompass two different kinds of preventive behavior: preventive screening and healthy lifestyle. On the one hand, preventive screenings might have a direct effect on the health stock by decreasing the amount the stock decreases in the event of an illness. On the other hand, healthy lifestyles do not only help to increase or at least prevent the deterioration of the health stock, but arguably, healthy lifestyle choices also have a direct effect in the utility function of an individual. In this variation of the model, I assume that an individual could increase her utility by consuming more unhealthy items (e.g. cigarettes, excessive number of alcoholic beverages, sedentary habits).

Suppose that the utility function contains a second consumption good whose price is paid, not in money, but in the rate of health deterioration. This component includes activities that relate to an unhealthy lifestyle which include but are not limited to smoking, the consumption of junk food, unsafe sex, and sedentary lifestyle. All of these activities are either low-cost or free and pleasurable or easy to engage in, but these are activities are paid out of a higher rate of health deterioration. Calling the added consumption item is G, i.e. U(Z(t), h(t), G), and assuming that G enter the rate of deterioration function such that δ(G) and δ'>0, then the additional first-order condition to (52) and (53) is:

$$U_G = \frac{\lambda \cdot e^{t\theta}}{\phi' r^t} \cdot \left\{ \frac{p^I}{f(t)} \cdot \frac{\partial \delta_t}{\partial G} \cdot H_t \right\} \tag{56}$$

Holding the right-side of the equation constant, elements that changes taste away from or reduces the marginal utility of G-goods will reduce their consumption and lower the rate of health deterioration. Once again, education seems to come in mind as a factor that drives a person away from unhealthy activities. Another such element that could shift preference could be a health shock to a relative or a spouse that comes as a consequence of theses unhealthy activities.

2.4.4. Useful variation of the model: The demand for preventive services in households

This theoretical setting will be modified in some ways in chapter 3 in order to provide some insight into the factors that might lead to explain why the demand for preventive services among spouses may be correlated. In the literature, there are 3 types of which may explain the correlation between partners' demand for health: assortative matching in the marriage market; social learning about health risks from the observation of one's partner; interactions due to bargaining within marriage. These characteristics link directly to some of the factors that are involved in the demand for preventive activities in this model.

Assortative mating assumes that partners in the marriage market match taking into consideration a number of observable characteristics like education, initial assets, education of parents, as well as the history of health-related behaviors. All these factors influence the λ in the model above. So, it follows that a shared λ would also link their health trajectories.

The social learning about health risks from the observation of one's partner can enter the model in a variety of ways. Learning from partner's experience can be a significant force in altering preferences for unhealthy behaviors and thus diminishing the demand for G in the model. For instance, an individual may switch a lifestyle after a spouse's stroke or heart attack.

Finally, interactions and bargaining between spouses represent another mechanism by which I should expect their demand for preventive investments to be correlated. I should expect spouses to have a similar health trajectory as they share many of the elements Q that affect the deterioration rates of health in the model due to sharing the same environment, financial situation or access to care.

2.5. A comment on uncertainty

The model presented in here does not deal with uncertainty as it was determined that its inclusion would unnecessarily complicate the concepts treated before. However, it is worth pointing out that some other models in the literature have incorporated elements of uncertainty as it has been recognized to be an important element of consideration in the health sector for a long time. Arrow (1963) claims that the uncertainty surrounding medical care is possibly more intense than the uncertainty in most other commodities. Yet, Grossman's model does not directly incorporate uncertainty, an omission that has encouraged revisions and extensions by other authors.

Cropper (1977) used a dynamic model with uncertainty but only regarded two health states: 'ill' or 'not ill', compared to this case where it was assumed that there were an infinite number of health states. In her model, the individuals wanted to increase their stock of health capital in order to decrease the probability of illness since in that case they did not receive any utility from consumption. Dardanoni and Wagstaff (1990) showed that under plausible assumptions the demand for medical care would increase in response to increased uncertainty over the ex ante level of health and/or in response to increased uncertainty over the effectiveness of medical care. Picone et al. (1998) extend Dardanoni and Wagstaffs' insights and determine that greater risk aversion causes extra precautionary behavior in an uncertain environment even when a health shock does not occur. It is precisely this last prediction that may be tested in the empirical framework of chapter 2. As it will be discussed, the available data contains some variables that indicate risk aversion and whose effect on preventive behavior can be examined.

2.6. Comparison to the Grossman model

In the final paragraph of his seminal paper, Michael Grossman provides some advice for future modeling efforts: "any model must recognize that health is a durable capital stock, that health capital differs in important respects from other forms of human capital, and that the demand for medical care must be derived from the more fundamental demand for 'good health' " (1972, p. 242). Under that optic, the variation of Grossman depicted here fulfills all three prescriptions. However, my model differs with Grossman in at least three significant ways. Firstly, although Grossman distinguishes between those health investments that can be bought with time and those that can be bought with wages. In Grossman's mind, this distinction is akin to telling apart lifestyle vs. medical treatment. However, there is no clear distinction between preventive and curative health investments in the sense that a, for instance, a mammography can be discriminated from a treatment for breast cancer. Two years later, Grossman together with Rand (2000) modify the original framework to distinguish prevention and cure by assuming that groups with low depreciation rates primarily demand preventive care while groups with high depreciation rates primarily demand curative care. In the opinion of the author, the model above is much more straightforward in the distinction by assuming that while prevention represents an ex ante investment undertaken by the utility maximize, curative treatment is an ex post reaction to the presence of disease.

Secondly, the model of health investment presented in this paper is a generalized version of Grossman's original model in the sense that it does not rely on the acceptance of household production theory and time prices. Grossman's model uses the wage rate as the best way to establish a price for time. However, since I focus on the demand for preventive services on near-elderly and elderly people, a majority of whom earn no wages since they are already retired, wage rate does not seem to be a sensible way to price prevention. By considering a more general treatment of the costs of health investments, I create a model that more closely adapts to the characteristics of my population of interest in this study.

Thirdly, my health depreciation function depends on more factors compared to Grossman's which is only a function of time. This renders the possibility for a more direct relationship to other variables such as education. As explained below, the slight modification in the depreciation function allows for a clearer interpretation of some of the comparative statics.

In terms of the comparative statics derived from both mine and Grossman models, one can contrast the predictions for education, age, wealth and insurance. Firstly, in my model if education reduces the rate of depreciation, the demand for preventive investments is positively correlated with it. This result conforms with the predictions of Grossman's investment model, but its justification is different. In his model, education is positively associated with health, because it increases the general non-market productivity of the individual in question, thus reducing the marginal cost of new investment in health, whereas in my model education is seen as operating on a more aggregate level in redirecting the choice of different production processes in a way which leads to a lifestyle that is less use-intensive in terms of health. Therefore, the comparative static results with respect to education derived here are qualitatively very similar to Grossman's predictions. However, the present model does not require the assumptions of input or commodity neutrality utilized in Grossman's analysis. It is also not dependent on the acceptance of the hypothesis that education affects household productivity in general.

In Grossman's model, because health capital is assumed to depreciate at a higher rate as people get older, if the price elasticity of the demand for health is smaller than one then the derived demand for curative medical care increases with age. In my model, since the depreciation rate is a function of time and education, the relationship is more complicated. In fact, the comparative static for the effect of aging is diametrically opposed to the effect of education through the mechanisms of the depreciation function. Thus, when education is positively associated with the demand for prevention, then age is negatively associated, and vice versa.

In traditional consumer analysis, increases in wealth lead to increased demand for normal goods. Thus, in Grossman's pure consumption model the wealth effect on health was expected to be positive. My model reaches the same conclusion for essentially the same reasons.

Grossman's model does not consider the effect of insurance. In fact, Grossman anticipate that the inclusion in further models of uncertainty regarding the age of death of a consumer "would give persons an incentive to protect themselves against the 'losses' associated with higher than average depreciation rates by purchasing various types of insurance and perhaps by holding an 'excess' stock of health" (1972, p. 248). In my model, I do not consider the effect of insurance directly, however, I predict the effect of insurance indirectly by observing the shielding of the price of both preventive and curative investments that might come with the existence of insurance.

As I final note, it is important to remark that the assessment of my comparative statics in relation with Grossman's is limited at best. The reason is that while my comparative statics apply only to preventive investments, Grossman's apply to the demand for all medical investments in general, including both curative and preventive investments. I purport that the failure to distinguish between prevention and treatment explicitly in Grossman's model has caused some confusion in the empirical evaluations of the model's predictions that have followed after the publication of the famous Grossman paper. It is my thought that a more convincing separation of preventive vs. curative treatment would conform to better agreements with the empirical evidence.

3. Background on empirical evidence

In this section I present a summary of the most relevant empirical studies examining some of the predictions that I have outline above.

Healthy people consume less medical care: Wagstaff (1986) observes that 48% of the 1976 DanishWelfare Survey (DWA) sample he employed recorded zero general practitioner visits and 46.5% recorded zero weeks in hospital.

Wealthier people have higher stocks of health: Smith (2004, 2007) uses self-reported health (SRH) status from the National Health Interview Survey (NHIS) and PSID to show how disparity in health between low and high-income individuals (the so-called socio-economic status [SES]-health gradient) increases with age.

Health and education: Van Doorslaer assumes that investment is a function of personal background variables (schooling, age, income, and gender). Thus, he regresses health in 1984 on these variables and on health in 1979. To test the hypothesis that schooling lowers the rate of depreciation, he allows for an interaction between this variable and health in 1979 in some of the estimated models. Van Doorslaer's main finding is that schooling has a positive and significant coefficient in the regression explaining health in 1984, with health in 1979 held constant.

Effect of time preferences: Farrell and Fuchs find that the negative relationship between schooling and smoking, which rises in absolute value for cohorts born after 1953, does not increase between the ages of 17 and 24. Since the individuals were all in the same school grade at age 17, the additional schooling obtained between that age and age 24 cannot be the cause of differential smoking behavior at age 24, according to the authors. Based on these results, Farrell and Fuchs reject the hypothesis that schooling is a causal factor in smoking behavior in favor of the view that a third variable causes both. Since the strong negative relationship between schooling and smoking developed only after the spread of information concerning the harmful effects of smoking, they argue that the same mechanism may generate the schooling-health relationship.

On separating schooling, health and time preferences: Berger and Leigh (1989) have developed an extremely useful methodology for disentangling the schooling effect from the time preference effect. Their methodology amounts to treating schooling as an endogenous variable in the health equation and estimating the equation by a variant of two-stage least squares. If the instrumental variables used to predict schooling in the first stage are uncorrelated with time preference, this technique yields an unbiased estimate of the schooling coefficient. Since the framework generates a recursive model with correlated errors, exogenous variables that are unique to the health equation are not used to predict schooling. Except for the last finding, these results are inconsistent with the time preference hypothesis and consistent with the hypothesis that schooling causes health.

On the correlation between spouses' demand for preventive activity: It has been found that among married couples, there is evidence of initial matching and compatibility in many areas due to endogamy and homogamy in race, religion, socioeconomic status (Mare 1991; Kalmijn 1998) substance use (Vanyukov et al. 1996), occupation (Hout 1982; Smits, Ultee, and Lammers 1999), and leisure preferences (Houts, Robins, and Huston 1996). Further inquiry has evaluated the transitions that occur in health behaviors after the initial matching, and spouse behavior is considered as an important risk factor for adopting, continuing, or relapsing to poor health behaviors. For instance, studies have estimated the effect of a husband's drinking on the wife's drinking during the transition to marriage and in the newlywed phase (Leonard and Das Eiden 1999; Leonard and Mudar 2004). In the case of smoking, both spousal support and spousal smoking status have been studied (Coppotelli and Orleans 1985; Mermelstein et al. 1986; Roski, Schmid, and Lando 1996; Monden, De Graaf, and Kraaykamp 2003; Homish and Leonard 2005). Studies typically evaluate one spouse's behavior simply as a risk factor for the other's without taking into account the joint process of change, although there are exceptions (Shattuck, White, and Kristal 1992; Franks, Pienta, and Wray 2002).

These spousal interactions have been theorized within a Grossman style framework (Jacobson 2000). Falba and Sindelar (2008) use HRS data to show empirically that when one spouse improves his or her behavior, the other spouse is likely to do so as well. They conclude that spouses influence the dynamics of each other's health habits.

On the effect of risk aversion and demand for insurance and prevention: Using the Health and Retirement Study, Finkelstein and McGarry (2006) show that two types of people purchase insurance: individuals with private information that they are high risk and individuals with private information that they have strong taste for insurance. Ex post, the former are higher risk than insurance companies expect, while the latter are lower risk. Specifically, they show that wealthier individuals and individuals who exhibit more cautious behavior—as measured either by their investment in preventive health care or by seat belt use—are both more likely to have long-term care insurance coverage and less likely to use long-term care.

4. Summary of predictions and preview of next chapters

In the next chapter of this dissertation I test empirically the validity of the following model predictions. With respect to the demand for preventive services, the model predicts:

a) The marginal demand for investments in preventive activities decreases with age if it increases with education and vice versa.

b) A higher time discount rate, i.e. a preference for short term consumption rather than long term planning, causes the health stock to deteriorate more rapidly.

c) An increase in the discount rate of time leads to a lower valuation of future consumption and, thus, decreases the return on prevention.

d) An increase on the deterioration rate of health will decrease the demand for preventive services.

e) Insurance coverage that covers both preventive and curative care should increase the demand for preventive activities.

f) Insurance coverage that covers only the cost of curative care but not the cost of the investment in preventive activity should have a mild negative effect on the demand for such activity.

Although not in my model per se, risk aversion has been modeled by others to positively correlate with demand for preventive investments. Such prediction will be tested empirically as well.

g) Individuals who are more risk averse will be more likely to engage in preventive behavior.

In chapter 3 of this dissertation, I explore the joint demand for preventive services within households. In that regard, I test not only whether the demand for those activities is correlated between spouses but also, and perhaps more interesting, I analyze the mechanisms that are in play when jointly demanding for prevention. In this sense, I test the following predictions:

e) If there is positive assortative matching over the demand of prevention, partners' estimated individual fixed effects in hierarchical linear model will be positively correlated.
f) Household decision-making suggests that respondent's decision to engage in preventive activities should be positively correlated with partner's lagged preventive activities once individual fixed effects are controlled for.
g) Partner's health developments may affect respondent's preventive activities. In the case of social learning, the partner will increase her investment in a preventive activity after a respondent suffers a health shock that is associated with the preventive behavior in question.

Finally, in chapter 4 of the dissertation, I use the insights of the previous two chapters in order to parse out the effect that preventive activities and the factors associated with them have on health expenditures. I use the predictions and significance of the variables included in Chapter 1's predictions to ameliorate the endogeneity present when trying to analyze the effect of preventive behavior on health expenditures. In chapter 4, a variety of methods underlying key findings from the theoretical model for the demand for prevention are used such as:

1) An examination of alternative hypotheses that might indicate self-selection.
2) Use of propensity scores to predict the probability of engaging in preventive activities or not by balancing observed characteristics very closely between groups.
3) Use of instrumental variables.

CHAPTER 2: AN EMPIRICAL STUDY ON THE FACTORS THAT AFFECT THE DEMAND FOR PREVENTION AMONG OLDER ADULTS

1. Introduction

The theoretical model presented in chapter 1 renders a series of predictions that are tested empirically in this chapter. Table 2.1 summarizes the predictions described in last chapter.

Table 2.1. Chapter 1model prediction on the demand for investment activities.

Variable	**Predicted Association with Investment in Preventive Activities**
Age, t	Opposite direction to the effect of education
Education, E	Opposite direction to the effect of age
Price of medical care, p^M	+
High discount rate for time, θ	-
Price of investment in health activities, p^I	-
Rate of deterioration of health stock, δ	-
Insurance coverage	+ for activities such as cancer screening. – for healthy lifestyle activities.
Risk aversion*	+
Wealth	+

*Risk aversion is not explicitly in my model, yet I choose to test its relation with the demand for prevention empirically as other theoretical models predictions have predicted such relationship.

2. Data

2.1. The Health and Retirement Study linked to Medicare claims data

For this chapter, I use publicly available data from the Health and Retirement Study (HRS), a nationally representative, longitudinal study sponsored by the National Institute on Aging and conducted by the Institute for Social Research at the University of Michigan, Ann Arbor. Designed to assess health status, retirement decisions, and economic security during retirement, this study enrolled non-institutionalized adults in the 48 contiguous US states who were born during the years 1931 through 1941, with oversampling of blacks, Hispanics, and Florida residents. I use waves 3, 5, and 7 collected in 1996, 2000, and 2004, respectively as only these waves contained all the necessary variables regarding preventive behavior. Further details of this survey are available at the following address: http://hrsonline.isr.umich.edu/

2.2. Prevention in the Health and Retirement Study.

HRS asked respondents questions regarding lifestyle preventive choices such as exercising, smoking and body weight in each of the 8 rounds. However, respondents were surveyed about clinical preventive activities, namely flu shot, cholesterol screening, pap smear test, mammography, and prostate screening only every other wave starting in wave 3. As such and in order to preserve consistency, only waves 3, 5, and 7 are considered for all preventive variables and covariates. The wave of origin was chosen to be that for which the interview age was closer to when the respondents turned 65. This is the same preventive behavior and timing that is studied in chapter 4 in connection with Medicare expenditures. The only exception is for the age for which a separate analysis was performed.

3. Econometric approach

The first step in this analysis is to estimate probit models with all independent variables (in table 2.3) included at the same time. This is termed the fully specified model. The second step is the examination the relationship between an individual's undertaking of a given preventive activity and the relevant key independent variable whose effect is predicted by the theoretical model. For this second step, I estimated the following two probits:

(1) $Prob(PREV = 1) = \Phi(\beta_2 B)$

(2) $Prob(PREV = 1) = \Phi(X\beta_1 + \beta_2 B)$

PREV is a binary variable for whether the individual practices one of the preventive activities that are available in the survey in the wave closer to age 65. Table 2.2 presents a summary of such variables and a description of such variables in the sample.[i] The coefficient of interest is β_2, the individual's key independent variables that are predicted in the model (plus the some variables regarding risk aversion), see table 2.3. In the first probit, no controls were used. In the second probit, a vector of covariates X was included. These covariates are the same used in McWilliams et al. (2003). Table 2.4 summarizes the covariates. Each of the independent variables was explored in separate probit models for each of the preventive activities/dependent variables.

For robustness, I also tried logistic regression models instead of probit models. The results of the logit models, although not shown, were extremely similar in significance to the probit models.

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[i] For the healthy lifestyle and clinical prevention index, I used ordinal probit models in the empirical specification.

Table 2.2. Summary statistics for dependent variables.

Type of preventive activity	Preventive activity	Description	Mean	Std. Deviation
Healthy Lifestyle Preventive activities	Vigorous physical exercise	Performs vigorous exercise 3+ times per week	38.5%	(48.7%)
	Non-smoking	Respondent currently does not smoke	84.3%	(36.4%)
	Normal weight	Survey asked for weight and height.	29.1%	(45.4%)
Clinical Preventive activities	Flu shot	Whether the respondent has received the shot this wave	58.8%	(49.2%)
	Cholesterol Screening	Whether the respondent has performed the test this wave	80.9%	(39.3%)
	Breast Cancer Screening	Whether the respondent has performed a mammography this wave	76.2%	(42.6%)
	Cervical Cancer Screening	Whether the respondent has performed a pap smears this wave	65.7%	(47.5%)
	Prostate Cancer Screening	Whether the respondent has performed any kind of prostate cancer test this wave	76.2%	(42.6%)
Composite measures	Any preventive activity	Any of the preventive activities listed above	99.1%	(9.5%)
	All preventive activity	All of the preventive activities listed above	4.8%	(21.4%)
	Lifestyle index	An index of 0-3 consisting of the sum of positive answers for frequent vigorous physical exercise, normal body weight, non-	2.5	(1.2)

smoking.

	Clinical prevention index	An index of 0-4 (0-3 for men) consisting of the sum of positive answers for flu shot, cholesterol screenings, and cancer screenings (pap smear test and mammograms for women; prostate screenings for men)	1.5	(0.8)
	Sample size		5,360	
	Sample size (female)		3,106	
	Sample size (male)		2,254	

Table 2.3. Summary statistics for key independent variables.

Variable	**Comments**	**Description**	**Mean**	**Std. Deviation**
Insurance status pre-65	1 if respondent had private and/or public insurance coverage in the wave before turning 65; 0 if no insurance was reported.	-	77.6%	(41.7%)

Wealth: Income (in 100,000)	Continuous.	Is the sum of respondent's and spouse's wage/salary income/ bonuses/overtime pay/commissions/tips, capital income, income from Social Security disability benefit, pension and annuity, income from social security retirement, income from unemployment and/or workers' compensation, other government transfers, and any other household income.	4.0	(10.3)
Wealth: Assets (in 100,000)	Continuous	Sum of value of primary residence, value of other real estate, net value of businesses, vehicles, IRA/Keogh, stock, checking/savings accounts, CDs, Saving bonds, T-bills, bond funds, and other savings minus debts, mortgage, and home loans.	0.6	(0.8)
Education: Number of years	Continuous		12.3	(3.2)
Health deterioration	Mean recent change in health (1 = much better, 5 = much worse)	This question asks the respondent to assess retrospectively how his/her health has changed since the last interview	3.1	(0.7)

Risk aversion to changing jobs	1 if the respondent is found to be among the most risk- adverse category.	In the first wave of HRS, the individual is asked to choose between pairs of jobs where one guarantees current family income and the other offers a chance to increase income but also carries the risk of loss of income. If R says he/she would take the risk, the same scenario but with riskier odds is presented. If R says he/she would not take the risk, the same scenario with less risky odds is asked.	60.3%	(48.9%)
Risk aversion: very frequent use of seatbelt	1 if the respondent claims to use seatbelt very frequently. 0 if not.		71.8%	(45.0%)
Risk aversion: life insurance	1 if the respondent has a life insurance policy. 0 if not.		69.5%	(46.0%)
Risk aversion: long-term care insurance	1 if the respondent has a long term care insurance policy.		11.6%	(32.1%)
Time preference	1: Short term financial planning (next few months, next year), long term financial planning (next few years, next 5-10 years).	In the first wave, HRS asks: "In deciding how much of their (family) income to spend or save, people are likely to think about different financial planning periods. In planning your (family's) saving and spending, which of the time periods listed in the booklet is most important to you [and your (husband/wife/partner)]?"	31.1%	(46.3%)

Table 2.4. Summary statistics of control variables.

Variable	Mean	Standard Dev.
Female	56.6%	(49.6%)
Race		
Non- Hispanic white	75.0%	(43.3%)
Non- Hispanic black	14.7%	(35.5%)
Hispanic	8.5%	(27.9%)
Other	1.8%	(13.3%)
Veteran status	25.3%	(43.5%)
Employment (full-time, part-time, unemployed, semiretired, retired, disabled, not in labor force)		
Full time	19.0%	(39.2%)
Part time	4.5%	(20.7%)
Unemployed	0.3%	(5.6%)
Semi-retired	14.2%	(34.9%)
Retired	51.1%	(50.0%)
Disabled	2.5%	(15.6%)
Not in labor force	8.4%	(27.8%)
Number of household members	2.2	(1.1)
Self-reported health status (poor, fair, good, very good or excellent)		
Excellent	13.4%	(34.0%)
Very good	30.2%	(45.9%)
Good	32.2%	(46.7%)
Fair	17.8%	(38.3%)
Poor	6.3%	(24.4%)
Number of functional limitations with activities of daily life (ADLA)	0.2	(0.7)
Diagnosis of chronic conditions (high blood pressure, diabetes, cancer, lung disease, heart disease, stroke, arthritis)		
High blood pressure	50.4%	(50.0%)
Diabetes	16.9%	(37.5%)
Cancer	11.0%	(31.3%)
Lung disease	8.9%	(28.4%)
Heart disease	19.0%	(39.3%)
Stroke	5.1%	(21.9%)

Arthritis	58.0%	(49.4%)
Social Security benefit recipient status	7.9%	(27.0%)
Mental health (CESD score)	1.3	(1.9)
Census divisions		
New England	3.8%	(19.1%)
Mid Atlantic	12.0%	(32.5%)
Eastern North Central	15.8%	(36.5%)
Western North Central	9.2%	(28.8%)
South Atlantic	24.8%	(43.2%)
Eastern South Central	6.8%	(25.2%)
Western South Central	10.0%	(29.9%)
Mountain	5.3%	(22.3%)
Pacific	12.3%	(32.8%)
Sample size	5,360	
Sample size (female)	3,106	
Sample size (male)	2,254	

Finally, I exploit the longitudinal aspect of the data and estimate fixed effects multivariate logistical models that allows controlling for unobserved heterogeneity at the individual level. Not all of the variables are suited for this analysis. Some of the dependent and independent variables and controls are only measured at one point in time of are fixed characteristics of the respondent (e.g. education).

The fixed effects logit estimator $\check{\beta}_2$ gives the effect of each element of B and X on the log-odds ratio:

$$(3)\quad log\frac{\Lambda(X_t\beta_1+\beta_2 B_t+c)}{1-\Lambda(X_t\beta_1+\beta_2 B_t+c)} = X_t\beta_1 + \beta_2 B_t + c$$

where c represents some unobserved heterogeneity (Wooldridge 2002).

In order to study the association with age, a slightly different empirical strategy has to be utilized. One cannot observe the effect of age on the demand for prevention if the criterion for selecting the timing of the variables is precisely being sufficiently close to age 65. Therefore, for this part of the analysis, I switch the sample to include all those respondents in wave 7 (the wave for which the majority of the respondents' information at age 65 come from) who do not have missing responses. Probabilistic and ordinal probabilistic regression models similar to the ones described above were estimated.

4. Results

4.1. Key independent and preventive activities in at age 65

4.1.1. Fully specified models

The first set of results corresponds to the probit models in a fully specified form that includes the associations of all controls and all other key variables in table 2.3 operating at the same time for each of the different preventive behaviors. In table 2.5, the results for the marginal effects of the key variables on eleven different probabilistic or ordinal probabilistic models are shown. The marginal effects for control variables are not shown. All variables, except for seatbelt use and risk aversion to changing jobs[ii], are considered at age 65.

The results of this specification show that insurance pre-65 was significantly and positively associated with all different clinical preventive behaviors and non-smoking behavior. Yet, insurance pre-65 was significantly (at 10% level) and negatively associated with physical activity. The association of a time preference for short term financial planning

[ii] These variables were only asked in wave 1 and asked in subsequent waves only for those respondents who haven't answered them before.

remained negative and significant for physical activity and all other clinical preventive activities, except for Pap smears test, and negative but not significant for healthy lifestyle preventive behaviors such as non-smoking and normal weight status. In this specification, health deterioration was negatively and significantly associated with physical activity and non-smoking but not significantly associated with any other activity. Finally, among the risk aversion measures, aversion to changing jobs was a positive significant predictor for any behavior but Pap smear test. Seatbelt use was never significantly associated with preventive behavior. Except for cholesterol screening and Pap smear tests, having life insurance was a predictor of increased preventive behavior. Long term care insurance positively and in almost all cases significantly predicts all preventive behaviors except for physical activity and normal weight status.

The collinearity in this model is high as evidenced by condition indexes of above 30. Hence, the analysis of the association of each of the independent variables separately (see section 4.1.2. below) is warranted.

Table 2.5. Coefficients for fully specified model.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Type of model	**DPROBIT**	**DPROBIT**	**DPROBIT**	**DPROBIT**	**DPROBIT**	**DPROBIT**	**DPROBIT**	**DPROBIT**	**DPROBIT**	**DPROBIT**	**OPROBIT**	**OPROBIT**
VARIABLES	**Vigorous activity**	**Non-smoker**	**Normal weight**	**Flu shot**	**Cholesterol screening**	**Pap smear test**	**Mammogram**	**Prostate screening**	**ANY prevention**	**ALL prevention**	**Healthy lifestyle index***	**Clinical index***
Insurance pre-65	-0.030*	0.020*	-0.01	0.122***	0.080***	0.104***	0.108***	0.077***	0.00	0.01	-0.01	0.368***
	(0.017)	(0.012)	(0.016)	(0.018)	(0.014)	(0.022)	(0.019)	(0.025)	(0.002)	(0.005)	(0.040)	(0.039)
Wealth: Household assets (100,000's)	0.00	0.00	0.00	0.003***	0.004***	0.004*	0.011***	0.00	0.00	0.00	0.00	0.007***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)	(0.001)	0.000	0.000	(0.001)	(0.002)
Wealth: Household income (100,000's)	0.00	0.026*	0.00	0.01	0.01	0.047**	0.02	0.036*	0.00	0.004**	0.02	0.069***
	(0.008)	(0.013)	(0.008)	(0.011)	(0.011)	(0.023)	(0.021)	(0.019)	(0.002)	(0.002)	(0.020)	(0.024)
Education years	0.00	0.008***	0.009***	0.011***	0.008***	0.00	0.00	0.014***	0.00	0.004***	0.031***	0.026***
	(0.003)	(0.002)	(0.003)	(0.003)	(0.002)	(0.004)	(0.003)	(0.003)	0.000	(0.001)	(0.006)	(0.006)
Risk aversion: Very frequent seatbelt use	0.01	0.01	-0.01	0.00	0.00	0.00	-0.01	0.02	0.00	0.00	0.00	-0.01
	(0.014)	(0.010)	(0.013)	(0.014)	(0.010)	(0.018)	(0.015)	(0.018)	(0.001)	(0.004)	(0.032)	(0.031)

	0.108***	0.062***	0.047***	0.057***	0.02	0.00	0.039**	0.043**	0.01***	0.01	0.317***	0.099***
Risk aversion: Life insurance	(0.014)	(0.011)	(0.014)	(0.015)	(0.011)	(0.019)	(0.017)	(0.020)	(0.002)	(0.005)	(0.035)	(0.033)
	-0.01	0.025**	-0.08***	0.052***	0.031***	0.063***	0.060***	0.072***	0.004*	0.00	-0.087**	0.181***
Risk aversion: Long term care insurance	(0.015)	(0.011)	(0.015)	(0.016)	(0.012)	(0.019)	(0.017)	(0.023)	(0.002)	(0.005)	(0.035)	(0.035)
	0.036*	0.061***	0.046**	0.050**	0.028*	-0.01	0.066***	0.073***	0.010*	0.012*	0.200***	0.165***
Risk aversion: Very risk averse to job loss	(0.022)	(0.014)	(0.021)	(0.022)	(0.016)	(0.028)	(0.022)	(0.027)	(0.006)	(0.007)	(0.049)	(0.048)
	-0.030**	-0.013*	0.02	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	-0.04	0.00
Health deterioration (1=much better… 5=much worse)	(0.012)	(0.008)	(0.011)	(0.012)	(0.009)	(0.014)	(0.012)	(0.015)	(0.001)	(0.004)	(0.026)	(0.024)
	-0.036**	-0.02	0.00	-0.05***	-0.03***	-0.05**	-0.05***	-0.048**	0.00	-0.008*	-0.084**	-0.16***
Short term financial planning	(0.015)	(0.011)	(0.014)	(0.015)	(0.011)	(0.019)	(0.017)	(0.021)	(0.001)	(0.005)	(0.034)	(0.033)

All of the variables in the first column were included in the same probit model controlled for gender, race, veteran status, working status (full time, part time, unemployed, partly retired, retired, disabled, other), number of household residents, self-reported health status, respondent's diagnosis of chronic conditions (high blood pressure, diabetes, cancer, lung disease, heart disease, stroke, arthritis), beneficiary of Social Security, mental health (CESD score), residence in one of 10 census divisions. Heteroskedasticity-adjusted robust standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

4.1.2. Analysis of independent variables one at a time

Table 2.6 reports the marginal effects from probit estimation of equation (1) in the odd-number columns, i.e. with no controls, and of equation (2) in the even-number columns. i.e. with controls, for those preventive activities that are related to a healthy lifestyle. Table 2.7 reports the marginal effect for those preventive activities that are related to medical services. Table 2.8 presents the results for the constructed variables for undergoing any and all of the preventive activities presented in the previous two tables, except for the indexes. The marginal effects on each of the rows in all tables were computed separately.

In general, the results of these specifications ratify the findings of table 2.5, albeit the magnitude of the associations are exacerbated by the fact that each key independent variable is analyzed separately.

The two variables that have to do with the current amount of affluence in a house are: household income and household wealth. The result shows that wealth is invariably positively and almost always significantly associated with all preventive behaviors. By the same token, education years are, in all instances, a positive and significant predictor of all preventive behaviors.

Health insurance in the wave prior to turning 65 has an uneven association on prevention behavior. While insurance has a positive and significant association on all clinical preventive services, this variable had a positive and significant association only with one of the healthy lifestyle preventive behaviors: being a non-smoker. Yet, insurance had a negative but insignificant association on vigorous physical activity and normal weight status. Respondents with insurance pre-65 were significantly more likely to engage in any preventive activity and in all preventive activities.

While the association of the time preference variables was clearly unidirectional, health deterioration had a more variable association on prevention. Respondents who had a short term financial planning (next few months, next year) were significantly less likely to engage in each, any and all of the preventive activities examined in the survey. Respondents whose health had deteriorated during the last 2 years, i.e. between waves, were significantly less likely to engage in all healthy lifestyle preventive behaviors and Pap smear test. A higher rate of health deterioration was positively and significantly correlated with having a flu shot and cholesterol screening, but insignificantly correlated with having a mammogram or prostate cancer screening.

Finally, the variables that were included in this analysis because they signal risk aversion reported mixed results. Firstly, HRS measure of the risk aversion to change jobs was not significant in predicting any preventive behavior. Seatbelt use was negatively and significantly associated with vigorous activity, non-smoking, normal weight status, flu shot, mammogram and prostate screening. Perhaps more robust and interesting are the measures of risk aversion regarding life insurance and long term care insurance. Respondents with a life insurance policy were significantly more likely to engage in all clinical preventive activities and in physical activity and non-smoking, yet less likely to report normal weight. Respondents with a long term care policy were significantly more likely to engage in each all of the preventive activities examined in HRS except for Pap smear test.

Table 2.6. Relationship between key variables and healthy lifestyle preventive activities at age 65.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	DPROBIT	**DPROBIT**	**DPROBIT**	**DPROBIT**	**DPROBIT**	**DPROBIT**	**OPROBIT#**	**OPROBIT#**
Independent variable	**Association of variable on vigorous activity at age 65, no controls**	**Association of variable on vigorous activity at age 65, with controls**	**Association of variable on non-smoker at age 65, no controls**	**Association of variable on non-smoker at age 65, with controls**	**Association of variable on normal weight at age 65, no controls**	**Association of variable on normal weight at age 65, with controls**	**Association of variable on healthy lifestyle index at age 65, No Controls**	**Association of variable on healthy lifestyle index at age 65, with controls**
Insurance pre-65	-0.02	-0.02	0.036***	0.044***	-0.026*	-0.01	0.00	0.03
	(0.016)	(0.017)	(0.012)	(0.013)	(0.015)	(0.016)	(0.037)	(0.039)
Wealth: Household assets (100,000's)	0.002***	0.00	0.005***	0.003**	0.002***	0.001**	0.010***	0.004***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Wealth: Household income (100,000's)	0.032***	0.00	0.065***	0.045***	0.016**	0.01	0.116***	0.040*
	(0.011)	(0.007)	(0.013)	(0.012)	(0.008)	(0.007)	(0.034)	(0.021)
Education years	0.017***	0.00	0.011***	0.010***	0.013***	0.007***	0.057***	0.024***
	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.004)	(0.005)
Risk aversion: Very frequent seatbelt use	0.128***	0.117***	0.068***	0.062***	0.053***	0.043***	0.348***	0.319***
	(0.013)	(0.014)	(0.011)	(0.011)	(0.013)	(0.013)	(0.032)	(0.033)
Risk aversion: Life insurance	0.031**	-0.01	0.029***	0.028***	-0.064***	-0.068***	0.00	-0.069**
	(0.013)	(0.014)	(0.010)	(0.011)	(0.013)	(0.014	(0.031)	(0.033)
Risk aversion: Long term care insurance	0.097***	0.045**	0.079***	0.061***	0.064***	0.038**	0.325***	0.200***
	(0.020)	(0.020)	(0.012)	(0.012)	(0.019)	(0.019)	(0.043)	(0.044)
Risk aversion: Very risk averse to job loss	0.01	0.01	0.00	0.00	0.00	-0.01	0.01	0.01
	(0.012)	(0.013)	(0.009)	(0.009)	(0.012)	(0.012)	(0.028)	(0.029)
Health	-0.107***	-0.036***	-0.036***	-0.012*	-0.025***	0.01	-0.234***	-0.052**

deterioration (1=much better… 5=much worse)	(0.009)	(0.011)	(0.007)	(0.007)	(0.009)	(0.010)	(0.021)	(0.024)
Short term financial planning	-0.072***	-0.033**	-0.035***	-0.021**	-0.028**	-0.01	-0.184***	-0.087***
	(0.013)	(0.014)	(0.010)	(0.010)	(0.012)	(0.013)	(0.030)	(0.031)

All columns show the marginal effect of the variable in question in separate models. Each of the even number columns present the relevant variable of separate probabilistic or ordinal probabilistic regressions controlled for gender, race, veteran status, working status (full time, part time, unemployed, partly retired, retired, disabled, other), number of household residents, self-reported health status, respondent's diagnosis of chronic conditions (high blood pressure, diabetes, cancer, lung disease, heart disease, stroke, arthritis), beneficiary of Social Security, mental health (CESD score), residence in one of 10 census divisions. Heteroskedasticity-adjusted robust standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively. # Ordinal probabilistic regression was used.

Table 2.7. Relationship between key variables and clinical preventive activities at age 65.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Type of model	**DPROBIT**	**DPROBIT**	**DPROBIT**	**DPROBIT**	**DPROBIT**	**DPROBIT**	**DPROBIT**	**DPROBIT**	**DPROBIT**	**DPROBIT**	**OPROBIT**	**OPROBIT**
Independent variables	**Association of variable on flu shot at age 65, no controls**	**Association of variable on flu shot at age 65, with controls**	**Association of variable on cholesterol screening at age 65, no controls**	**Association of variable on cholesterol screening at age 65, with controls**	**Association of variable on pap smear test at age 65, no controls**	**Association of variable on pap smear test at age 65, with controls**	**Association of variable on mammograms at age 65, no controls**	**Association of variable on mammograms at age 65, with controls**	**Association of variable on prostate screening at age 65, no controls**	**Association of variable on prostate screening at age 65, with controls**	**Association of variable on clinical index at age 65, No Controls**	**Association of variable on clinical index at age 65, With Controls**
Insurance pre-65	0.150***	0.143***	0.121***	0.101***	0.111***	0.121***	0.138***	0.130***	0.144***	0.120***	0.360***	0.432***
	(0.016)	(0.017)	(0.014)	(0.014)	(0.020)	(0.021)	(0.019)	(0.019)	(0.025)	(0.025)	(0.036)	(0.038)
Wealth:	0.005***	0.004***	0.006***	0.008***	0.007***	0.006***	0.014***	0.013***	0.002***	0.00	0.009***	0.011***

Household assets (100,000's)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.003)	(0.003)	(0.001)	(0.001)	(0.002)	(0.002)
Wealth: Household income (100,000's)	0.037***	0.043***	0.054***	0.062***	0.105***	0.087***	0.103***	0.095***	0.032***	0.00	0.092***	0.162***
	(0.012)	(0.015)	(0.013)	(0.014)	(0.023)	(0.023)	(0.022)	(0.022)	(0.011)	(0.007)	(0.021)	(0.031)
Education years	0.016***	0.017***	0.013***	0.014***	0.010***	0.005*	0.013***	0.009***	0.022***	0.022***	0.038***	0.047***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.004)	(0.005)
Risk aversion: Very frequent seatbelt use	0.052***	0.056***	0.02	0.021*	0.01	0.00	0.052***	0.047***	0.059***	0.052***	0.131***	0.109***
	(0.014)	(0.015)	(0.011)	(0.011)	(0.018)	(0.019)	(0.017)	(0.017)	(0.018)	(0.019)	(0.030)	(0.031)
Risk aversion: Life insurance	0.044***	0.055***	0.045***	0.041***	0.071***	0.065***	0.070***	0.066***	0.130***	0.111***	0.108***	0.208***
	(0.014)	(0.015)	(0.011)	(0.011)	(0.017)	(0.018)	(0.015)	(0.016)	(0.020)	(0.021)	(0.030)	(0.032)
Risk aversion: Long term care insurance	0.101***	0.084***	0.060***	0.052***	0.04	0.01	0.102***	0.081***	0.117***	0.103***	0.282***	0.238***
	(0.019)	(0.019)	(0.014)	(0.014)	(0.024)	(0.025)	(0.019)	(0.020)	(0.021)	(0.023)	(0.041)	(0.043)
Risk aversion: Very risk averse to job loss	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.02	0.04	0.01
	(0.013)	(0.013)	(0.010)	(0.010	(0.016)	(0.017)	(0.015)	(0.015)	(0.017)	(0.017)	(0.027)	(0.028)
Health deterioration (1=much better… 5=much worse)	0.025***	0.00	0.020***	0.00	-0.032***	0.01	-0.01	0.00	0.00	0.01	0.03	0.01
	(0.009)	(0.011)	(0.007)	(0.008)	(0.012)	(0.013)	(0.011)	(0.012)	(0.012)	(0.013)	(0.019)	(0.022)
Short term financial planning	-0.06***	-0.050***	-0.04***	-0.036***	-0.061***	-0.053***	-0.08***	-0.07***	-0.06***	-0.050***	-0.15***	-0.17***
	(0.013)	(0.014)	(0.011)	(0.011)	(0.017)	(0.018)	(0.016)	(0.016)	(0.018)	(0.019)	(0.029)	(0.030)

All columns show the marginal effect of the variable in question in separate models. Each of the even number columns present the relevant variable of separate probabilistic or ordinal probabilistic regressions controlled for gender, race, veteran status, working status (full time, part time, unemployed, partly retired, retired, disabled, other), number of household residents, self-reported health status, respondent's diagnosis of chronic conditions (high blood pressure, diabetes, cancer, lung disease, heart disease, stroke, arthritis), beneficiary of Social Security, mental health (CESD score), residence in one of 10 census divisions. Heteroskedasticity-adjusted robust standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

Table 2.8. Relationship between key variables and any or all preventive activities at age 65.

	(1)	(2)	(3)	(4)
VARIABLES	**DPROBIT**	**DPROBIT**	**DPROBIT**	**DPROBIT**
	Association of variable on any prevention activity at age 65, no controls	**Association of variable on any prevention activity at age 65, with controls**	**Association of variable on all prevention activities at age 65 no controls**	**Association of variable on all prevention activities at age 65 with controls**
Insurance pre-65	0.007**	0.004*	0.012*	0.010**
	(0.004)	(0.002)	(0.006)	(0.005)
Wealth: Household assets (100,000's)	0.001***	0.001***	0.001***	0.000*
	0.000	0.000	0.000	0.000
Wealth: Household income (100,000's)	0.008**	0.005**	0.011***	0.005***
	(0.004)	(0.002)	(0.003)	(0.002)
Education years	0.001***	0.000**	0.008***	0.004***
	0.000	0.000	(0.001)	(0.001)
Risk aversion: Very frequent seatbelt use	0.008**	0.005**	0.013**	0.01
	(0.003)	(0.002	(0.006)	(0.005)
Risk aversion: Life insurance	0.006**	0.005**	0.00	0.00
	(0.003)	(0.002)	(0.006)	(0.005)
Risk aversion: Long term care insurance	0.007***	0.003**	0.041***	0.019**
	(0.002)	(0.002)	(0.011)	(0.008)
Risk aversion: Very risk averse to job loss	0.00	0.00	0.00	0.00
	(0.002)	(0.001)	(0.006)	(0.004)
Health deterioration (1=much better… 5=much worse)	0.00	0.00	-0.014***	0.00
	(0.001)	(0.001)	(0.004)	(0.004)
Short term financial planning	0.00	0.00	-0.021***	-0.009**
	(0.003)	(0.002)	(0.005)	(0.005)

All columns show the marginal effect of the variable in question in separate models. Each of the even number columns present the relevant variable of separate probabilistic or ordinal probabilistic regressions controlled for gender, race, veteran status, working status (full time, part time, unemployed, partly retired, retired, disabled, other), number of household residents, self-reported health status, respondent's diagnosis of chronic conditions (high blood pressure, diabetes, cancer, lung disease, heart disease, stroke, arthritis), beneficiary of Social Security, mental health (CESD score), residence in one of 10 census divisions. Heteroskedasticity-adjusted robust standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

4.2. The association of age

Table 2.9 shows exclusively the association of age with the different preventive activities/dependent variables. The results show that the association of age varies for different preventive activities. While older people are significantly less likely to exercise, get Pap smear tests or mammograms. Age is positively and significantly associated with being in a normal weight range, not smoking, and receiving the flu shot. The results for cholesterol screening and the constructed lifestyle and clinical indexes are mixed and barely significant.

Table 2.9. Relationship between AGE and preventive activities in wave 7.

Dependent variable	**Specification**	**Marginal effect**	**Robust standard error**
Physical activity in wave 7	No controls	-0.006***	(0.000)
	With controls	-0.005***	(0.001)
Non-smoker status in wave 7	No controls	0.007***	(0.000)
	With controls	0.007***	(0.000)
Normal weight in wave 7	No controls	0.006***	(0.000)
	With controls	0.008***	(0.001)
Healthy lifestyle index#	No controls	-0.002	(0.001)
	With controls	0	(0.001)
Flu shot in wave 7	No controls	0.012***	(0.001)
	With controls	0.008***	(0.001)
Cholesterol screening in wave 7	No controls	0.002***	0.000
	With controls	-0.001*	0.000
Pap smears test in wave 7	No controls	-0.014***	(0.001)
	With controls	-0.014***	(0.001)
Mammogram in wave 7	No controls	-0.005***	(0.001)
	With controls	-0.007***	(0.001)
Prostate screening in wave 7	No controls	0.002**	(0.001)
	With controls	0	(0.001)
Clinical index#	No controls	0.001	(0.001)
	With controls	-0.008***	(0.001)

Sample size	13,443
Sample size (female)	8,420
Sample size (male)	5,023

All ROWS show the marginal effect of the variable in question in separate probabilistic (or ordinal probabilistic regression models for indexes). Controls included regression were used and controlled for working status (full time, part time, unemployed, partly retired, retired, disabled, other), number of household residents, self-reported health status, respondent's diagnosis of chronic conditions (high blood pressure, diabetes, cancer, lung disease, heart disease, stroke, arthritis), beneficiary of Social Security, mental health (CESD score), residence in one of 10 census divisions. Standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively. #Ordinal probabilistic models were estimated.

4.3. The association of insurance

In order to analyze the association of insurance, I study whether changes in insurance coverage affect the decision to initiate a preventive activity. Initiation of preventive behavior takes place strictly when the person had not engaged in such behavior at the previous wave (in the case of clinical preventive services, I take the wave before the previous wave since clinical preventive questions were asked only every other wave). Table 2.10 presents the results on initiation of each of the different preventive services conditional on positive changes in insurance coverage.

Remarkably, yet not unexpectedly, insurance coverage has a significant effect on clinical preventive services but does not affect initiation of lifestyle preventive behaviors. The reason for this phenomenon probably obeys to the fact that insurance policies typically cover clinical services such as cholesterol screening, flu shot or mammograms. Hence, as predicted in the model, a change in the price faced by respondents in clinical preventive services increases the demand for such services. Lifestyle preventive activities, on the other hand, tend to be only very marginally and seldom shielded by insurance policies. Thus, it is to be expected that changes in insurance coverage have an insignificant effect in initiation of lifestyle preventive activities.

Table 2.10. Effect of positive changes in insurance coverage in initiation of preventive activities.

Dependent variable	**Statistic Type**	**Statistic**
Physical activity	Marginal effect	0.02
	Standard error	(0.040)
Non-smoker status	Marginal effect	0.12
	Standard error	(0.100)
Normal weight	Marginal effect	-0.09
	Standard error	(0.070)
Flu shot	Marginal effect	0.40***
	Standard error	(0.080)
Cholesterol screening	Marginal effect	0.47***
	Standard error	(0.070)
Pap smears test	Marginal effect	0.44***
	Standard error	(0.090)
Mammogram	Marginal effect	0.56***
	Standard error	(0.090)
Prostate screening	Marginal effect	0.54***
	Standard error	(0.120)
Sample size		18,511
Sample size (female)		10,811
Sample size (male)		7,700

All columns show the marginal effect of the variable in question in separate models. Fixed effects logistic regression were used and controlled for working status (full time, part time, unemployed, partly retired, retired, disabled, other), number of household residents, self-reported health status, respondent's diagnosis of chronic conditions (high blood pressure, diabetes, cancer, lung disease, heart disease, stroke, arthritis), beneficiary of Social Security, mental health (CESD score), residence in one of 10 census divisions. Standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

4.4. Fixed effect regressions

Table 2.11 shows the results for fixed effects regressions with and without controls. Given that HRS asked the questions regarding clinical preventive services every other year, and only during waves 3, 5, and 7, the fixed effect models would not converge for those dependent variables. An explanation for this lack of convergence may be attributed to a short panel (t=3). Alternatively, it could also be due to the fact that there is little variation between the dependent dummy variables for prevention throughout the waves and thus the sample is reduced to the point where convergence was not achieved. The key variables regarding education years, time preference, seatbelt use, and risk aversion to job change are constant throughout the panel and therefore are excluded from the fixed effects analysis. Appendix A shows a version of these fixed effects models but with all independent variables included simultaneously (fully specified models).

The results show that the key independent variables analyzed are less often significant in predicting changes in vigorous physical activity, non-smoker status, and normal weight than in the cross-section analyses. Age is significantly associated with less vigorous activity, a higher likelihood of being a non smoker and outside the normal weight parameter. Interestingly, changes in both health and life insurance status significantly predicted less vigorous activity and a lower likelihood of being in the normal weight category, but insurance was significantly associated with a higher likelihood of being a nonsmoker. Changes in wealth and income had an insignificant role in predicting any preventive variables. Long term care insurance had a positive and significant effect on vigorous physical activity but insignificant in predicting smoking and normal weight status.

Table 2.11. Fixed effects logistic regressions on the effect of key independent variables and preventive services.

	(1)	(2)	(3)	(4)	(5)	(6)
Type of model	**xtlogit**	**xtlogit**	**Xtlogit**	**xtlogit**	**xtlogit**	**xtlogit**
Variables	**Fixed effects of variable on vigorous activity, no controls**	**Fixed effects of variable on vigorous activity, with controls**	**Fixed effects of variable on non-smoker, no controls**	**Fixed effects of variable on non-smoker, with controls**	**Fixed effects of variable on normal weight, with controls**	**Fixed effects of variable on normal weight, with controls**
Age	-0.120***	-0.098***	0.266***	0.176***	-0.033***	-0.041***
	(0.003)	(0.004)	(0.007)	(0.011)	(0.004)	(0.005)
Household income (1000's)	0	0	0	0.001	-0.001*	0
	0.000	0.000	0.000	0.000	0.000	0.000
Household assets (1000's)	0	0.000*	0.000**	0	-0.000***	-0.000***
	0.000	0.000	0.000	0.000	0.000	0.000
Education years	N/A	N/A	N/A	N/A	N/A	N/A
	N/A	N/A	N/A	N/A	N/A	N/A
Short term financial planning	N/A	N/A	N/A	N/A	N/A	N/A
	N/A	N/A	N/A	N/A	N/A	N/A
Reported change in health (1=much better… 5=much worse)	-0.309***	-0.109***	0.248***	-0.004	-0.041**	-0.024
	(0.014)	(0.017)	(0.033)	(0.042)	(0.019)	(0.023)
Risk aversion: Very risk averse to job loss	-0.110*	-0.114*	0.167	-0.067	0.078	0.007
	(0.059)	(0.060)	(0.135)	(0.156)	(0.102)	(0.107)
Risk aversion: Very frequent seatbelt use	N/A	N/A	N/A	N/A	N/A	N/A
	N/A	N/A	N/A	N/A	N/A	N/A
Risk aversion: Life insurance	0.169***	0.054	-0.294***	0.066	0.121***	0.090*
	(0.030)	(0.033)	(0.070)	(0.087)	(0.042)	(0.048)
Risk aversion: Long term care insurance	0.115***	0.121***	-0.074	0.024	-0.073	-0.045
	(0.038)	(0.040)	(0.095)	(0.111)	(0.058)	(0.064)

All columns show the marginal effect of the variable in question in separate models. Fixed effects logistic regression were used and controlled for working status (full time, part time, unemployed, partly retired, retired, disabled, other), number of household residents, self-reported health status, respondent's diagnosis of chronic conditions (high blood pressure, diabetes, cancer, lung disease, heart disease, stroke, arthritis), beneficiary of Social Security, mental health (CESD score), residence in one of 10 census divisions. Standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

5. Discussion

In this chapter I document the factors that influence the demand of preventive services among the elderly and near elderly. In order to ensure robustness, I explore the results of different probabilistic regression models without any other covariates and with different sets of covariates. Further, I use fixed effect models to control for individual characteristics that are unobservable in the data. The results presented above generally agree with the predictions derived from the theoretical model of the previous chapter.

The effect of age in the model cannot be signed unambiguously. Its effect on the demand for preventive services depends on the marginal efficiency of health capital. This is perhaps the reason why empirically the association of age varies for different preventive activities. In the context of activities such as flu shot which is quite efficient in protecting the health stock from being ravaged by influenza, might be an activity still worth pursuing even at advance ages. Other activities such as exercising or cancer screening might have a very low marginal efficiency in preserving the health stock as people get older and therefore the demand is negative. Alternatively, people might engage in these preventive activities less as they age simply because their health stock deteriorates more rapidly as time advances.

The theoretical model predicted that increased education lowers the user cost of health investment. The model, however predicts an inverse effect of education and age on preventive behavior. Such association was not observed empirically as education is positively associated with the demand of all preventive services in all the different specifications. It has been observed in the literature that more educated people tend to be healthier to begin with. Thus, one might question whether the correlation of education with prevention was influenced by confounding effect of respondents being in better health. However, it is worth remembering that the results on education were robust to the inclusion of controls on health stock such as self-reported health status, mental health score, and the presence of different chronic conditions.

The results of this chapter also seem to agree with the model prediction regarding time preferences. As predicted, people that have a short planning horizon were less likely to invest in preventive activities. Therefore, as overviewed in the literature, there are indications that the interaction between time preferences and preventive activity might be mediated by other factors such as education, age or risk aversion.

In addition, I observe the association of initiation of insurance coverage with the decision to start both lifestyle and clinical preventive behaviors. For this analysis, I used a more comprehensive sample in HRS than the one used for other aspects of the analysis in this chapter. I find that gain in coverage of insurance can be associated with the initiation of clinical preventive services. Yet, the effect of changes in insurance coverage is not significant in predicting changes in lifestyle behaviors. This is in agreement with the theoretical model in chapter 2 and with the findings of McWilliams et al. (2007). In such study, the authors of reported that being uninsured prior to Medicare was associated with increased use of preventive screenings after joining the Medicare program. Despite the fact that both studies differ in design, since in theirs, the authors compare pre- and post- 65 demand of such services between uninsured and insured, the results show remarkable agreement.

As pointed out before, a higher rate of depreciation may have an ambiguous association on the demand for prevention. On the one hand, prevention becomes less effective the higher the deterioration rate; on the other hand, more prevention is needed in order to retain the current state of health. The results in the estimated models reflect some of this dichotomy. While more health deterioration is negatively associated with the healthy lifestyle behaviors, as health deteriorates, respondents demand more clinical prevention. This is consistent with the effect of age and insurance presented above. In other words, it would seem that as the population age and their health gets worse, they seem to be replacing healthy lifestyle behaviors with medical interventions.

Wealth and risk aversion were not explicitly modeled in the last chapter's model. However, given the availability of such variables in HRS and the theoretical analysis found in other models in the literature, their associations were empirically tested. Measures of wealth such as income and household assets had an overwhelmingly positive association with the demand for all preventive activities in cross section analysis. However, in the fully specified model, when education and other covariates, were included the wealth positive association with healthy lifestyle behaviors disappeared but on clinical care activities persisted.

Finally, although no perfect risk aversion exist in the HRS, I attempted to examine 4 different variables that were related to the perception of risk. In this, I find that risk aversion to changing jobs, very frequent use of seatbelt, having a life insurance policy or having a long term care insurance policy were good predictors of most preventive behavior but in particular of the clinical ones.

Table 2.12 summarizes the concordance between the model predictors and the empirical results.

Table 2.12. Comparison of model prediction and empirical results on the demand for investment activities

Variable	***Model prediction***	***Average association for healthy lifestyle prevention***	***Average association for clinical prevention***
Age, t	Ambiguous but opposite to education	ambiguous	Ambiguous
Education, E	Opposite to age	+++	+++
Price of medical care, p^M	+	none	None
High discount rate for time, θ	-	-	-
Price of investment in health activities, p^I	-	-	-
Rate of deterioration of health stock, δ	Ambiguous but probably negative	none	None
Insurance coverage	+ for activities such as cancer screening. – for healthy lifestyle activities.	Not significant	+
Risk aversion	N/A	+	+
Wealth	+	+	+

In sum, the model seems to be accurate in some of its predictions but not necessarily in all of them. It is worth mentioning that the prediction of the theoretical model are quite broad and encompass a very general understanding of what a preventive activity might be. As illustrated by the data available, there are substantial differences in the nature of the variables that entail preventive behavior. So, it is not surprising that some of the predictions tended to be correct for a certain class of preventive behavior and not for others. In addition, it is worth noticing that there might be unobserved institutional or environmental factors for each of such preventive behaviors that are not controlled for in the empirical analysis.

6. Appendix

Table A.2.1. Fully specified fixed effects logistic regressions on the effect of key independent variables and preventive services with all controls.

	(1)	(2)	(3)
Type of model	**xtlogit**	**xtlogit**	**xtlogit**
Variables	**Fully specified model for vigorous activity**	**Fully specified model for nonsmoker**	**Fully specified model for normal weight**
Age	-0.031*	0.141***	-0.144***
	(0.016)	(0.052)	(0.032)
Household income (1000's)	0.001	0.004	-0.001
	(0.001)	(0.003)	(0.001)
Household assets (1000's)	0	0	0
	0.000	0.000	0.000
Insurance	0.026	0.063	-0.274
	(0.137)	(0.378)	(0.255)
Reported change in health (1=much better… 5=much worse)	-0.149**	-0.01	0.012
	(0.064)	(0.172)	(0.109)
Risk aversion: Life insurance	0.166	(0.495)	0.242
	(0.129)	(0.393)	(0.239)
Risk aversion: Long term care insurance	0.02	0.255	-0.152
	(0.151)	(0.472)	(0.299)

All columns show the marginal effect of the variable in question in separate models. Fixed effects logistic regression were used and controlled for working status (full time, part time, unemployed, partly retired, retired, disabled, other), number of household residents, self-reported health status, respondent's diagnosis of chronic conditions (high blood pressure, diabetes, cancer, lung disease, heart disease, stroke, arthritis), beneficiary of Social Security, mental health (CESD score), residence in one of 10 census divisions. Standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

CHAPTER 3: SPOUSAL CORRELATION ON THE DEMAND FOR PREVENTION AMONG OLDER ADULTS

1. Introduction

In the past chapter, I examined the factors driving the demand for preventive activities among older adults. Chapter 3 explores the demand for these services among members of the same household. In essence, the interest is to understand whether marriage can motivate behavioral change. Smoking, drinking, and obesity have all garnered much attention for their detrimental effects on health and other outcomes. Behaviors such as exercise and a healthy diet, in contrast, are thought to have positive effects on health. If indeed there is a public policy seeking to increase the demand for these preventive activities it is important to know if spousal influence can play a role.

The increasingly recognized health benefit of marriage yields a rich context for exploring the influence of the social environment on individual health behavior. A growing literature documents that married individuals survive longer and enjoy better health than do their unmarried counterparts (Burman & Margolin, 1992; Ross, Mirowsky, Goldsteen, 1990). At the same time, smoking and obesity have all garnered much attention for their detrimental effects on health and other outcomes. Behaviors such as exercise and a healthy diet, in contrast, can have positive effects on health. Similarly, the use of preventive services, such as cholesterol screening and flu shots, are typically regarded as advisable activities. A critical question is how to improve the health of the public by encouraging healthy decisions. This chapter focuses on exploring the nature and the causes for correlation of the household member's in their decision to use preventive care.

It has been found that among married couples, there is evidence of initial matching and compatibility in many areas due to endogamy in race, religion, socioeconomic status (Mare 1991; Kalmijn 1998), substance use (Vanyukov et al., 1996), occupation (Hout, 1982; Smits, Ultee, and Lammers 1999), and leisure preferences (Houts, Robins, and Huston 1996). Commonalities generated by assortative mating are well documented and discussed across several disciplines (Alpern and Reyniers 2005; Van Leeuwen and Maas 2005). Additionally, concordance has been documented for smoking (Sutton 1980; Venters, Jacobs, and Luepker 1984; Clark and Etilé 2006), drinking (Leonard and Das Eiden 1999), and diet and exercise (Macken, Yates, and Blancher 2000; Farrell and Shields 2002).

In this chapter, I examine interactions between spouses in terms of behaviors that have both attracted notable attention lately and might have important repercussions on health: preventive behaviors. Using long-run panel data I find, as other have reported (Falba and Sindelar 2008), a strong correlation between husbands' and wives' behaviors regarding a wide array of different preventive activities that vary noticeably in nature. Nevertheless, the reasons for this correlation in such a wide range of preventive activities have not been studied before. The main contribution of this study is not only to provide more evidence regarding the existence of these correlations, but to formalize their possible causes and to use empirical evidence to disentangle them. In this sense, the insights of my analysis signify an important contribution to the field because understanding the dynamics underlying preventative behavior may be beneficial in trying to motivate behavior change. A thoughtful consideration of the motivation for preventive behavior has the potential of finding the tools for both (a) improving population health and (b) reducing consumption of care (i.e. costs).

The correlation in preventive behavior among spouses can have several sources. Firstly, individuals may tend to marry those who share the same preferences and characteristics. This phenomenon was described in the concept of assortative matching in the spousal market by Becker (1974). This sorting and mating process will induce what in the literature of identification problems is known as correlated effects (Manski 1995).

A second hypothesis suggests that the correlation in partners' preventive behavior may reflect the household's decision-making process. The idea here is that the presence of some shared marital output, which is affected by a preventive behavior, may lead couples to interact via their preventive status in cooperative or non-cooperative bargaining. For instance, a couple may decide to stop smoking jointly in order to not only increase their own life expectancies but also to make the transition into non-smoking easier for each other. This can be likened to the endogenous effects in Manski (1995).

Third, correlated effects may also arise because spouses share the same environment. In particular, they largely receive the same information about the costs and benefits of a preventive activity. In this context, households interact via learning about health risks, whereby the health developments of other household members reveal information about one's own risk from non preventive or unhealthy behavior (Clark and Etilé, 2002).

This chapter uses six waves of the Health and Retirement Study (HRS) data to look at the correlation in preventive behavior between elderly and near-elderly partners. I consider both participation in preventive activities (physical activity, nonsmoking status, normal weight maintenance, flu shot, cholesterol screening, prostate screening, pap smear test, and mammography) using the panel aspect of the data, and the decision to start or stop a preventive activity. I estimate a number of different specifications to try to distinguish between correlated and endogenous effects. Assortative matching on lifestyle preferences will be picked up by correlated effects in the male and female smoking equations.

Under household decision-making, I expect partner´s behaviors to be correlated even after individual fixed effects have been introduced. This will be my key test of endogenous versus correlated. I will also test directly for learning by including partner's health shocks.

My results show that, the spouse's past behavior is a significant predictor of the respondent's current preventive behavior. However, when individual fixed effects are added, the significance of the spouse's past physical activity disappears, all other preventive activities are unaffected by these individual effects. Furthermore, for all preventive activities studied except vigorous activity, initiation and termination of the preventive behaviors are significantly and positively correlated. Spouse's health shocks are not significant predictors of initiation or termination of any of the preventive activities, therefore reducing the likelihood that social learning about risks and benefits of a given lifestyle might be driving the correlation. These results suggest that the correlation between physical activity among elderly and near elderly spouses seems to be consistent with positive matching in marriage, while the correlation between all other preventive behaviors studied here appears to be connected to bargaining within the household.

The chapter is organized as follows. In section 2, I present a simple life-cycle model of marriage and health. In section 3, I describe the literature concerning some of the ways in which to think of correlation between partner's behaviors: matching, social learning, and household bargaining. Section 4 presents the data, and in Section 5 the econometric approach. My main findings are reported in Section 6. Section 7 discusses the results.

2. Model

This section modifies and extends the demand model examined in chapter 1 in order to analyze the demand for prevention among both members of the household. I use Wilson (2002), Bolin et al. (2003), Becker (1973), Grossman (1972), and Jacobson (2000) to create a simple conceptual framework to understand the inter-spousal demand for preventive health services and other kinds of inter-temporal investments in health.

The household seeks to maximize the household lifetime utility. Utility is a function of a composite consumption goods by the household, Z(t), at each time t, and of the services of the stock of health. The services of health are defined as reduced illness in the form of healthy time for both members, i=M anf F, of the household, $h^i(t)$:

$$(57) \qquad \int_0^T e^{-\theta(t)} U[Z(t), h^F(t), h^M(t)]dt,$$

where θ is the individual's subjective rate of time preferences. Healthy time h(t) is produced from the stock of health, H^i, according to:

$$(58) \qquad h^i(t) = \phi(H^i(t)),\ \phi' > 0,\ \phi'' < 0$$

The time of death, T, is defined by the stock of health.

$$(59) \qquad T = \min\{t: H(t) \leq \bar{H}(t)\}$$

Consider a simple economy with an equal number of men and women who each live two periods. At the beginning of the first period all the men and women enter the marriage market, which has a market-clearing equilibrium characterized by complete monogamous pairings between the men and women. As part of the marriage market equilibrium, individuals make agreements on how to divide the output from marriage.

Potential partners observe a vector of characteristics. Among them, partners can observe a vector of characteristics that may affect the price of investment in healthy behaviors, X^F and X^M. These characteristics are assumed to be determined prior to entry into the marriage market and include variables such as education, time preference, wealth levels, and others.

Following Liljas (1998) health stock changes over time, where in this model, as compared to Grossman's original model, the depreciation of health capital is also a function of other variables, X^i. For the sake of an argument, the woman's function would look like:

(60) $$\frac{dH^F}{dt} = \dot{H}_t^F = f(t) \cdot I^F + f(t) \cdot I^M - \delta[t, X^F] \cdot H^F, \text{ for i=M, F.}$$

where I stands for investment in preventive measures. Health can be improved through investments I in one's health and by partner's investments, and deteriorates at the "natural" health deterioration rate δ. f(t) is the input coefficient of preventive activities and satisfies the following condition:

(61) $f(t)>0$ for all t,

Z, represents investment in other consumption goods.

Curative care can be purchased at price p^C for either member of the household. The amount of curative care is assumed to depend on the state of health which is represented by the stock of health capital H. Thus M=M(H) with:

$$M'(H^i) < 0, M''(H^i) > 0 \quad (62)$$

Since the decision on the amount of curative care is usually taken by the physician, it is not modeled here; it is simply included in the budget constraint.

The next dynamic constraint in the model expresses the change in the household's stock of wealth, $\dot{W}_t$, which is a function of W(t), income Y(t) and the costs of investments. In the marriage market, individuals contract to divide the output of the households. Household labor income in the first period, Y, is exogenously determined. In subsequent periods, labor income Y is a function of the level of health status of each spouse, H^M and H^F, even if individuals cannot know what their health status will be in the future. The price of investment in health is also affected by environmental factors, λ, which are common for both members of the household. Hence, the price of investments can be seen as $p^i(\lambda,t)$.

$$\frac{dW}{dt} = \dot{W}_t = rW(t) + Y(\mathrm{h}^F, \mathrm{h}^M, X^F, X^M) - [p^Z(t) \cdot Z(t) + p^F(\lambda, t) \cdot I^F(t) + \quad (63)$$

$$pM\lambda{,}t\cdot IMt+pC(t)\cdot MF(Ht+pC(t)\cdot MM(Ht),$$

where $p^Z(t)$, $p^F(\lambda, t)$, $p^M(\lambda, t)$ are the prices of Z(t), $I^F(t)$, and $I^M(t)$ respectively, r is a constant rate of interest and Y is earned income and $Y(\mathrm{h}^F, \mathrm{h}^M, X^F, X^M)$ meaning that household income is a function of health time for both household members as well as some other characteristics such as the ones that are involved in matching, X^F, X^M.

(64) $$\frac{\partial Y}{\partial h} = Y_h \geq 0$$

In other words, the healthier a person is, the more favorable the conditions are for the earning of income.

Like in the case for individuals, let's assume that preventive activities are positive throughout {0,T}. In this case, the optimization requires the following conditions.

(65) $$H^i(0) = H_0^i$$

(66) $$W^i(0) = W_0^i,$$

which are both assumed to be a constant.

(67) $$H^i(T) = H^i{}_{min}$$

(68) $$H^i(t) > H_{min} \; at \; t < T$$

(69) $$W^i(t) \geq 0$$

And

(70) $H^F(t), H^M(t), Z(t), I^F(t), I^M(t), p^F(\lambda, t), p^M(\lambda, t), p^Z(t)$ are non-negative for all t.

Where t is a continuous variable.

Maximization of expression (1), taking into account (2), gives the following Hamiltonian:

(71) $$L = e^{-\theta t} \cdot U[Z(t), \phi(H^F(t), \phi(H^M(t))] + \lambda_H^M \cdot \{f(t) \cdot I^M(t) + f(t) \cdot$$

$IF(t)-\delta t,XM\cdot HM(t)+\lambda HF\cdot ft\cdot IF(t)+ft\cdot IM(t)-\delta t,XF\cdot HF(t)+\lambda W\cdot r\cdot Wt+Y\mathrm{h}F$

$, \mathrm{h}M,XF,$

$XM-[pZt\cdot Zt+pF\lambda,t\cdot IFt+pM\lambda,t\cdot IMt+pC(t)\cdot MF(HFt+pC(t)\cdot MM(HMt)]$

where λ_1 is the adjoint variable associated with the differential equation (4) for health H(t), λ_2 is the adjoint variable associated with the differential equation (7) for wealth W(t).

The necessary conditions for a maximum require, in addition to (4) and (7) and the boundary conditions, that the following conditions are satisfied:

(72) $$\frac{\partial L}{\partial Z(t)} = e^{-\theta t} \cdot U_Z - \lambda_W \cdot p^Z \leq 0$$

(73) $$Z(t) \geq 0$$

(74) $$\frac{\partial L}{\partial I^i(t)} = \lambda_H^i \cdot f(t) - \lambda_W \cdot p^i \geq 0 \qquad \text{i=M, F}$$

(75) $$I^i(t) \geq 0, \text{by assumption}$$

(76) $$\frac{\partial L}{\partial H^i} = -\dot{\lambda}_H^i = e^{-\theta t} \cdot U_h \cdot \phi_{H^i} - \lambda_H^i \cdot \delta\left[t, X^i\right] + \lambda_W \cdot Y_h \cdot \phi_{H^i} - \lambda_W \cdot p^C \cdot$$

M_{H^i} i=M, F

(77) $$\frac{\partial L}{\partial W} = -\dot{\lambda}_W = r \cdot \lambda_W$$

(78) $$\frac{\partial L}{\partial \lambda_H^i} = f(t) \cdot I^i(t) - \delta\left[t, X^i\right] \cdot H^i(t) \text{ i=M, F}$$

(79) $$\frac{\partial L}{\partial \lambda_W} = r \cdot W(t) + Y[\mathrm{h}^F, \mathrm{h}^M, X^F, X^M] - [p^Z(t) \cdot Z(t) + p^F(\lambda, t) \cdot I^F(t) +$$

$$p^M(\lambda, t) \cdot I^M(t) + p^C(t) \cdot M^F(H^F(t) + p^C(t) \cdot M^M(H^M(t))$$

The individual's time of death, T, depends on the individual's investment in health capital in earlier periods and will occur when the level of health is equal to H_{min}. The value of the maximized Hamiltonian at the unspecified final time T, equals zero:

(80) $$\lambda_1 \cdot [H(T) - \overline{H}] = 0$$

(81) $$\lambda_2 \cdot W(T) = 0$$

Meaning that at the time close to the individual's death, T, her gross investments in health capital are smaller than the depreciation of health capital, thus investing in health is of no value for the individual at the moment of death.

The case that the individual never invests in health in t ≤ T may appear, but will not be considered in the following. Thus since I(t)>0, equation (18) can be set equal to zero by assumption:

(82) $$\lambda_H^i = \frac{\lambda_W \cdot p^i}{f(t)} = \lambda_W \cdot C^i(t)$$

Differentiating (26) renders:

(83) $$\dot{\lambda}_H^i = \dot{\lambda}_W \cdot C^i(t) + \lambda_W \cdot \dot{C}^i(t)$$

Where,

(84) $$C^i(t) = \frac{p^i}{f(t)}$$

Therefore,

(85) $$e^{-\theta t} \cdot U_h \cdot \phi_{H^i} - \lambda_W \cdot C^i(t) \cdot \delta^i\left[t, X^i\right] + \lambda_W \cdot Y_h \cdot \phi_{H^i} - \lambda_W \cdot p^C \cdot M_{H^i} = -(\lambda_W \cdot r \cdot C^i(t) + \lambda_W \cdot \dot{C}^i(t))$$

Re-arranging equation (29) gives the marginal condition:

$$(86) \qquad \frac{e^{-\theta t} \cdot U_h \cdot \phi_{H^i}}{\lambda_W} - C^i(t) \cdot \delta^i\left[t, X^i\right] + Y_h \cdot \phi_{H^i} - p^C \cdot M_{H^i} = r \cdot C^i(t) - \dot{C}^i(t)$$

Set i equal to M and F, respectively and divide the expression for M with the one for F to obtain the marginal condition:

$$(87) \qquad \frac{\frac{\partial U}{\partial H_M}}{\frac{\partial U}{\partial H_F}} = \frac{C^M\left(\delta^M + r - \frac{\dot{C}^M}{C^M}\right) - \left[(Y_h \cdot \phi_{H^M} - p^C \cdot M_{H^M}\right]}{C^F\left(\delta^F + r - \frac{\dot{C}^F}{C^F}\right) - \left[(Y_h \cdot \phi_{H^F} - p^C \cdot F_{H^F}\right]}$$

In a two-person family with common preferences, husband and wife together invest in health until the rate of marginal consumption benefits (left hand side of Eq. 31) equals the rate of marginal net effective cost of health capital (right hand side). The net effective cost of health capital equals the user cost of capital less the marginal investment benefit of health capital (in brackets).

From this conceptual framework I can extract the following insights that are relevant on the study of the joint-demand for preventive activities:

a) Returns to investment in healthy behavior are captured in two ways: through the direct effect of improvements in spouses' health and indirectly through effects in household income.

b) Observable characteristics on which spouses choose to mate have an effect in the depreciation function of the health stock equation. Before mating, a person is able to observe a series of characteristics in the potential spouse that might affect his or her inclination for health-related investments, such as smoking, education, propensity to exercise, proclivity to go to the doctor for preventive care, risk aversion, and others.

c) Another way that preventive investments in the model are affected is by environmental factors, λ. Environmental changes may have a crucial role in household decision-making since an environment that encourages investment in health-related behaviors such as easy access to physical fitness programs, anti-smoking bias in one's neighborhood, is shared by household members. These factors are not observable to the agents in this model prior to mating but affect the price that both household members face when choosing to invest in prevention.

d) Investments in wife's healthy behaviors are assumed to have a positive impact on the wife's health but could also potentially have a direct positive impact on the husband's health.

3. Literature Review

In this section I briefly formalize and present some of the arguments derived from the theoretical model above which may account for a correlation between partners' preventive behavior. These explanations are not specific to preventive behavior and may apply to other lifestyle decisions. Among the plausible explanations, there are three that are particularly relevant to preventive behavior in health-related activities: assortative matching in the marriage market; social learning about health risks from the observation of one's partner; interactions due to bargaining within marriage.

3.1. Matching in the marriage market

The first theoretical consideration refers to the process of matching on the marriage market. Becker's (1974) model considers the gains that two rational individuals can obtain from marriage. Becker posits that complementarities of partners' traits in the marital production function implies positive assortative matching. Preference for the preventive activities that are studied in this chapter such as physical activity, normal weight, nonsmoker status, and clinical preventive services may be considered as some of the traits that determine marriage assignments. It seems likely that these lifestyle variables will be complements in the marital production function, in the sense that partners enjoy sharing these activities. Moreover, Contoyannis and Jones (2004) have shown that a number of lifestyle variables are correlated between themselves. As such, I expect to find positive assortative matching with respect to lifestyle preferences.

Matching with respect to life expectancy may be enhanced by preventive activities. Risk-aversion to time spent alone in widowhood will reinforce preferences for partners whose life expectancy coincides with one's own. Also, similarities within household members regarding risk aversion and taste for health care procedures might lead to a positive correlation in the uptake of clinical preventive services such as vaccination and preventive screenings.

Marriage on the marriage market thus corresponds to correlated effects in partners' behaviors. The implication for empirical estimation is that partners' preventive behavior will be correlated due to similarities in unobservable individual traits. I control for this by including fixed effects in both male and female prevention equations.

3.2. Household decision- making

The second interpretation of the correlation between partners' behavior relies on the ongoing decision-making process within household. Following Manser and Brown (1980) and McElroy and Horney (1981), spouses may have established preferences over decisions regarding preventive activities. However, such decisions may be influence of adjustment over time due to changes in environmental factors that affect both households, i.e. in terms of the theoretical model this could be seen as changes in the price of prevention. Oftentimes, such environmental factors are unobserved by the econometrician. Yet, any household decision process over preventive behaviors for which the threat points do not involve divorce, an option that is excluded in this analysis, can be distinguished from matching, because the outcome is susceptible to change over time; further, any change in own preventive behavior should be systematically related to changes in both partners' past preventive behavior. The empirical interpretation is that respondent uptake of a preventive activity at t depends on partner´s decision at $t-1$, even after controlling for individual fixed effects. This effect is expected to be positive, since there is complementarity both between partners' health statuses in household production, and between past and current preventive behavior statuses in the personal return from prevention. If this relationship is not found in the data, I will conclude that household bargaining does not explain the correlation in spousal preventive behavior.

Household bargaining regarding preventive behavior can also be interpreted more broadly in terms of decisions regarding life expectancy. Under uncertainty, one important benefit from marriage is risk-sharing (Weiss, 1997). In this respect, aversion to spending time on one's own widowhood may lead spouses to under-invest in health. Preventive behaviors may be interpreted as signal of the partner's commitment to an increased health stock.

3.3. Social learning

In the theoretical model it is assumed that the health investments undertaken by one of the members of the couple has a positive impact in the stock of the other couple member. However, there is uncertainty about the risk that not carrying out these healthy behaviors conveys or about the importance of clinical preventive services for one's and each other's health; as such new information regarding these risks and benefits may be received by individuals, in particular through the observation of others. Partners will likely learn from each other, so that their information will be shared, and their risk assessments will be correlated. This leads naturally to a correlation in observed behavior.

Information is difficult to assess. My empirical approach will control for correlated information by allowing for correlation in contemporaneous unobservable shocks: specifically, male and female preventive behavior equations are written as seemingly unrelated regressions where the error terms are not necessarily independent (Wooldridge 2002). In addition, I look for direct evidence of correlated information effects using the approach taken by Clark and Etilé (2002), wherein health changes for one partner may affect the attitudes toward preventive behaviors.

3.4. Empirical implications

Sections 3.1-3.3 presented three different explanations of spousal correlation in preventive behavior. These provide us with arguments for the specification of an appropriate household empirical model for prevention in Section 5. Matching implies correlation in individual traits, which leads us to a model with individual fixed effects. Further, social learning suggests that the error terms in male and female prevention equations may be correlated. Together, these suggest the use of seemingly unrelated regressions with correlated error terms. Regarding the right-hand side variables, household decision-making implies that both own and partner's lagged consumption will be important.

These arguments yield three empirical predictions:

• *Prediction 1*. If there is positive assortative matching over preventive behavior, partners' estimated individual fixed effects will be positively correlated.

• *Prediction 2*. Household decision-making suggests that respondent's current uptake of preventive activities should be positively correlated with partner's lagged preventive behavior, once individual fixed effects are controlled for.

• *Prediction 3*. Partner's health developments may affect respondent decisions regarding preventive behavior.

In the following sections, I try to evaluate these three predictions using long-run American panel data.

4. Data

4.1. The Health and Retirement Study

The data come from the six successive waves of the Health and Retirement Study (HRS) spanning from 1996 to 2006.[3] The HRS is a panel data set, representative of non-

[3] HRS currently has 9 biannual waves running from 1992 to 2008. The first two waves were excluded from the analysis because several questions relevant to the analysis were either not

institutionalized individuals and their spouses in the United States. The study includes individuals aged 51 or older.[4] All adults in the household are interviewed separately with respect to their socio-demographic characteristics, income, employment, and health. Further details of this survey are available at the following address: http://hrsonline.isr.umich.edu/

4.2. Prevention in the HRS

Table 3.1 describes the different preventive activities available in the survey. It is important to mention that respondents were surveyed about clinical preventive activities only every other wave starting in wave 3.

Table 3.1. Preventive services in the Health and Retirement Study.

Type of preventive investment	**Preventive investment**	**Description**
Healthy Lifestyle Preventive activities	Vigorous physical exercise	Performs vigorous exercise 3+ times per week
	Non-smoking	Respondent currently does not smoke
	Normal weight	Survey asked for weight and height.
Clinical related Preventive activities	Flu shot	Whether the respondent has gotten the shot this wave. Only available in waves 3, 5, and 7.
	Cholesterol Screening	Whether the respondent has gotten the test this wave. Only available in waves 3, 5, and 7.
	Breast Cancer Screening	Whether the respondent has gotten a mammography this wave. Only available in waves 3, 5, and 7.
	Cervical Cancer	Whether the respondent has gotten a Pap

included or had a very different wording. The last wave, wave 9, was not included as data was not yet available as of the writing of this manuscript.

[4] HRS originally started with a cohort of individuals born between 1931 and 1941 (otherwise known as the HRS cohort). Soon after, the study added individuals born before 1923 from the Aging and Health Dynamic (AHEAD) Study. This cohort is known as the AHEAD cohort. In 1998, HRS added two extra cohorts: Children of Depression (CODA, born in 1923-1930) and War babies (WB, born in 1942-1947). Finally, in 2004, a cohort of Early Baby Boomers (EBB, born in 1948-1953) was included.

Screening	smears this wave. Only available in waves 3, 5, and 7.
Prostate Cancer Screening	Whether the respondent has gotten any kind of prostate cancer test this wave. Only available in waves 3, 5, and 7.

I first consider all individuals observed over at least two consecutive waves. This initial subsample (*Sample 1*) includes 97,946 observations (23,761 individuals). While 80.66% of the men in this sample are in couples, only 57.11% of the women are. It is possible that this reflects a widowhood effect. For the regression analysis, I consider couples who stay together over all six waves (waves 3-8), and for whom information on both partners (of different gender) is available, which leaves me with 18,900 observations on 3,150 couples observed (*Sample 2)*.

Descriptive statistics for *Samples 1* and *2* are shown in Table 3.2. The rates of participation in different preventive activities are very similar between genders; however, men are more likely to engage in physical activity. Also, men are more likely to report having a prostate cancer screening test than women receiving a Pap smear test or a mammography. Participation in preventive behavior is high in almost all of the observed activities except for physical activity and maintenance of a normal weight[5].

[5] Normal weight if Body mass index is ≥20.0 and ≤25.0

Table 3.2. Descriptive statistics.

Variable	SAMPLE 1				SAMPLE 2			
	Female		Male		Female		Male	
	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error
Preventive activity at t								
Physical activity	37.06%	(47.91%)	48.73%	(49.92%)	40.56%	(49.10%)	50.63%	(50.00%)
Non-smoking	82.51%	(37.57%)	82.39%	(38.52%)	84.98%	(35.73%)	86.16%	(34.54%)
Normal weight	37.82%	(48.27%)	28.95%	(45.29%)	36.95%	(47.85%)	25.94%	(43.80%)
Flu shot	57.13%	(49.45%)	57.82%	(49.54%)	64.21%	(47.94%)	65.45%	(47.56%)
Cholesterol screening	77.28%	(42.18%)	77.60%	(42.02%)	82.20%	(38.26%)	83.81%	(36.84%)
Pap smear	62.32%	(48.70%)	0.00%	(0.00%)	68.47%	(46.47%)	0.00%	(0.00%)
Mammogram	72.14%	(45.53%)	0.00%	(0.00%)	79.06%	(40.69%)	0.00%	(0.00%)
Prostate screening	0.00%	(0.00%)	72.40%	(45.13%)	0.00%	(0.00%)	78.11%	(41.35%)
Age	66.81	(11.67)	67.58	(10.03)	65.23	(8.39)	68.93	(7.73)
Log individual yearly real income	10.27	(1.05)	10.59	(0.97)	10.72	(0.84)	10.72	(0.84)
Household size	2.15	(1.22)	2.27	(1.13)	2.40	(0.92)	2.40	(0.92)
Has at least one child	93.03%	(25.71%)	93.14%	(24.77%)	96.49%	(18.40%)	96.49%	(18.40%)
Marital status								
Coupled	58.33%	(49.49%)	79.94%	(39.50%)	100.00%	(0.00%)	100.00%	(0.00%)
Married	55.94%	(49.77%)	76.54%	(41.84%)	96.35%	(18.77%)	97.45%	(15.78%)
Not in couple	41.67%	(49.49%)	20.06%	(39.50%)	0.00%	(0.00%)	0.00%	(0.00%)
Length of current marriage	35.71	(15.32)	35.60	(15.40)	39.09	(13.07)	39.20	(13.00)
Race								
White	75.34%	(43.58%)	79.01%	(41.87%)	81.02%	(39.21%)	81.28%	(39.01%)
Black	14.63%	(35.67%)	11.51%	(32.80%)	8.81%	(28.35%)	9.15%	(28.83%)
Hispanic	8.11%	(27.82%)	7.47%	(27.51%)	8.16%	(27.37%)	7.88%	(26.94%)
Other	1.91%	(14.27%)	2.00%	(14.43%)	1.76%	(13.14%)	1.70%	(12.91%)
Veteran status	0.98%	(9.85%)	56.94%	(49.72%)	0.92%	(9.56%)	58.71%	(49.24%)
Labor force status								
Full time	21.60%	(40.57%)	30.34%	(46.14%)	19.37%	(39.52%)	25.62%	(43.66%)
Part time	7.09%	(25.37%)	2.65%	(17.07%)	7.42%	(26.22%)	2.91%	(16.81%)

Unemployed	0.85%	(9.17%)	0.83%	(9.05%)	0.31%	(5.59%)	0.35%	(5.87%)
Retired	43.56%	(49.53%)	52.74%	(49.96%)	40.73%	(49.13%)	55.46%	(49.70%)
Semi-retired	6.28%	(23.63%)	10.65%	(29.70%)	7.88%	(26.94%)	13.53%	(34.21%)
Disabled	3.19%	(18.85%)	2.23%	(16.80%)	2.34%	(15.12%)	1.74%	(13.09%)
Not in labor force	17.44%	(39.01%)	0.56%	(8.91%)	20.57%	(40.42%)	0.41%	(6.38%)
Education								
Less than high school	24.64%	(44.04%)	23.31%	(43.89%)	19.98%	(39.98%)	24.34%	(42.92%)
High school/GED	38.67%	(48.51%)	32.30%	(46.63%)	41.15%	(49.21%)	32.87%	(46.98%)
Some college	21.29%	(40.56%)	20.07%	(39.32%)	21.87%	(41.34%)	17.70%	(38.17%)
College or above	15.40%	(35.68%)	24.32%	(41.86%)	16.60%	(37.21%)	24.74%	(43.15%)
Years of education	12.13	(3.19)	12.49	(3.57)	12.39	(2.93)	12.41	(3.47)
Self reported health status								
Excellent	12.45%	(32.53%)	13.41%	(33.36%)	13.46%	(34.13%)	11.94%	(32.42%)
Very good	29.07%	(44.97%)	28.98%	(44.71%)	32.28%	(46.76%)	30.38%	(45.99%)
Good	30.61%	(45.91%)	31.78%	(46.37%)	30.20%	(45.91%)	33.60%	(47.24%)
Fair	19.53%	(39.97%)	18.68%	(39.65%)	16.16%	(36.81%)	18.28%	(38.65%)
Poor	8.32%	(29.46%)	7.15%	(28.24%)	6.49%	(24.64%)	5.76%	(23.30%)
CESD mental score	1.68	(2.06)	1.25	(1.76)	1.34	(1.85)	0.98	(1.52)
Functional limitations	2.93	(3.06)	2.04	(2.72)	2.60	(2.82)	1.97	(2.47)
Insurance status								
Any health insurance	89.95%	(29.78%)	92.40%	(28.64%)	90.18%	(29.75%)	94.65%	(22.50%)
Public health insurance	58.62%	(49.07%)	62.05%	(48.62%)	53.23%	(49.90%)	69.73%	(45.95%)
Private health insurance	50.09%	(50.00%)	53.98%	(49.88%)	57.78%	(49.39%)	53.48%	(49.88%)
Life insurance	63.39%	(48.46%)	74.18%	(44.13%)	65.48%	(47.54%)	76.40%	(42.47%)
Long term care insurance	10.90%	(30.75%)	11.12%	(30.65%)	13.36%	(34.02%)	12.59%	(33.18%)
Census regions								
New England	3.89%	(19.43%)	4.08%	(19.60%)	3.73%	(18.95%)	3.86%	(19.27%)
Mid-Atlantic	12.47%	(33.29%)	11.95%	(32.52%)	11.83%	(32.30%)	12.02%	(32.52%)

EN Central	16.75%	(37.17%)	16.83%	(37.07%)	16.16%	(36.81%)	16.48%	(37.10%)
WN Central	8.59%	(27.53%)	9.00%	(27.80%)	9.47%	(29.28%)	9.57%	(29.42%)
South Atlantic	24.64%	(42.98%)	24.24%	(42.95%)	22.26%	(41.60%)	22.64%	(41.85%)
ES Central	5.81%	(23.37%)	5.35%	(23.05%)	6.66%	(24.93%)	6.73%	(25.05%)
WS Central	10.24%	(30.61%)	9.69%	(30.62%)	10.15%	(30.20%)	10.19%	(30.26%)
Mountain	5.13%	(21.92%)	5.48%	(22.34%)	5.39%	(22.59%)	5.34%	(22.49%)
Pacific	12.10%	(32.70%)	13.04%	(33.53%)	12.55%	(33.13%)	12.80%	(33.40%)
Other	0.00%	(2.95%)	0.00%	(3.05%)			0.17%	(4.17%)
Number of observations	59,313		38,633		15,750		15,750	
Number of individuals	13,948		9,813		3,150		3,150	

In table 3.3, I calculate conditional probabilities to illustrate the correlation in spouses' behaviors in sample 1. For instance, the first panel in the table should be read as follows: given that the female engages in physical activity, the probability of the male spouse exercising is 62.2%; given that the woman does not decide to uptake physical activity, the probability that the male counterpart will is 41.9%. The odds ratio, 1.49 in the case described, is presented in the second panel of table 3.3.[6] There is evidently a positive correlation between partners' decision to engage contemporaneously in preventive activities. There does not seem to be a marked difference between male and female's odds ratios. In the remainder of this chapter, I try to investigate this correlation in the light of Section 2's theoretical considerations.

[6] The descriptive odds ratio is the ratio of the conditional probability of positive outcome when the conditioning variable is active to the conditional probability of positive outcome when the conditioning variable is inactive. Here:

$$\frac{\Pr\left(\,male\ exercises \mid female\ exercise\right)}{\Pr\left(male\ exercises \mid female\ does\ not\ exercise\right)} = \frac{0.622}{0.454} = 1.49$$

It is important to mention that among the preventive behaviors studied in the survey, there are three gender specific activities: mammography, Pap smear test, and prostate screening. Since all of these activities relate to cancer prevention, in this analysis I try to correlate both the demand for prostate screening with the demand for Pap smear screenings, as well as the demand for prostate screening in men for that for mammography in women.

Table 3.3. Conditional probabilities and odds ratios on spousal preventive behavior.

	Panel A. Conditional Probabilities				***Panel B. Odds ratios (95% confidence interval)***	
	Male=positive prevention		**Female=positive prevention**			
Preventive Activity	*Female=positive prevention*	*Female=negative prevention*	*Male=positive prevention*	*Male=negative prevention*	**Male**	**Female**
Physical activity	62.17%	42.54%	51.09%	31.99%	1.46 (1.43-1.49)	1.60 (1.55-1.64)
Non-smoker	88.98%	56.16%	89.46%	57.36%	1.58 (1.54-1.63)	1.56 (1.52-1.60)
Normal weight	32.84%	22.43%	46.61%	34.06%	1.46 (1.41-1.52)	1.37 (1.39-1.41)
Flu shot	78.99%	30.95%	77.31%	28.89%	2.55 (2.46-2.65)	2.68 (2.57-2.78)
Cholesterol screening	83.49%	64.73%	82.26%	62.72%	1.29 (1.26-1.32)	1.31 (1.28-1.35)
Pap smear/Prostate screening	78.04%	66.46%	72.71%	59.77%	1.17 (1.15-1.20)	1.22 (1.18-1.25)
Mammogram/Prostate screening	78.62%	60.91%	81.23%	64.70%	1.32 (1.26-1.33)	1.26 (1.23-1.29)

4.3. Accounting for selection bias

Since I am only interested in couples for this analysis, there is likely some selection bias involved in moving from *Sample 1* to *Sample 2*, as a number of contemporaneous shocks may simultaneously affect the duration of the couple or the death of one of the spouses, and preventive behavior. As such, the regression sample (*Sample 2*) will not necessarily reflect the total population of couples. In particular, there could be an unobserved variable which determines couple stability, or that is to blame for the missing of a member of the couple in the survey perhaps due to death, which is also linked to their joint preventive behavior.

To correct for any selection bias in moving from *Sample 1* to *Sample 2*, I compute a Mills ratio using a selection variable that equals 1 at period t if the individual is observed over the six periods and does not separate or leaves the sample in period t. This selection equation is estimated on *Sample 1*, as shown in Appendix, table A.3.1, as a function of education (3 dummies), labor force status (6 dummies), U.S. Census division and age dummies.

5. Econometric specification

The econometric modeling of this analysis follows closely the one suggested by Clark and Etilé (2006). Let $Y_{i,t}$ be a binary indicator for each of the preventive activities by individual I during period t, and $X_{i,t}$ a vector of exogenous individual and household covariates. The agent decide to engage in each of the preventive activities at time t ($Y_{i,t}$=1) if the latent variable $Y_{i,t}^{*}$ is positive. I consider the following specification of the household preventive decision:

$$Y_{i,t} = \begin{cases} 1 \; if \; Y^*_{i,t} = \alpha_1 Y_{i,t-1} + \beta_1 Y_{-i,t-1} + \gamma_i X_{i,t} + c_i + \tilde{\varepsilon}_{i,t} > 0 \\ 0 \; otherwise \end{cases}$$

$$Y_{-i,t} = \begin{cases} 1 \; if \; Y^*_{-i,t} = \alpha_2 Y_{-i,t-1} + \beta_2 Y_{i,t-1} + \gamma_2 X_{-i,t} + c_{-i,} + \tilde{\varepsilon}_{-i,t} > 0 \\ 0 \; otherwise \end{cases}$$

(10)

Where $Y_{-i,-t}$ refers to the lagged effect of the preventive behavior of i's partner. The residuals have two components: an individual fixed effect c_i and a time-varying shock $\tilde{\varepsilon}_{i,t}$. In terms of the three arguments presented in section 2, the addition of c_i and c_{-i} will capture matching, whereas β corresponds to the bargaining effect. Last, $\tilde{\varepsilon}_{i,t}$ capture time-varying effects. I assume that c_i and $\tilde{\varepsilon}_{i,t}$ have zero expectations and covariance matrices Σ_c and Σ_ε, respectively, and are mutually uncorrelated with the rest of the covariates, similarly for the spouse –i.

Although Clark and Etilé (2006) use a dynamic bivariate probit model, in this analysis I find poor convergence properties of the bivariate specification, therefore I choose to use a system of linear probability models as a convenient approximation to the underlying response probabilities (Biørn, 2004). By using a seemingly unrelated regression system, I can ensure that the contemporaneous cross-equation error correlations for the equations of both members of the household are taken into account. As stated in section 3, this serves to account for contemporaneous information effects within households.

I used two different kinds of seemingly unrelated regressions (SUR). In the first one, individual level fixed effects are omitted, i.e. this is the strict bargaining specification. The second specification includes individual fixed effects, which according to the specification above, control for matching. Last, in the specifications the use of control variables which take different values for the two partners (labor force status, age) allows the robust identification of the correlation coefficient ϱ.

In addition, I analyze the robustness of the estimates with SUR with all of the preventive behaviors predicted at the same time for each of the household members.

To examine the effect of information on health risks, I use simple initiation and quit models for preventive behavior, with and without individual fixed effects to examine the effect of health shocks on each member of the household's decision to start or stop the different preventive services.

6. Results

6.1. Matching or Bargaining

Table 3.4 reports results from two different specifications. The table has four columns. Columns 1 and 2 report benchmark estimates from a specification using seemingly unrelated regressions without fixed effects. The seemingly unrelated regressions (SUR) in columns 3 and 4 add individual fixed effect for both partners as well as an individual fixed effect. The results show that physical activity behaves very different to the rest of the preventive behaviors.

The results for the effect of physical activity are striking. First, in the specification with individual fixed effects (columns 3 and 4) the coefficient on own lagged participation in physical activity drops as compared with the specification without fixed effects although it remains significant. Second, individual physical activity participation is statistically independent of partner's physical activity participation in the specification with fixed effects at the individual level. The statistically significant effect of partner's in the specification without the fixed effects entirely disappear in specification with fixed effects.

In all other cases, the effect of spouses past behavior is relevant in determining each the respondent's behavior regardless of the presence of the individual fixed effects. Given the modeling presented above, these results suggest that while the correlation between spouses in smoking behavior, normal weight maintenance, flu shot, cholesterol screening, and cancer related screening (prostate, mammogram and pap smear) may arise as a consequence of a decision-making model, the correlation in physical activity is likely to be due to positive assortative matching.

Table 3.4. Matching vs. bargaining.

Dependent variable= Corresponding preventive activity at t		(1)	(2)	(3)	(4)
		SUR with no fixed effects		**SUR with fixed effects**	
		Male	**Female**	**Male**	**Female**
(1)	Respondent's Physical Activity at t-1	0.325***	0.333***	0.263***	0.281***
		(0.009)	(0.009)	(0.006)	(0.006)
	Spouse's Physical Activity at t-1	0.041***	0.034***	0.004	-0.006
		(0.009)	(0.008)	(0.006)	(0.006)
(2)	Respondent's Non-smoker status at t-1	0.799***	0.813***	0.799***	0.822***
		(0.006)	(0.006)	(0.006)	(0.005)
	Spouse's Non-smoker status at t-1	0.020***	0.031***	0.021***	0.026***
		(0.006)	(0.006)	(0.006)	(0.005)
(3)	Respondent's normal weight at t-1	0.753***	0.737***	0.753***	0.748***
		(0.006)	(0.006)	(0.006)	(0.006)
	Spouse's normal weight at t-1	0.010*	0.020***	0.01	0.015**
		(0.005)	(0.007)	(0.006)	(0.006)
(3)	Respondent's flu shot at t-1	0.440***	0.465***	0.438***	0.472***
		(0.013)	(0.013)	(0.013)	(0.013)
	Spouse's flu shot at t-1	0.098***	0.101***	0.094***	0.092***
		(0.013)	(0.013)	(0.013)	(0.013)

(4)	Respondent's cholesterol screening at t-1	0.265***	0.239***	0.266***	0.248***
		(0.013)	(0.013)	(0.013)	(0.012)
	Spouse's cholesterol screening at t-1	0.042***	0.074***	0.042***	0.072***
		(0.012)	(0.013)	(0.012)	(0.012)
(5)	Respondent's prostate screening (male)/Pap smear test (female) at t-1	0.295***	0.043***	0.293***	0.041***
		(0.014)	(0.015)	(0.014)	(0.015)
	Spouse's prostate screening (female)/Pap smear test (male) at t-1	0.072***	0.400***	0.072***	0.406***
		(0.013)	(0.014)	(0.013)	(0.014)
(6)	Respondent's prostate screening (male)/mammography (female) at t-1	0.294***	0.424***	0.292***	0.426***
		(0.014)	(0.013)	(0.014)	(0.013)
	Spouse's prostate screening (female)/mammography (male) at t-1	0.077***	0.053***	0.075***	0.049***
		(0.014)	(0.013)	(0.014)	(0.013)
Number of coupled observations		15,750			
Number of couples		3,150			

All columns show the marginal effect of the variable in question in separate models predicting the preventive activity at t. All regressions were controlled by controlled for the inverse mills ratio, age, age squared, race, veteran status, working status (full time, part time, unemployed, partly retired, retired, disabled, other), number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education years, mental health (CESD score), residence in one of 10 census divisions and wave. Standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

In appendix table A.3.2, I repeat the analysis differentiating matching vs. bargaining but instead of pairing both members of household in the seemingly unrelated regressions for each preventive activity, I include all the preventive activities at once for each household member. In this manner, efficiency in the estimates is gained by the fact that the error terms are assumed to be correlated across the equations. The results are very similar to those in table 3.4.

In addition, I repeat table 3.4 but this time including the spouses' covariates alongside the respondent's covariates. The results, presented in appendix table A.3.3, show little variation with respect to table 3.4. However, this specification proves to be highly collinear and thus is avoided.

Some more evidence regarding the effect of bargaining within the household comes from examining the couple's decision to start or stop one of the preventive behaviors in the survey. I look into whether the respondent's decision to start or stop one of these behaviors at t is affected not only by past respondent's and spouse's behavior, but also by concurrent spouse's decision. Initiation of preventive behavior takes place strictly when the person had not engaged in such behavior at the previous wave. Similarly, termination is indicated when such activity was present at t-1 (t-2 for clinical activities) but no longer observed at t. Table 3.5 presents summary statistics of preventive activity initiation and termination.

Table 3.5. Summary statistics for initiation and termination of preventive activity.

Preventive Activity	**Initiation of preventive activity**		**Termination of preventive activity**	
	Male	**Female**	**Male**	**Female**
Physical activity	13.85%	12.98%	16.49%	16.47%
	(34.54%)	(33.61%)	(37.11%)	(37.09%)
Nonsmoker status	2.60%	2.32%	1.36%	1.23%
	(15.93%)	(15.06%)	(11.57%)	(11.03%)
Normal weight status	4.22%	4.47%	4.43%	5.81%
	(20.12%)	(20.66%)	(20.58%)	(23.39%)
Flu shot	17.91%	17.49%	4.41%	4.27%
	(38.35%)	(37.99%)	(20.53%)	(20.23%)
Cholesterol screening	13.04%	14.21%	7.07%	7.95%
	(33.68%)	(34.92%)	(25.63%)	(27.05%)

Prostate screening	12.55% (33.14%)	9.90% (29.87%)
Pap smear test	9.87% (29.83%)	14.14% (34.85%)
Mammography	9.12% (28.80%)	17.02% (37.58%)

Standard errors in parenthesis

Table 3.6 shows that for all behaviors except for physical activity, there is a strong and significant relationship between the household members' decision to initiate a preventive activity regardless of the presence of individual level fixed effects (table A.3.4 in appendix shows similar results for termination). This lends credibility to the household bargaining process in which spouses are constantly negotiating their participation and termination of preventive behavior jointly. Notably, the magnitude of the effects decreases considerably once the fixed effects are added. This might indicate that the omitted household effects in columns 1 and 2 biases upwards the coefficient on spouse activity initiation.

Table 3.6. Effect of spouse decision to initiate a given preventive behavior on respondent's decision to start such behavior, full sample.

Dependent variables= Initiation of corresponding preventive activity at t	**(1)**	**(2)**	**(3)**	**(4)**
	SUR with no fixed effects		**SUR with fixed effects**	
	Male	**Female**	**Male**	**Female**
Spouse initiation of physical activity at t	0.128 (0.090)	0.128 (0.090)	0.066 (0.089)	0.065 (0.070)
Spouse initiation of non-smoker status (i.e. quitting) at t	0.267*** (0.011)	0.261*** (0.010)	#	#

Spouse initiation of normal weight status at t	0.024*** (0.009)	0.025*** (0.010)	0.013 (0.009)	0.019** (0.009)
Spouse initiation of flu shot at t	0.538*** (0.013)	0.552*** (0.014)	0.296*** (0.014)	0.299*** (0.014)
Spouse initiation of cholesterol screening at t	0.105*** (0.014)	0.115*** (0.015)	0.052*** (0.014)	0.063*** (0.015)
Spouse initiation of Pap smear screening (male respondents) prostate screening (female screening) at t	0.111*** (0.014)	0.119*** (0.015)	0.060*** (0.014)	0.059*** (0.015)
Spouse initiation of mammography (male respondents) prostate screening (female respondent) at t	0.094*** (0.016)	0.085*** (0.014)	0.059*** (0.016)	0.059*** (0.013)
Number of coupled observations	15,750			
Number of couples	3,150			

All columns show the marginal effect of the variable in question in separate models predicting the initiation of each preventive activity at t. All regressions were controlled for respondent's and spouse's past participation in the relevant preventive activity at t-1, the inverse mills ratio, age, age squared, race, veteran status, working status (full time, part time, unemployed, partly retired, retired, disabled, other), number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education years, mental health (CESD score), residence in one of 10 census divisions and wave. Standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively. **# The models regarding smoking quitting did not converge when fixed effects at the individual level were included.**

In 3.7, I repeat the analysis of the joint initiation of preventive activities with a reduced sample. Of the 15,750 observations of table 3.6, I dropped those observations that are not eligible to initiate a given preventive activity because they already engage in such. In appendix A.3.5, I do the proper for termination dropping those observations in which the dependent variable is not eligible to terminate a preventive activity because he or she is not undertaking it. The samples in both cases, initiation and termination, were reduced and is reported in both table 3.7 and table A.3.4, respectively. The results not only corroborate what was found in tables 3.6 and A.3.3, in fact, the magnitudes of the association between spouses are even stronger when only people that are eligible are studied.

Table 3.7. Effect of spouse decision to initiate a given preventive behavior on respondent's decision to start such behavior among those eligible to initiate.

Dependent variables= Initiation of corresponding preventive activity at t among people eligible to initiate	SUR with no fixed effects		SUR with fixed effects		Number of observations (Number of individuals)	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
Spouse initiation of physical activity at t	0.02 (0.014)	0.012 (0.009)	0.011 (0.015)	0.008 (0.012)	7,187 (2,335)	9,025 (2,915)
Spouse initiation of non-smoker status (i.e. quitting) at t	0.609*** (0.034)	0.226*** (0.012)	0.327*** (0.035)	0.259*** (0.024)	2,183 (1,174)	2,890 (1,815)
Spouse initiation of normal weight status at t	0.027** (0.011)	0.022** (0.010)	0.014 (0.011)	0.027** (0.013)	9,202 (2,420)	8,652 (2,531)
Spouse initiation of flu shot at t	0.691*** (0.021)	0.519*** (0.016)	0.389*** (0.022)	0.372*** (0.021)	2,362 (1,537)	2,653 (1,748)
Spouse initiation of cholesterol screening at t	0.184*** (0.039)	0.094*** (0.019)	0.090** (0.039)	0.103*** (0.036)	1,332 (927)	1,584 (1,095)
Spouse initiation of Pap smear screening (male respondents) prostate screening (female screening) at t	0.204*** (0.037)	0.193*** (0.033)	0.111*** (0.038)	0.095*** (0.031)	783 (586)	2,074 (1,425)
Spouse initiation of mammography (male respondents) prostate screening (female respondent) at t	0.137*** (0.040)	0.147*** (0.039)	0.085** (0.042)	0.116*** (0.037)	619 (466)	1,441 (1,015)

All columns show the marginal effect of the variable in question in separate models predicting the initiation of each preventive activity at t. All regressions were controlled for respondent's and spouse's past participation in the relevant preventive activity at t-1, the inverse mills ratio, age, age squared, race, veteran status, working status (full time, part time, unemployed, partly retired, retired, disabled, other), number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education years, mental health (CESD score), residence in one of 10 census divisions and wave. Standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

In addition, I look at a variation on the specification for changes in weight. Instead of examining the effect of spouse's initiation or termination of a normal weight status, I look at the association between spouses' changes in BMI. Table 3.8 presents the results of seemingly unrelated regressions between spouses with and without fix effect. The correlations are positive and significant even when fixed effects are included.

Table 3.8. Effect of spouse's BMI change on respondent's BMI change.

Dependent variable=Respondent's change in BMI	(1)	(2)	(3)	(4)
	SUR with no fixed effects		SUR with fixed effects	
	Male	Female	Male	Female
Spouse BMI change	0.133***	0.208***	0.069***	0.102***
	(0.007)	(0.012)	(0.008)	(0.011)

Seemingly unrelated regression of both household members' BMI at t. All regressions were controlled with the inverse mills ratio, age, age squared, race, veteran status, working status (full time, part time, unemployed, partly retired, retired, disabled, other), number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education years, mental health (CESD score), residence in one of 10 census divisions and wave. Standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

6.2. Effect of health changes

The third prediction is that preventive behavior may be positively correlated with the partner's past health changes, as a consequence of either correlated effects (social learning) or household decision-making. Table 3.9 shows the percentage of people in sample 2 that undergo a health shock in the form of a new diagnosis of heart problems, diabetes, cancer, lung disease, or high blood pressure at each given wave. As expected, the number of people suffering a health shock increases as the population gets older. Men, probably due to being older than women, have a higher incidence of health shocks.

Table 3.9. Percentage of people suffering a health shock at each wave.

	Health shocks	
	Male	Female
Wave 4 (1998)	11.87% (32.36%)	10.28% (30.38%)
Wave 5 (2000)	14.49% (35.20%)	11.63% (3206.10%)
Wave 6 (2002)	16.67% (35.20%)	13.55% (34.23%)
Wave 7 (2004)	16.41% (37.04%)	13.98% (34.69%)
Wave 8 (2006)	18.17% (38.56%)	15.10% (35.82%)

Standard errors in parenthesis.

Table 3.10 shows the results of the effect that a health shock, on the respondent's inclination to initiate or terminate at a given wave each one of the preventive behaviors studied here with and without individual fixed effects. Except for vigorous activity and normal weight status, a shock in respondent's own health is likely to increase the likelihood that the respondent initiates a preventive activity. However, a shock in spouse's health does not translate into a change in respondent's behavior. The implications are interesting as the results suggest that the survey respondents update their perception of health risk and their inclination towards preventive behavior as a consequence of the diagnosis of the disease. Alternatively, a new health shock might increase the respondent's access to medical care therefore increasing the likelihood of performance of routine preventive care. Columns 5-8 of table 3.10 show that health shocks in spouses have no effect in increasing the likelihood that a respondents start any of the preventive behavior studied.

Table A.3.6 in the appendix repeats the analysis but this time considering only cardiology related shocks (i.e. new diagnosis of heart disease, high blood pressure, diabetes, and stroke). The results are similar to table 3.10. Spouse's cardiac health shocks do not encourage initiation of any preventive activity. As expected, the magnitude of the effect of respondent's own cardiology related shocks are smaller than the effect that the more general measure of health shocks that included a new diagnosis of cancer and lung disease had. Interestingly, cardiology-related shocks were still significant in predicting initiation of cancer related tests like prostate screening or pap smear test, lending credibility to the hypothesis that health shocks increase clinical preventive behavior as a result of increased in contact to medical care, even if it's unrelated to the cause of the shock per se.

Table 3.10. Effect of own and spouse's health shock on initiation of preventive activities, full sample.

Dependent variable= Initiation of corresponding preventive activity at t	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
	Effect of own health shock on preventive activity				**Effect of spouse's health shock on preventive activity**			
	SUR with no fixed effects		**SUR with fixed effects**		**SUR with no fixed effects**		**SUR with fixed effects**	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Health shock on vigorous physical activity	-0.007	0.005	-0.004	0.001	-0.006	-0.006	-0.005	-0.005
	(0.008)	(0.009)	(0.006)	(0.008)	(0.008)	(0.008)	(0.008)	(0.007)
Health shock on nonsmoker status	0.020***	0.013***	0.027***	0.013***	-0.001	0.004	-0.001	0.004
	(0.004)	(0.005)	(0.004)	(0.004)	(0.005)	(0.004)	(0.005)	(0.004)
Health shock on normal weight status	0.007	0.010*	0.008	0.008	-0.001	0.001	-0.001	0.001
	(0.005)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Health shock on flu shot	0.033**	0.030**	0.032**	0.040***	-0.002	-0.009	0.007	0
	(0.013)	(0.014)	(0.013)	(0.014)	(0.014)	(0.013)	(0.014)	(0.013)
Health shock on cholesterol screening	0.051***	0.041***	0.050***	0.046***	0	0.008	0.002	0.014
	(0.009)	(0.010)	(0.009)	(0.010)	(0.010)	(0.010)	(0.010)	(0.009)
Health shock on prostate screening (male)/Pap smear (female)	0.315***	0.264**	0.023**	0.027**	0.001	-0.009	0.002	-0.008
	(0.118)	(0.108)	(0.010)	(0.011)	(0.011)	(0.010)	(0.010)	(0.010)
Health shock	0.021**	0.016	0.023**	0.016*	0.001	0.014	0.002	0.007

on prostate screening (male)/mammography (female)	(0.010)	(0.010)	(0.009)	(0.009)	(0.011)	(0.009)	(0.010)	(0.009)
Number of coupled observations				15,750				
Number of couples				3,150				

All columns show the marginal effect of the variable in question in separate models predicting the initiation of each preventive activity at t. All regressions were controlled for respondent's and spouse's past participation in the relevant preventive activity at t-1, the inverse mills ratio, age, age squared, race, veteran status, working status (full time, part time, unemployed, partly retired, retired, disabled, other), number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education years, mental health (CESD score), residence in one of 10 census divisions and wave. Standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

I repeat table 3.10 and table 3.6 in appendix but this time only with those eligible to initiate a preventive activity. In other words, I drop those observations that were already engaging in prevention. The results in table 3.11 for all health shocks, and table A.3.7 for cardio shocks reiterate the findings that except for physical activity, respondents react to their own health shocks by initiating a preventive activity but do not quite respond to health shocks in spouses' health in quite the same way.

Table 3.11. Effect of own and spouse's health shock on initiation of preventive activities, among those eligible to initiate.

Dependent variable= Initiation of corresponding preventive activity at t among eligible to initiate	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(5)	(6)
	Effect of OWN health shock on preventive activity				**Effect of SPOUSE health shock on preventive activity**				**Number of observations (Number of individuals)**	
	SUR with no fixed effects		**SUR with fixed effects**		**SUR with no fixed effects**		**SUR with fixed effects**			
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Health shock on vigorous physical activity	-0.011	0.004	-0.014	-0.015	-0.009	0.020**	-0.009	0.013	7,187	9,025
	(0.012)	(0.008)	(0.012)	(0.010)	(0.010)	(0.009)	(0.011)	(0.010)	(2,335)	(2,915)
Health shock on nonsmoker status	0.048***	0.021**	0.055***	0.035***	-0.022	-0.005	-0.01	0.006	2,182	2,889
	(0.015)	(0.009)	(0.016)	(0.011)	(0.014)	(0.009)	(0.015)	(0.012)	(1,174)	(1,814)
Health shock on normal weight status	-0.016***	-0.015***	-0.012*	-0.007	-0.005	0.004	-0.003	0.009	9,201	8,649
	(0.006)	(0.005)	(0.007)	(0.007)	(0.005)	(0.005)	(0.006)	(0.007)	(2,420)	(2,531)
Health shock on flu shot	0.100***	0.038**	0.101***	0.098***	0.001	-0.031*	0.013	0.035*	2,362	2,651
	(0.020)	(0.017)	(0.022)	(0.020)	(0.019)	(0.017)	(0.021)	(0.021)	(1,537)	(1,747)
Health shock on cholesterol screening	0.162***	0.092***	0.166***	0.181***	0.024	-0.011	0.033	-0.01	1,332	1,583
	(0.024)	(0.018)	(0.025)	(0.023)	(0.025)	(0.017)	(0.026)	(0.024)	(927)	(1,095)
Health shock on prostate screening (male)/mammography (female)	0.146***	0.131***	0.146***	0.075***	0.018	-0.005	0.019	0.024	619	1,441
	(0.038)	(0.038)	(0.041)	(0.026)	(0.036)	(0.035)	(0.039)	(0.027)	(466)	(0,466)
Health shock on prostate screening (male)/Pap smear (female)	0.128***	0.090***	0.119***	0.044**	0.018	0.003	0.014	-0.001	783	2,073
	(0.033)	(0.032)	(0.035)	(0.020)	(0.031)	(0.030)	(0.034)	(0.021)	(586)	(1,424)

All columns show the marginal effect of the variable in question in separate models predicting the initiation of each preventive activity at t. All regressions were controlled for respondent's and spouse's past participation in the relevant preventive activity at t-1, the inverse mills ratio, age, age squared, race, veteran status, working status (full time, part time, unemployed, partly retired, retired, disabled, other), number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education years, mental health (CESD score), residence in one of 10 census divisions and wave. Standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

Lastly, I look at the effect of a health shock in the decision to terminate a preventive behavior. Table 3.12 presents two panels: columns 1-4 evaluate the effect of a shock in respondent's health on the respondent's own preventive behavior; columns 5-8 evaluate the effect of a shock in spouse's health in the respondent's behavior. Table A.3.8 in appendix repeats this analysis but with a curtailed sample of those respondents who are actually eligible to terminate the behavior. Similar to tables 3.10 and 3.11, I found that a shock in spouse's health has no effect in the decision to terminate a preventive behavior. A health shock in one's own health had a positive effect in terminating physical activity and normal weight status. However, it has a negative effect in terminating all of the clinical preventive behaviors. In other words, the results for termination are clearly the opposite to the ones found for the initiation of these preventive behaviors.

Table 3.12. Effect of own and spouse's health shock on termination of preventive activities, full sample.

Dependent variable= Termination of corresponding preventive activity at t	**(1)**	**(2)**	**(3)**	**(4)**	**(1)**	**(2)**	**(3)**	**(4)**
	Effect of OWN health shock on termination of preventive activity				**Effect of SPOUSE health shock on termination of preventive activity**			
	SUR with no fixed effects		**SUR with fixed effects**		**SUR with no fixed effects**		**SUR with fixed effects**	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Health shock on vigorous physical activity	0.016**	0.015**	0.021**	0.01	0.001	0	0.005	0.011
	(0.008)	(0.007)	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Health shock on non-smoker status	-0.001	0.001	0	0.002	0.002	0.001	0.004	0
	(0.003)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)
Health shock on normal weight status	0.008*	0.017***	0.012**	0.028***	-0.005	0.004	0	0.008
	(0.004)	(0.005)	(0.005)	(0.005)	(0.004)	(0.005)	(0.004)	(0.005)
Health shock on flu shot	-0.024***	-0.017**	-0.025***	-0.012*	-0.008	-0.011	-0.009	-0.01
	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.007)	(0.006)	(0.007)
Health shock on cholesterol	-0.063***	-0.057***	-0.065***	-0.056***	0.003	-0.01	0	-0.007
	(0.009)	(0.009)	(0.009)	(0.009)	(0.008)	(0.009)	(0.008)	(0.009)

screening								
Health shock on prostate screening (male)/mammography (female)	-0.025**	-0.015*	-0.024**	-0.016*	-0.009	-0.003	-0.007	0.003
	(0.011)	(0.009)	(0.011)	(0.008)	(0.009)	(0.009)	(0.009)	(0.009)
Health shock on prostate screening (male)/Pap smear (female)	-0.026**	0.004	-0.024**	0.001	-0.012	-0.004	-0.009	-0.008
	(0.010)	(0.011)	(0.011)	(0.011)	(0.009)	(0.011)	(0.009)	(0.011)
Number of observations	15,750							
Number of couples	3,150							

All columns show the marginal effect of the variable in question in separate models predicting the termination of each preventive activity at t. All regressions were controlled for respondent's and spouse's past participation in the relevant preventive activity at t-1, the inverse mills ratio, age, age squared, race, veteran status, working status (full time, part time, unemployed, partly retired, retired, disabled, other), number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education years, mental health (CESD score), residence in one of 10 census divisions and wave. Standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

7. Discussion

I used six waves of HRS data to examine intra-spousal correlations in preventive behavior. One of this chapter's contributions has been to the interpretation of observed correlation between spouses' behaviors. These can come about because partners' fixed traits are similar, as in matching models of marriage. Alternatively, household decision-making can lead people to make similar investments in preventive activities. Last, individuals may decide to switch behaviors into healthier ones by observing changes in spouses' health, i.e. due to social learning.

Firstly, it is noted that there is indeed a correlation in preventive behavior in the raw data. Seemingly unrelated regressions without controls for unobserved household effects reveal a positive correlation between partner's preventive activities participation: this is consistent with both matching and decision-making. The empirical approach used here has allowed me to investigate and distinguish between three different explanations for this correlation for a variety of preventive activities. Partners' propensities to engage in physical activity are statistically independent in seemingly unrelated regressions with individual fixed effects: all of the correlation in physical activity seems to work through the correlation in individual effects suggesting a case of assortative matching in those characteristics that drive physical activity. For all other preventive activities in HRS, the correlation withstood the inclusion of individual effects suggesting a household decision-making. I find very little evidence to support social learning from both members of the household as an explanation for the correlation in their preventive behavior.

Although the approach used here was used by Clark and Etilé (2006) in British panel data, I have expanded its use not only to a different panel of data comprised by an older population but also to a wider set of preventive behaviors. It is important to mention that Clark and Etilé (2006), contrary to my own findings, found a strong assortative matching effect and not significant evidence on household decision-making on smoking behavior. An explanation may rely in the fact that the population studied in this chapter is much older than theirs. Moreover, the length of marriage in my sample is much longer than in their sample. Thus, it sounds perhaps credible that household-decision making is more important for older marriages than newer marriages.

Clark and Etilé (2006) used the more appropriate bivariate models for binary outcomes like the ones studied here while I used an ordinary least square regression framework. That is, a limitation of my study. Unless the range of the independent variables is severely restricted, linear probability models cannot be a good description of the population response probability P(y=1|x). For given values of the population parameters estimated, there would usually be feasible values of the covariates that fall outside the unit interval (Wooldridge, 2002). The hope is that linear probability models approximate the response probability for common values of the covariates.

There are at least two important highlights of this empirical analysis of the interaction between household members. The first is purely descriptive or positive: if one is able to identify the source of similarity in couples' behaviors, one can build better and more accurate economic models of the household. The second is normative: optimal policy is bound to depend on the nature of household interactions. Given the interest in the American health care system to increase preventive behavior, is useful to know whether is more efficient to target one person per household in term of a given health intervention, to target all members. The evidence in this chapter shows that for most preventive activities, the demand is jointly driven by bargaining within the household, perhaps targeting only one household member, for example women, could have the spillover effect of shifting the behavior in men too.

8. Appendix

Table A.3.1. Instrumental regression for selection bias

	(1)	(2)
	Males	Females
Labor force status		
Full time	-0.363***	1.076*
	(0.020)	(0.602)

Part time	-0.258***	1.098*
	(0.026)	(0.603)
Unemployed	-0.671***	1.018*
	(0.076)	(0.611)
Semi-retired	-0.184***	1.066*
	(0.026)	(0.602)
Retired	-0.217***	1.035*
	(0.016)	(0.602)
Disabled	-0.575***	1.032*
	(0.038)	(0.604)
Not in the labor force (omitted)	0	0
	0.000	0.000
Education		
Less than high school	-0.216***	1.497***
	(0.020)	(0.087)
High school/GED	0.013	1.545***
	(0.017)	(0.087)
Some college	-0.025	1.490***
	(0.019)	(0.088)
College or above (omitted)	0	0
	0.000	0.000
Census divisions	YES	YES
Age dummies	YES	YES

Heteroskedasticity-adjusted robust standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

Table A.3.2. Matching vs. bargaining with all preventive equations in the same set of seemingly unrelated regressions, full sample.

Dependent variable= Corresponding preventive activity at t		(1) SUR spouses single activities simultaneously	(2)	(1) SUR, all preventive activities simultaneously	(2)
		Male	**Female**	**Male**	**Female**
(1)	Respondent's Physical Activity at t-1	0.325***	0.333***	0.297***	0.324***
		(0.009)	(0.009)	(0.015)	(0.015)
	Spouse's Physical	0.041***	0.034***	0.004	0.015

	Activity at t-1	(0.009)	(0.008)	(0.015)	(0.015)
(2)	Respondent's Non-smoker status at t-1	0.799***	0.813***	0.782***	0.800***
		(0.006)	(0.006)	(0.009)	(0.009)
	Spouse's Non-smoker status at t-1	0.020***	0.031***	0.022**	0.038***
		(0.006)	(0.006)	(0.009)	(0.009)
(3)	Respondent's normal weight at t-1	0.753***	0.737***	0.750***	0.742***
		(0.006)	(0.006)	(0.010)	(0.011)
	Spouse's normal weight at t-1	0.010*	0.020***	0.021**	0.013
		(0.005)	(0.007)	(0.009)	(0.012)
(3)	Respondent's flu shot at t-1	0.440***	0.465***	0.430***	0.450***
		(0.013)	(0.013)	(0.014)	(0.015)
	Spouse's flu shot at t-1	0.098***	0.101***	0.089***	0.089***
		(0.013)	(0.013)	(0.014)	(0.015)
(4)	Respondent's cholesterol screening at t-1	0.265***	0.239***	0.231***	0.231***
		(0.013)	(0.013)	(0.013)	(0.014)
	Spouse's cholesterol screening at t-1	0.042***	0.074***	0.019	0.048***
		(0.012)	(0.013)	(0.012)	(0.014)
(5)	Respondent's prostate screening (male)/Pap smear test (female) at t-1	0.295***	0.043***	0.266***	0.362***
		(0.014)	(0.015)	(0.014)	(0.014)
	Spouse's prostate screening (female)/Pap smear test (male) at t-1	0.072***	0.400***	0.001	0.042***
		(0.013)	(0.014)	(0.002)	(0.016)
(6)	Respondent's prostate screening (male)/mammography (female) at t-1	0.294***	0.424***	0.267***	0.366***
		(0.014)	(0.013)	(0.014)	(0.013)
	Spouse's prostate screening (female)/mammography (male) at t-1	0.077***	0.053***	0.001	0.037***
		(0.014)	(0.013)	(0.002)	(0.013)
Number of observations		15,750			
Number of individuals		3,150			

All columns show the marginal effect of the variable in question in seemingly unrelated regressions predicting all the preventive activity at t simultaneously.. All regressions were controlled for the inverse mills ratio, age, age squared, race, veteran status, working status (full time, part time, unemployed, partly retired, retired, disabled, other), number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education years, mental health (CESD score), residence in one of 10 census divisions and wave. Standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

Table A.3.3. Matching vs. bargaining with respondent's AND spouse's covariates included, full sample.

	Dependent variable= Corresponding preventive activity at t	**(1)**	**(2)**	**(3)**	**(4)**
		SUR with no fixed effects		**SUR with fixed effects**	
		Male	**Female**	**Male**	**Female**
(1)	Respondent's Physical Activity at t-1	0.324***	0.332***	0.248***	0.252***
		(0.009)	(0.009)	(0.009)	(0.008)
	Spouse's Physical Activity at t-1	0.003	0.003	0.003	0.003
		(0.009)	(0.009)	(0.009)	(0.008)
(2)	Respondent's Non-smoker status at t-1	0.798***	0.813***	0.798***	0.819***
		(0.006)	(0.006)	(0.006)	(0.005)
	Spouse's Non-smoker status at t-1	0.020***	0.028***	0.020***	0.023***
		(0.006)	(0.006)	(0.006)	(0.005)
(3)	Respondent's normal weight at t-1	0.753***	0.736***	0.753***	
		(0.006)	(0.006)	(0.006)	(0.006)
	Spouse's normal weight at t-1	0.009	0.018***	0.008	0.012*
		(0.006)	(0.007)	(0.006)	(0.006)
(3)	Respondent's flu shot at t-1	0.438***	0.463***	0.437***	0.474***
		(0.013)	(0.013)	(0.013)	(0.013)
	Spouse's flu shot at t-1	0.097***	0.100***	0.098***	0.094***
		(0.013)	(0.013)	(0.013)	(0.013)
(4)	Respondent's cholesterol screening at t-1	0.263***	0.237***	0.264***	0.245***
		(0.013)	(0.013)	(0.013)	(0.012)
	Spouse's cholesterol screening at t-1	0.042***	0.074***	0.043***	0.069***
		(0.012)	(0.013)	(0.012)	(0.012)
(5)	Respondent's prostate screening (male)/Pap smear test (female) at t-1	0.306***	0.420***	0.282***	0.420***
		(0.013)	(0.013)	(0.014)	(0.013)
	Spouse's prostate screening (female)/Pap smear test (male) at t-1	0.071***	0.039***	0.077***	0.039***
		(0.014)	(0.012)	(0.015)	(0.012)
(6)	Respondent's prostate screening (male)/mammography (female) at t-1	0.306***	0.397***	0.285***	0.398***
		(0.013)	(0.014)	(0.014)	(0.014)
	Spouse's prostate screening (female)/mammography (male) at t-1	0.072***	0.040***	0.071***	0.041***
		(0.012)	(0.014)	(0.013)	(0.014)
	Number of observations	15,750			
	Number of individuals	3,150			

All columns show the marginal effect of the variable in question in seemingly unrelated regressions predicting all the preventive activity at t simultaneously. All regressions were controlled for the inverse mills ratio, the respondent's and the spouse's age, age squared, race, veteran status, working status (full time, part time, unemployed, partly retired, retired, disabled, other), number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education years, mental health (CESD score), residence in one of 10 census divisions and wave. Standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

Table A.3.4. Effect of spouse's termination of preventive activities, full sample.

Dependent variable= Termination of corresponding preventive activity at t	**(1)**	**(2)**	**(3)**	**(4)**
	SUR with no fixed effects		**SUR with fixed effects**	
	Male	**Female**	**Male**	**Female**
Spouse termination of physical activity at t	0.017	0.015	0.008	0.008
	(0.011)	(0.012)	(0.010)	(0.008)
Spouse termination of non-smoker status (i.e. quitting) at t	0.086***	0.085***	0.047***	0.048***
	(0.011)	(0.011)	(0.011)	(0.010)
Spouse termination of normal weight status at t	0.047***	0.064***	0.024***	0.028***
	(0.008)	(0.011)	(0.008)	(0.010)
Spouse termination of flu shot at t	0.207***	0.203***	0.107***	0.115***
	(0.015)	(0.014)	(0.015)	(0.014)
Spouse termination of cholesterol screening at t	0.147***	0.164***	0.074***	0.080***
	(0.014)	(0.015)	(0.014)	(0.015)
Spouse termination of Pap smear screening (male respondents) prostate screening (female screening) at t	0.038***	0.047***	0.023*	0.028*
	(0.013)	(0.017)	(0.013)	(0.016)
Spouse termination of mammography (male respondents) prostate screening (female respondent) at t	0.050***	0.045***	0.028*	0.016
	(0.016)	(0.015)	(0.016)	(0.017)
Number of coupled/observations	15,750			
Number of individuals	3,150			

All columns show the marginal effect of the variable in question in separate models predicting the initiation of each preventive activity at t. All regressions were controlled for respondent's and spouse's past participation in the relevant preventive activity at t-1, the inverse mills ratio, age, age squared, race, veteran status, working status (full time, part time, unemployed, partly retired, retired, disabled, other), number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education years, mental health (CESD score), residence in one of 10 census divisions and wave. Standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

Table A.3.5. *Effect of spouse's termination of preventive activities among those eligible to terminate the activity.*

Dependent variable= Termination of corresponding preventive activity at t among eligible to terminate	**(1)**	**(2)**	**(3)**	**(4)**		
	SUR with no fixed effects		**SUR with fixed effects**		**Number of observations (Number of individuals)**	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
Spouse termination of physical activity at t	0.210***	0.142***	0.110***	0.128***	7,857	7,257
	(0.014)	(0.009)	(0.014)	(0.014)	(2,428)	(2,498)
Spouse termination of non-smoker status (i.e. quitting) at t	0.114***	0.076***	0.062***	0.053***	8,871	9,780
	(0.013)	(0.009)	(0.012)	(0.010)	(2,566)	(2,985)
Spouse termination of normal weight status at t	0.144***	0.064***	0.064**	0.049**	3,427	5,339
	(0.025)	(0.011)	(0.025)	(0.022)	(1,078)	(1,663)
Spouse termination of flu shot at t	0.246***	0.180***	0.127***	0.167***	3,304	3,493
	(0.020)	(0.015)	(0.020)	(0.021)	(1,999)	(2,145)
Spouse termination of cholesterol screening at t	0.160***	0.158***	0.080***	0.085***	4,229	4,568
	(0.015)	(0.015)	(0.015)	(0.016)	(2448)	(2,717)
Spouse termination of Pap smear screening (male respondents) prostate screening (female screening) at t	0.038***	0.054***	0.024*	0.034*	3,511	4,152
	(0.014)	(0.020)	(0.014)	(0.020)	(2088)	(2,485)
Spouse termination of mammography (male respondents) prostate screening (female respondent) at t	0.052***	0.041***	0.028	0.012	3,738	4,443
	(0.018)	(0.015)	(0.018)	(0.014)	(2187)	(2,615)

All columns show the marginal effect of the variable in question in separate models predicting the termination of each preventive activity at t. All regressions were controlled by controlled for respondent's and spouse's past participation in the relevant preventive activity at t-1, the inverse mills ratio, age, age squared, race, veteran status, working status (full time, part time, unemployed, partly retired, retired, disabled, other), number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education years, mental health (CESD score), residence in one of 10 census divisions and wave. Standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

Table A.3.6. *Effect of own and spouse's cardiology related health shock on initiation of preventive activities.*

Dependent variable= Initiation of corresponding preventive activity at t	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
	Effect of own cardiology related health shock on preventive activity				**Effect of spouse's cardiology related health shock on preventive activity**			
	SUR with no fixed effects		**SUR with fixed effects**		**SUR with no fixed effects**		**SUR with fixed effects**	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Health shock on vigorous physical activity	-0.005	0.005	-0.008	0.001	-0.006	-0.011	-0.005	-0.006
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.008)
Health shock on nonsmoker status	0.019***	0.010***	0.027***	0.010**	0.002	0.004	0.001	0.002
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)
Health shock on normal weight status	0.011*	0.006	0.012**	0.004	-0.002	0.004	-0.001	0.005
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)
Health shock on flu shot	0.032**	0.022	0.030**	0.035**	0.001	-0.014	-0.002	-0.003
	(0.014)	(0.016)	(0.015)	(0.015)	(0.015)	(0.014)	(0.010)	(0.014)
Health shock on cholesterol screening	0.051***	0.041***	0.050***	0.046***	0	0.008	0.002	0.014
	(0.009)	(0.010)	(0.009)	(0.010)	(0.010)	(0.010)	(0.010)	(0.009)
Health shock on prostate screening (male)/Pap smear (female)	0.264**	0.237**	0.020*	0.026**	-0.005	-0.009	-0.006	-0.008
	(0.128)	(0.115)	(0.011)	(0.012)	(0.012)	(0.011)	(0.011)	(0.011)
Health shock on prostate screening (male)/mammography (female)	0.018	0.013	0.021**	0.013	-0.005	0.013	-0.007	0.006
	(0.011)	(0.011)	(0.010)	(0.010)	(0.012)	(0.010)	(0.011)	(0.009)
Number of coupled/observations	15,750							
Number of couples	3,150							

All columns show the marginal effect of the variable in question in separate models predicting the initiation of each preventive activity at t. All regressions were controlled for respondent's and spouse's past participation in the relevant preventive activity at t-1, the inverse mills ratio, age, age squared, race, veteran status, working status (full time, part time, unemployed, partly retired, retired, disabled, other), number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education years, mental health (CESD score), residence in one of 10 census divisions and wave. Standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

Table A.3.7. Effect of own and spouse's cardiology related health shock on initiation of preventive activities among those eligible to initiate.

Dependent variable= Initiation of corresponding preventive activity at t among eligible to initiate	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(5)	(6)
	Effect of OWN cardiac related shock on preventive activity				Effect of SPOUSE cardiac related on preventive activity				Number of observations (Number of individuals)	
	SUR with no fixed effects		SUR with fixed effects		SUR with no fixed effects		SUR with fixed effects			
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Health shock on vigorous physical activity	-0.019* (0.011)	0.005 (0.008)	-0.022* (0.012)	-0.011 (0.009)	-0.015 (0.010)	0.008 (0.008)	-0.014 (0.011)	0.002 (0.009)	7,187 (2,335)	9,025 (2,915)
Health shock on nonsmoker status	0.041*** (0.014)	0.027*** (0.009)	0.047*** (0.015)	0.035*** (0.011)	-0.021 (0.014)	-0.009 (0.008)	-0.008 (0.014)	0.002 (0.011)	2,182 (1,174)	2,889 (1,814)
Health shock on normal weight status	-0.015*** (0.005)	-0.018*** (0.005)	-0.013** (0.006)	-0.013* (0.007)	-0.003 (0.005)	0.004 (0.005)	-0.001 (0.006)	0.007 (0.007)	9,201 (2,420)	8,649 (2,531)
Health shock on flu shot	0.081*** (0.019)	0.038** (0.017)	0.089*** (0.021)	0.084*** (0.020)	-0.003 (0.018)	-0.019 (0.016)	0.01 (0.020)	0.016 (0.020)	2,362 (1,537)	2,651 (1,747)
Health shock on cholesterol screening	0.152*** (0.024)	0.077*** (0.018)	0.157*** (0.025)	0.185*** (0.023)	0.012 (0.024)	-0.013 (0.016)	0.02 (0.025)	0.004 (0.023)	1,332 (927)	1,583 (1,095)
Health shock on prostate screening	0.136***	0.119***	0.136***	0.068***	0.044	-0.022	0.041	0.017	619	1,441

(male)/mammography (female)	(0.036)	(0.038)	(0.040)	(0.026)	(0.035)	(0.035)	(0.038)	(0.025)	(466)	(0,466)
Health shock on prostate screening (male)/Pap smear (female)	0.130***	0.101***	0.120***	0.041**	0.037	-0.015	0.032	-0.01	783	2,073
	(0.031)	(0.031)	(0.033)	(0.020)	(0.030)	(0.029)	(0.032)	(0.020)	(586)	(1,424)

All columns show the marginal effect of the variable in question in separate models predicting the initiation of each preventive activity at t. All regressions were controlled for respondent's and spouse's past participation in the relevant preventive activity at t-1, the inverse mills ratio, age, age squared, race, veteran status, working status (full time, part time, unemployed, partly retired, retired, disabled, other), number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education years, mental health (CESD score), residence in one of 10 census divisions and wave. Standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

Table A.3.8. Effect of own and spouse's health shock on termination of preventive activities among those eligible to terminate.

Dependent variable= Termination of corresponding preventive activity at t among those eligible to terminate	**(1)**	**(2)**	**(3)**	**(4)**	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	Effect of OWN health shock on termination of preventive activity				**Effect of SPOUSE health shock on termination of preventive activity**				**Number of observations (Number of individuals)**	
	SUR with no fixed effects		**SUR with fixed effects**		**SUR with no fixed effects**		**SUR with fixed effects**			
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Health shock on vigorous physical activity	0.019*	0.013	0.025**	0.014	-0.001	-0.005	0.006	0.019	7,857	7,257
	(0.011)	(0.008)	(0.011)	(0.011)	(0.010)	(0.008)	(0.011)	(0.012)	(2,428)	(2,498)
Health shock on non-smoker status	0	0	0.001	0.004	0.003	0	0.004	0.002	8,871	9,777
	(0.003)	(0.002)	(0.004)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(2,566)	(2,985)
Health shock on normal weight status	0.030**	0.021**	0.031*	0.060***	-0.021	-0.006	0.001	0.016	3,425	5,335
	(0.014)	(0.009)	(0.016)	(0.012)	(0.013)	(0.009)	(0.016)	(0.012)	(1,078)	(1,662)

Health shock on flu shot	-0.040*** (0.010)	-0.017** (0.008)	-0.042*** (0.011)	-0.016* (0.009)	-0.014 (0.009)	-0.019** (0.009)	-0.014 (0.009)	-0.018* (0.010)	3,304 (1,999)	3,492 (2,145)
Health shock on cholesterol screening	-0.075*** (0.010)	-0.055*** (0.009)	-0.075*** (0.010)	-0.061*** (0.010)	0.003 (0.009)	-0.003 (0.010)	0 (0.009)	-0.008 (0.010)	4,229 (2448)	4,565 (2,716)
Health shock on prostate screening (male)/mammography (female)	-0.031** (0.013)	-0.016 (0.010)	-0.029** (0.013)	-0.019* (0.010)	-0.005 (0.011)	-0.005 (0.011)	-0.002 (0.011)	0.003 (0.010)	3,738 (2187)	4,440 (2,614)
Health shock on prostate screening (male)/Pap smear (female)	-0.034*** (0.013)	0.006 (0.014)	-0.032** (0.013)	0.001 (0.013)	-0.009 (0.011)	0.001 (0.015)	-0.006 (0.011)	-0.009 (0.013)	3,511 (2088)	4,150 (2,485)

All columns show the marginal effect of the variable in question in separate models predicting the termination of each preventive activity at t. All regressions were controlled for respondent's and spouse's past participation in the relevant preventive activity at t-1, the inverse mills ratio, age, age squared, race, veteran status, working status (full time, part time, unemployed, partly retired, retired, disabled, other), number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education years, mental health (CESD score), residence in one of 10 census divisions and wave. Standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

CHAPTER 4: THE ASSOCIATION BETWEEN PREVENTION AND MEDICARE EXPENDITURES

1. Introduction

It has been suggested that preventive lifestyle interventions targeted at lifestyle-related risk factors, such as smoking and obesity, have the potential of not only increasing public health but at the same time lowering health-care expenditures (Fries et al., 1993; OECD, 2005). In fact, in the recent debate over health reform where questions regarding national resources and how they should be used were raised, prevention was among the contested topics. The Obama administration and several others policy makers promoted prevention of unhealthy lifestyles as simultaneously reducing costs and improving public health but this has yet to be proven to be true. In fact, although some preventive measures do save money, the vast majority reviewed in the health economics literature do not (Cohen et al., 2007). For many, it remains counterintuitive that a healthy lifestyle results in more rather than in less lifetime health-care expenditures. This is problematic as it may result in inefficient use of health-care resources based on overly optimistic assumptions regarding lower health-care expenditures due to prevention, and thus may cause disappointment, particularly among policymakers, when prevention fails to meet these expectations.

An important observation regarding the value of preventive services is that they might still provide desirable benefits in the form of improved health. However, the fact that prevention may increase lifetime expenditures due to an increase of unrelated diseases in life years gained is currently not adequately reflected in most economic evaluations (Rappange et al., 2009). Most studies fail to take into account the costs of unrelated diseases in life years gained. For example, NICE recently investigated the cost-effectiveness of several smoking cessation interventions and concluded that many interventions result in cost savings (Flack, Taylor, Trueman, 2009) This conclusion was reached, however, by ignoring the unrelated medical costs in life years gained. If these costs would be included, the interventions may not be cost saving anymore. Therefore, a crucial aspect of an analysis of the value of preventive services is to know whether life expectancy is affected by preventive behavior.

The push for prevention pre-empts the recent health care reform debate. In fact, prevention was emphasized back in 1993 when President Clinton attempted to reform the health care system (Keigher, 1993). Again, in 2002 when the US Congressed passed the Medicare Prescription Drug, Improvement and Modernization Act of 2003 (MMA), beneficiaries were entitled to a new expanded menu of preventive benefits by covering an initial preventive physical examination. This benefit, also referred to as the "Welcome to Medicare" visit, represented a way for new Medicare beneficiaries to get up-to-date on screenings and vaccinations. According to the Center for Medicare and Medicaid Services (CMS), the Welcome to Medicare visit enables the health care provider to comprehensively review his or her patient's health, to identify risk factors that may be associated with various diseases, and to detect diseases early when outcomes are best (Centers for Medicare & Medicaid Services 2010). Beneficiaries enrolled in Medicare Part B have one year from their Part B enrollment date to take advantage of the “Welcome to Medicare” visit. Nevertheless, the demand for the “Welcome to Medicare” program is very low. An analysis of claims data in preparation for this study shows that less than 5% of beneficiaries take advantage of this program. However, the existence of this program is useful in this analysis as a reason to benchmark the preventive behaviors of older adults at age 65.

This chapter examines the question of whether prevention affects health expenditures from a different perspective. Taking into consideration that the "Welcome to Medicare" program is meant to provide preventive services as soon as a person enrolls in the program presumably at age 65, I ask whether beneficiaries who undergo different kinds of preventive behaviors close to that age have higher or lower expenditures than people who do not engage in such activities. Similarly, in this chapter I analyze whether people who engaged in preventive behaviors close to age 65 end up living longer lives or not.

This chapter aims to add to the empirical question of whether prevention can affect health expenditures. Rather than evaluate the cost effectiveness of different preventive interventions, I use observational data from the Health and Retirement Study linked to Medicare Claims data. Using a variety of econometric specifications to try to understand endogeneity bias, I find that the term prevention as a tool for cost effectiveness or cost saving is used remarkably expansively as the different preventive activities have markedly diverse effects on expenditures. Only physical activity and non-smoking behavior show signs of unequivocal reductions in Medicare spending. Other interventions such as flu shot and cholesterol screening are associated with increased expenditures. Cancer screenings such as breast, cervical and prostate cancer screenings do not seem to affect the expenditures trends of respondents in sample. In addition, I find that only non-smoking can be associated with an increase in life expectancy.

This chapter is organized as follows. In section 2, I present a review of the literature relevant to the relationship between different kinds of preventive services and health expenditures and life expectancy. Section 3, presents the data and section 4 discusses the empirical strategy. Findings are reported in section 5, section 6 discusses them, and section 7 concludes.

2. Background

2.1. Lifestyle prevention

Lifestyle changes are often thought of obvious targets for interventions that can produce both better health and medical savings. However, the evidence in these activities is not always clear cut.

On the one hand, studies such as Daviglus et al. (2004) used longitudinal data to find that body mass index (BMI) assessed during young adulthood and middle age was significantly and positively associated with average annual cardiovascular disease-related and total Medicare health care charges in older age as well as with cardiovascular disease (CVD)-related and total cumulative charges from age 65 years to death or to age 83 years. In addition, Daviglus et al. (2005) studied participants in the Chicago Heart Association Detection Project in Industry (CHA) study. The sample consisted on men and women aged 32 to 64 years at baseline in 1967 through 1973, who died at ages 66 to 99 years and had Medicare coverage for at least one year in 1984 through 2002. In it, CVD expenditures were obtained for 39,522 adults from Medicare Claims data. Participants were classified as having favorable levels of all major cardiovascular risk factors (low risk), that is, serum cholesterol level lower than 200 mg/dL (>.2 mmol/L), blood pressure 120/80 mm Hg or lower and no antihypertensive medication, body mass index (calculated as weight in kilograms divided by the square of height in meters) lower than 25, no current smoking, no diabetes, and no electrocardiographic abnormalities. The study shows categorically that in the last year of life, average Medicare charges were lowest for low-risk persons.

On the other hand, the Diabetes Prevention Study showed that lifestyle changes could substantially reduce the risk of developing diabetes (Tuomilehto et al., 2001). Middle-aged overweight people whose oral glucose tests put them at high risk of diabetes were randomly assigned to a lifestyle program or a control group. The program provided individually tailored diet and exercise plans, backed up by visits to a nutritionist and physical training sessions. Over the following four years, only 11% of those enrolled in the program developed diabetes, compared with 23% in the control group. Even so, the program added substantially to medical costs ("health plan" costs in the study). Medical costs were $192,000 for each healthy year gained in 2007 dollars.

For smoking cessation programs, costs ranged from $2200-2300 per quitter (1995 dollars) for intensive group counseling to $7,922 per quitter for minimal counseling by a physician with no nicotine replacement, a relatively ineffective approach (Eddy, Schlessinger, Kahn 2005). Averaged over the various programs, the cost for each healthy year gained was low, about $5,000 even in 2007 dollars. Though even they do not reduce medical spending, smoking cessation programs are a very cost-effective way to improve health.

Among the few studies that have used publicly available data, one of them used data from four waves of the HRS to assess the impact of smoking on use of hospital and physicians' services and nursing home care. The authors uncovered that smoking increased medical utilization and dollar outlays by 5 to 8 percent on average, with substantial variation in incidence by payer. Public payers bore a disproportionate burden.

In sum, the evidence that lifestyle changes necessarily reduce health expenditures is not obvious. Importantly, it is worth noting than the studies mentioned here as well as in the majority of the literature fail to take into account the time that the subjects spend engaging in these activities. Nevertheless, lifestyle changes involve expenditures outside the medical sector and use people's time. The people who incur the expenditures and spend the time realize that they must take money and time from other uses. They make their choices based on the costs and benefits they see. Savings to the medical sector are more akin to cost shifting than true savings since, to produce them additional resources must be spent outside the medical sector (Russell, 2007).

2.2. Screening

Screening, or early detection, is only useful if a condition can be treated more effectively when it is discovered early. For heart disease, screening makes treatment of risk factors possible, and new medications make it effective; evaluations have tended to focus on the medications rather than the screening. For other diseases, perhaps because the treatment for early disease is not so different from treatment for later disease, studies more often begin with screening and focus on evaluating the costs and health outcomes of screening people with different risks, of screening them more or less frequently, or of using different screening tests. Since screening is only successful if it leads to more effective treatment, understanding its medical costs and savings depends on tracing the complete path of events. If the medical costs of screening and early treatment are less than those of treating when the disease declares itself through symptoms, screening reduces medical spending.

Studies of cancer screening find that, like other preventive measures, it usually adds more to medical costs than it saves. How much medical costs increase depends, in part, on patients' risk. Screening targeted to high-risk groups is more cost-effective than general screening. Screening frequency and the cost of follow up tests can also have a major impact on costs. Annual screening for cervical cancer, usually a slow-moving disease, adds greatly to medical costs, with little additional health benefit, compared to screening less often (Eddy, 1990). Studies agree that screening for colorectal cancer in adults aged 50 or older adds to medical costs and that the additional cost per healthy year of life gained is within the range of accepted medical practices; there are, however, several different screening tests, many ways to combine them, and no consensus on the most cost-effective ways (Frazier et al., 2000; Pignone et al., 2005). Mammography to screen for breast cancer, MRI screening for women with genetic mutations that put them at high risk for breast cancer, all add more to medical expenditures than they save (Lindfors, Rosenquist, 1995; Mandelblatt et al., 2003).

The last 40 years have seen the rise of medications to control 'risk factors' for disease, especially risk factors for cardiovascular disease such as elevated blood pressure and cholesterol. Risk factors are not themselves diseases, but are associated with higher risk of developing disease. After clinical trials showed that medications could reduce blood pressure, and with it, strokes and heart attacks, national guidelines were developed to encourage their use (Russell, 1986). Other trials showed that lowering blood cholesterol with medication could prevent heart disease and guidelines for those medications followed (Russell 1994). In each case, the prevention process has two parts: people are first screened to discover their blood pressure or cholesterol levels; then, for those whose levels warrant it, medications are prescribed. Screening is conducted every year or every few years. Treatment, once begun, is supposed to continue indefinitely. Evaluations sometimes examine screening, sometimes treatment, sometimes both. One of the earliest cost-effectiveness studies estimated medical costs and savings, and gains in health, from prescribing medication to lower blood pressure in people whose elevated pressures had already been identified by screening (Weinstein 1976). Even ignoring the costs of screening, the study found that medication added to medical costs more than it saved.

2.3. Flu shot

Vaccines are among the most cost-effective preventive interventions. Even when they do not save money, they prevent disease and death, and preserve health, at a much lower cost than many other medical interventions, either preventive or therapeutic. They sometimes reduce medical spending as well, but the examples cited indicate that spending reductions depend on a number of circumstances – disease risk in the population, vaccine effectiveness, price per dose – and cannot be assumed to happen as a matter of course.

Evaluations of the pneumococcal vaccine have shown that it can reduce medical costs in older adults. In people 65 or older vaccination reduced medical spending as long as the price per dose was less than $35 in 2007 dollars (Sisk et al. 1997). Vaccination can also reduce medical spending among high-risk people aged 50-64 (people with heart disease, emphysema, diabetes, and other chronic conditions), and, in some circumstances, in the general population aged 50-64 – especially among blacks, who suffer higher rates of invasive pneumococcal disease (Sisk et al. 2003). The cost of the vaccine and its administration was lower in the second analysis, $25 in 2007 dollars. The 2007 cost per dose, which excludes costs of administration, is $15-17 to CDC and $26-29 for private sector purchasers (Centers for Disease Control).

3. Data

3.1. The Health and Retirement Study linked to Medicare claims data

In this study I use publicly available data from the Health and Retirement Study (HRS), a nationally representative, longitudinal study sponsored by the National Institute on Aging and conducted by the Institute for Social Research at the University of Michigan, Ann Arbor. Designed to assess health status, retirement decisions, and economic security during retirement, this study enrolled non-institutionalized adults in the 48 contiguous US states who were born during the years 1931 through 1941, with oversampling of blacks, Hispanics, and Florida residents. I use waves 3, 5, and 7 collected in 1996, 2000, and 2004, respectively as only these waves contained all the necessary variables regarding preventive behavior. Further details of this survey are available at the following address: http://hrsonline.isr.umich.edu/

In addition, HRS data was linked to claim data from 1996 to 2005 extracted from Medicare inpatient, outpatient, carrier (physician), home care and hospice care analytical files.

3.2. Prevention in the Health and Retirement Study.

HRS asks respondents questions regarding lifestyle preventive choices such as exercising, smoking and body weight in each of the 8 rounds. However, respondents were surveyed about medical care related preventive activities, namely flu shot, cholesterol screening, pap smear test, mammography, and prostate screening (table 4.1), only every other wave starting in wave 3. As such and in order to preserve consistency, only waves 3, 5, and 7 are considered for all preventive variables and covariates. Since the primarily interest of this study is to understand the effect of preventive services performed close to the age of enrollment into Medicare, the wave of origin was chosen to be that for which the interview age was closer to when the respondents turned 65.

Table 4.1. Preventive services in the Health and Retirement Study.

Type of preventive investment	Preventive investment	Description
Healthy Lifestyle Preventive activities	Vigorous physical exercise	Performs vigorous exercise 3+ times per week
	Non-smoking	Respondent currently does not smoke
	Normal weight	Respondent whose body mass index (body weight in pounds divided by the square of one's height in inches) is more than 20 and less than 25.
Clinical Preventive activities	Flu shot	Whether the respondent has gotten the shot this wave
	Cholesterol Screening	Whether the respondent has gotten the test this wave
	Breast Cancer Screening	Whether the respondent has gotten a mammography this wave
	Cervical Cancer Screening	Whether the respondent has gotten a Pap smears this wave
	Prostate Cancer Screening	Whether the respondent has gotten any kind of prostate cancer test this wave

3.3. Health Expenditures

In order to better understand the expenditure trends among respondents in sample, I analyze different types of expenditure variable found in Medicare claims data from years 1996 to 2005. The main specification for health expenditures includes those expenditures within the first 5 years in the Medicare program, among those respondents that had 5 or more years as beneficiaries. In order to standardize the expenditures, all monetary measures were adjusted to 2005 dollars using the Consumer Price Index (CPI):

a) Inpatient expenditures: include final action claims data submitted by inpatient hospital providers for reimbursement of facility costs.

b) Outpatient expenditures: encompass final action claims data submitted by institutional outpatient providers. Examples of institutional outpatient providers include hospital outpatient departments, rural health clinics, renal dialysis facilities, outpatient rehabilitation facilities, comprehensive outpatient rehabilitation facilities, and community mental health centers.

c) Physician expenditures: contains final action claims data submitted by non-institutional providers. Examples of non-institutional providers include physicians, physician assistants, clinical social workers, nurse practitioners, independent clinical laboratories, ambulance providers, and free-standing ambulatory surgical centers.

d) All Medicare expenditures: includes inpatient, outpatient, carrier (physician), plus home care and hospice care.

I repeat the analysis for alternative definitions of the expenditure measures. In the appendix, I include the results for expenditures during the first 10 years in Medicare (ages 65-74) and average yearly expenditures.

3.4. Sample

The working sample includes all respondents who had no missing answers in the round closer to age 65. Since the main outcome analyzed in section 5 is the expenditures during the first 5 years during in Medicare (ages 65 to less than 70), I describe the characteristics of the subsample of respondents that have all 5 years of data in table 4.2.

Table 4.2. Descriptive characteristics of main sample.

Variable	**Mean**	**Std. Dev.**
Preventive Behaviors		
Vigorous Physical Activity	49.48%	(50.01%)
Non-smoker status	86.54%	(34.13%)
Normal weight status	30.34%	(45.98%)
Flu shot	60.19%	(48.96%)
Cholesterol screening	81.44%	(38.89%)
Mammogram	78.80%	(40.89%)
Pap smear test	67.03%	(47.03%)
Prostate screening	80.20%	(39.87%)
Variables in model (plausible instruments)		
Life insurance	72.53%	(44.65%)
Long term care insurance	13.10%	(33.75%)
Health Insurance in previous round	92.43%	(26.46%)
Long term planning horizon	71.32%	(45.70%)
Risk averse to job change	62.94%	(48.31%)
Less than high school	23.38%	(42.33%)
High School or GED	40.12%	(49.03%)
Some College	17.45%	(37.96%)
College or above	19.00%	(39.24%)
Health depreciation (Change in self-reported measures)	3.09	(0.76)
Covariates		
Female	56.63%	(49.57%)
Non-Hispanic white	80.15%	(39.90%)
Non-Hispanic black	13.03%	(33.67%)
Hispanic	5.36%	(22.53%)
Other race	1.46%	(11.99%)
Veteran status	27.91%	(44.86%)
Working full time or part time	15.99%	(36.66%)
Total assets/1000	396.76	(733.67)
Married	72.86%	(44.48%)
Number of household residents	2.16	(0.99)
Self Reported Health (1. excellent, 2. very good, 3. good, 4. fair, 5. poor)	2.70	(1.09)
Ever diagnosed with high blood pressure	49.15%	(50.00%)

Ever diagnosed with heart disease	19.71%	(39.79%)
Ever diagnosed with diabetes	8.56%	(27.98%)
Ever diagnosed with lung disease	15.24%	(35.95%)
Ever diagnosed with cancer	10.79%	(31.03%)
Ever diagnosed with a stroke	4.66%	(21.08%)
Ever diagnosed with psychiatric problems	10.49%	(30.65%)
Ever diagnosed with arthritis	58.17%	(49.34%)
Activities of Daily Living	0.22	(0.71)
Recipient of SS benefits	8.14%	(27.35%)
Functional limitations	2.44	(2.76)
Mental Health score	1.35	(1.81)
Census division New England	3.57%	(18.57%)
Census Division Mid-Atlantic	9.08%	(28.74%)
Census Division Eastern North Central	19.24%	(39.43%)
Census Division Western North Central	11.34%	(31.71%)
Census Division South Atlantic	24.88%	(43.24%)
Census Division Western South Central	7.86%	(26.91%)
Census Division Eastern South Central	12.79%	(33.41%)
Census Division Mountain	3.95%	(19.49%)
Census Division Pacific	7.15%	(25.77%)
Census Division Other	0.14%	(3.75%)
N	1966	

3.4. Accounting for selection bias

Since I am only interested in the respondents who have agreed to have their Medicare data linked to Medicare, there is likely some selection bias involved in moving from a sample in which people choose not to make their Medicare files available to HRS and the sample in which they do. As such, the samples used for regression will not necessarily reflect the total population of couples. In particular, there could be an unobserved variable which determines the desire to share health expenditure data publicly, which is also linked to the outcome of interest.

To correct for any selection bias in moving from the HRS interviewed sample to the sample with Medicare data, I compute a Mills ratio using a selection variable that equals 1 at period t if the individual has Medicare data. This selection equation is estimated as a function of HRS birth cohort, education (3 dummies), labor force status (working or not), U.S. Census division and age dummies. The identifying variables were the labor force status at age 65 and cohort membership. This dummy variable (1 if the person works full time or part time, 0 if she does not) was not used in this way in the list of controls. Membership in each of the HRS cohorts was not used as a control either.

4. Econometric Specification

4.1. Descriptive statistics and naïve models

Three methods were used to analyze the association of preventive activities on expenditures:

1) Ordinary Least Square with Propensity Scores Weights: Here, the outcome variable is regressed on the treatment indicator and weighted with the estimated propensity score inverse weights.

$$Y = \beta_0 + \beta_1 \cdot Prevention + X^T \cdot \beta_X + \varepsilon$$

2) Two part model with Propensity Scores Weights: In this model I estimate a probit model for the probability of any expenditure and a log-linear conditional expenditure function (Manning and Mullahy, 2001). The log-linear model was weighted with the estimated propensity score inverse weights.

$$\ln(Y) = \beta_0 + \beta_1 \cdot Prevention + X^T \cdot \beta_X + \varepsilon$$

3) Generalized Linear Models (GLM) with a log link function, with a variance proportional to the E(y|x): This GLM estimator assumes that the raw-scale variance is proportional to the conditional expectation, which is a Poisson-like assumption with overdispersion, but without the discrete nature of the usual Poisson variate.

For all three models, I assume robust heteroskedastic standard errors to account for the correct variance-covariance matrix.

The combination of all covariates and dependent variable were checked for multi-colinearity. Condition indexes were found to be acceptably less than 30 in most of the cases and less than 40 in only a few of them (Belsley, 1991).

The marginal effect of prevention on expenditures (y) was calculated for two part models by considering that when x_p is a dummy for the preventive activity in question:

$$E(y|x_p = 1) - E(y|x_p = 0)$$

$$= \left[\Pr(y > 0|x_p = 1) - (\Pr(y > 0|x_p = 0) \times E(y|y > 0|x_p = 1\right]$$

$$- \Pr(y > 0|x_p = 0) \times \left[(\mathrm{E}(y|y > 0|x_p = 1) - E(y|y > 0|x_p = 0)\right]$$

4.1.1. Propensity scores

As mentioned above, the OLS models include propensity scores inverse weights. I used a propensity-score weighting technique (Rosenbaum and Rubin, 1984) to balance the distributions of numerous characteristics between comparison groups at age 65, approximately. These characteristics were chosen to be those that were found in the theoretical model (chapters 1) of this study and in the empirical section of the demand for prevention (chapter 2) to have an important role in driving the use of preventive services. I used logistic regression to model the odds of using each of the preventive behaviors analyzed in here as a function of these characteristics. Predicted probabilities of using each of the preventive behaviors (propensity scores) were used to derive individual weights equal to the probability of belonging to the opposite group, making the weighted distribution of characteristics of preventive and non preventive users identical. Weighted analyses therefore adjusted for potential confounding due to measured predictors of both preventive and use of services.

4.2. Problems with naïve approach

The first problem inherent in my OLS estimation is that ordinary least squares estimation is biased because an explanatory variable in the regression is correlated with the error term in the regression cov (Prevention $\cdot$ ε) $\neq 0$. Such a correlation can result from an endogenous, mismeasured, or omitted explanatory variable, or a lagged dependent variable among the explanatory variables (Murray, 2006). In the particular general equation above, an omitted explanatory variable may arise when individuals who engage in preventive behavior might do so because they are in a healthier status to begin with. Conversely, people with chronic conditions might be less likely to exercise. Bias due to an omitted explanatory variable will be evident if more health conscious people are inherently more inclined towards preventive services and healthy living. It is foreseeable that such healthier populations or more health conscious populations will then have diminished health expenditures when in Medicare. If that is the case, then the coefficient of preventive behavior in the empirical models outlined before will be overestimated (in absolute value): $|\beta_1| > |\beta_{true}|$. In other words, the OLS strategy will over-emphasize the estimates of the true effect that preventive services have in affecting cardiovascular expenditures.

If, on the other hand, the engagement in preventive activities is correlated with the visit to a physician office where an ailment has been diagnosed, then the opposite might be true. In this case, the subject who undertakes activities after physician advice might already have a more detrimental health status which influences the amount of Medicare expenditures incurred in later in life. One such service that comes in mind that illustrates this situation is cholesterol screening. If respondents undertake this type of screening because they know or suspect they might have a health problem, these respondents can be expected to have higher health costs in the future. In this case, the magnitude of coefficient of preventive behavior in the specification above will be underestimated: $|\beta_1| < |\beta_{true}|$. In table 4.3, I summarize the main biases that can be found in the empirical approach

Table 4.3. Summary of Biases.

Type of bias	Description	Effect on Preventive Behavior
Bias due to better underlying health	Preventive activity is undertaken by people that are healthier to begin with.	It is hypothesized that this bias will tend to overestimate the effect of the explanatory variable: $|\beta_1| > |\beta_{true}|$
Bias due to more health consciousness	Preventive activity is undertaken by people that worry more about their health status.	Presumably, $|\beta_1| > |\beta_{true}|$
Bias due to more contact with the medical system	A person might engage in preventive behavior upon a physician advice to do so. Alternatively, increased preventive behavior might simply be a proxy for better access to medical care.	A bias of this type will most likely lead to an underestimation of the explanatory variable: $|\beta_1| < |\beta_{true}|$

Bias due to health care preferences	When undertaking of preventive behaviors proxies for other unmeasured preferences in the consumption of health care services that themselves have a causal effect on health expenditures	Ambiguous

4.3. Solutions to endogeneity problems

4.3.1. Examination of alternative explanations

As explained before, comparisons of observational data to estimate the effect of a given intervention are problematic due to the fact that assignment of treatment is typically not random in these data. Instead, it is plausible that it is based on several confounding factors that may also affect outcomes. In section 5.2, I will explore the distribution of some of these potentially confounding factors among those that engage in each of the studied preventive activities and those that do not. Also, I will analyze how the coefficients change in response to inclusion and exclusion of these variables. Among those plausible variables affecting the distribution of the decision to engage in prevention, I will study the distribution of the following:

a) Education: In traditional health production models, education improves the efficiency of the production of health therefore decreasing the use of medical services. Also, more education has been associated with a preference for longer term investments. Thus it is reasonable to believe that more educated respondents will have a higher demand for preventive services, as it was examined in chapter 2. It is less clear as to whether or how higher education levels might impact health expenditures.

b) Self-reported health status: It is hypothesized that people with better health status are more inclined to undertake preventive activities, particularly those preventive activities that involve lifestyle decisions (e.g. physical activity, normal weight maintenance, and non-smoking behavior). However, for other preventive activities, the effect of the underlying health of the respondent is not as clear as a decision to engage in clinical preventive activities might come as a result of a doctor's recommendation upon an ailment.

c) Chronic conditions: The existence of chronic conditions among the respondents might increase the demand for these preventive services often as a consequence of the treatment and management for these conditions, i.e. tertiary prevention. Also, the demand for these activities such as mammogram and Pap smear cancer might be related to the future existence of these conditions, i.e., secondary prevention. So, chronic conditions might indicate a higher demand for preventive services and very likely higher health expenditures. Not including controls for the existence of the prevalence of these conditions at baseline might tend to underestimate the positive effects of some preventive activities on health expenditures

d) Preference for medical care: The demand for preventive services can also be explained by the fact that respondents might have more proximity the health care system either because they have a preference for more health care services, a history of having insurance coverage before joining Medicare. A history of more frequent contacts with the health care system also is likely to be correlated to higher expenditures as well.

4.3.2. Propensity scores for average treatment effect

Another way to deal with cases in which confounding factors that affect the propensity to receive any one treatment exist, in this case prevention, is by using propensity scores methods. In such methods, one estimates how various characteristics affect the probability of treatment receipt, creates a score based on this estimation and then compares observed outcomes between treated and untreated subjects conditional on this score (Rosenbaum and Rubin, 1983). The theory of propensity scores suggests that, conditional on this scalar propensity score, all of the selection bias generated by differences in observed covariate values between the treatment and control group can be removed.

In section 5.5, I attempt to use propensity score methods to determine the average treatment effect (ATE) of the different prevention activities studied. The difference in weighted average of the outcomes between treatment and untreated group gives a consistent estimate of the ATE, where the weights are proportional to the inverse of the estimated propensity scores. The propensity score for each preventive service is calculated using a logistic regression where the variables that were also attempted to use as instruments (see table 4.4) are used as regressors. The average treatment effect was calculated using the nearest neighbor matching.

4.3.3. Instruments

Another plausible solution to the endogeneity problem of my estimation models may lie in the use of instrumental variables. Any instrument must comply with two conditions. Firstly, for a variable to serve as a valid instrumental variable for preventive behavior, it must be the case that the instruments affect the undertaking of preventive activities. Second, it should also be the case that the instrument is not correlated with unobservable characteristics of respondents that affect health expenditures other than through preventive behaviors (Angrist, Imbens, Rubin 1996).

In section 5.5, I use the insights from the theoretical model in chapter 1 to explore the feasibility of using the following variables as instruments.

Table 4.4. Summary of plausible instruments to be used in two- stage least squares models.

Instrument	Description
1. Spouse preventive activity	Indicator of whether the spouse engages in the corresponding preventive activity
2. Education	Number of years of education
3. Time discount rate	Long term financial planning (next few years, next 5-10 years).
4. Deterioration of health stock	This question asks the respondent to assess retrospectively how his/her health has changed since the last interview
5. Wealth	Household assets
6. Risk aversion	if the respondent is found to be among the most risk- adverse category to changing jobs
7. Life insurance	Indicator on whether the respondent has a long term care insurance policy
8. Long term Health insurance	Indicator of whether the respondent has a long term care insurance policy.

5. Results

5.1. Descriptive results and naïve regressions

5.1.1. Physical activity

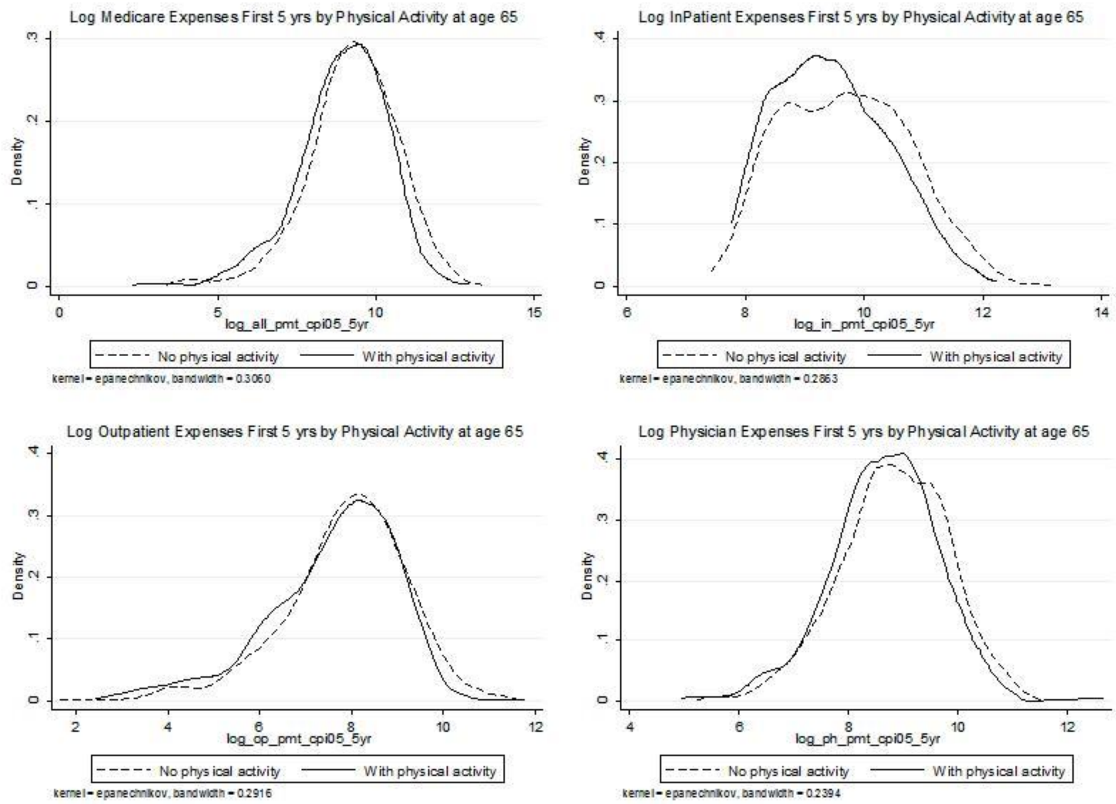
Table 4.5 presents the overall descriptive statistics for the expenditures during the first 5 years in Medicare. The results show that people who engage in regular vigorous physical activity at age 65 tend to have significantly less overall, inpatient and outpatient expenditures and number of claims. The results are similar when analyzing the results for expenditures throughout the first 10 years of Medicare and average annual expenditures (see appendix 8.1).

Table 4.5. Medicare first 5 year expenditures by physical activity.

Type of expenditure/claim	**Not vigorous activity**		**P-value (T-test)**	**With vigorous activity**	
	Mean	**Std. Dev.**		**Mean**	**Std. Dev.**
Expenditures through first 5 years in Medicare					
Overall	**$19,224.64**	($34,404.55)	<0.001	$14,372.58	($27,948.19)
Inpatient	**$9,273.83**	($22,947.73)	<0.001	$5,690.27	($15,132.73)
Physician	$6,181.22	($9,722.61)	0.447	$6,047.54	($16,790.94)
Outpatient	**$3,021.64**	($6,499.24)	0.005	$2,417.34	($5,460.12)
Number of claims through first 5 years in Medicare					
All kind	**50.3**	(58.50)	0.002	43.73	(48.06)
Inpatient	**0.84**	(1.75)	<0.001	0.54	(1.19)
Physician	**38.04**	(48.32)	0.02	33.92	(40.82)
Outpatient	**11.06**	(18.01)	0.002	9.15	(14.46)

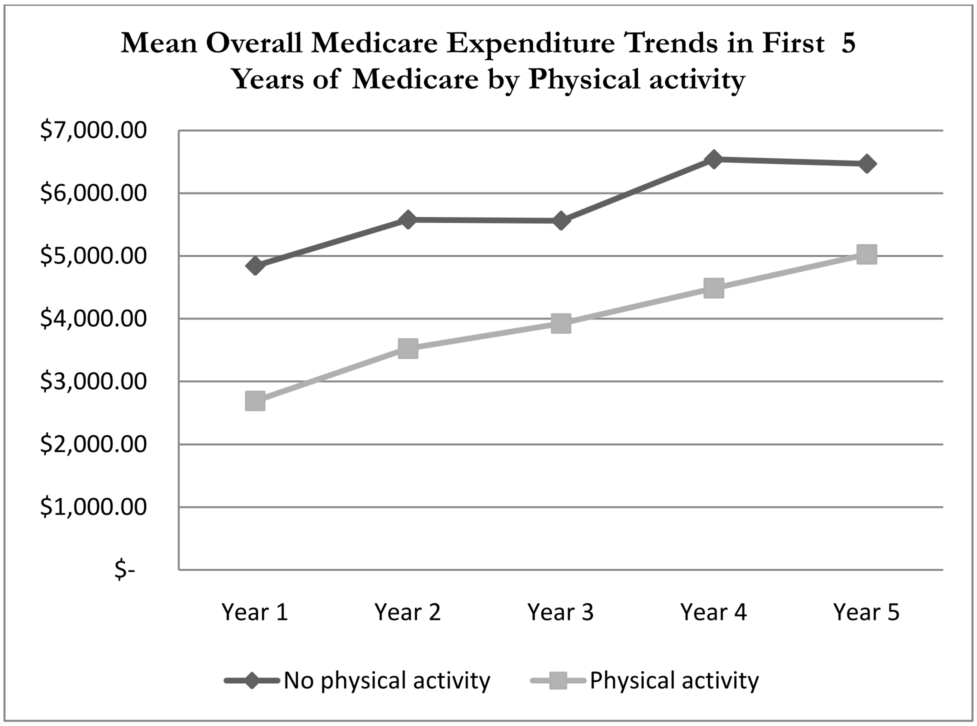
The histograms of the logarithm of the expenditures depicts a similar story whereby people that engage in physical activity have slightly less overall, inpatient and outpatient expenditures than people than do not (figure 1).

Figure 1. Histogram of the logarithm of expenditures by physical activity.



Another useful way to analyze and illustrate the relationship of prevention and expenditures is by looking at the time trends in expenditures. One could argue that Medicare leads people to do preventive care at 65 then those most likely to do preventive care would have a relative decline in expenditures over time. Looking at trends might also prove useful to separate the fixed effect of the healthiness of a person at age 65 from the impact on a preventive activity on subsequent expenditure. Figure 2 shows the time trends for the yearly average of overall Medicare expenditures over the first 5 years in Medicare. In this representation, the differences between people that engage in physical activity and those that do not become more evident.

Figure 2. Trends in annual average Medicare expenditures by level of physical activity.



In regressions with a wide variety of controls though, the significance of the differences between the physically active and the non-physically active tends to go away (see table 4.6). Interestingly, the savings in inpatient expenditures, although insignificant, cancel out with increased expenditures in physician services. Hence, once controlled for observables at age 65, vigorous physical activity does not have a significant association with Medicare expenditures.

Table 4.6. Association of vigorous physical activity in multivariate regression analysis, weighted by propensity scores.

Model	Reported statistic description	(1) Vigorous physical activity on all Medicare expenditures age 65 to 69	(2) Vigorous physical activity on Inpatient expenditures age 65 to 69	(3) Vigorous physical activity on Physician expenditures age 65 to 69	(4) Vigorous physical activity on Outpatient expenditures age 65 to 69
OLS	Marginal effect on expenditures	-1,628.87	-2,363.913***	815.461	57.114
	Robust standard error	(1337.890)	(867.223)	(726.586)	(224.648)
Two part log linear model	Marginal effect on expenditures	-3,350.10	-2,292.14	-925.44	-312.54
	Coefficient in log linear conditional equation	-0.082	-0.158**	-0.002	0.109
	Robust standard error in log linear conditional equation	(0.072)	(0.078)	(0.058)	(0.086)
GLM, log link function, Poisson family	Marginal effect on expenditures	-6,275.75	-4,548.06	-529.93	-589.55
	Coefficient in GLM equation	-0.105	-0.334***	0.128	0.017
	Robust standard error in GLM equation	(0.079)	(0.116)	(0.104)	(0.080)

All columns show the marginal effect of the preventive behavior at age 65 (or close) in separate models predicting Medicare expenditures at age 65-69. All regressions were controlled for respondent's variables at age 65: inverse mills ratio (for selection bias), propensity weights, insurance status, risk aversion, time preference, gender, race, veteran status, working status, number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education (less than high school, high school/GED, some college, college or above), assets, mental health (CESD score), functional limitations, previous diagnosis of cancer, heart disease, lung disease, stroke, diabetes, arthritis, high blood pressure, residence in one of 10 census divisions and year when age 65. Heteroskedasticity adjusted standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

5.1.2. Smoker status

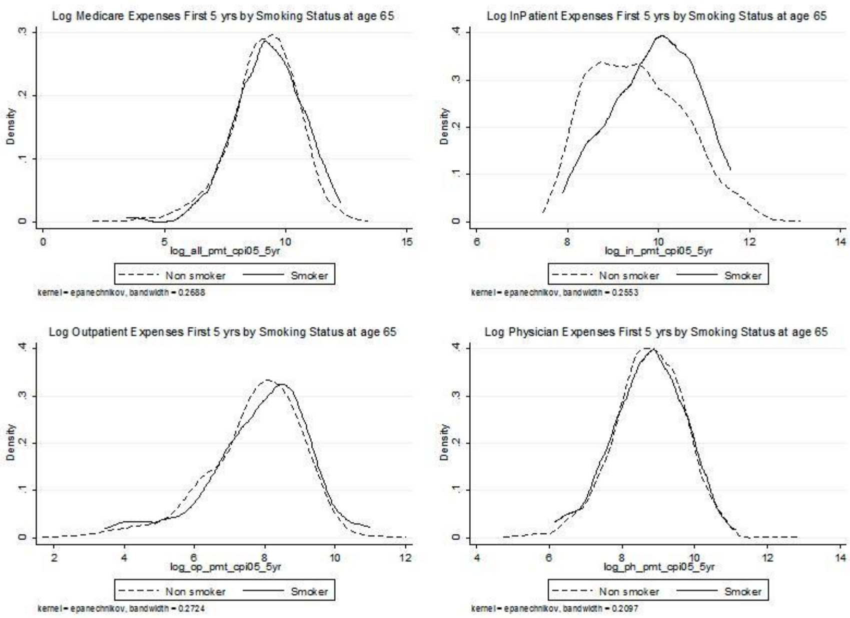
Smokers tend to have greater yet insignificant more expenditures than non-smokers (table 4.7). The only difference that is significant is the amount of inpatient expenditures where smokers tend to have significantly more of.

Table 4.7. Medicare first 5 year expenditures by smoking status.

Type of expenditure/claim	**Smoker**		**P-value (T-test)**	**Non-smoker**	
	Mean	**Std. Dev.**		**Mean**	**Std. Dev.**
Expenditures through first 5 years in Medicare					
Overall	$20,750.89	($32,676.48)	0.12	$17,420.65	($33,856.53)
Inpatient	**$11,411.31**	($24,494.88)	0.008	$7,714.42	($21,331.87)
Physician	$5,622.34	($8,785.09)	0.472	$6,286.30	($14,097.29)
Outpatient	$3,211.38	($6,982.59)	0.196	$2,715.21	($6,021.46)
Number of claims through first 5 years in Medicare					
Overall	45.54	(53.09)	0.499	48.11	(54.87)
Inpatient	0.86	(1.73)	0.11	0.71	(1.59)
Physician	32.59	(41.96)	0.15	36.97	(46.01)
Outpatient	11.77	(19.35)	0.135	10.16	(16.34)

Figure 3 shows the histograms for 5 years of expenditures. The histograms for all Medicare, physician, and outpatient expenditures are virtually identical. Smokers do seem to have a different inpatient expenditure profile.

Figure 3. Histogram of the logarithm of expenditures by smoking status



The time trends of overall expenditures shows that in most years, smokers have more expenditures on average than non-smokers (figure 4).

Figure 4. Trends in annual average Medicare expenditures by smoking status.

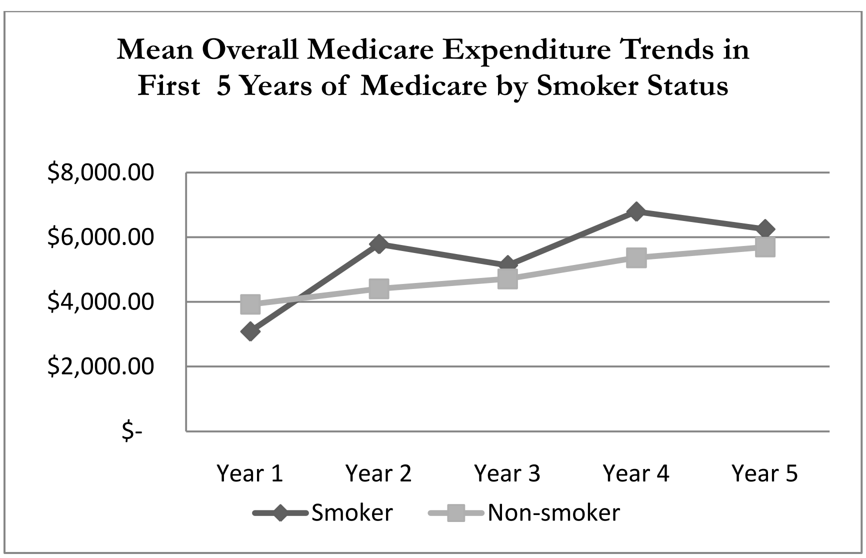


Table 4.8. Association of smoker status in multivariate regression analysis, weighted by propensity scores.

Model	Reported statistic description	(1) Smoker status on all Medicare expenditures age 65 to 69	(2) Smoker status on Inpatient expenditures age 65 to 69	(3) Smoker status on Physician expenditures age 65 to 69	(4) Smoker status on Outpatient expenditures age 65 to 69	Reported statistic description	(5) Smoker status on all Medicare expenditures age 65 to 69	(6) Smoker status on Inpatient expenditures age 65 to 69	(7) Smoker status on Physician expenditures age 65 to 69	(8) Smoker status on Outpatient expenditures age 65 to 69
OLS	Marginal effect of NON-SMOKER	-3,990.7*	-4,153.1**	703.3	-548.8	Marginal effect of CURRENT NON-SMOKER vs. smoker	-921	-261.7	944.8	-633.278
	Robust standard error of NON SMOKER	(2,294.1)	(1,773.4)	(615.6)	(437.1)	Standard error of CURRENT SMOKER	(2,560.8)	(1,718.2)	(773.9)	(590.091)
	Marginal effect of SMOKER	omitted category				Marginal effect of NEVER-SMOKER vs. smoker	-2,688.19	-915.404	-669.439	-338.161

	Robust standard error of SMOKER					Standard error of NEVER SMOKER	(2518.237)	(1748.514)	(920.340)	(800.575)
Two part log linear model	Marginal effect on expenditures	-2,376.6	-3,440.1	156.5	-330.5	Marginal effect of CURRENT NON-SMOKER vs. smoker	-2,508	-519.1	1,126.1	-230.9
	Coefficient in log linear conditional equation	-0.151	-0.492***	0.068	-0.168	Coefficient in log linear conditional equation for CURRENT SMOKER	-0.11	-0.280*	0.094	-0.114
	Robust standard error in log linear conditional equation	(0.100)	(0.109)	(0.085)	(0.125)	Standard error for CURRENT SMOKER	(0.123)	(0.152)	(0.119)	(0.165)
	Marginal effect of SMOKER	omitted category				Marginal effect of NEVER-SMOKER vs. smoker	-2,693.90	-897.08	-828.61	-322.02
	Robust standard error of SMOKER					Coefficient in log linear conditional equation for NEVER SMOKER	-0.226*	-0.310*	-0.078	-0.194

	Robust standard error in log linear conditional equation SMOKER					Standard error for NEVER SMOKER	(0.129)	(0.160)	(0.122)	(0.170)
GLM, log link function , Poisson family	Marginal effect on expenditures	-4,326.05	-4,448.34	689.57	-599.01	Marginal effect of CURRENT NON-SMOKER vs. smoker	-1452.35	-253.30	1379.51	-183.33
	Coefficient in GLM equation	-0.210*	-0.456***	0.124	-0.183	Coefficient in log linear conditional equation for CURRENT SMOKER	-0.07	-0.087	0.093	-0.24
	Robust standard error in GLM equation	(0.111)	(0.164)	(0.100)	(0.133)	Standard error for CURRENT SMOKER	(0.140)	(0.226)	(0.132)	(0.178)
	Marginal effect of SMOKER	omitted category				Marginal effect of NEVER-SMOKER vs. smoker	-1,544.51	-398.35	-1,042.20	-26.18

Robust standard error of SMOKER		Coefficient in log linear conditional equation for NEVER SMOKER	-0.15	-0.127	-0.132	-0.132
Robust standard error in log linear conditional equation SMOKER		Standard error for NEVER SMOKER	(0.151)	(0.240)	(0.147)	(0.231)

All columns show the marginal effect of the preventive behavior at age 65 (or close) in separate models predicting Medicare expenditures at age 65-69. In columns 1-4, non-smoker is the key independent variable and smoker is the omitted category. In columns 5-8, dummies for current non-smoker and never smoker were included, the omitted category is current smoker..All regressions were controlled for respondent's variables at age 65: inverse mills ratio (for selection bias), propensity weights, insurance status, risk aversion, time preference, gender, race, veteran status, working status, number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education (less than high school, high school/GED, some college, college or above), assets, mental health (CESD score), functional limitations, previous diagnosis of cancer, heart disease, lung disease, stroke, diabetes, arthritis, high blood pressure, residence in one of 10 census divisions and year when age 65. Heteroskedasticity adjusted standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

Once controlled for observables, non smokers tend to have negative and significant coefficients on all, and inpatient expenditures (table 4.8, columns 1-4). The results are very similar when one compares never smokers to current smokers (i.e. those respondents who currently do not smoke but who reported to have smoked before), and current smokers (table 4.8, columns 5-8). Both never smokers and current non smokers tend to have a negative association with health expenditures compared to current smokers (omitted category). Never smokers tend to have a slight less negative association than current non-smokers. Yet those differences between each other are hardly significant.

5.1.3. Normal weight

Respondents with normal weight report less expenditures for overall Medicare expenditures as well as inpatient and outpatient expenditures compared to overweight and obese respondents. However, only inpatient expenditures and claims tend to be significant at the 10% and 5% respectively (table 4.9).

Table 4.9. Medicare first 5 year expenditures by weight status.

Type of expenditure/claim	Obese/Overweight		P-value (T-test)	Normal weight	
	Mean	**Std. Dev.**		**Mean**	**Std. Dev.**
Expenditures through first 5 years in Medicare					
Overall	$19,140.39	($28,436.47)	0.11	$17,317.44	($34,122.80)
Inpatient	**$9,746.64**	($19,833.52)	0.08	$7,739.17	($21,442.02)
Physician	$5,622.34	($8,785.09)	0.963	$6,286.30	($14,097.29)
Outpatient	$3,211.38	($6,982.59)	0.291	$2,715.21	($6,021.46)
Number of claims through first 5 years in Medicare					
Overall	48.53	(54.86)	0.109	45.14	(51.54)
Inpatient	**0.76**	(1.69)	0.01	0.61	(1.23)
Physician	37.06	(46.04)	0.14	34.55	(42.37)
Outpatient	10.4	(17.03)	0.429	9.8	(15.26)

The histograms for expenditures of normal weight and overweight/obese respondents reveal to be very similar to each other (figure 5). However, the time trends for mean overall expenditures by weight status show that overweight or obese respondents might have higher expenditures than normal weight respondents (figure 6).

Figure 5. Histogram of the logarithm of expenditures by weight status.

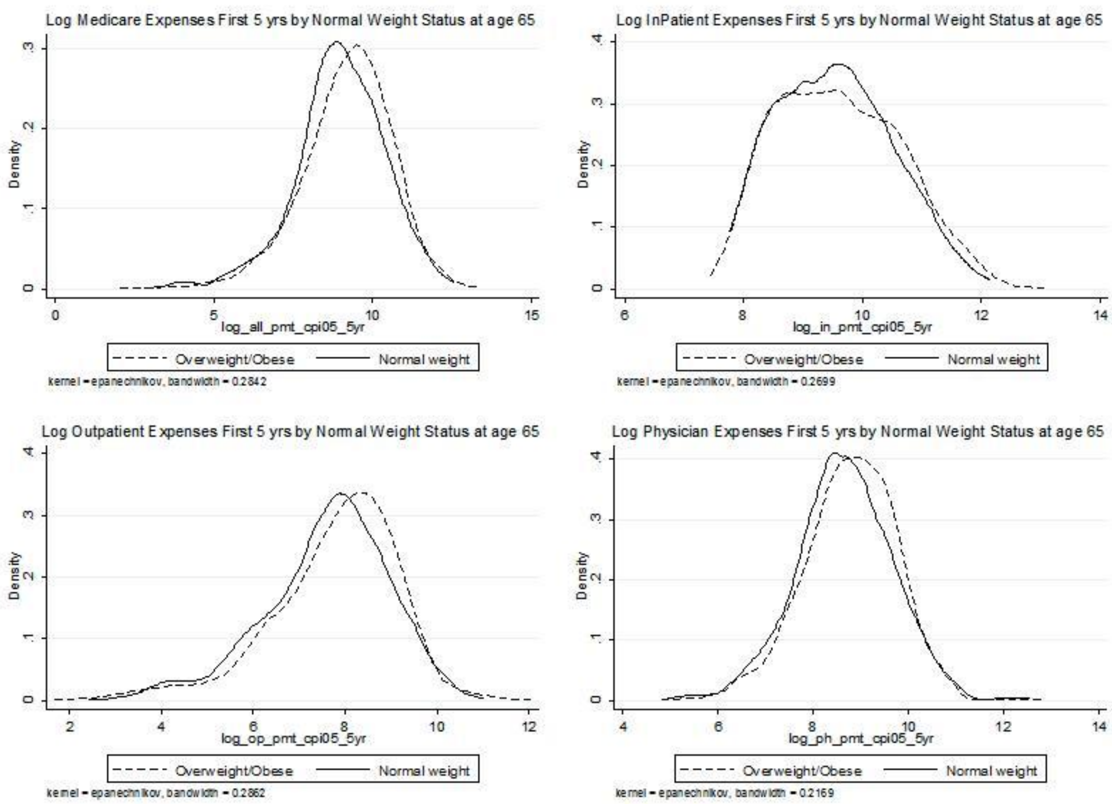


Figure 6. Trends in annual average Medicare expenditures by weight status.

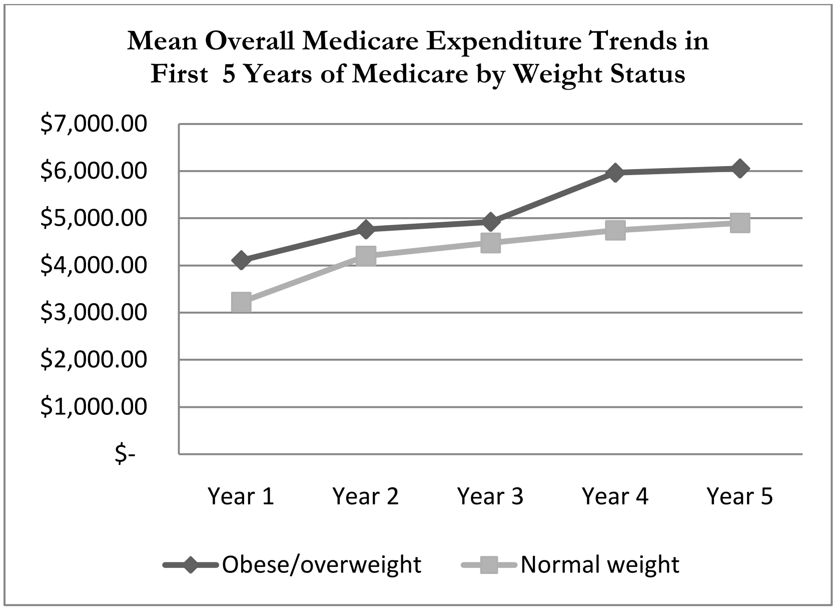


Table 4.10. Association of weight status in multivariate regression analysis, weighted by propensity scores.

Model	Reported statistic description	(1) Weight status on all Medicare expenditures age 65 to 69	(2) Weight status on Inpatient expenditures age 65 to 69	(3) Weight status on Physician expenditures age 65 to 69	(4) Weight status on Outpatient expenditures age 65 to 69	(5) Weight status on all Medicare expenditures age 65 to 69	(6) Weight status on Inpatient expenditures age 65 to 69	(7) Weight status on Physician expenditures age 65 to 69	(8) Weight status on Outpatient expenditures age 65 to 69
OLS	Marginal effect of NORMAL WEIGHT vs. overweight	626.863	575.171	253.284	28.849	1672.441	1147.991	-92.245	725.714
	Standard error NORMAL WEIGHT	(1379.188)	(919.117)	(591.078)	(247.380)	(1808.545)	(1190.582)	(291.789)	(794.194)
	Marginal effect of UNDERWEIGHT vs. overweight	NA	NA	NA	NA	-329.734	-389.452	-306.552	512.658
	Standard error UNDERWEIGHT	NA	NA	NA	NA	(2757.858)	(1607.573)	(528.055)	(1169.464)
Two part log linear model	Marginal effect of NORMAL WEIGHT vs. overweight	-1,727.27	-765.11	-720.34	-307.31	-2,967.30	-1,585.04	-504.54	-547.96
	Coefficient in log linear conditional	-0.01	0.06	-0.06	0.01	-0.05	0.09	-0.08	-0.02

	equation for NORMAL WEIGHT								
	Standard error for NORMAL WEIGHT	(0.078)	(0.088)	(0.063)	(0.091)	(0.094)	(0.110)	(0.108)	(0.080)
	Marginal effect of UNDERWEIGHT vs. overweight	NA	NA	NA	NA	-2,217.00	-1,589.59	-755.15	-1,347.59
	Coefficient in log linear conditional equation for UNDERWEIGHT	NA	NA	NA	NA	0.11	0.07	-0.16	-0.16
	Standard error for UNDERWEIGHT	NA	NA	NA	NA	(0.180)	(0.195)	(0.237)	(0.196)
GLM, log link function, Poisson family	Marginal effect of NORMAL WEIGHT vs. overweight	-2,778.36	-4,448.34	-462.17	-446.46	-770.20	-485.17	-457.17	520.02
	Coefficient in log linear conditional equation for NORMAL WEIGHT	0.04	0.09	0.03	0.01	0.13	0.18	-0.03	0.16
	Standard error	(0.082)	(0.123)	(0.093)	(0.096)	(0.107)	(0.166)	(0.111)	(0.122)

for NORMAL WEIGHT								
Marginal effect of UNDERWEIGHT vs. overweight	NA	NA	NA	NA	-3,223.40	-1,527.54	-843.39	-347.60
Coefficient in log linear conditional equation for UNDERWEIGHT	NA	NA	NA	NA	0.00	-0.01	-0.18	0.09
Standard error for UNDERWEIGHT	NA	NA	NA	NA	(0.204)	(0.297)	(0.261)	(0.215)

All columns show the marginal effect of the preventive behavior at age 65 (or close) in separate models predicting Medicare expenditures at age 65-69. Columns 5-8 include an additional dummy variable indicating whether a person is underweight (BMI<20). All regressions were controlled for respondent's variables at age 65: inverse mills ratio (for selection bias), propensity weights, insurance status, risk aversion, time preference, gender, race, veteran status, working status, number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education (less than high school, high school/GED, some college, college or above), assets, mental health (CESD score), functional limitations, previous diagnosis of cancer, heart disease, lung disease, stroke, diabetes, arthritis, high blood pressure, residence in one of 10 census divisions and year when age 65. Heteroskedasticity adjusted standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

In multivariate regressions, no significant differences were found between the two groups (table 4.10).

5.1.4. Flu shot

Persons with flu shot tend to have greater expenditures and number of claims than persons without a flu shot. Yet, only outpatient expenditures, overall claims, physician claims, and outpatient claims are significantly different.

Table 4.11. Medicare first 5 year expenditures by flu shot.

Type of expenditure/claim	Without Flu shot		P-value (T-test)	With Flu shot	
	Mean	**Std. Dev.**		**Mean**	**Std. Dev.**
Expenditures through first 5 years in Medicare					
Overall	$16,756.36	($37,231.79)	0.41	$18,000.71	($31,129.61)
Inpatient	$7,742.92	($19,944.95)	0.59	$8,268.50	($22,906.42)
Physician	$6,052.46	($17,386.83)	0.846	$6,202.85	($9,813.04)
Outpatient	$2,201.18	($4,590.06)	<0.001	**$3,086.80**	($6,631.75)
Number of claims through first 5 years in Medicare					
Overall	41.3	(51.37)	<0.001	**51.45**	(56.39)
Inpatient	0.67	(1.56)	0.16	0.77	(1.67)
Physician	32.09	(42.67)	<0.001	**38.87**	(47.33)
Outpatient	8.26	(14.31)	<0.001	**11.54**	(17.96)

The figure showing the histogram of expenditures show that the trends that respondents with and without flu shot resemble each other in their expenditures trends. Respondents with flu shot tend to have greater outpatient and physician expenditures (figure 7). Similarly, the time trends in figure 8 reveal that respondents with flu shot had higher expenditures throughout the years.

Figure 7. Histogram of the logarithm of expenditures by flu shot.

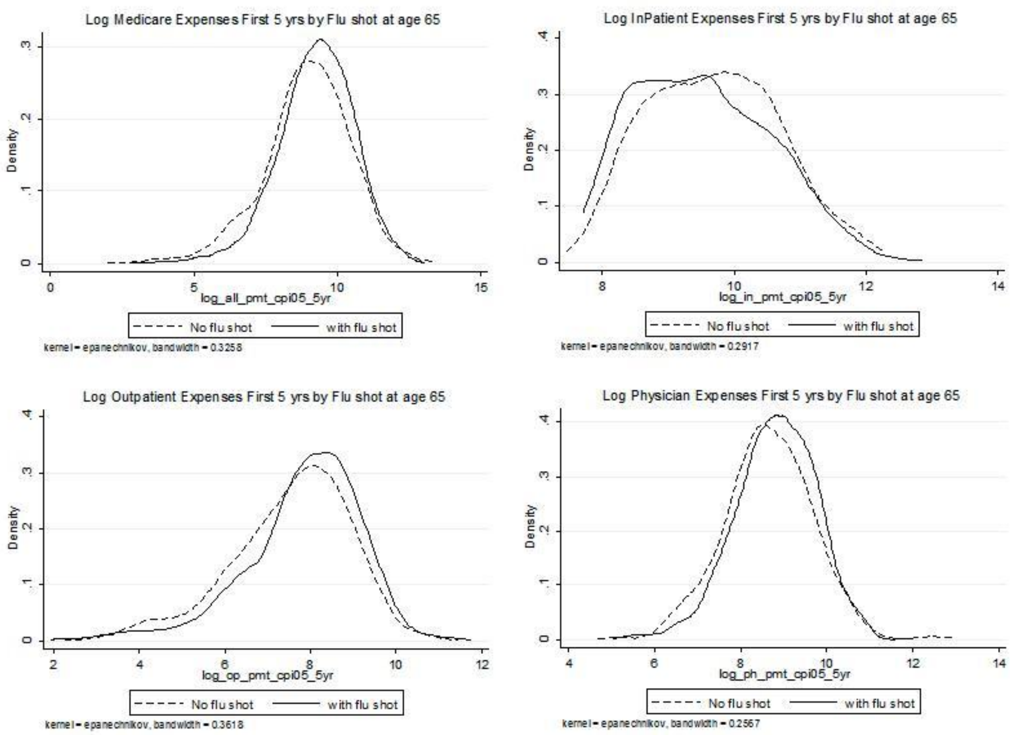
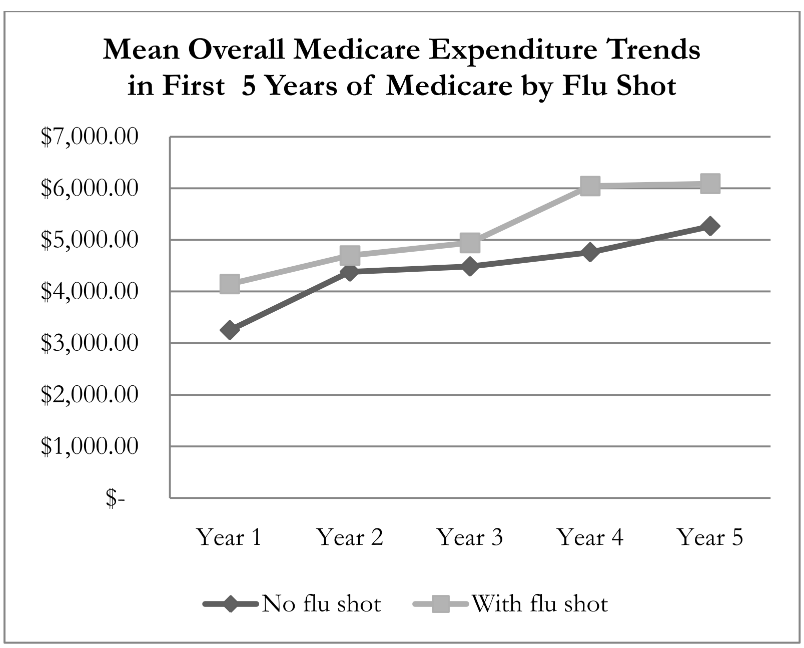


Figure 8. Trends in annual average Medicare expenditures by flu shot.



In multivariate regressions, respondents with flu shots have less, but insignificantly so, of overall, inpatient and physician expenditures. Yet they tend to have significantly more outpatient expenditures.

Table 4.12. Association of flu shot in multivariate regression analysis, weighted by propensity scores.

Model	**Reported statistic description**	**(1) Flu shot on all Medicare expenditures age 65 to 69**	**(2) Flu shot on Inpatient expenditures age 65 to 69**	**(3) Flu shot on Physician expenditures age 65 to 69**	**(4) Flu shot on Outpatient expenditures age 65 to 69**
OLS	Marginal effect on expenditures	-366.44	-12.074	-854.948	898.736***
	Robust standard error	(1551.017)	(916.894)	(798.535)	(258.926)
Two part log linear model	Marginal effect on expenditures	3,450.23	560.38	1,166.33	650.40
	Coefficient in log linear conditional equation	0.209***	-0.083	0.081	0.251***
	Robust standard error in log linear conditional equation	(0.073)	(0.083)	(0.060)	(0.085)
GLM, log link function, Poisson family	Marginal effect on expenditures	2,737.58	1,438.35	392.70	1,172.51
	Coefficient in GLM equation	-0.003	-0.011	-0.108	0.359***
	Robust standard error in GLM equation	(0.084)	(0.118)	(0.112)	(0.097)

All columns show the marginal effect of the preventive behavior at age 65 (or close) in separate models predicting Medicare expenditures at age 65-69. All regressions were controlled for respondent's variables at age 65: inverse mills ratio (for selection bias), propensity weights, insurance status, risk aversion, time preference, gender, race, veteran status, working status, number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education (less than high school, high school/GED, some college, college or above), assets, mental health (CESD score), functional limitations, previous diagnosis of cancer, heart disease, lung disease, stroke, diabetes, arthritis, high blood pressure, residence in one of 10 census divisions and year when age 65. Heteroskedasticity adjusted standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

5.1.5. Cholesterol screening

Respondents with cholesterol screening had significant more overall, physician and outpatient expenditures and claims that those without cholesterol screening.

Table 4.13. Medicare first 5 year expenditures by cholesterol screening.

Type of expenditure/claim	No cholesterol screening		P-value (T-test)	Cholesterol screening	
	Mean	**Std. Dev.**		**Mean**	**Std. Dev.**
Expenditures through first 5 years in Medicare					
Overall	$13,889.40	($22,442.83)	0.02	**$18,476.25**	($36,213.45)
Inpatient	$6,744.87	($15,432.49)	0.21	$8,337.18	($22,647.26)
Physician	$4,773.36	($7,790.21)	0.02	**$6,549.61**	($14,829.82)
Outpatient	$2,123.75	($4,591.30)	0.02	**$2,927.87**	($6,401.51)
Number of claims through first 5 years in Medicare					
Overall	36.57	(43.09)	<0.001	**50.24**	(57.01)
Inpatient	0.63	(1.33)	0.24	0.75	(1.67)
Physician	28.26	(36.94)	<0.001	**38.23**	(47.43)
Outpatient	7.54	(12.90)	<0.001	**10.95**	(17.46)

The histograms of respondents with and without cholesterol screening reflect the results from the table above. The histograms of those with cholesterol screening tend to be shifted to the right of those without cholesterol screening hinting higher expenditures (figure 9). This is also corroborated by the time trends in figure 10. Respondents with cholesterol screening have higher Medicare expenditures every year during the first 5 years in the program than those who do not have cholesterol screening.

Figure 9. Histogram of the logarithm of expenditures by cholesterol screening

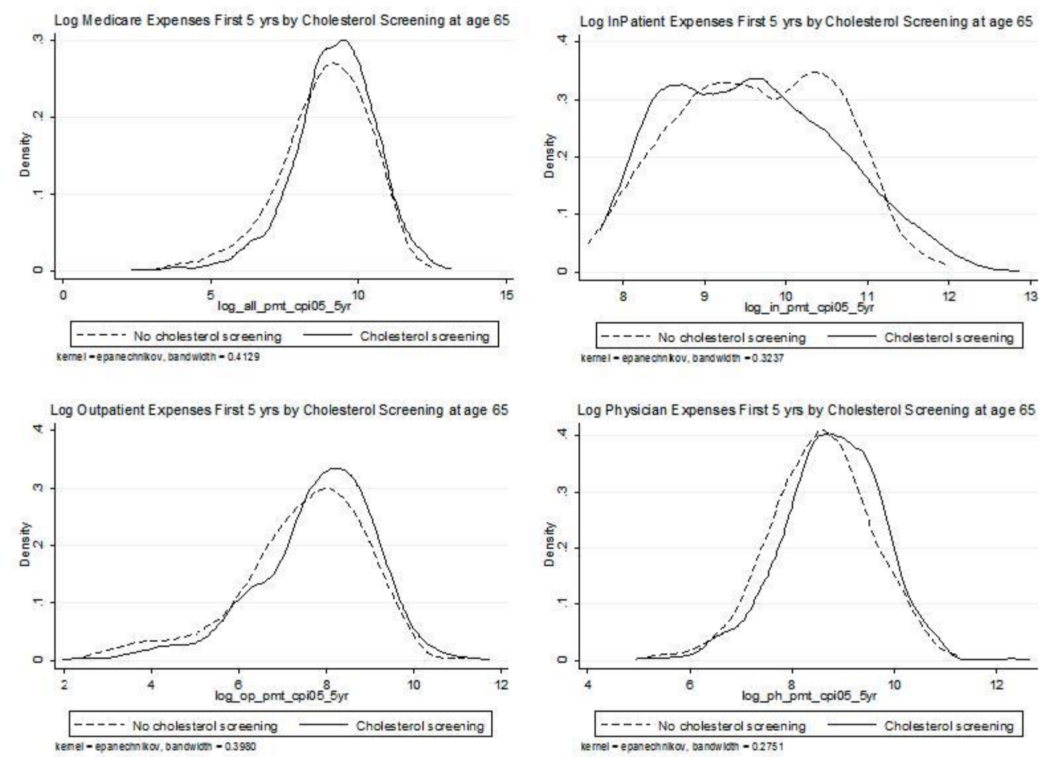
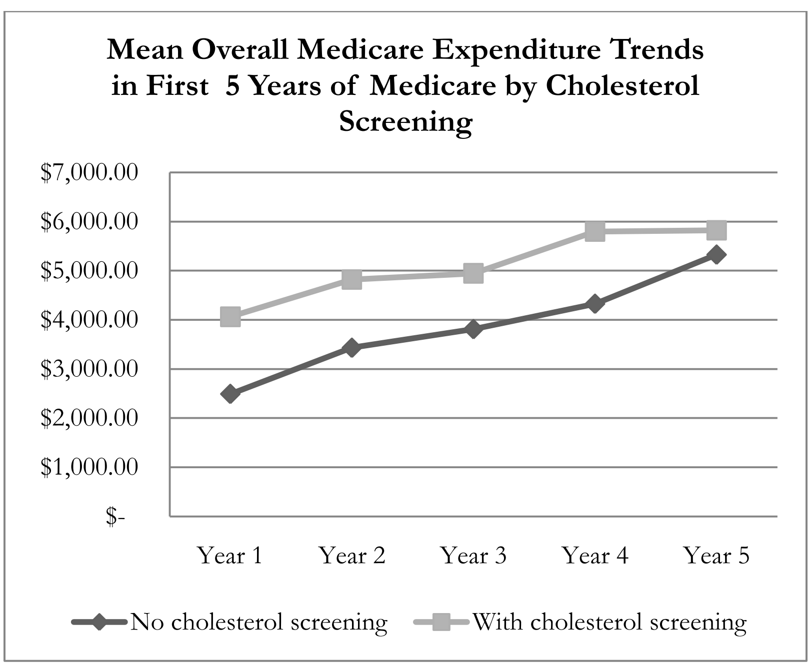


Figure 10. Trends in annual average Medicare expenditures by cholesterol screening.



As with flu shot, once I control for observables, the differences in expenditures between people receiving cholesterol screening at age 65 and those that do not are not significant.

Table 4.14. Association of cholesterol screening in multivariate regression analysis, weighted by propensity scores.

Model	**Reported statistic description**	**(1) Cholesterol screening on all Medicare expenditures age 65 to 69**	**(2) Cholesterol screening on Inpatient expenditures age 65 to 69**	**(3) Cholesterol screening on Physician expenditures age 65 to 69**	**(4) Cholesterol screening on Outpatient expenditures age 65 to 69**
OLS	Marginal effect on expenditures	734.63	-104.493	443.922	370.533
	Robust standard error	(1474.531)	(1008.452)	(519.797)	(322.856)
Two part log linear model	Marginal effect on expenditures	3,038.26	248.70	1,477.90	604.93
	Coefficient in log linear conditional equation	0.115	-0.161	0.136*	0.184
	Robust standard error in log linear conditional equation	(0.095)	(0.108)	(0.076)	(0.116)
GLM, log link function, Poisson family	Marginal effect on expenditures	5,074.22	1,757.09	2,075.82	879.41
	Coefficient in GLM equation	0.078	0.013	0.11	0.165
	Robust standard error in GLM equation	(0.099)	(0.145)	(0.101)	(0.140)

All columns show the marginal effect of the preventive behavior at age 65 (or close) in separate models predicting Medicare expenditures at age 65-69. All regressions were controlled for respondent's variables at age 65: inverse mills ratio (for selection bias), propensity weights, insurance status, risk aversion, time preference, gender, race, veteran status, working status, number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education (less than high school, high school/GED, some college, college or above), assets, mental health (CESD score), functional limitations, previous diagnosis of cancer, heart disease, lung disease, stroke, diabetes, arthritis, high blood pressure, residence in one of 10 census divisions and year when age 65. Heteroskedasticity adjusted standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

5.1.6. Mammogram

Female respondents have significant more physician and outpatient expenditures as well as more overall, physician and outpatient claims.

Table 4.15. Medicare first 5 year expenditures by mammography.

Type of expenditure/claim	No mammogram		P-value (T-test)	Mammogram	
	Mean	Std. Dev.		Mean	Std. Dev.
Expenditures through first 5 years in Medicare					
Overall	$16,673.54	($32,871.11)	0.78	**$17,385.57**	($34,723.78)
Inpatient	$8,963.06	($22,320.41)	0.13	$6,826.34	($18,695.47)
Physician	$4,959.67	($8,210.37)	0.073	**$6,742.69**	($15,025.29)
Outpatient	$2,084.00	($6,509.52)	0.013	**$3,040.61**	($5,485.98)
Number of claims through first 5 years in Medicare					
Overall	41.14	(53.62)	<0.001	**56.3**	(60.79)
Inpatient	0.87	(1.93)	0.12	0.69	(1.45)
Physician	31.66	(43.77)	0	**42.49**	(50.45)
Outpatient	8.17	(13.93)	<0.001	**12.84**	(18.90)

The histograms of women with cholesterol screening hint for lower expenditures in inpatient care but higher in outpatient and physician care (figure 11). The time trends of mean yearly expenditures for women with and without a mammography reveal to be very close to each other (figure 12).

Figure 11. Histogram of the logarithm of expenditures by mammogram

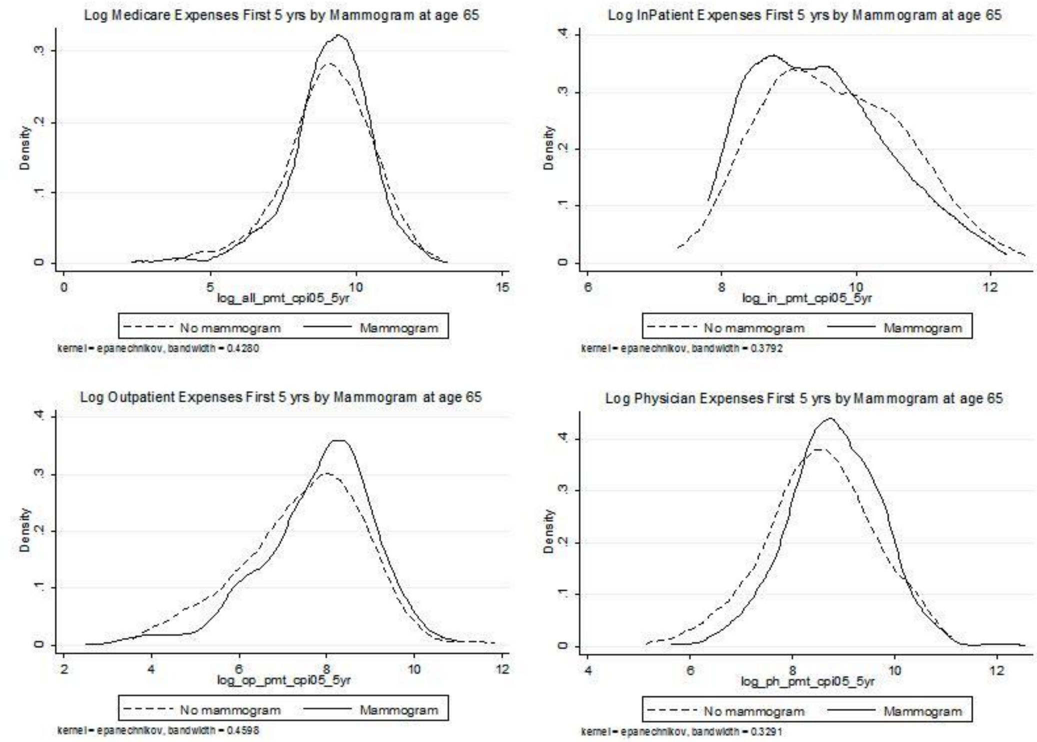
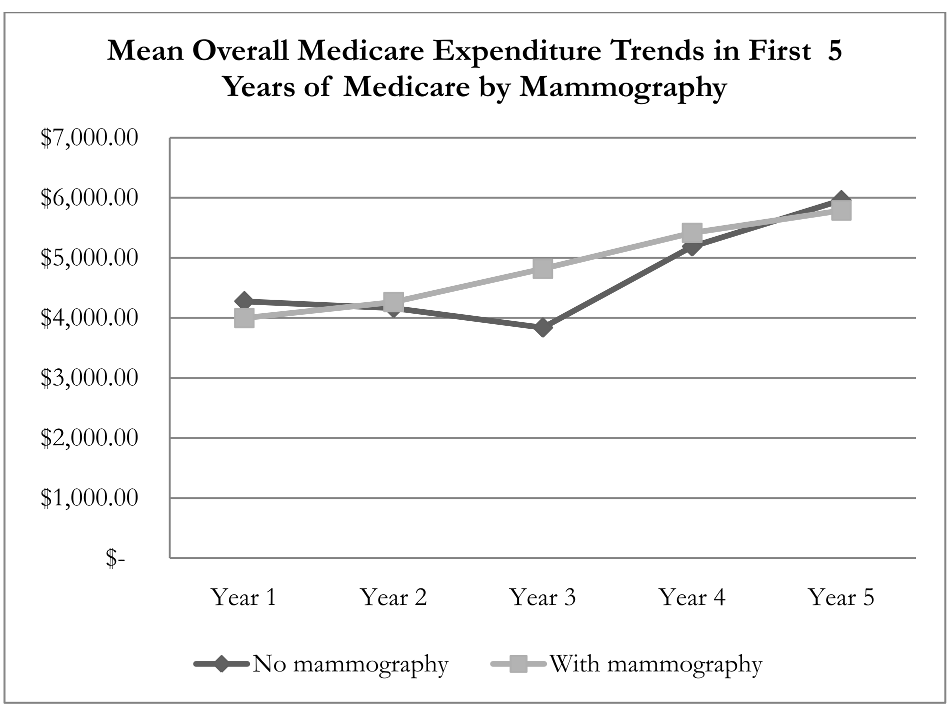


Figure 12. Trends in annual average Medicare expenditures by mammography



Once controlled for observables in multivariate regressions, the association of a mammogram is insignificantly negative for inpatient care and significantly positive for physician and outpatient expenditures.

Table 4.16. Association of mammography in multivariate regression analysis, weighted by propensity scores.

Model	Reported statistic description	(1) Mammogram on all Medicare expenditures age 65 to 69	(2) Mammogram on Inpatient expenditures age 65 to 69	(3) Mammogram on Physician expenditures age 65 to 69	(4) Mammogram on Outpatient expenditures age 65 to 69
OLS	Marginal effect on expenditures	694.32	-1849.085	1,620.242**	756.989
	Robust standard error	(2219.894)	(1589.577)	(706.738)	(489.578)
Two part log linear model	Marginal effect on expenditures	1,269.37	-1,187.07	1,666.15	697.02
	Coefficient in log linear conditional equation	0.05	-0.222*	0.293***	0.314**
	Robust standard error in log linear conditional equation	(0.116)	(0.134)	(0.092)	(0.150)
GLM, log link function, Poisson family	Marginal effect on expenditures	1,327.37	-2,005.19	2,209.05	848.37
	Coefficient in GLM equation	0.025	-0.246	0.286**	0.306*
	Robust standard error in GLM equation	(0.128)	(0.184)	(0.130)	(0.184)

All columns show the marginal effect of the preventive behavior at age 65 (or close) in separate models predicting Medicare expenditures at age 65-69. All regressions were controlled for respondent's variables at age 65: inverse mills ratio (for selection bias), propensity weights, insurance status, risk aversion, time preference, gender, race, veteran status, working status, number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education (less than high school, high school/GED, some college, college or above), assets, mental health (CESD score), functional limitations, previous diagnosis of cancer, heart disease, lung disease, stroke, diabetes, arthritis, high blood pressure, residence in one of 10 census divisions and year when age 65. Heteroskedasticity adjusted standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

5.1.7. Pap smear test

The difference in expenditures and number of claims between female respondents with and without Pap smear test is not significant (table 4.17).

Table 4.17. Medicare first 5 year expenditures by Pap smear test.

Type of expenditure/claim	No pap smears		P-value (T-test)	Pap smears	
	Mean	**Std. Dev.**		**Mean**	**Std. Dev.**
Expenditures through first 5 years in Medicare					
Overall	$18,322.87	($43,345.55)	0.46	$16,780.67	($29,005.05)
Inpatient	$8,133.11	($22,861.69)	0.27	$6,850.48	($17,380.29)
Physician	$6,017.87	($12,015.65)	0.51	$6,614.30	($15,209.42)
Outpatient	$2,640.94	($6,903.97)	0.38	$2,941.29	($5,136.61)
Number of claims through first 5 years in Medicare					
Overall	49.89	(60.02)	0.129	54.96	(59.29)
Inpatient	0.79	(1.81)	0.33	0.7	(1.43)
Physician	38.04	(49.73)	0.22	41.52	(49.02)
Outpatient	10.48	(17.46)	0.381	12.55	(18.17)

The expenditure histograms of respondents with and without Pap smear test are remarkable similar to one another. The time trends, however, tell a slightly different story (figure 13). In years 1, 2, 3, and 4, expenditures were greater for the women without a Pap smear test. On year 3, the mean annual expenditures for women with a Pap smear were higher than for those without one.

Figure 13. Histogram of the logarithm of expenditures by Pap smear test

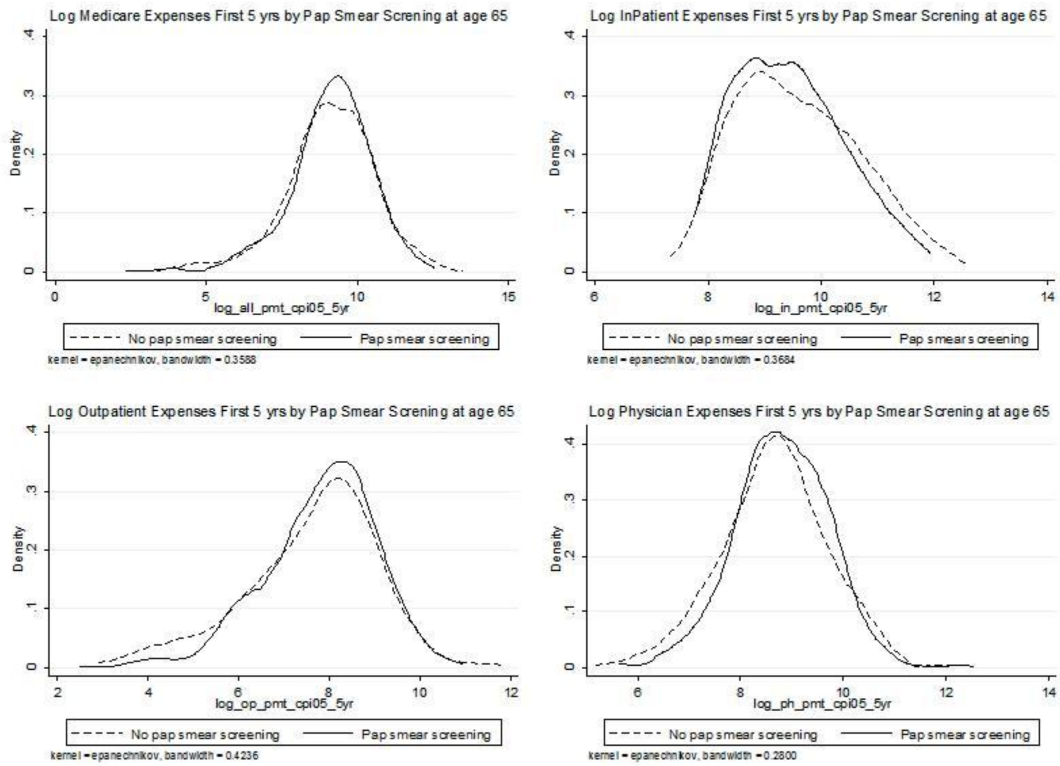
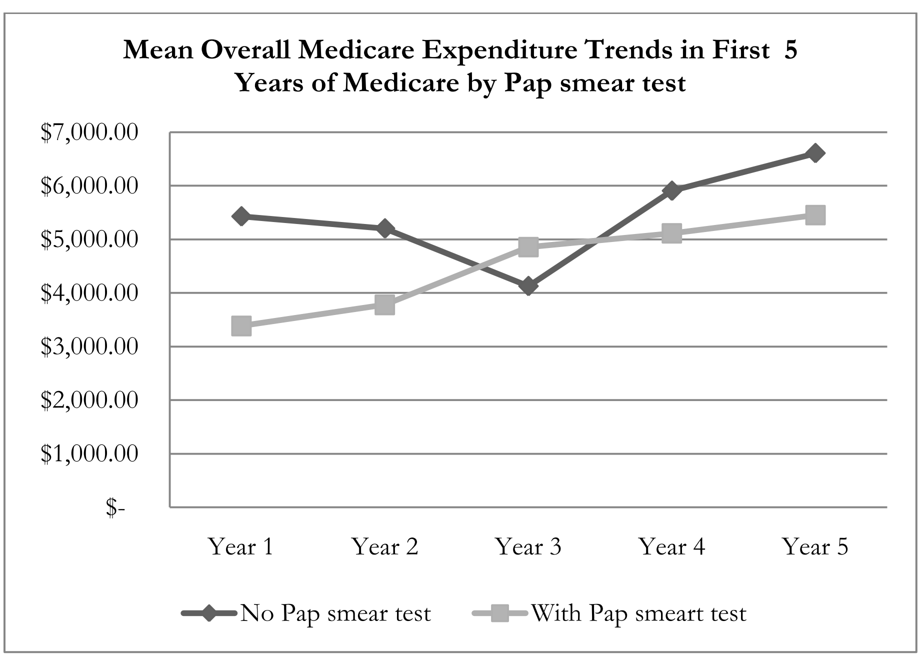


Figure 14. Trends in annual average Medicare expenditures by Pap smear test



Controlled for covariates, the association of Pap smear screening in expenditures tends to be positive but only significant for outpatient expenditures (table 4.18).

Table 4.18. Association of Pap smear test in multivariate regression analysis, weighted by propensity scores.

Model	Reported statistic description	(1) Pap smears test on all Medicare expenditures age 65 to 69	(2) Pap smears test on Inpatient expenditures age 65 to 69	(3) Pap smears test on Physician expenditures age 65 to 69	(4) Pap smears test on Outpatient expenditures age 65 to 69
OLS	Marginal effect on expenditures	380.50	-286.71	797.618	611.496*
	Robust standard error	(2033.092)	(1213.751)	(693.375)	(333.482)
Two part log linear model	Marginal effect on expenditures	405.25	-1,138.38	896.22	237.35
	Coefficient in log linear conditional equation	0.167*	-0.031	0.238***	0.272**
	Robust standard error in log linear conditional equation	(0.091)	(0.110)	(0.076)	(0.113)
GLM, log link function, Poisson family	Marginal effect on expenditures	-2,069.50	-1,801.52	534.51	272.51
	Coefficient in GLM equation	0.028	-0.046	0.136	0.239**
	Robust standard error in GLM equation	(0.095)	(0.149)	(0.098)	(0.112)

All columns show the marginal effect of the preventive behavior at age 65 (or close) in separate models predicting Medicare expenditures at age 65-69. All regressions were controlled for respondent's variables at age 65: inverse mills ratio (for selection bias), propensity weights, insurance status, risk aversion, time preference, gender, race, veteran status, working status, number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education (less than high school, high school/GED, some college, college or above), assets, mental health (CESD score), functional limitations, previous diagnosis of cancer, heart disease, lung disease, stroke, diabetes, arthritis, high blood pressure, residence in one of 10 census divisions and year when age 65. Heteroskedasticity adjusted standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

5.1.8. Prostate screening

Similar to the case of other cancer related preventive services, respondents with prostate cancer screening have higher but insignificant expenditures and number of claims than people without prostate screening. The only significant difference is in the number of physician claims (table 4.19).

Table 4.19. Medicare first 5 year expenditures by prostate cancer screening.

Type of expenditure/claim	**No prostate screening**		**P-value (T-test)**	**Prostate Screening**	
	Mean	**Std. Dev.**		**Mean**	**Std. Dev.**
Expenditures through first 5 years in Medicare					
Overall	$15,653.84	$22,976.49	0.35	$17,914.80	$34,180.84
Inpatient	$8,055.75	$16,092.67	0.73	$8,620.77	$23,586.54
Physician	$4,993.01	$8,567.59	0.23	$6,151.93	$14,175.53
Outpatient	$2,470.17	$4,018.99	0.56	$2,760.39	$7,175.25
Number of claims through first 5 years in Medicare					
Overall	34.77	(43.33)	0.06	**41.71**	(47.42)
Inpatient	0.74	(1.41)	0.76	0.69	(1.65)
Physician	26.09	(37.01)	0.05	**32.37**	(40.34)
Outpatient	7.85	(14.41)	0.57	8.42	(14.69)

The histograms of overall Medicare expenditures between respondents with and without prostate screening are virtually identical. Respondents with prostate screening have slightly less inpatient and outpatient expenses but more physician expenses (figure 15). The time trends of the annual average of Medicare expenditures of respondents with prostate screening shows higher expenditures than those without prostate screening (figure 16)

Figure 15. Histogram of the logarithm of expenditures by prostate cancer screening.

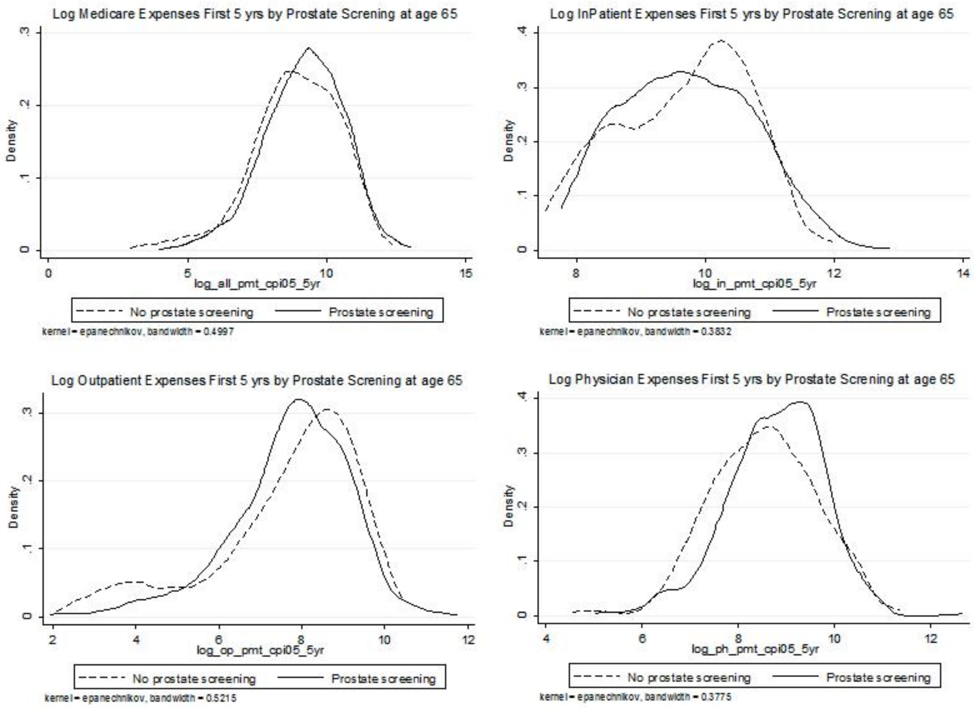
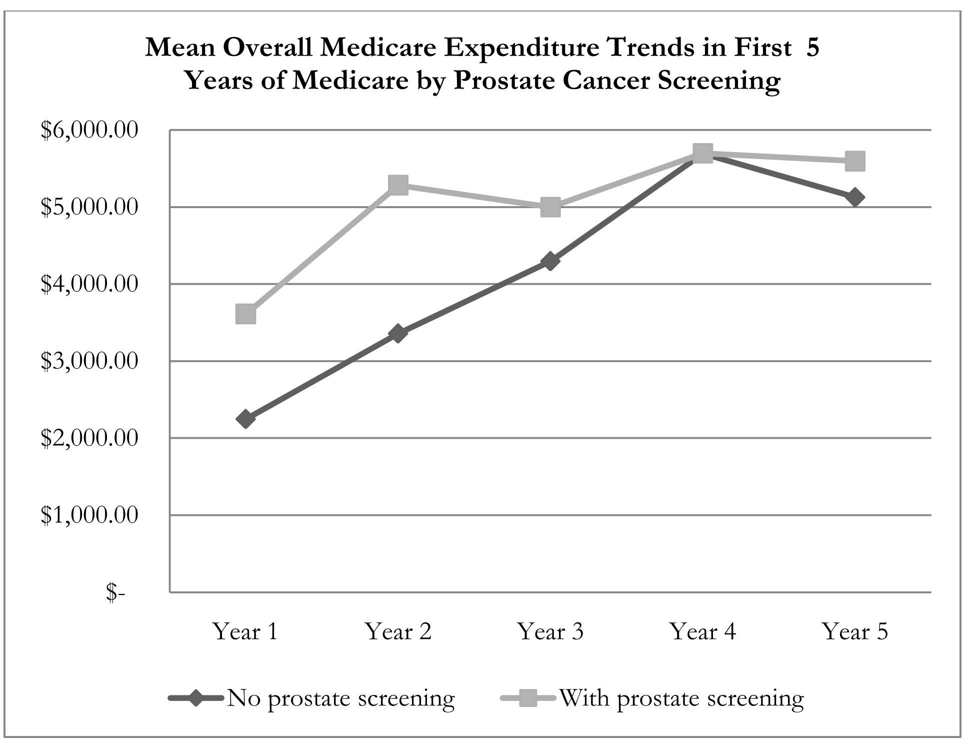


Figure 16. Trends in annual average Medicare expenditures by prostate cancer screening



When controlled for observables, the association of the prostate screening tends to be positive yet insignificant.

Table 4.20. Association of prostate cancer screening in multivariate regression analysis, weighted by propensity scores.

Model	Reported statistic description	(1) Prostate cancer screening on all Medicare expenditures age 65 to 69	(2) Prostate cancer screening on Inpatient expenditures age 65 to 69	(3) Prostate cancer screening on Physician expenditures age 65 to 69	(4) Prostate cancer screening on Outpatient expenditures age 65 to 69
OLS	Marginal effect on expenditures	3,120.51	2,244.591	493.115	77.236
	Robust standard error	(2436.888)	(1780.832)	(864.945)	(495.958)
Two part log linear model	Marginal effect on expenditures	1,172.21	-352.57	1,350.46	-69.86
	Coefficient in log linear conditional equation	0.286*	0.016	0.355***	0.087
	Robust standard error in log linear conditional equation	(0.159)	(0.184)	(0.133)	(0.213)
GLM, log link function, Poisson family	Marginal effect on expenditures	3,591.92	2,076.46	1,221.53	121.41
	Coefficient in GLM equation	0.249*	0.334	0.135	0.059
	Robust standard error in GLM equation	(0.151)	(0.227)	(0.158)	(0.182)

All columns show the marginal effect of the preventive behavior at age 65 (or close) in separate models predicting Medicare expenditures at age 65-69. All regressions were controlled for respondent's variables at age 65: inverse mills ratio (for selection bias), propensity weights, insurance status, risk aversion, time preference, gender, race, veteran status, working status, number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education (less than high school, high school/GED, some college, college or above), assets, mental health (CESD score), functional limitations, previous diagnosis of cancer, heart disease, lung disease, stroke, diabetes, arthritis, high blood pressure, residence in one of 10 census divisions and year when age 65. Heteroskedasticity adjusted standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

5.1.9. Preventive activities altogether

In the past sub-sections I have tried to examine the association of each of the preventive services by adding it to the covariates individually. In this section, I examine the marginal effect of the preventive activities when added all at once in the regression models. As the cancer related preventive measures (mammogram, Pap smear test, and prostate cancer screening) are gender specific, I run the models (OLS, two part log-linear, and GLM log Poisson) separately for women (table 4.21) and for men (table 4.22). The results are very comparable to the ones found when models are run separately.

Table 4.21. Association of all preventive activities on expenditures when used altogether among women.

Model	Preventive Activity	Reported statistic description	(1) Prevention on all Medicare expenditures age 65 to 69	(2) Prevention on Inpatient expenditures age 65 to 69	(3) Prevention on Physician expenditures age 65 to 69	(4) Prevention on Outpatient expenditures age 65 to 69
OLS	Physical Activity	Marginal effect on expenditures	-1,358.87	-948.17	832.12	-297.67
		Robust standard error	(2407.065)	(1125.833)	(1205.070)	(277.026)
	Non-smoker status	Marginal effect on expenditures	-3,158.17	-3,158.55	1,499.62	-1,248.148**
		Robust standard error	(2971.334)	(1940.838)	(1008.807)	(607.989)
	Normal weight status	Marginal effect on expenditures	1,945.63	953.77	1,588.60	25.15
		Robust standard error	(2302.576)	(1156.528)	(1416.458)	(320.527)
	Flu shot	Marginal effect on expenditures	3,563.08	209.90	-2,262.96	581.916**
		Robust standard error	(3675.092)	(1294.884)	(1809.656)	(290.455)

	Cholesterol screening	Marginal effect on expenditures	405.20	1,153.52	-637.67	577.869*
		Robust standard error	(2201.562)	(1319.256)	(845.805)	(300.557)
	Mammogram	Marginal effect on expenditures	2,213.71	-789.69	176.74	508.66
		Robust standard error	(3291.814)	(1406.381)	(1140.335)	(347.539)
	Pap smear test	Marginal effect on expenditures	4,553.44	-449.83	2,364.837**	659.069*
		Robust standard error	(3758.718)	(1852.410)	(1179.460)	(386.565)
Two part log linear model	Physical Activity	Marginal effect on expenditures	-4,910.11	-2,195.10	-1,179.34	-580.88
		Coefficient in log linear conditional equation	-0.077	-0.094	0.029	-0.004
		Robust standard error in log linear conditional equation	(0.101)	(0.112)	(0.082)	(0.105)
	Non-smoker	Marginal effect on expenditures	-2,160.46	-1,977.74	424.50	-574.69
		Coefficient in log linear conditional equation	-0.251*	-0.518***	0.066	-0.394**
		Robust standard error in log linear conditional equation	(0.131)	(0.190)	(0.129)	(0.163)
	Normal weight	Marginal effect on expenditures	-3,633.40	-1,855.91	-1,056.44	-566.91
		Coefficient in log linear conditional equation	-0.02	-0.01	-0.014	-0.089

	Robust standard error in log linear conditional equation	(0.104)	(0.118)	(0.084)	(0.121)
Flu shot	Marginal effect on expenditures	3,984.92	284.43	1,194.19	853.92
	Coefficient in log linear conditional equation	0.169	-0.125	0.001	0.270**
	Robust standard error in log linear conditional equation	(0.109)	(0.125)	(0.087)	(0.121)
Cholesterol screening	Marginal effect on expenditures	3,763.29	382.60	1,512.81	794.78
	Coefficient in log linear conditional equation	0.038	-0.049	-0.044	0.086
	Robust standard error in log linear conditional equation	(0.149)	(0.158)	(0.114)	(0.167)
Mammogram	Marginal effect on expenditures	1,687.12	-469.58	1,767.46	851.77
	Coefficient in log linear conditional equation	0.009	-0.045	0.229*	0.264
	Robust standard error in log linear conditional equation	(0.167)	(0.172)	(0.117)	(0.201)
Pap smear test	Marginal effect on expenditures	-178.93	-1,428.33	764.14	238.08
	Coefficient in log linear conditional	0.138	-0.028	0.13	0.158

		equation				
		Robust standard error in log linear conditional equation	(0.113)	(0.122)	(0.095)	(0.136)
GLM, log link function, Poisson family	Physical Activity	Marginal effect on expenditures	-6,821.38	-3,948.06	-640.42	-1,107.82
		Coefficient in log linear conditional equation	-0.055	-0.201	0.126	-0.115
		Robust standard error in log linear conditional equation	(0.103)	(0.161)	(0.107)	(0.102)
	Non-smoker	Marginal effect on expenditures	-801.47	-2,299.80	1,947.21	-1,282.22
		Coefficient in log linear conditional equation	-0.158	-0.492**	0.267*	-0.348**
		Robust standard error in log linear conditional equation	(0.153)	(0.237)	(0.139)	(0.143)
	Normal weight	Marginal effect on expenditures	-3,746.18	-2,227.37	116.35	-561.08
		Coefficient in log linear conditional equation	0.129	0.129	0.181*	-0.013
		Robust standard error in log linear conditional equation	(0.113)	(0.173)	(0.110)	(0.111)
	Flu shot	Marginal effect on expenditures	1,274.29	1,293.62	89.29	1,054.96

	Coefficient in log linear conditional equation	-0.086	0.023	-0.15	0.255**
	Robust standard error in log linear conditional equation	(0.109)	(0.169)	(0.111)	(0.106)
Cholesterol screening	Marginal effect on expenditures	5,896.51	1,837.39	2,112.50	1,463.97
	Coefficient in log linear conditional equation	0.071	0.15	-0.086	0.291*
	Robust standard error in log linear conditional equation	(0.126)	(0.217)	(0.129)	(0.152)
Mammogram	Marginal effect on expenditures	3,195.44	-1,044.69	2,591.52	1,326.65
	Coefficient in log linear conditional equation	0.14	-0.109	0.383***	0.293*
	Robust standard error in log linear conditional equation	(0.145)	(0.213)	(0.145)	(0.173)
Pap smear test	Marginal effect on expenditures	1,382.92	-362.61	585.35	542.81
	Coefficient in log linear conditional equation	-0.017	-0.034	0.025	0.184
	Robust standard error in log linear conditional equation	(0.100)	(0.156)	(0.105)	(0.123)

All columns show the marginal effect of the preventive behavior at age 65 (or close) in separate models predicting Medicare expenditures at age 65-69 among women with all preventive activities included at the same time. All regressions were controlled for respondent's variables at age 65: inverse mills ratio (for selection bias), propensity weights, insurance status, risk aversion, time preference, gender, race, veteran status, working status, number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education (less than high school, high school/GED, some college, college or above), assets, mental health (CESD score), functional limitations, previous diagnosis of cancer, heart disease, lung disease, stroke, diabetes, arthritis, high blood pressure, residence in one of 10 census divisions and year when age 65. Heteroskedasticity adjusted standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

Table 4.22. Association of all preventive activities on expenditures when used altogether among men.

Model	Preventive Activity	Reported statistic description	(1) Prevention on all Medicare expenditures age 65 to 69	(2) Prevention on Inpatient expenditures age 65 to 69	(3) Prevention on Physician expenditures age 65 to 69	(4) Prevention on Outpatient expenditures age 65 to 69
OLS	Physical Activity	Marginal effect on expenditures	-5,260.696**	-5,130.1***	8.11	70.56
		Robust standard error	(2546.252)	(1781.152)	(1048.732)	(404.724)
	Non-smoker status	Marginal effect on expenditures	-4,421.21	-4,403.72	281.52	-145.74
		Robust standard error	(4477.984)	(3445.384)	(1208.659)	(769.175)
	Normal weight status	Marginal effect on expenditures	-2,080.88	-1,326.44	-179.74	-333.14
		Robust standard error	(2425.617)	(1681.526)	(821.624)	(434.576)
	Flu shot	Marginal effect on expenditures	641.35	-42.03	-404.78	1,079.883***
		Robust standard error	(2804.473)	(1730.328)	(1427.642)	(404.798)
	Cholesterol screening	Marginal effect on expenditures	1,428.58	-1,701.43	681.28	-473.95
		Robust standard error	(3869.539)	(2443.091)	(1187.751)	(895.924)
	Prostate cancer screening	Marginal effect on expenditures	6,267.184*	4,915.93**	815.99	211.27
		Robust standard error	(3260.826)	(2174.142)	(1100.336)	(698.418)

Two part log linear model	Physical Activity	Marginal effect on expenditures	-4,297.87	-3,908.73	-1,667.90	-117.11
		Coefficient in log linear conditional equation	-0.221	-0.320**	-0.161	0.165
		Robust standard error in log linear conditional equation	(0.140)	(0.142)	(0.107)	(0.189)
	Non-smoker	Marginal effect on expenditures	-791.99	-6,977.44	390.67	-469.18
		Coefficient in log linear conditional equation	0.002	-0.670***	0.055	-0.265
		Robust standard error in log linear conditional equation	(0.205)	(0.199)	(0.152)	(0.233)
	Normal weight	Marginal effect on expenditures	1,247.73	-117.24	31.94	-106.52
		Coefficient in log linear conditional equation	0.08	-0.184	0.003	0.009
		Robust standard error in log linear conditional equation	(0.145)	(0.154)	(0.119)	(0.171)
	Flu shot	Marginal effect on expenditures	5,146.13	1,103.03	1,776.91	636.06
		Coefficient in log linear conditional equation	0.363***	-0.162	0.218**	0.221
		Robust standard error in log linear conditional equation	(0.138)	(0.150)	(0.110)	(0.161)
	Cholesterol screening	Marginal effect on expenditures	3,906.39	-193.48	1,641.84	523.18
		Coefficient in	0.099	-0.272	0.007	0.047

		log linear conditional equation				
		Robust standard error in log linear conditional equation	(0.178)	(0.221)	(0.168)	(0.225)
	Prostate cancer screening	Marginal effect on expenditures	1,900.85	221.53	1,681.60	-83.20
		Coefficient in log linear conditional equation	0.267	0.276	0.395**	0.183
		Robust standard error in log linear conditional equation	(0.186)	(0.230)	(0.164)	(0.267)
GLM, log link function, Poisson family	Physical Activity	Marginal effect on expenditures	-8,547.23	-7,103.61	-825.42	-315.69
		Coefficient in log linear conditional equation	-0.272**	-0.552***	-0.022	0.052
		Robust standard error in log linear conditional equation	(0.133)	(0.184)	(0.125)	(0.157)
	Non-smoker	Marginal effect on expenditures	-5,595.73	-5,710.48	444.25	-171.14
		Coefficient in log linear conditional equation	-0.262	-0.444*	0.024	-0.085
		Robust standard error in log linear conditional equation	(0.204)	(0.259)	(0.198)	(0.284)
	Normal weight	Marginal effect on expenditures	-2,335.70	-721.49	-742.51	-604.93
		Coefficient in log linear conditional equation	-0.115	-0.126	-0.041	-0.104

	Robust standard error in log linear conditional equation	(0.134)	(0.180)	(0.141)	(0.179)
Flu shot	Marginal effect on expenditures	4,361.15	2,648.39	418.23	1,441.15
	Coefficient in log linear conditional equation	0.034	-0.017	-0.011	0.481***
	Robust standard error in log linear conditional equation	(0.157)	(0.207)	(0.138)	(0.163)
Cholester ol screening	Marginal effect on expenditures	3,697.18	1,325.66	2,200.60	90.56
	Coefficient in log linear conditional equation	-0.08	-0.144	0.094	-0.189
	Robust standard error in log linear conditional equation	(0.224)	(0.255)	(0.234)	(0.339)
Prostate cancer screening	Marginal effect on expenditures	4,766.99	3,258.57	1,851.38	-392.26
	Coefficient in log linear conditional equation	0.470**	0.689**	0.233	0.143
	Robust standard error in log linear conditional equation	(0.192)	(0.276)	(0.193)	(0.244)

All columns show the marginal effect of the preventive behavior at age 65 (or close) in separate models predicting Medicare expenditures at age 65-69 with all preventive activities included at the same time among men. All regressions were controlled for respondent's variables at age 65: inverse mills ratio (for selection bias), propensity weights, insurance status, risk aversion, time preference, gender, race, veteran status, working status, number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education (less than high school, high school/GED, some college, college or above), assets, mental health (CESD score), functional limitations, previous diagnosis of cancer, heart disease, lung disease, stroke, diabetes, arthritis, high blood pressure, residence in one of 10 census divisions and year when age 65. Heteroskedasticity adjusted standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

5.2. Alternative Explanations

In this section, I explore plausible alternative explanations that might bias the results of the results of section 5.1. Among these explanations for differences in expenditures, I identify the following that can be observed and controlled for in the data: differences in education levels, different underlying health status, differences in the prevalence of chronic conditions, differences in the number of difficulties with activities of daily living, differences in preference for medical care.

5.2.1. Education

Higher levels of education are often thought to improve the efficiency of the health production process (Grossman 1972) possibly diminishing the quantity of care needed in the later stages of life. Schooling might also affect time preference those with more schooling are more willing to invest at a lower rate of return. Thus more schooling could result in better health by increasing investments in health such as preventive investments (Fuchs 1982). Similar to the effect of health status depicted above, if not take into account appropriately, one can overestimate the negative effect that prevention has on health expenditures.

The results of table 23 show that higher levels of education seem to be significantly and positively associated with every preventive activity. Respondents with not even high school or GED education are more likely to avoid each of the preventive behaviors studied.

Table 4.23. Education level by preventive activity participation.

Preventive Activity	No degree	GED	High School	High School/ GED	AA/ LT	BA	MA/ MBA	Law/ MD	Chi-square test
No vigorous activity	28.46%	5.98%	33.97%	13.38%	2.37%	8.25%	5.69%	1.90%	<0.001
With vigorous activity	18.89%	4.42%	35.58%	16.28%	3.52%	12.26%	6.23%	2.81%	
Smoker	32.03%	7.47%	33.10%	18.51%	2.14%	4.63%	1.07%	1.07%	
Non-smoker	22.51%	4.86%	35.01%	14.20%	3.05%	11.09%	6.73%	2.55%	<0.001
Overweight/ Obese	32.03%	7.47%	33.10%	18.51%	2.14%	4.63%	1.07%	1.07%	0.10
Normal Weight	20.93%	4.19%	34.14%	16.59%	4.03%	11.27%	6.28%	2.58%	
No flu shot	25.07%	5.67%	35.01%	14.01%	2.45%	9.73%	5.81%	2.24%	
With flu shot	20.93%	4.19%	34.14%	16.59%	4.03%	11.27%	6.28%	2.58%	0.004
No cholesterol screening	31.94%	6.28%	33.51%	11.78%	2.09%	8.12%	4.97%	1.31%	
With cholesterol screening	21.88%	5.00%	35.02%	15.55%	3.13%	10.67%	6.15%	2.59%	0.001
No mammogram	32.10%	5.76%	37.86%	11.93%	1.65%	7.00%	3.70%	0.00%	
With mammogram	21.70%	4.79%	37.66%	17.02%	3.09%	9.04%	5.85%	0.85%	0.011
No Pap Smear test	29.35%	6.75%	35.84%	12.99%	3.64%	5.45%	5.71%	0.26%	
With Pap smear test	21.23%	4.15%	38.44%	17.46%	2.39%	10.18%	5.28%	0.88%	0.001
No prostate cancer screening	38.92%	7.19%	28.74%	13.17%	1.80%	6.59%	0.60%	2.99%	
With Prostate Cancer screening	19.88%	5.19%	31.41%	13.11%	3.46%	13.69%	8.21%	5.04%	<0.001

As further sensitivity analysis I now run 4 OLS models (results in table 4.24). Column 1 shows the association of prevention with expenditures in different models for each preventive activity without any controls. Column 2 shows the associations controlled only for education. Column 3 uses all the controls used in the regression models of section 5.1 except for educations and column 4 uses all controls including education.

The effect of adding education to the list of controls is not homogenous. The coefficients of some preventive activities become more positive when education is added, e.g. physical activity, normal weight status, while the others become less positive. In all cases the significance is not changed much. These results indicate that education, or other unobservables associated with it, might not play a significant source of bias for the association between prevention and expenditures.

Table 4.24. Results of OLS regression for all Medicare expenditures with and without education controls

Preventive activity	**(1)** No controls	**(2)** Controlled only for education	**(3)** All controls except for education	**(4)** All controls including education
Physical Activity	-5,690.445***	-5,493.832***	-1,684.27	-1,628.87
	(1371.878)	(1351.279)	(1344.906)	(1337.890)
Non-smoker status	-3,494.233*	-3,330.31	-3,106.97	-3,990.709*
	(2115.511)	(2130.759)	(2280.746)	(2294.134)
Normal weight status	-2,502.271*	-2,212.25	605.80	626.863
	(1453.442)	(1417.205)	(1393.317)	(1379.188)
Flu shot	2,556.424*	2,854.951*	321.35	-366.442
	(1531.809)	(1525.274)	(1542.666)	(1551.017)
Cholesterol screening	5,346.954***	5,870.765***	1,507.19	734.631
	(1435.728)	(1513.369)	(1478.697)	(1474.531)
Mammogram	1,344.45	2,000.37	1,342.87	694.323
	(2240.249)	(2360.992)	(2171.866)	(2219.894)
Pap smear test	-2,698.55	-2,240.28	911.76	380.495
	(2438.321)	(2360.524)	(2033.579)	(2033.092)
Prostate cancer screening	4,394.425**	4,825.132**	4,515.449*	3120.506
	(2091.318)	(2257.388)	(2529.736)	(2436.888)

Standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent and 10-percent level, respectively.

5.2.2. Health care status

A potential bias in the estimation of the models may lie in the fact that the underlying health status of a person might be unobservable but could affect not only the propensity of a person to undergo prevention and the utilization of health care services. While it is not possible to obtain detailed information regarding the health of a person, HRS does inquire for the self-reported health status (poor, fair, good, very good or excellent) at each wave. If healthier respondents are likelier to both undergo prevention and have less expenditures, the adjusted analyses would overestimate (in absolute value): $|\beta_1| > |\beta_{true}|$.

Therefore, the OLS strategy would over-emphasize the estimates of the true effect that preventive services have in affecting expenditures. Also, if the preventive activity is a product of proximity to the health system as a consequence of a lower health status and disease, then the coefficient β_1 would be overestimating the positive effect of prevention.

The descriptive analysis in table 4.25 of the differences in health status reveals that the distribution is significantly different among users and non users of every preventive activity (Chi square less than 0.1). Respondents who answered affirmative to exercising, being in non smoker or normal weight status, and have pap smear and prostate cancer screenings tend to be more likely to report excellent or very good health status. Respondents with positive responses to flu shot and cholesterol screening are slightly more likely to find themselves in fair or poor health than those who did not.

Table 4.25. Self-reported health status by preventive activity participation

Preventive Activity	Excellent	Very good	Good	Fair	Poor	Chi-square test
No vigorous activity	7.29%	26.80%	34.47%	21.31%	10.13%	<0.001
With vigorous activity	20.70%	36.28%	29.65%	10.25%	3.12%	
Smoker	8.51%	26.24%	35.46%	21.63%	8.16%	
Non-smoker	14.64%	32.22%	31.60%	15.04%	6.50%	0.001
Overweight/Obese	11.69%	29.25%	34.43%	17.00%	7.63%	<0.001
Normal Weight	18.65%	36.33%	26.85%	13.50%	4.66%	
No flu shot	15.74%	33.09%	30.75%	14.64%	5.78%	0.067

With flu shot	12.53%	30.32%	33.06%	16.81%	7.28%	
No cholesterol screening	17.75%	32.64%	30.81%	15.67%	3.13%	
With cholesterol screening	12.95%	31.20%	32.53%	15.90%	7.41%	0.006
No mammogram	10.29%	31.69%	28.40%	23.46%	6.17%	
With mammogram	12.66%	31.81%	33.51%	15.64%	6.38%	0.054
No Pap Smear test	9.61%	29.61%	30.65%	21.82%	8.31%	
With Pap smear test	13.44%	32.79%	33.29%	15.08%	5.40%	0.005
No prostate cancer screening	16.67%	25.60%	30.95%	14.29%	12.50%	
With Prostate Cancer screening	15.97%	32.23%	32.09%	13.96%	5.76%	0.03

The effect of adding health status as control is that the estimate becomes less negative for physical activity and non-smoker status signaling that the people engaging in such activities are in better underlying health. However, the difference in the estimates in column 3 and 4 are not significantly different nor do they change the main conclusion for the effect of such preventive decisions. For flu shot and cholesterol screening, the effect of underlying health, as measured by health status is exactly the opposite. When self reported measures of health are not included, the estimator for the association of flu shot or cholesterol screening is much more positive. When control variables for health status are added, the estimates go down considerably. This might be a consequence of respondents having worst health and hence more expenditures associated with the use of this services. The rest of the estimates are barely affected when controls for health status are added. Thus, health status levels have the effect of decreasing the overestimation of the association of prevention.

Table 4.26. Results of OLS regression for all Medicare expenditures with and without health status controls

Preventive activity	**(1)** No controls	**(2)** Controlled only for health status	**(3)** All controls except for health status	**(4)** All controls including health status
Physical Activity	-5,690.445*** (1371.878)	-2,227.88 (1398.287)	-2,108.07 (1313.636)	-1,628.87 (1337.890)
Non-smoker status	-3,494.233* (2115.511)	-1,592.27 (2109.655)	-4,299.069* (2305.475)	-3,990.709* (2294.134)
Normal weight status	-2,502.271* (1,453.442)	-677.08 (1,408.606)	612.97 (1,371.645)	626.863 (1,379.188)
Flu shot	2,556.424* (1,531.809)	1,558.90 (1493.717)	-223.96 (1,560.204)	-366.442 (1,551.017)
Cholesterol screening	5,346.954*** (1,435.728)	3,800.923*** (1,363.704)	1,048.49 (1,481.377)	734.631 (1,474.531)
Mammogram	1,344.45 (2,240.249)	2,295.36 (2128.474)	591.36 (2,217.620)	694.323 (2,219.894)
Pap smear test	-2,698.55 (2,438.321)	-640.03 (2,176.014)	185.07 (2,087.702)	380.495 (2,033.092)
Prostate cancer screening	4,394.425** (2,091.318)	6,266.280*** (2,325.498)	3,152.34 (2,425.761)	3120.506 (2,436.888)

Standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

5.2.3. Chronic conditions

In order to determine whether the expenditure differences by preventive behavior are attributable to chronic health conditions, I applied several empirical tests. First, I considered whether there were differences in the prevalence of such conditions between users and non-users of prevention. These conditions included diabetes, high blood pressure, heart disease, lung disease, stroke, and cancer (table 4.27).

Respondents who engaged in physical activity were significantly more likely to have less prevalence of heart disease, diabetes, stroke, lung disease, and high blood pressure but not cancer. Not entirely unexpectedly, non-smoker have significantly less prevalence of lung disease and high blood pressure but not different from other disease. Normal weight respondents have significantly lower rates of diabetes and high blood pressure, but not for the other chronic diseases.

Respondents who received a flu shot were significantly more likely to suffer higher rates of heart disease, diabetes, lung disease, and high blood pressure. Respondents with positive cholesterol screening have significantly higher rates of heart disease, diabetes and high blood pressure. Respondents with mammogram were significantly less likely to report a stroke but more likely to have diabetes, high blood pressure and cancer. - Respondents with Pap smear test are less likely to have stroke, lung disease, but more likely to report cancer prevalence. Respondents with prostate cancer screening were less likely to report stroke prevalence but more likely to report high blood pressure.

Table 4.27. Prevalence of chronic conditions by preventive activity participation

Preventive behavior	**Heart Disease**	**P Value in T-test**	**Diabetes**	**P Value in T-test**	**Stroke**	**P Value in T-test**
No vigorous activity	22.35%	0.003	16.86%	0.014	6.82%	<0.001
With vigorous activity	16.88%		13.17%		2.41%	
Smoker	21.99%	0.316	11.70%	0.105	6.38%	0.174
Non-smoker	19.33%		15.60%		4.41%	
Overweight/Obese	20.29%	0.293	18.75%	<0.001	4.76%	<0.001
Normal Weight	18.33%		6.59%		4.50%	
No flu shot	16.61%	0.001	12.05%	0.004	4.56%	0.822
With flu shot	21.75%		17.06%		4.77%	
No cholesterol screening	9.92%	<0.001	8.88%	<0.001	3.92%	0.364
With cholesterol screening	21.87%		16.45%		4.88%	
No mammogram	13.99%	0.122	12.76%	<0.001	7.82%	0.010

With mammogram	17.77%		13.19%		3.83%	
No Pap Smear test	19.22%	0.191	17.40%	0.798	7.29%	0.003
With Pap smear test	15.95%		11.06%		3.39%	
No prostate cancer screening	18.45%	0.150	13.10%	0.132	7.74%	0.027
With Prostate Cancer screening	24.32%		18.56%		3.88%	
Preventive behavior	**Lung Disease**	**P Value in T-test**	**High Blood Pressure**	**P Value in T-test**	**Cancer**	**P Value in T-test**
No vigorous activity	12.03%	<0.001	53.79%	<0.001	10.54%	0.590
With vigorous activity	5.13%		45.03%		11.26%	
Smoker	17.02%	<0.001	42.91%	0.028	10.00%	0.579
Non-smoker	7.35%		50.59%		11.03%	
Overweight/Obese	8.96%	0.525	56.47%	<0.001	10.71%	0.622
Normal Weight	8.04%		33.60%		11.29%	
No flu shot	4.92%	<0.001	46.37%	0.012	8.38%	0.001
With flu shot	11.16%		51.66%		12.54%	
No cholesterol screening	7.57%	0.406	39.16%	<0.001	7.59%	0.016
With cholesterol screening	8.86%		51.93%		11.64%	
No mammogram	12.35%	0.208	44.03%	0.056	7.85%	0.032
With mammogram	9.36%		50.00%		12.25%	
No Pap Smear test	12.47%	0.034	50.65%	0.409	8.62%	0.038
With Pap smear test	8.79%		47.99%		12.69%	
No prostate cancer screening	7.14%	0.975	38.69%	<0.001	8.93%	0.439
With Prostate Cancer screening	6.91%		53.24%		10.66%	

Adding chronic conditions as controls makes the prevention coefficient estimates for flu shot, cholesterol screening, mammograms and prostate cancer screening less positive. Yet, the significance is only changed in the cases of cholesterol screening and prostate cancer screening. For physical activity and for non-smoker status, the inclusion of chronic conditions enhances the magnitude of the association of the preventive activity in question.

Table 4.28. Results of OLS regression for all Medicare expenditures with and without chronic conditions controls.

Preventive activity	**(1) No controls**	**(2) Controlled only for chronic conditions**	**(3) All controls except for chronic conditions**	**(4) All controls including chronic conditions**
Physical Activity	-5,690.445***	-4,162.791***	-1,536.86	-1,628.87
	(1371.878)	(1305.105)	(1359.317)	(1337.890)
Non-smoker status	-3,494.233*	-3,122.98	-2,622.60	-3,990.709*
	(2115.511)	(2095.232)	(2257.400)	(2294.134)
Normal weight status	-2,502.271*	-396.269	54.894	626.863
	(1453.442)	(1332.137)	(1436.177)	(1379.188)
Flu shot	2,556.424*	506.895	1,406.95	-366.442
	(1531.809)	(1498.285)	(1564.809)	(1551.017)
Cholesterol screening	5,346.954***	2,762.871**	2,598.995*	734.631
	(1435.728)	(1368.266)	(1466.235)	(1474.531)
Mammogram	1,344.45	1,508.78	1,351.82	694.323
	(2240.249)	(2162.567)	(2205.341)	(2219.894)
Pap smear test	-2,698.55	-659.238	201.765	380.495
	(2438.321)	(2195.684)	(2153.214)	(2033.092)
Prostate cancer screening	4,394.425**	3,387.496*	5,271.307**	3,120.51
	(2091.318)	(1976.105)	(2572.457)	(2436.888)

Standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

5.2.4. Difficulties with activities of daily living

An additional variable used to identify underlying health is the sum of the activities of daily living which respondents might have difficulty performing. Such activities of daily living (ADLA) are: bathing, dressing, eating, getting in bed, getting out of bed, and walking. Table 4.29 describes the distribution of the number of difficulties in these activities by preventive activities. People with physical activity, normal weight status, Pap smear, and

Prostate cancer have a significantly different distribution to those without these activities. In general, people who participate in these preventive activities have fewer difficulties than people that do not.

Table 4.29. Difficulties with activities of daily living (ADLA) by preventive activity participation

Preventive activity	No difficulties	Difficulties with 1 ADLA	Difficulties with 2 ADLA's	Difficulties with 3 ADLA's	Difficulties with 4 ADLA's	Difficulties with 5 ADLA's	P value for Chi-square test
No vigorous activity	81.06%	10.21%	3.81%	2.69%	1.30%	0.93%	<0.001
With vigorous activity	93.99%	4.58%	0.95%	0.10%	0.38%	0.00%	
Smoker	84.27%	10.49%	2.80%	1.75%	0.35%	0.35%	0.321
Non-smoker	87.84%	7.04%	2.31%	1.38%	0.94%	0.50%	
Overweight/ Obese	85.08%	8.77%	2.97%	1.59%	1.17%	0.41%	<0.001
Normal Weight	82.17%	4.79%	1.12%	1.12%	0.16%	0.64%	
No flu shot	88.09%	7.19%	1.77%	1.18%	1.42%	0.35%	0.115
With flu shot	87.00%	7.60%	2.82%	1.57%	0.47%	0.55%	
No cholesterol screening	89.85%	6.85%	1.78%	1.02%	0.51%	0.00%	0.497
With cholesterol screening	87.06%	7.54%	2.44%	1.51%	0.93%	0.52%	
No mammogram	83.60%	11.20%	2.80%	0.80%	1.60%	0.00%	0.336
With mammogram	85.74%	7.44%	3.35%	1.89%	1.36%	0.21%	
No Pap Smear test	81.07%	10.49%	3.84%	1.28%	3.07%	0.26%	0.004
With Pap smear test	87.30%	7.15%	2.96%	1.85%	0.62%	0.12%	
No prostate cancer screening	84.36%	10.61%	2.23%	1.12%	0.56%	1.12%	0.024
With Prostate Cancer screening	91.87%	5.42%	1.08%	0.95%	0.00%	0.68%	

Adding and removing the ADLA control variables hardly makes a difference in the estimates of the association of physical activity with expenditures (table 4.30) signifying that in this age group, difficulties with these activities, which usually signals for serious illness, is not a huge source of bias.

Table 4.30. Results of OLS regression for all Medicare expenditures with and without difficulties with ADLA

	(1)	(2)	(3)	(4)
Preventive activity	**No controls**	**Controlled only for access for medical care**	**All controls except for access for medical care**	**All controls including access for medical care**
Physical Activity	-5,690.445***	-4,051.416***	-1,634.00	-1,628.87
	(1371.878)	(1327.445)	(1336.775)	(1337.890)
Non-smoker status	-3,494.233*	-3,209.70	-3,898.727*	-3,990.709*
	(2115.511)	(2120.379)	(2289.420)	(2294.134)
Normal weight status	-2,502.271*	-1,642.99	635.99	626.863
	(1453.442)	(1382.513)	(1370.735)	(1379.188)
Flu shot	2,556.424*	2,467.97	-401.92	-366.442
	(1531.809)	(1511.563)	(1567.907)	(1551.017)
Cholesterol screening	5,346.954***	4,714.220***	841.10	734.63
	(1435.728)	(1405.370)	(1467.371)	(1474.531)
Mammogram	1,344.45	1,258.53	879.88	694.32
	(2240.249)	(2216.692)	(2229.982)	(2219.894)
Pap smear test	-2,698.55	-1,326.55	257.882	380.495
	(2438.321)	(2081.822)	(2120.298)	(2033.092)
Prostate cancer screening	4,394.425**	5,044.930**	3,162.53	3,120.51
	(2091.318)	(2156.388)	(2439.982)	(2436.888)

Standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

5.2.5. All health variables

As a final test of what might be the most important concern in terms of sources of bias, I analyze the effect on the estimates of adding the sets of health related variables one at a time (self-reported health status, chronic conditions, and difficulties with ADLA). The concern is that health is presumably endogenous to the decision to undertake a preventive activity. Thus, if not captured perfectly by the existent variables, a significant amount of bias might be introduced to the equation. In order to understand the directionality of this bias, table 4.31 shows the coefficient for preventive activities in separate OLS models under different covariate specifications.

Table 4.31. Results of OLS regression for all Medicare expenditures adding health variables.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Preventive activity	**No health variables**	**Adding ADLA difficulties only**	**Adding health status only**	**Adding chronic conditions only**	**Adding ADLA difficultie s and health status**	**Adding ADLA difficulties and chronic conditions**	**Adding health status and chronic conditions**	**Adding ALL health variables**
Physical Activity	-2,273.103*	-2,268.133*	-1,652.81	-2,116.798	-1,640.05	-2,108.07	-1,785.86	-1,628.87
	(1,341.853)	(1,342.758)	(1,360.129)	(1,313.076)	(1,360.513)	(1,313.636)	(1,346.105)	(1,337.890)
Non-smoker status	-3,740.29	-3,848.698*	-3,589.55	-4,207.448*	-3,663.47	-4,299.069*	-4,119.360*	-3,990.709*
	(2283.642)	(2,280.530)	(2,253.174)	(2,301.391)	(2,254.114)	(2,305.475)	(2,277.921)	(2,294.134)
Normal weight status	-272.91	-261.46	9.61	618.748	28.96	612.97	624.35	626.86
	(1407.491)	(1,407.557)	(1,441.072)	(1,363.748)	(1,435.071)	(1,371.645)	(1,395.543)	(1,379.188)
Flu shot	1,385.08	1,417.40	785.73	-257.811	810.02	-223.96	-292.53	-366.44
	(1620.211)	(1,602.135)	(1,591.772)	(1,576.896)	(1,574.745)	(1,560.204)	(1,559.386)	(1,551.017)
Cholesterol screening	2,996.474**	2,892.156*	1,794.22	1,158.092	1,723.32	1,048.49	687.10	734.63
	(1478.474)	(1,487.496)	(1,488.765)	(1,473.522)	(1,496.939)	(1,481.377)	(1,501.835)	(1,474.531)
Mammogra m	1,143.36	928.49	840.69	778.262	662.35	591.36	724.21	694.32
	(2,279.378)	(2,271.410)	(2,232.362)	(2,223.614)	(2,232.674)	(2,217.620)	(2,186.623)	(2,219.894)
Pap smear test	-687.92	-588.70	-328.70	64.152	-249.08	185.07	281.58	380.50
	(2,294.593)	(2,214.829)	(2,220.058)	(2,178.590)	(2152.026)	(2,087.702)	(2,117.886)	(2,033.092)
Prostate cancer screening	4,156.855*	4,146.082*	4,263.667*	3,197.635	4,249.927*	3,152.34	3,501.74	3,120.51
	(2,468.576)	(2,471.493)	(2,536.761)	(2,428.563)	(2,540.464)	(2,425.761)	(2,446.953)	(2,436.888)

Standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

For physical activity, Pap smears, and normal weight, the addition of health related control variables render the estimates of the coefficients more positive. This result would indicate that the negative association between these preventive activities and expenditures is driven by a selection bias due to better underlying health. On the other hand, for flu shot, cholesterol screening, mammogram and prostate cancer screening, adding the controls for health related variables tend to make the estimates less positive, possibly indicating that respondents with these preventive interventions are in worse health thereby biasing the results toward less expenditures.

In sum, the evidence presented here signals that underlying health status is a significant source of bias in this analysis. The observables found in HRS help to distinguish the source of the bias. It seems that lifestyle medical activities are positively associated with the error term. Clinical preventive activities are negatively associated with the error term. However, it is possible that the measures of health (self reported health status, chronic conditions, and difficulties with daily life activities) are inadequate in terms of controlling for one's true health status such that unobserved measures of health still play a roll.

5.2.6. Preventions with and without chronic conditions: returns to prevention

In addition to the analysis of section 5.2.5 where I looked at the differential estimates of the association between prevention and Medicare expenditures in two different cases: when no diagnosis of a chronic disease (heart disease, diabetes, stroke, high blood pressure, lung disease or cancer) was reported, and when there was a diagnosis. In other words, in the first case I examine the case for what is often termed primary (or secondary in the case of screening) prevention. When a diagnosis is present, one could argue that engaging in these preventive activities represents more appropriately tertiary prevention or disease management whereby further complications related to the disease in question are forestalled. Tables 4.32 and 4.33 look at the associations of prevention in the cases of primary and tertiary prevention, respectively.

For those without diagnosis of chronic conditions (43% of the sample), lifestyle preventive activities such as non smoker status and normal weight are negatively yet not significantly associated with 5 year Medicare expenditures. All other preventive activities are positively but not significantly associated with overall Medicare expenditures. Therefore, it would seem that there are very few, if any, quantifiable returns on prevention for those respondents that have no history of chronic conditions.

Table 4.32. Results of OLS regression on Medicare expenditures among those without chronic conditions diagnoses.

Diagnoses	Preventive activity	(1) Prevention on all Medicare expenditures age 65 to 69	(2) Prevention on Inpatient expenditures age 65 to 69	(3) Prevention on Physician expenditures age 65 to 69	(4) Prevention on Outpatient expenditures age 65 to 69
No diagnosis of heart disease, diabetes, stroke, high blood pressure or lung disease	Physical Activity	254.46	-1,488.54	1,653.32	100.49
		(1,759.947)	(967.812)	(1,202.253)	(280.946)
	Non-smoker status	-895.58	-6.87	-66.10	-850.91
		(2,018.422)	(1,083.407)	(1,099.986)	(561.524)
	Normal weight status	-2,125.15	-1,809.344**	-19.92	-266.35
		(1,415.807)	(884.822)	(798.885)	(268.532)
	Flu shot	170.67	927.94	-1,318.47	576.199**
		(1,910.061)	(859.559)	(1,583.856)	(270.787)
	Cholesterol screening	342.04	-176.77	279.54	266.46
		(1,458.124)	(985.003)	(720.712)	(310.543)
No cancer diagnosis	Mammogram	1,673.10	-638.10	1,425.325**	800.81
		(2,011.557)	(1,386.949)	(668.015)	(521.038)
	Pap smear	1,072.33	719.06	654.11	613.506*

test	(2,094.372)	(1,082.287)	(742.049)	(343.426)
Prostate cancer screening	2,974.11	2,326.83	376.32	-85.67
	(2,638.062)	(1,956.342)	(926.324)	(422.026)

All columns show the marginal effect of the preventive behavior at age 65 (or close) in separate models predicting Medicare expenditures at age 65-69 with all preventive activities included at the same time among men. All regressions were controlled for respondent's variables at age 65: inverse mills ratio (for selection bias), propensity weights, insurance status, risk aversion, time preference, gender, race, veteran status, working status, number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education (less than high school, high school/GED, some college, college or above), assets, mental health (CESD score), functional limitations, previous diagnosis of cancer, heart disease, lung disease, stroke, diabetes, arthritis, high blood pressure, residence in one of 10 census divisions and year when age 65. Heteroskedasticity adjusted standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

For those respondents who have a diagnosis of the chronic conditions described in table 4.33 (57% of the sample), the picture is somewhat different. Normal weight status, flu shot, cholesterol screening, and prostate cancer screening are associated with increased but not significant post-65, 5 year Medicare expenditures. On the other hand, physical activity, non smoker status, mammogram and Pap smear test are associated with diminished expenditures. However, only the association of non-smoker status is significant. Hence, among that sub sample with chronic disease diagnosis, the associations of prevention with expenditures are more sizable than among those without such diagnoses.

Table 4.33. Results of OLS regression on Medicare expenditures among those with a chronic conditions diagnosis.

Diagnoses	Preventive activity	(1) Prevention on all Medicare expenditures age 65 to 69	(2) Prevention on Inpatient expenditures age 65 to 69	(3) Prevention on Physician expenditures age 65 to 69	(4) Prevention on Outpatient expenditures age 65 to 69
At least one diagnosis of heart	Physical Activity	-2,882.94	-2,853.556**	262.09	-59.53
		(1903.865)	(1290.148)	(821.836)	(329.395)
	Non-smoker status	-5,779.690*	-6,453.986**	1,005.44	-415.36
		(3450.285)	(2665.894)	(831.114)	(631.782)

disease, diabetes, stroke, high blood pressure or lung disease	Normal weight status	1,455.35 (2202.096)	1,916.44 (1486.238)	-139.11 (738.272)	193.90 (387.518)
	Flu shot	688.73 (2269.482)	381.72 (1435.783)	-264.45 (930.078)	1,142.697*** (348.824)
	Cholesterol screening	1,841.82 (2488.544)	436.18 (1665.775)	601.29 (808.710)	550.47 (527.483)
With a cancer diagnosis	Mammogram	-10,077.63 (14828.405)	-10,960.18 (11567.645)	396.75 (4695.845)	301.14 (1155.154)
	Pap smear test	-8,278.19 (9313.953)	-9,331.61 (7423.996)	754.18 (2959.954)	356.58 (1134.835)
	Prostate cancer screening	6,555.96 (10826.915)	2,964.68 (5763.275)	-1,542.45 (2076.503)	5,152.34 (6767.311)

All columns show the marginal effect of the preventive behavior at age 65 (or close) in separate models predicting Medicare expenditures at age 65-69 with all preventive activities included at the same time among men. All regressions were controlled for respondent's variables at age 65: inverse mills ratio (for selection bias), propensity weights, insurance status, risk aversion, time preference, gender, race, veteran status, working status, number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education (less than high school, high school/GED, some college, college or above), assets, mental health (CESD score), functional limitations, previous diagnosis of cancer, heart disease, lung disease, stroke, diabetes, arthritis, high blood pressure, residence in one of 10 census divisions and year when age 65. Heteroskedasticity adjusted standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

Another attempt to distinguish the differences between primary and tertiary prevention and the association with expenditures was performed by looking at the expenditure trends for each of the activities when a previous diagnosis of chronic conditions or cancer was present. Figure 17 presents the expenditure trends of physical activity, non-smoker status, normal weight status, flu shot, and cholesterol screening with and without a diagnosis of chronic conditions prior to age 65 (heart disease, diabetes, stroke, high blood pressure, lung disease). Figure 18 presents the trends for mammography, Pap smears test, and prostate cancer screening when a cancer diagnosis prior to age 65 existed.

In all of the trends, it is evident that respondents with chronic conditions or cancer had more expenditures that those who do not. Respondents who did not exercise, those who smoked or those who were obese or overweight, had a tendency for higher expenditures than those who do not, regardless of the presence of chronic conditions. Conversely, respondents with cholesterol screening and flu shot had more expenditures than those without these services notwithstanding the presence of chronic conditions. For the cancer related activities, it is more difficult to elucidate much about the trends since the samples or people with cancer are get small very fast. As such, the trends seem to be susceptible to the effect of some observations with unusually high expenditures in a given year probably linked to the cancer diagnosis itself. Interestingly, though, the trends of the respondents with and without these services tend to converge to each other at the end of the five year period. In none of the graphs in figures 17 or 18 there is evidence of a plateau or decline in expenditures that could be attributed to the preventive services.

Figure 17. Five year expenditure trends by preventive activity and presence of chronic conditions at age 65.

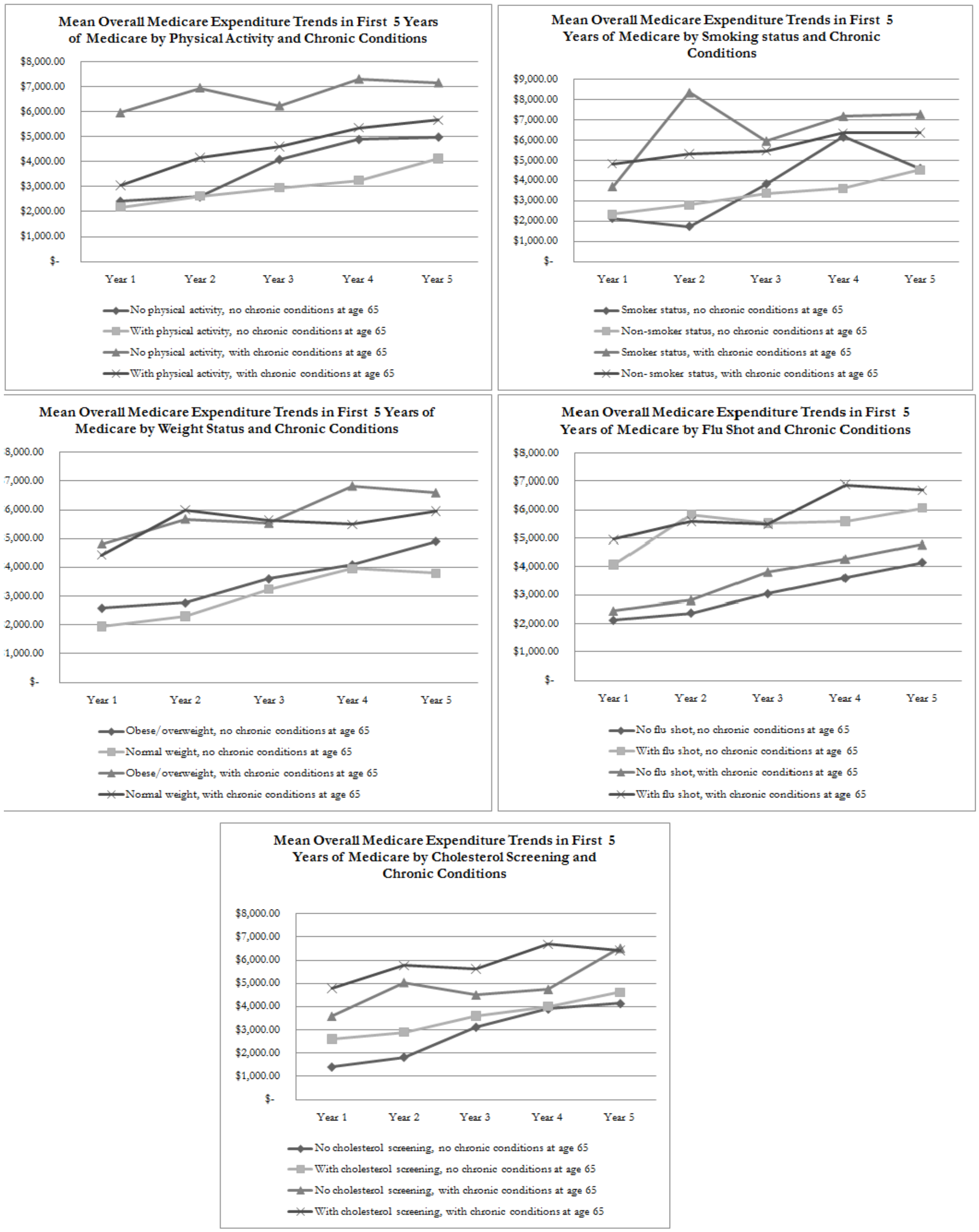
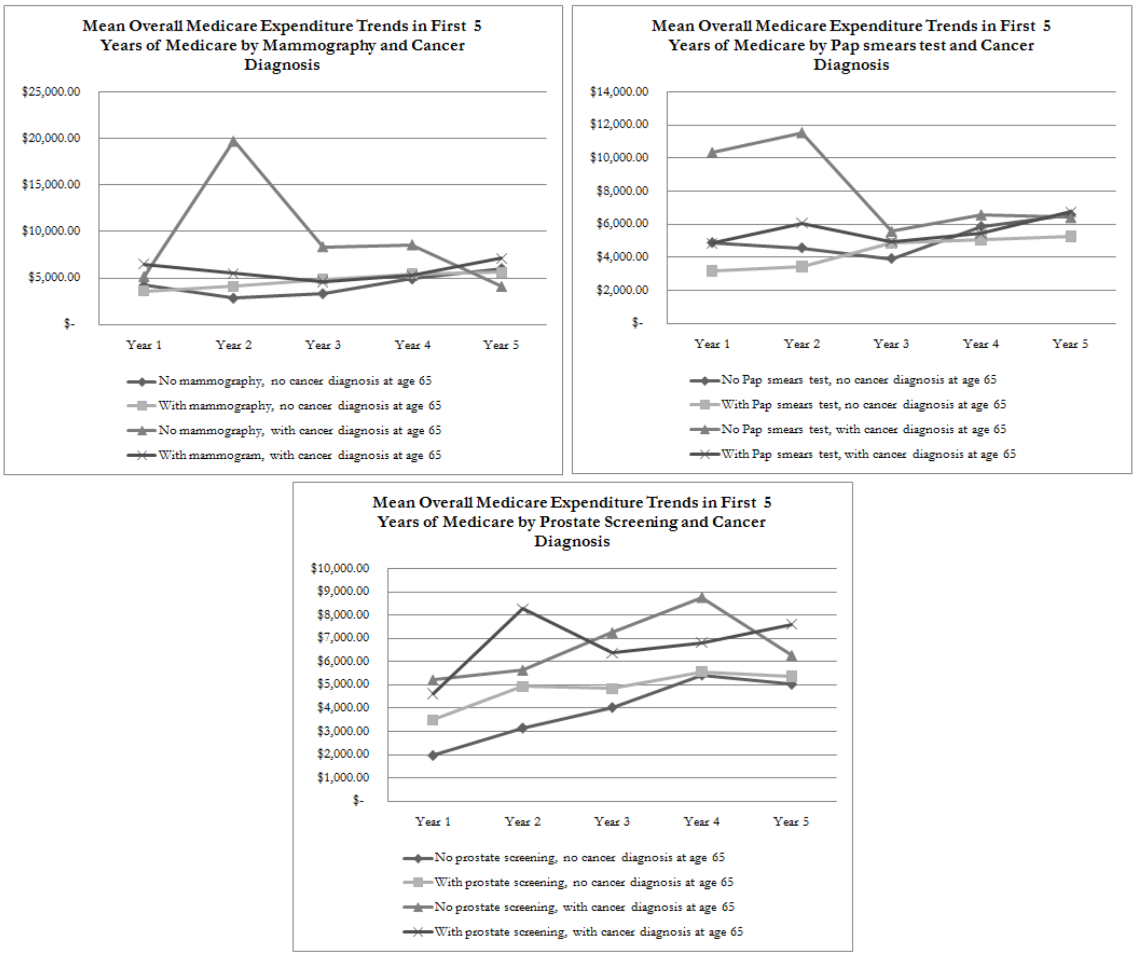


Figure 18. Five year expenditure trends by preventive activity and presence of cancer at age 65



5.2.7. Taste for medical care

An increased preference for medical system might pose an additional bias. On the one hand, might engage in preventive behavior upon a physician advice to do so. Alternatively, increased preventive behavior might simply be a proxy for better access to medical care or simply a preference for increased services and possibly to higher expenditures in the long run. In this section I analyzed the effect of different medical access measures (insurance in previous wave, at least one doctor visit, number of doctor visits, outpatient surgery in the last 2 years, dental visits in previous 2 years) on the decision to engage in the usual set of preventive activities by access. It is believed that the bias induced by omission of these variables could most likely lead to an underestimation of the explanatory variable: $|\beta_1| < |\beta_{true}|$.

The descriptive statistics in table 4.34 show that respondents with a positive response for the lifestyle preventive services are in general not significantly more likely to have sought medical services in the previous wave than people who do not engage in that kind of activities. Respondents with a positive medical related preventive activity were typically significantly more likely to have health insurance, at least on doctor visit, more doctor visit during the last two years before the interview, and more dental visits. People engaging in medical related preventive activities have more need or a preference for more medical care in the previous wave.

Table 4.34. Medical utilization measures in t-1 by preventive activity participation.

Preventive Activity	**Insurance at t-1**	**P Value in T-test**	**At least one doctor visit in last 2 years, pre age 65**	**P Value in T-test**	**Number of doctor visits in last 2 years, at t-1**	**P Value in T-test**	**Outpatient surgery in last 2 years, at t-1**	**P Value in T-test**	**Dental Visit in previous 2 yrs, at t-1**	**P Value in T-test**
No vigorous activity	76.36%	0.598	94.91%	0.586	9.74	<0.001	18.14%	0.975	62.14%	<0.001
With vigorous activity	75.23%		94.30%		6.96		18.08%		72.22%	
Smoker	74.21%	0.538	89.24%	0.110	9.03	0.433	14.73%	0.159	47.11%	<0.001
Non-smoker	76.12%		95.51%		8.29		18.64%		70.15%	
Overweight/Obese	72.17%	0.430	95.19%	0.538	8.93	0.035	18.36%	0.674	65.17%	0.038
Normal Weight	78.04%		93.19%		7.40		17.47%		70.53%	
No flu shot	72.17%	0.008	91.87%	<0.001	7.14	0.003	16.99%	0.360	60.36%	<0.001
With flu shot	78.04%		96.30%		9.14		18.79%		71.10%	
No cholesterol screening	64.18%	<0.001	84.32%	<0.001	6.09	0.001	16.26%	0.396	53.63%	<0.001
With cholesterol screening	78.31%		96.82%		8.87		18.38%		69.84%	
No mammogram	59.68%	<0.001	88.30%	<0.001	7.08	0.023	11.05%	0.006	45.79%	<0.001
With mammogram	75.65%		97.04%		9.33		19.49%		71.41%	
No Pap Smear test	68.20%	0.043	92.53%	0.005	8.92	0.963	14.42%	0.053	55.59%	<0.001
With Pap smear test	74.49%		96.64%		8.88		19.52%		71.45%	
No prostate cancer screening	71.67%	0.006	78.51%	<0.001	6.43	0.137	17.07%	0.632	56.10%	0.002
With Prostate Cancer screening	82.72%		96.95%		7.84		18.94%		70.70%	

In table 4.35, adding the controls for access to medical care made the association of prevention less positive in the cases of normal weight status, flu shot, cholesterol screening, prostate cancer screening. Adding the controls for access to medical care made the estimates for the associations of physical activity, non smoking status, mammogram, and Pap smear test more positive. Thus, there is no conclusive evidence regarding the effect that access to medical care might have on the regression models.

Table 4.35. Results of OLS regression for all Medicare expenditures with and without controls for taste for medical care.

Preventive activity	**(1)** No controls	**(2)** Controlled only for taste for medical care	**(3)** All controls except for taste for medical care	**(4)** All controls including taste for medical care
Physical Activity	-5,690.445***	-4,299.346**	-1,628.87	-580.63
	(1,371.878)	(1,731.869)	(1,337.890)	(1,602.591)
Non-smoker status	-3,494.233*	-1,551.607	-3,990.709*	-3,514.756
	(2,115.511)	(2,477.245)	(2,294.134)	(2,436.336)
Normal weight status	-2,502.271*	-1,174.515	626.863	993.812
	(1,453.442)	(1,735.337)	(1,379.188)	(1,737.982)
Flu shot	2,556.424*	-210.034	-366.442	-1,916.311
	(1,531.809)	(2,001.846)	(1,551.017)	(2,115.649)
Cholesterol screening	5,346.954***	3,528.673*	734.631	490.935
	(1,435.728)	(1,946.489)	(1,474.531)	(1,927.918)
Mammogram	1,344.445	3,061.585	694.323	2,301.86
	(2,240.249)	(2,838.736)	(2,219.894)	(2,791.082)
Pap smear test	-2698.552	-2,100.948	380.495	1,369.609
	(2,438.321)	(2,855.999)	(2,033.092)	(2,434.402)
Prostate cancer screening	4,394.425**	1,880.948	3,120.506	2,280.56
	(2,091.318)	(2,887.857)	(2,436.888)	(3,118.083)

Standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

5.2.8. Conditional prevention

As it has become evident in the analysis of the data in this chapter, lifestyle preventive activities vary widely from medical related preventive activities in its associations with Medicare expenditures. As shown in section 5.2.7., some preventive services are positively correlated with a taste for medical care such as flu shot and cholesterol screening; others such as exercising or normal weight status are negatively correlated. In order to explore these opposite characteristics in the demand for prevention, I repeat the analysis of OLS regressions of the association of each of the clinical preventive services on 5 years overall Medicare expenditures but (1) controlling and (2) interacting for the demand for all of the lifestyle preventive activities. Thirteen percent of the sample reported demanding all 3 of the lifestyle preventive activities (physical activity, non smoker status, normal weight). Table 4.36 presents the regression coefficients and standard errors of the baseline regression for each of the clinical preventive activity with the usual controls (column 1), the marginal effect when a control for all lifestyle prevention is added (column 2), and finally when the preventive activity is interacted with a dummy variable indicating if the person engaged in all lifestyle prevention activities.

Table 4.36. Results of OLS regression of clinical prevention on all Medicare expenditures conditional on lifestyle prevention.

	(1)	**(2)**	**(3)**
	Association of preventive activity on Medicare expenditures from ages 65-69		
Preventive Activity	**All controls except for any lifestyle prevention**	**Controlling for any lifestyle prevention**	**Interacting with lifestyle prevention**
Flu shot	-366.442 (1551.017)	-319.463 (1,572.385)	-429.977 (1,721.759)
All lifestyle prevention		-1,481.872 (1,833.864)	-1,929.752 (3,130.549)

Flu shot*All lifestyle prevention			771.36
			(3,872.429)
Cholesterol screening	734.631	1,039.766	698.252
	(1474.531)	(1,473.722)	(1,657.647)
All lifestyle prevention		-1,955.341	-3,953.697*
		(1,860.416)	(2,261.836)
Cholesterol screening*All lifestyle prevention			2,450.733
			(3,266.976)
Mammogram	694.323	820.319	787.595
	(2219.894)	(2,246.374)	(2,430.005)
All lifestyle prevention		80.957	-223.72
		(2,951.069)	(4,944.076)
Mammogram*All lifestyle prevention			348.315
			(5,666.993)
Pap smear test	380.495	345.17	-265.405
	(2033.092)	(2,009.077)	(2,206.610)
All lifestyle prevention		292.968	-3837.609
		(3,017.029)	(3,238.231)
Pap smear test*All lifestyle prevention			5,300.625
			(4,360.945)
Prostate cancer screening	3120.506	3,999.215	5,471.837**
	(2436.888)	(2,443.568)	(2,677.043)
All lifestyle prevention		-6,224.892***	3,381.256
		(2,304.090)	(4,991.876)
Prostate cancer screening*All lifestyle prevention			-11,559.430**
			(5,661.249)
Any clinical prevention	2594.275	2,597.613	3,231.552
	(2008.717)	(2,030.556)	(2,262.337)
All lifestyle prevention		-1,956.964	2,580.954
		(1,788.842)	(4,274.068)
Any clinical prevention*All lifestyle prevention			-4,798.837
			(4,754.545)
All clinical prevention	-276.58	-70.345	-328.817
	(1,463.594)	(1,484.808)	(1,566.326)
All lifestyle prevention		-1,009.622	-1,809.125
		(2,049.608)	(2,862.274)
All clinical prevention*All lifestyle prevention			1,742.01
			(3,959.881)

All columns show the marginal effect of the preventive behavior at age 65 (or close) in separate models predicting Medicare expenditures at age 65-69. All regressions were controlled for respondent's variables at age 65: inverse mills ratio (for selection bias), propensity weights, insurance status, risk aversion, time preference, gender, race, veteran status, working status, number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education (less than high school, high school/GED, some college, college or above), assets, mental health (CESD score), functional limitations, previous diagnosis of cancer, heart disease, lung disease, stroke, diabetes, arthritis, high blood pressure, residence in one of 10 census divisions and year when age 65. Heteroskedasticity adjusted standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

Adding a control for demand of all lifestyle preventive activities hardly changes the magnitude of the coefficient of the medical preventive activities. The coefficient for the control dummy variable for "all lifestyle preventive activities" tended to be negative and not significant, except in the regression for prostate cancer screening. When the interaction of the preventive activity in question and the dummy for all lifestyle preventive activities was added, it is found that demanding all lifestyle preventive services and at the same time flu shot, cholesterol screening, or prostate cancer screening results in negative expenditures.

Table 4.37 repeats the analysis shifting the roles of medical prevention from independent variables to controls and lifestyle prevention from controls to independent variables. Forty percent of the sample reports having all medical preventive activities (flu shot, cholesterol screening, Pap smear test and mammogram for women; flu shot, cholesterol screening, prostate cancer screening) in the wave closest to age 65.

Table 4.37. Results of OLS regression of lifestyle prevention on all Medicare expenditures conditional on receiving all clinical prevention

	(1)	(2)	(3)
	Association of preventive activity on all Medicare expenditures from ages 65-69		
Preventive Activity	**All controls except for any clinical prevention**	**Controlling for any clinical prevention**	**Interacting with clinical prevention**
Physical activity	-1,628.87	-1,638.636	-1,112.671
	(1,337.890)	(1,336.866)	(1,778.001)
All clinical prevention		-188.622	467.9
		(1,430.953)	(2,140.501)
Physical prevention*All clinical prevention			-1,232.801
			(2,688.402)
Non-smoker	-3,990.709*	-3,942.198*	-3,857.264
	(2,294.134)	(2,292.418)	(2,801.486)
All clinical prevention		-362.678	-135.974
		(1,440.553)	(4,312.675)
Non-smoker status*All clinical prevention			-257.155
			(4,578.583)
Normal weight	626.863	635.068	1,392.144
	(1,379.188)	(1,385.951)	(1,928.181)
All clinical prevention		79.849	684.052
		(1,382.143)	(1,660.129)
Normal weight*All clinical prevention			-1,808.618
			(2,758.944)
Any lifestyle prevention	-7142.529	-7108.304	-6,587.744
	(4,403.854)	(4,405.130)	(5,196.029)
All clinical prevention		-453.375	1,057.194
		(1,435.431)	(9,338.634)
Any lifestyle prevention*All clinical prevention			-1,577.121
			(9,487.378)
All lifestyle prevention	-1,517.809	-1,479.595	-1,741.84
	(1,987.934)	(1,999.551)	(2,869.372)
All clinical prevention		527.421	431.211
		(1,399.347)	(1,460.807)
All lifestyle prevention*All clinical prevention			579.195
			(3,771.388)

All columns show the marginal effect of the preventive behavior at age 65 (or close) in separate models predicting Medicare expenditures at age 65-69. All regressions were controlled for respondent's variables at age 65: inverse mills ratio (for selection bias), propensity weights, insurance status, risk aversion, time preference, gender, race, veteran status, working status, number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education (less than high school, high school/GED, some college, college or above), assets, mental health (CESD score), functional limitations, previous diagnosis of cancer, heart disease, lung disease, stroke, diabetes, arthritis, high blood pressure, residence in one of 10 census divisions and year when age 65. Heteroskedasticity adjusted standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

When added as a control a dummy indicating whether a respondent demands all clinical prevention services, the coefficient for the association of each of the single lifestyle preventive activities hardly changes. The dummy variable for all medical prevention is negative yet not significant. When the interaction term was added, the sum of the coefficients shows that engaging in physical activity while demanding all of the medical preventive services has a negative association with Medicare expenditures. The same can be said about being a non-smoker and demanding medical prevention. Yet, none of these are significant. When normal weight status is combined with demand for all the medical prevention services, there is a non significant positive association with expenditures.

5.3. Average Treatment Effect

Following Rosenbaum (1998) and Hirano, Imbens and Ridder (2003), the difference in weighted average of the outcomes between treatment and untreated group gives a consistent estimate of the average treatment effect (ATE) using nearest neighbor matching where the weights are proportional to the inverse of the estimated propensity scores. Propensity scores were calculated using logistic regression with the following regressors: race, age, education, financial planning horizon, life insurance policy, risk aversion to changing jobs, wealth, marital status, and long term care health insurance.

Table 4.38 summarizes the ATE for the different preventive activities in separate models using inverse propensity scores as weights. The results confirm what was found in section 5.1. Lifestyle preventive activities tend to be correlated with lower the average expenditures during the first periods of Medicare of $2634 in the case normal weight status, $1,840 for non smoker status, and $1,143 for physical activity. These results are less negative that the OLS results yet not significant. The propensity scores seem to have ameliorated some of the selection biased that was evidenced in the examination of the alternative hypotheses in section 5.2.

The average treatment effect for all clinical preventive activities on the first 5 years of Medicare data is positive. However, only cholesterol screening has a positive and significant ATE.

Table 4.38. Average treatment effect of each preventive activity on all Medicare expenditures

Preventive activity	**Average Treatment Effect on all Medicare expenditures**
Physical Activity	-1,143.75 (3,296.38)
Non-smoker status	-1,840.91 (3,482.204)
Normal weight status	-2,633.89 (14,485.45)
Flu shot	1,696.72 (4,312.23)
Cholesterol screening	6,401.31* (3,355.31)
Mammogram	5,072.48 (2,895.51)
Pap smear test	204.40 (3,101.16)
Prostate cancer screening	5,229.17 (5,034.87)

Standard errors are in parentheses. ***, **, *
denote statistical significance at the 1-percent,
5-percent, and 10-percent level, respectively.

5.4. Instruments

I try 8 plausible instruments that were thought in the theoretical model to be strong predictors of the demand for preventive care. I use each of these instruments in instrumental variable two stage least square models controlling for all the covariates used before (see table 4.4). The results are disappointing as the estimates of the coefficients are extremely imprecise and not reliable. I attribute such results to the fact that in most cases, the instruments are too weak and show a Kleibergen-Paap statistic that is lower than the minimum standard of 10 to be considered sufficiently good instruments.

It is well recognized in the literature that using weak instruments will produce second stage marginal estimates with large standard errors. Also, if the instruments are not strongly correlated with the endogenous explanatory variable, then even a weak correlation between the instruments and the error in the original equation can lead to a large inconsistency in IV estimates (Bound, Jaeger & Baker, 1995). Both of these situations are evident in the use of my instrumental variables. The estimates for the marginal effects presented in table 4.39 are clearly unreasonable since some of them surpass the maximum actual observations of Medicare expenditures by many orders of magnitude. As such, I can only conclude that in this case, the use of instrumental variables does not help to alleviate the endogeneity problem in my estimation.

Table 4.39. Instrumental variable analysis of the effect of prevention on 5 year overall Medicare expenditures.

		(1)	(1a)	(2)	(3)	(4)	(5)
Panel A. Non risk averse instruments							
Preventive Activity	**Statistic**	**Spouse's preventive activity (mammogram for prostate cancer screening)**	**Spouse's preventive activity (pap smear for prostate cancer screening)**	**Education years**	**Long term financial planning**	**Deterioration of health stock**	**Household assets**
Physical Activity	Coefficient	-14,831.34	.	-3,482,884.89	-19,945.85	105,806.99	-111,191.76
	Robust Std. Error	(12,656.87)	.	(59,166,332.77)	(57,438.06)	(99,168.97)	(203,104.37)
	Kleibergen-Paap rk Wald F statistic for weak instruments	22.3	.	0.0	1.1	1.7	0.4
Non-smoker status	Coefficient	-10,454.39	.	90,732.703**	-92,275.29	388,846.14	-93,624.99
	Robust Std. Error	(16,302.98)	.	(45,609.17)	(191,179.30)	(812,817.36)	(82,095.60)
	Kleibergen-Paap rk Wald F statistic for weak instruments	29.3	.	11.6	0.4	0.2	2.0
Normal weight status	Coefficient	83,625.55	.	106252.156	61,074.70	-311,476.46	-50,292.54
	Robust Std. Error	(72,482.11)	.	(107,205.02)	(130,694.41)	(806,968.05)	(37,938.63)
	Kleibergen-Paap rk Wald F statistic for weak	2.8	.	1.6	0.4	0.2	2.9

	instruments						
Flu shot	Coefficient	3,758.32	.	42,527.131*	-30,893.39	209,442.14	-135,178.31
	Robust Std. Error	(3,992.40)	.	(21,915.27)	(42,332.91)	(362,298.37)	(268,402.36)
	Kleibergen-Paap rk Wald F statistic for weak instruments	300.5	.	19.0	2.6	0.4	0.3
Cholesterol screening	Coefficient	19,617.27	.	53,023.985*	-30,387.29	671,033.06	-60,425.28
	Robust Std. Error	(17,165.98)	.	(27,230.82)	(53,726.05)	########	(46,820.57)
	Kleibergen-Paap rk Wald F statistic for weak instruments	16.7	.	21.0	2.5	0.1	3.6
Mammography	Coefficient	-13,474.83	.	40707.778	-19,403.02	-213,936.84	-5,552.43
	Robust Std. Error	(68,243.37)	.	(30,965.28)	(29,862.75)	(600,181.42)	(23,733.15)
	Kleibergen-Paap rk Wald F statistic for weak instruments	1.6	.	12.2	5.9	0.2	4.3
Pap smear test	Coefficient	-4,310.79	.	45244.646	-17,114.75	178,921.42	-4,386.49
	Robust Std. Error	(32,888.99)	.	(34,599.23)	(32,934.94)	(407,020.98)	(33,839.26)
	Kleibergen-Paap rk Wald F statistic for weak instruments	4.7	.	8.1	3.7	0.2	1.9
Prostate	Coefficient	62,619.87	42040.927	55,889.081*	-26,474.51	-175,815.22	-100,966.08

screening							
	Robust Std. Error	(39,580.18)	-66389.684	(29,056.04)	(64,023.78)	(281,403.49)	(94,775.42)
	Kleibergen-Paap rk Wald F statistic for weak instruments	4.9	2.4	17.6	1.7	0.5	1.9

Panel B. Risk averse instruments

		(6)	(7)	(8)
Preventive Activity	**Statistic**	**Risk aversion to job change**	**Life insurance**	**Long term care insurance**
Physical Activity	Coefficient	46,008.88	13,749.12	-117,571.34
	Robust Std. Error	(55,395.79)	(32,818.31)	(360,943.06)
	Kleibergen-Paap rk Wald F statistic for weak instruments	1.9	2.9	0.1
Non-smoker status	Coefficient	100,928.82	-128,275.14	71,517.85
	Robust Std. Error	(131,653.17)	(331,695.71)	(96,034.33)
	Kleibergen-Paap rk Wald F statistic for weak instruments	1.1	0.2	1.7
Normal weight status	Coefficient	-25,450.99	188,120.41	214,680.12
	Robust Std. Error	(37,511.92)	(689,920.73)	(681,636.59)

	Kleibergen-Paap rk Wald F statistic for weak instruments	3.3	0.1	0.1
Flu shot	Coefficient	-393,502.55	-43,933.12	44,368.39
	Robust Std. Error	(2,203,931.46)	(84,720.62)	(57,476.52)
	Kleibergen-Paap rk Wald F statistic for weak instruments	0.0	0.7	1.7
Cholesterol screening	Coefficient	141,473.27	-139,537.18	694,928.06
	Robust Std. Error	(266,902.14)	(359,348.29)	(6,343,066.07)
	Kleibergen-Paap rk Wald F statistic for weak instruments	0.4	0.2	0.0
Mammography	Coefficient	227,540.36	-274,487.20	259,770.97
	Robust Std. Error	(460,117.15)	(859,952.79)	(748,781.73)
	Kleibergen-Paap rk Wald F statistic for weak instruments	0.3	0.1	0.1
Pap smear test	Coefficient	178,474.32	-202,052.76	-33,707.50
	Robust Std. Error	(333,283.71)	(554,458.39)	(36,197.86)
	Kleibergen-Paap rk Wald F statistic for weak instruments	0.3	0.1	4.4
Prostate	Coefficient	-133,808.02	7,817.25	11,076.20

screening				
	Robust Std. Error	(620,830.29)	(21,495.01)	(60,983.53)
	Kleibergen-Paap rk Wald F statistic for weak instruments	0.1	10.4	1.4

*All columns show the marginal effect of the preventive behavior at age 65 (or close) in separate models predicting Medicare expenditures at age 65-69. All regressions were controlled for respondent's variables at age 65: inverse mills ratio (for selection bias), propensity weights, insurance status, risk aversion, time preference, gender, race, veteran status, working status, number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education (less than high school, high school/GED, some college, college or above), assets, mental health (CESD score), functional limitations, previous diagnosis of cancer, heart disease, lung disease, stroke, diabetes, arthritis, high blood pressure, residence in one of 10 census divisions and year when age 65. Heteroskedasticity adjusted standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.*

5.5. Life expectancy

As evidenced in the last section, the differences in spending seem small even when significant. However, it has been pointed out that aside from financial gains some researchers have emphasized the potential health benefits of prevention as a way to justify increased funding for preventive activities and programs. Some European countries have reported that effective investment can be instrumental in securing longer life expectancy and, crucially, healthier life expectancy, by preventing and/or treating premature or avoidable morbidity (Raitano, 2006). To explore the possibility that prevention might affect life expectancy, in this section I turn to survival analysis.

I used Cox proportional-hazard modeling to compute the hazard ratios, such that:

$\log \lambda(t: x) = x\beta + \log \lambda_0(t), \lambda_0(t) > 0$ is the baseline hazard

Confounders included the same covariates used when estimating the effect for health expenditures (table 4.2). Table 4.40 summarizes the hazard ratios estimated in individual models for each of the preventive activities. The only significantly differences in the hazard ratios were found in non smokers and normal weights. Non smokers had a 55.3% lower risk of death than smokers. Surprisingly, normal weight people had a 39.7% higher risk of death than overweight and obese respondents.

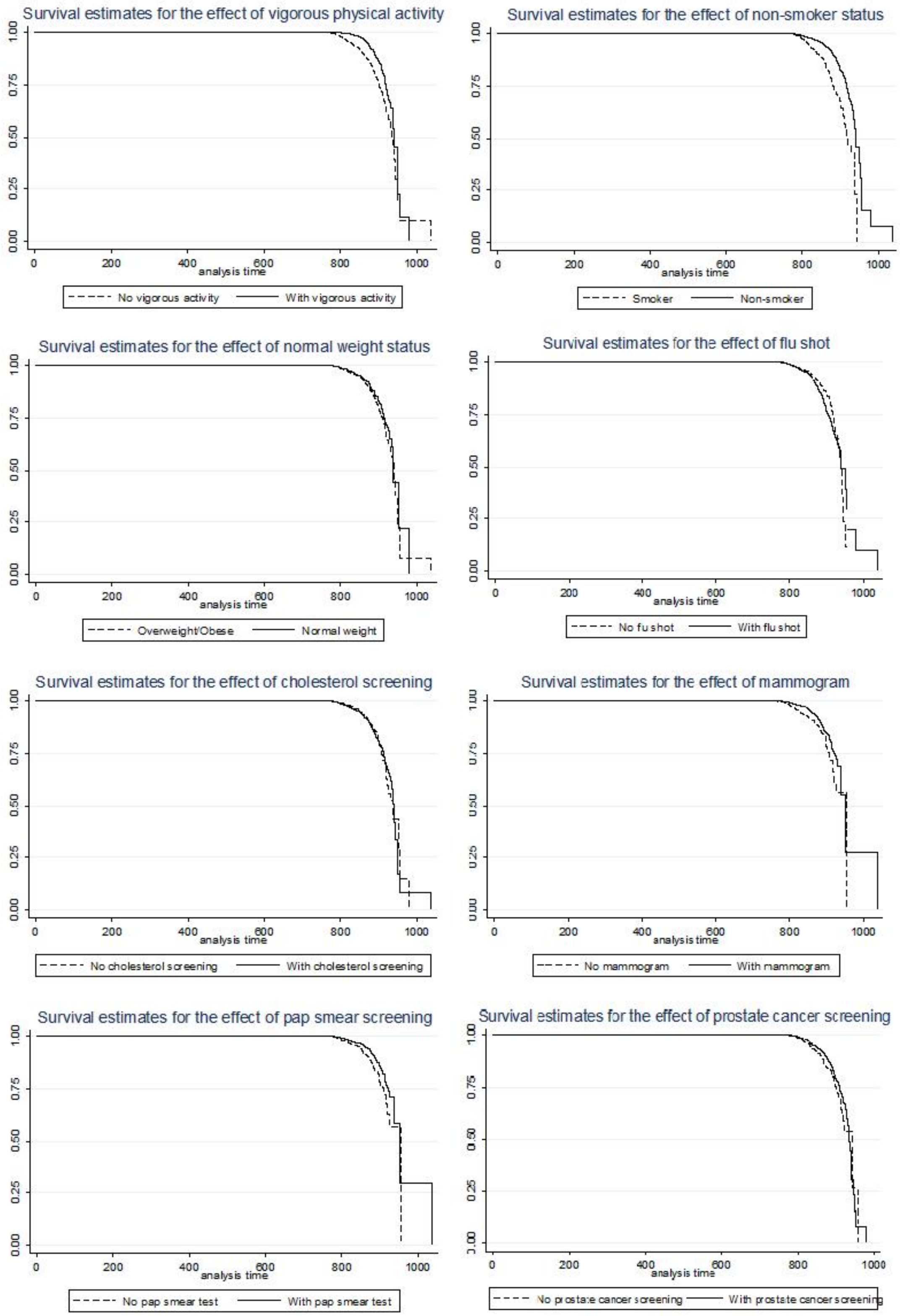
Table 4.40. Hazard ratios in Cox proportional hazard models.

Preventive activity	**Effect of preventive activity on screening on survival models (respondents with at least five years of claim data)**
Physical Activity	1.095 (0.183)
Non-smoker status	0.447*** (0.083)
Normal weight status	1.397** -0.237
Flu shot	1.269 (0.208)
Cholesterol screening	0.765 (0.138)
Mammogram	1.007 (0.297)
Pap smear test	0.743 (0.183)
Prostate cancer screening	1.357 (0.393)

All columns show the marginal effect of the preventive behavior at age 65 (or close) in separate models predicting Medicare expenditures at age 65-69. All regressions were controlled for respondent's variables at age 65: inverse mills ratio (for selection bias), propensity weights, insurance status, risk aversion, time preference, gender, race, veteran status, working status, number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education (less than high school, high school/GED, some college, college or above), assets, mental health (CESD score), functional limitations, previous diagnosis of cancer, heart disease, lung disease, stroke, diabetes, arthritis, high blood pressure, residence in one of 10 census divisions and year when age 65. Heteroskedasticity adjusted standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

Figure 19 shows the shape of the Kaplan-Meier failure functions by each of the different preventive activities separately. As expected from the Cox proportional hazards models' estimates presented above, there seems to be very little difference in the graphs.

Figure 19. Failure functions by preventive activity.



6. Discussion

In this nationally representative study, the association between Medicare expenditures and preventive behavior at age 65 was analyzed. The results show that the kind of activities that are often catalogued as preventive activities have very different correlations with expenditures. As such, widely different conclusions can be derived from each of them. None of these are without caveats as the study struggles to overcome the endogeneity concerns that are common in the topic of prevention

In terms of the association of preventive activities with expenditures, I find three groups: the ones that have a negative association (physical activity, non-smoking and normal weight status, although the correlation of the last one is much more pronounced and significant in the long term), the ones with a positive association with expenditures (flu shot and cholesterol screening), and those that are largely ineffectual (mammograms, prostate cancer screening, and Pap smear test).

Respondents who perform physical activity 3 or more times a week end up spending $4,852 less than respondents who exercise less frequently when analyzing 5 years of Medicare expenditures. When adjusting for confounding variables, the association reduces to $1,629 less dollars. Yet the magnitude of the association is insignificant. However, it does seem that physical activity is negatively and significantly associated with inpatient expenditures. The reason why adding controls substantially decrease the magnitude of the association of physical activity and expenditures is that respondents who engage in physical activity report having less chronic conditions and, importantly better health status. Hence, there is a powerful selection bias in the uptake of physical activity which is potentially driving the differences in expenditures as well. Even if the difference in expenditures could be attributable to the effect of physical activity, it is worth considering that rather that true savings, these could be considered transfers as respondents invested considerable amounts of time and even perhaps foregone wages and leisure time exercising.

Non- smoking is found to be associated with savings of $1,823 over 5 years, most of them coming from less inpatient expenditures. Similarly to the case of physical activity, non-smokers tended to be also in better underlying health, more educated, and less prone to chronic conditions at baseline. Yet, when confounding effects were added, the negative association of non smoking on expenditures is exacerbated in adjusted multivariate analysis.

Respondents with cholesterol screening and flu shots have higher 5 year Medicare expenditures: $4,586.85 for the former, and $1,244 for the latter. The associations are not significant when controlling for covariates. The differences seen in the descriptive analysis come probably as a result of worse underlying health at baseline. The evidence examined here indicate that respondents who engage in this activity have worse health status, more chronic conditions, and higher contact with the medical profession prior to Medicare.

Cancer screenings, often grouped as forms of secondary prevention, did not seem to make any difference in the expenditure trends of respondents. Interestingly, women with mammograms and Pap smear test tended to have less inpatient expenditures (although these were mostly insignificant), but more outpatient and physician expenditures. The differences cancel each other. On the other hand, prostate cancer screening seems to be unequivocally correlated with insignificantly higher expenditures.

Selection bias might be in play since and examination of alternative hypothesis showed that people in better underlying health were more prone to exercise and to be non-smokers. Similarly, sicker people and people with more chronic conditions were more likely to have cholesterol screenings and flu shots, and a history of more access to the health care system in the past. Propensity score methods were tried to ameliorate these biases. The average treatment effect derived from such methods confirm the general trends of the OLS regressions but the standard errors of such effects are too big to render the estimates significant.

To address the question of whether the effect of health expenditures is obscured by effects on life expectancy, I used survival analysis. Survival graphs were shown to vary very little by preventive activity, where only non-smoking appearing to have an effect on the survival graphs. And in proportional hazard models with multiple covariates, non-smoking is also the only preventive activity that seems to significantly affect the survival rates.

To try to address endogeneity concerns, instrumental variable analysis was attempted with several variables that were thought, using the theoretical background, to have good predictive power but that were ineffectual in affecting by themselves the expenditure trends. However, the analysis of these instrumental variables reveal a very weak first stage correlation with preventive behaviors leading to inflated second stage coefficients and large standard errors. Therefore, the instrumental variable analysis was deemed irrelevant.

The study has numerous limitations. Firstly, although many attempts were performed to include and interpret a comprehensive set of observed variables that are present in HRS but seldom available in Medicare data analysis, it is still possible that unobserved variables may be driving the variation in expenditures. Secondly, the analysis is prone to a problem of counterfactuals. In this study, I observe the expenditure trends of people conditional on their decision to undertake prevention. However, I do not know how their expenditure profile would have looked had they chose the alternative route. Also, there is considerable measurement error in my variables as the survey questions contain self reported information. Finally, the study does not take into account the lifetime history of prevention. It only looks at the preventive behavior at one point in time, namely at age 65.

7. Conclusion and implications

This study lends to the argument that prevention is less likely to result in cost savings among the older adults than often hoped. It is important to stress this, since politically prevention is still sometimes seen as a means to reduce health-care spending. From this analysis, it is clear that it is impossible to generalize about preventive interventions as though they were all alike. Some, like smoking cessation programs, may be good investments almost regardless of how they are applied as this study shows that non smokers spend less money and live longer. Some other might be associated with the advent of disease in such a way that it is impossible to understand its effect on expenditures absent randomized trials.

It is important to clarify that this study does not answer the question of whether it is worth to invest in prevention or not. It just analyzes whether expenditure trends among Medicare beneficiaries are likely to be different or not without establishing any causal relationships, for which only carefully designed long term randomized experiments could definitive provide answers. There might be many reasons why prevention are be a worthwhile investment. For once, some of these preventive activities might actually prove to be cost-effective if not cost-saving. They might also provide with better health outcomes. These questions were beyond the scope of this analysis.

8. Appendix

8.1. *Alternative expenditure measurements*

8.1.1. 10 years of data

In this additional section I look at all those expenditures and claims during the first 10 years of a respondent's tenure in Medicare for the population that have at least 5 years of data in Medicare.

Table A.4.1. Expenditures and claims during the first 10 years in Medicare by preventive activity.

Preventive activity	**Type of expenditure/claims**	**No prevention**		**Prevention**		**P-value (T-test)**
		Mean	**Std. Dev.**	**Mean**	**Std. Dev.**	
Vigorous Physical activity	Overall expenditures	**$ 47,235.90**	($61,215.67)	$ 35,346.58	($45,792.79)	<0.001
	Inpatient expenditures	**$ 22,057.07**	($38,799.77)	$ 14,202.48	($28,060.32)	<0.001
	Physician expenditures	**$ 15,981.73**	($16,912.09)	$ 14,299.26	($19,637.89)	0.007
	Outpatient expenditures	**$ 7,409.28**	($13,252.87)	$ 6,159.99	($10,147.65)	0.003
	Overall claims	**124.60**	(95.34)	107.37	(74.24	<0.001
	Inpatient claims	**1.93**	(3.16)	1.22	(1.97	<0.001
	Physician claims	**95.49**	(75.04)	83.37	(57.54	<0.001
	Outpatient claims	**26.37**	(30.63)	22.46	(26.86	<0.001
Non-smoker status	Overall expenditures	**$ 48,559.16**	($52,219.33)	$ 41,642.27	($56,540.20)	0.05
	Inpatient expenditures	**$ 23,535.77**	($34,730.02)	$ 18,248.37	($35,463.06)	0.02
	Physician expenditures	$ 16,257.37	($17,841.87)	$ 15,163.59	($18,235.85)	0.330
	Outpatient expenditures	$ 7,376.30	($10,501.11)	$ 6,811.38	($12,081.41)	0.390
	Overall claims	**111.96**	(83.93)	117.89	(87.15)	<0.001
	Inpatient claims	**1.96**	(3.05)	1.60	(2.72)	0.04
	Physician claims	**82.80**	(62.52)	91.07	(68.29)	0.06
	Outpatient claims	26.51	(29.87)	24.58	(29.18)	0.19
Normal weight	Overall expenditures	**$ 44,349.94**	($58,299.11)	$ 37,219.15	($47,355.93)	0.00
	Inpatient expenditures	**$ 19,696.90**	($36,202.07)	$ 16,503.92	($32,261.22)	0.02

	Physician expenditures	$ 15,808.91	($17,319.69)	$ 14,031.48	($17,077.56)	0.032
	Outpatient expenditures	**$ 7,179.44**	($12,084.46)	$ 5,869.26	($8,684.81)	0.007
	Overall claims	**122.14**	(90.87)	107.49	(78.23)	<0.001
	Inpatient claims	**1.77**	(2.98)	1.34	(2.20)	<0.001
	Physician claims	**94.02**	(70.51)	82.83	(62.26)	<0.001
	Outpatient claims	**25.64**	(30.50)	22.91	(26.95)	0.02
Flu shot	Overall expenditures	$ 40,275.35	($53,711.15)	**$ 44,789.96**	($58,038.58)	0.09
	Inpatient expenditures	$ 17,615.98	($31,906.85)	$ 20,296.05	($38,529.15)	0.14
	Physician expenditures	$ 14,937.66	($20,330.67)	$ 15,797.97	($16,649.72)	0.361
	Outpatient expenditures	$ 6,063.70	($9,933.67)	**$ 7,409.97**	($12,380.95)	0.006
	Overall claims	107.95	(80.24)	**124.82**	(91.28)	<0.001
	Inpatient claims	1.49	(2.47)	**1.77**	(2.99)	0.04
	Physician claims	83.33	(62.32)	**95.69**	(71.49)	0.00
	Outpatient claims	22.46	(26.83)	**26.71**	(31.01)	<0.001
Cholesterol Screening	Overall expenditures	$ 39,863.86	($48,400.64)	$ 43,438.36	($57,893.67)	0.22
	Inpatient expenditures	$ 19,171.36	($33,361.81)	$ 18,994.46	($35,922.37)	0.97
	Physician expenditures	$ 13,769.71	($14,285.25)	**$ 15,797.64**	($19,217.13)	0.033
	Outpatient expenditures	$ 5,705.89	($8,868.24)	**$ 7,154.28**	($12,217.04)	0.023
	Overall claims	99.19	(75.61)	**121.97**	(89.14)	<0.001
	Inpatient claims	1.56	(2.4)	1.67	(2.83)	0.49
	Physician claims	77.27	(59.34)	**93.55**	(69.56)	<0.001
	Outpatient claims	19.80	(23.89)	**26.08**	(30.30)	<0.001
Mammogram	Overall expenditures	$ 42,325.17	($61,698.97)	$ 39,687.11	($53,931.31)	0.51
	Inpatient expenditures	$ 21,325.61	($39,875.77)	$ 15,884.24	($31,525.64)	0.27
	Physician expenditures	$ 12,881.12	($13,986.85)	**$ 15,273.78**	($18,660.74)	0.060
	Outpatient expenditures	$ 6,098.58	($12,633.75)	$ 6,910.68	($10,055.24)	0.308
	Overall claims	105.30	(85.98)	**127.75**	(90.66)	<0.001
	Inpatient claims	1.84	(3.12)	1.53	(2.76)	0.15
	Physician claims	79.17	(66.34)	**97.84**	(71.46)	<0.001
	Outpatient claims	23.20	(27.36)	**27.75**	(30.26)	0.01

Pap smear test	Overall expenditures	**$ 47,799.94**	($72,049.93)	$ 36,433.75	($45,667.42)	0.00
	Inpatient expenditures	**$ 22,718.47**	($41,876.52)	$ 14,214.39	($28,275.17)	<0.001
	Physician expenditures	$ 14,652.42	($17,129.36)	$ 14,776.90	($18,460.44)	0.920
	Outpatient expenditures	$ 7,441.95	($14,094.50)	$ 6,385.02	($8,737.71)	0.118
	Overall claims	122.38	(101.61)	122.71	(83.71)	0.80
	Inpatient claims	**1.99**	(3.46)	1.39	(2.44)	<0.001
	Physician claims	91.79	(77.27)	94.51	(67.26)	0.46
	Outpatient claims	27.39	(31.40)	26.32	(28.68)	0.76
Prostate cancer screening	Overall expenditures	$ 42,956.33	($46,817.76)	$ 45,119.12	($56,545.41)	0.67
	Inpatient expenditures	$ 20,328.66	($28,594.94)	$ 20,694.65	($37,075.23)	0.98
	Physician expenditures	$ 13,837.79	($13,831.62)	**$ 16,485.17**	($19,712.25)	0.081
	Outpatient expenditures	$ 7,610.86	($14,139.39)	$ 6,959.41	($13,188.99)	0.657
	Overall claims	96.43	(80.36)	**112.75**	(81.12)	0.01
	Inpatient claims	1.75	(2.44)	1.65	(2.57)	0.58
	Physician claims	70.96	(56.52)	**88.45**	(63.62)	0.00
	Outpatient claims	23.18	(34.86)	22.18	(26.86)	0.83

Table A.4.2. OLS regression coefficients for expenditures during the first 10 years in Medicare

	(1)	(2)	(3)	(4)
Preventive activity/Type of expenditure	**Preventive activity on screening on all Medicare expenditures age 65 to 74**	**Preventive activity on screening on inpatient expenditures age 65 to 74**	**Preventive activity on screening on physician expenditures age 65 to 74**	**Preventive activity on screening on outpatient expenditures age 65 to 74**
	-25,944.719**	-15,617.937**	-9,620.998**	-22.023
Vigorous Activity	(11818.767)	(7347.050)	(4081.034)	(2209.505)
	-26,241.665	-26,723.983*	1,305.995	-251.694
Non smoker status	(17784.402)	(14454.907)	(4026.941)	(1960.019)
	-24,055.661***	-13,823.418**	-5,812.305*	-4,166.765*
Normal weight	(9118.511)	(5760.033)	(3143.177)	(2232.342)
	6,371.769	5,808.199	733.226	116.829
Flu shot	(7791.875)	(5384.040)	(2683.153)	(1695.166)
Cholesterol	-2,902.725	-5,903.329	-525.647	3,945.397*
Screening	(13136.321)	(9071.591)	(3861.587)	(2208.077)
	-15,193.972	-10,079.477	-2,052.012	-2,459.255
Pap smear test	(13513.576)	(9769.720)	(3072.486)	(3093.311)
	-9,583.652	-11184.06	2,908.023	-864.687
Mammogram	(13365.322)	(8889.879)	(3329.916)	(3107.139)
Prostate cancer	25,478.441	11,821.023	12,108.223	1,088.711
screening	(22547.980)	(14455.423)	(7596.269)	(2898.598)
N		229		
N-female		122		
N-male		107		

All columns show the marginal effect of the preventive behavior at age 65 (or close) in separate models predicting Medicare expenditures at age 65-69. All regressions were controlled for respondent's variables at age 65: inverse mills ratio (for selection bias), propensity weights, insurance status, risk aversion, time preference, gender, race, veteran status, working status, number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education (less than high school, high school/GED, some college, college or above), assets, mental health (CESD score), functional limitations, previous diagnosis of cancer, heart disease, lung disease, stroke, diabetes, arthritis, high blood pressure, residence in one of 10 census divisions and year when age 65. Heteroskedasticity adjusted standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

8.1.2. Average Annual Expenditures

In this section, I calculate average yearly expenditures for the population that has at least one year of Medicare claims data.

Table A.4.3. Average expenditures and claims during the first 10 years in Medicare by preventive activity

Preventive activity	Type of expenditure/claims	No prevention		Prevention		P-value (T-test)
		Mean	Std. Dev.	Mean	Std. Dev.	
Vigorous Physical activity	Overall expenditures	**$ 6,348.25**	($10,315.89)	$4,641.66	($7,393.67)	<0.001
	Inpatient expenditures	$16,604.58	($16,336.54)	$15,568.74	($15,463.09)	0.20
	Physician expenditures	**$2,180.57**	($3,058.60)	$1,867.50	($3,191.81)	0.002
	Outpatient expenditures	**$1,508.88**	($3,168.86)	$1,088.47	($1,555.95)	<0.001
	Overall claims	**15.55**	(13.00)	13.52	(9.90)	<0.001
	Inpatient claims	**1.38**	(0.65)	1.32	(0.54)	0.03
	Physician claims	**12.15**	(10.26)	10.72	(8.01)	<0.001
	Outpatient claims	**4.34**	(4.26)	3.68	(3.17)	<0.001
Non-smoker status	Overall expenditures	**$6,607.53**	($10,901.69)	$5,452.06	($8,906.39)	0.005
	Inpatient expenditures	**$19,896.91**	($20,405.34)	$15,477.09	($14,984.10)	<0.001
	Physician expenditures	$2,100.90	($3,567.27)	$2,036.45	($3,036.11)	0.645
	Outpatient expenditures	$1,385.87	($3,044.65)	$1,326.45	($2,559.22)	0.646
	Overall claims	**13.65**	(12.04)	14.87	(11.79)	0.02
	Inpatient claims	**1.43**	(0.67)	1.34	(0.59)	0.02
	Physician claims	**11.74**	(9.36)	13.44	(9.40)	0.001
	Outpatient claims	4.22	(3.85)	4.02	(3.85)	0.29
Normal weight	Overall expenditures	**$5,891.05**	($5,891.05)	$4,921.18	($8,265.58)	0.003
	Inpatient expenditures	$15,979.33	($15,387.64)	$16,606.47	($17,799.77)	0.50
	Physician expenditures	**$2,103.28**	($3,065.02)	$1,917.73	($3,294.97)	0.096
	Outpatient expenditures	**$1,365.51**	($2,632.47)	$2,632.47	($2,052.59)	0.044
	Overall claims	**15.24**	(12.31)	13.40	(10.59)	<0.001
	Inpatient claims	1.36	(0.62)	1.33	(0.56)	0.41

	Physician claims	**11.97**	(9.78)	10.58	(8.54)	<0.001
	Outpatient claims	**4.17**	(4.01)	3.71	(3.35)	0.00
Flu shot	Overall expenditures	$5,494.48	($9,208.84)	$5,725.02	($9,244.85)	0.44
	Inpatient expenditures	$16,176.59	($15,438.61)	$16,199.69	($16,365.75)	0.977
	Physician expenditures	$2,004.25	($3,843.79)	$2,078.68	($2,518.40)	0.465
	Outpatient expenditures	$1,250.92	($2,461.30)	**$1,385.73**	($2,726.47)	0.148
	Overall claims	13.15	(10.90)	15.74	(12.33)	<0.001
	Inpatient claims	1.33	(0.58)	**1.37**	(0.62)	0.16
	Physician claims	10.34	(8.76)	**12.35**	(9.76)	<0.001
	Outpatient claims	3.76	(3.55)	**4.25**	(4.03)	<0.001
Cholesterol Screening	Overall expenditures	$5,679.15	($9,222.13)	$5,630.42	($9,251.95)	0.90
	Inpatient expenditures	**$18,016.91**	($19,173.89)	$15,795.33	($15,131.86)	0.03
	Physician expenditures	$1,860.97	($3,273.33)	**$2,092.82**	($3,080.35)	0.07
	Outpatient expenditures	$1,326.73	($2,804.36)	$1,335.00	($2,591.47)	0.94
	Overall claims	11.89	(9.82)	**15.35**	(12.15)	<0.001
	Inpatient claims	1.36	(0.57)	1.35	(0.62)	0.86
	Physician claims	9.26	(7.84)	**12.08**	(9.66)	<0.001
	Outpatient claims	3.69	(3.44)	**4.13**	(3.92)	0.01
Mammogram	Overall expenditures	**$6,365.41**	($11,973.45)	$5,125.15	($8,151.97)	0.01
	Inpatient expenditures	**$18,605.22**	($20,604.12)	$13,768.54	($13,407.46)	<0.001
	Physician expenditures	$1,997.83	($3,742.59)	$2,102.60	($3,197.06)	0.54
	Outpatient expenditures	$1,326.30	($2,887.50)	$1,198.25	($2,288.43)	0.35
	Overall claims	13.95	(13.76)	**16.18**	(12.06)	<0.001
	Inpatient claims	1.49	(0.75)	**1.31**	(0.58)	<0.001
	Physician claims	10.62	(10.74)	**12.73**	(9.58)	<0.001
	Outpatient claims	4.30	(4.05)	4.20	(3.89)	0.64
Pap smear test	Overall expenditures	**$6,222.54**	($10,955.23)	$4,940.27	($7,961.86)	0.002
	Inpatient	**$17,127.09**	($19,122.60)	$13,628.91	($12,934.23)	0.00

	expenditures					
	Physician expenditures	$2,030.68	($3,261.29)	$2,082.40	($3,320.12)	0.73
	Outpatient expenditures	$1,308.14	($2,606.17)	$1,179.22	($2,326.03)	0.28
	Overall claims	15.54	(13.61)	15.69	(11.84)	0.78
	Inpatient claims	**1.47**	(0.74)	1.29	(0.54)	<0.001
	Physician claims	11.88	(10.43)	12.39	(9.57)	0.26
	Outpatient claims	**4.45**	(4.24)	4.09	(3.72)	0.06
Prostate cancer screening	Overall expenditures	$6,247.52	($9,593.56)	$5,822.38	($9,207.62)	0.42
	Inpatient expenditures	$19,070.49	($17,687.73)	$17,334.54	($15,298.39)	0.22
	Physician expenditures	$1,844.58	($2,444.78)	$2,058.23	($2,929.53)	0.18
	Outpatient expenditures	$1,528.58	($2,737.83)	$1,448.00	($2,871.57)	0.66
	Overall claims	11.71	(10.09)	**13.98**	(10.92)	<0.001
	Inpatient claims	1.43	(0.64)	1.33	(0.56)	0.06
	Physician claims	9.05	(7.95)	**11.13**	(8.76)	<0.001
	Outpatient claims	3.92	(4.39)	3.82	(3.55)	0.66

Table A.4.4. OLS regression coefficients for average yearly expenditure

Preventive activity	(1) Preventive activity on screening on all Medicare expenditures age 65 to 74	(2) Preventive activity on screening on inpatient expenditures age 65 to 74	(3) Preventive activity on screening on physician expenditures age 65 to 74	(4) Preventive activity on screening on outpatient expenditures age 65 to 74
Vigorous Activity	-409.633	62.661	40.214	-179.265*
	(291.099)	(815.681)	(115.128)	(100.660)
Non smoker status	-697.022	-4,695.346***	7.794	-19.237
	(480.458)	(1402.879)	(156.608)	(161.122)
Normal weight	-208.371	830.282	-25.255	-120.075
	(304.485)	(954.932)	(120.782)	(85.918)
Flu shot	-309.822	-803.572	-178.328	67.413
	(307.401)	(844.951)	(140.559)	(92.820)
Cholesterol Screening	-973.589**	-4,305.168***	-62.367	-165.246
	(408.864)	(1243.372)	(142.729)	(147.248)
Pap smear test	-240.908	-2,794.045**	225.395	-25.255
	(439.526)	(1337.001)	(156.053)	(137.359)
Mammogram	-754.478	-5,427.344***	129.693	-0.82
	(513.393)	(1564.793)	(199.272)	(130.711)
Prostate cancer screening	-479.75	-953.478	178.299	-105.459
	(557.512)	(1483.696)	(142.545)	(215.101)
N	3647			
N-female	2102			
N-male	1545			

All columns show the marginal effect of the preventive behavior at age 65 (or close) in separate models predicting Medicare expenditures at age 65-69. All regressions were controlled for respondent's variables at age 65: inverse mills ratio (for selection bias), propensity weights, insurance status, risk aversion, time preference, gender, race, veteran status, working status, number of household residents, self-reported health status, insurance status, life insurance status, long term care insurance, education (less than high school, high school/GED, some college, college or above), assets, mental health (CESD score), functional limitations, previous diagnosis of cancer, heart disease, lung disease, stroke, diabetes, arthritis, high blood pressure, residence in one of 10 census divisions and year when age 65. Heteroskedasticity adjusted standard errors are in parentheses. ***, **, * denote statistical significance at the 1-percent, 5-percent, and 10-percent level, respectively.

CONCLUSION

The main objective of this dissertation is to investigate the demand and the association of prevention with Medicare expenditures among older adults. In order to do so, I have adapted some of the most existent theoretical frameworks in the literature to the better predict the factors influence the uptake of prevention among an older population. In addition, I have made use of a unique combination of data resources in the form of eight rounds of the longitudinal data set Health and Retirement Study linked to Medicare claims data. To my knowledge, this is one of the first studies to try to attack such a thorny area of a study in such a comprehensive manner. The combination of the theoretical and empirical work renders a thorough analysis of the area of study.

In the first part of the dissertation, I find that empirically higher levels of education translate in a higher demand for prevention. A higher discount rate of time is negatively correlated with prevention. Risk aversion and wealth were also found empirically to be highly correlated with preventive investments. These results were predicted in the conceptual theoretical model of prevention.

In the analysis of preventive behavior in the household, I outline theoretical reasons that might explain the large correlation between spouses demand for prevention. I find that the correlation between physical activity among elderly and near elderly spouses seems to be consistent with positive matching in marriage, while the correlation between all other preventive behaviors appears to be connected to decision-making within the household. Spouse's health shocks are not significant predictors of initiation or termination of any of the preventive activities studied, therefore reducing the likelihood that social learning about risks and healthy lifestyle benefits might be driving the correlation.

This chapter provides at least two important contributions for the field. The first is purely descriptive or positive: if we are able to identify the source of similarity in couples' behaviors, we will build better and more accurate economic models of the household. The second is normative: optimal policy is bound to depend on the nature of household interactions. Given the interest in the American health care system to increase preventive behavior, is useful to know whether is more efficient to target one person per household in term of a given health intervention, or to target all members. The evidence in this chapter shows that for most preventive activities, the demand is jointly driven by bargaining within the household, perhaps targeting only one household member, for example women, could have the spillover effect of shifting the behavior in men too.

Using a panel data set from the Health and Retirement study linked to Medicare claims data, I find evidence that while lifestyle prevention such as physical activity, non-smoking and normal weight status maintenance are negatively associated with Medicare expenditures at ages 65-69, clinical preventive activities such flu shot, cholesterol screening, mammography, Pap smears test and prostate cancer screening have at best no effect on expenditures, at worst they are positively associated, yet these findings are biased by uncontrolled unobservables.

As stated at the beginning of this dissertation, prevention is still sometimes seen as a means to reduce health-care spending particularly in certain political and policy making circles. From this analysis, it is clear that it is impossible to generalize about preventive interventions as though they were all alike. As I have thoroughly examined in this dissertation, lifestyle preventive activities and clinical ones are very different from each other and their corresponding associations with Medicare expenditures vary widely. Still, the question of why preventive services might or might not save money remains.

After reviewing the evidence in the literature and using the analysis in this dissertation, I believe that smoking cessation programs may indeed be considered a good investment almost regardless of how they are applied as this study shows that non smokers spend less money and live longer. The results in chapter 4 seem to be robust under different specifications controlling for a wide variety of factors.

Physical activity and maintaining a normal weight proved to be negatively associated with 5- year Medicare expenditures yet not significantly so. However, they seem to make much more of a difference over the 10th year period. It is problematic to attribute causal relationship between these two activities and expenditures since there is strong evidence of self-selection even when controlling for a comprehensive list of variables as I did. Furthermore, even if exercising had a direct effect on less expenditures, one would have to consider the possibility that it can be considered a transfer from personal income/leisure time to whoever pays the medical bills (Medicare plus the respondent herself who might cover co-payments). Exercising at least 3 times a week, as posed in the question asked in the HRS survey, takes a considerable amount of time that could be spent otherwise. Following the traditional Grossman model or any other human capital model, the time spent exercising comes either from foregone income or leisure time. In other words, a person investing time and money to engage in physical activity could be essentially transferring money to Medicare. From the point of view of the Medicare program this could be seen, of course, as a net gain.

Thus, there is no reason to discourage people from maintaining a healthy weight or exercising. However, one has to keep in mind that the magnitudes for the savings that could be associated with exercising (i.e. $1,000-$5,000 per person over 5 years of expenditures), even if one could indeed make a causal connection, are timid when compared to the financial troubles confronted by the Medicare program. Hence, when policy makers talk about the savings that could be gained by these interventions, they should realize the limitations and magnitudes of such policies.

Clinical preventive services might not save money for a number of reasons. Firstly, these preventive services are not always used exactly in the Grossman sense of a means for creating health stock. Rather, as it was found in chapter 3, they are often used in response to a health shock or illness episode. It is conceivable that oftentimes, preventive services such as flu shot or a cholesterol screening not only follow a doctor visit or a hospitalization, but are prescribed as a consequence of them. This would be in agreement with the evidence that respondents who report having either of these services were demonstrably sicker of had more ailments on average that people who do not undergo these services. This translates in a larger expenditure stream in the following years.

Another possibility is that preventive activities do not save money per se, rather they change the mix of services in which the money is spent. For instance, in the cases of Pap smears and mammography it was found that respondents with either of these preventive services had less inpatient expenditures but more outpatient and physician expenditures. In the end, these expenditures balance off.

Another reason that might contribute to explain why investment services do not translate in saving in medical expenditures lies in the fact that the people that demand medical services have more appetite or a higher preference for medical care. In this study, people that were more prone to exercise, being non smoker, have flu shots, cholesterol screening, Pap smear test, mammography, prostate cancer screening were also more likely to demand medical services (such as dental care, outpatient services, and doctor visits) prior to turning 65. These people might be unlikely to cut their use of services while on Medicare thus diluting any potential effect that prevention is having in shifting their need for medical care.

Prostate cancer screening, at this particular age seems to be highly ineffectual as a cost containment strategy. Respondents who report this service do not appear to be demonstrably sicker than people without the test, yet, as noted above, they do have a preference for more medical care. In the end, they end up spending more in all measures: 5 year Medicare spending, 10 year Medicare spending, and average annual spending. It might well be that this is the wrong timing to measure the effectiveness or desirability of prostate cancer screening since this disease tend to presents itself later in life. Yet, given the controversy regarding the treatment for prostate cancer to begin with and given its poor cost-effectiveness demonstrated in clinical trials, one should really question if there is much use to prostate cancer screening to begin with, at least at that age.

As corollary of this, one could say that perhaps the reason why prevention is not effective a significant cost containment tool is because the people for which those services could be more effective either do not get or are not the only ones to get it. One has to be aware that the results presented in this chapter represent an average effect on the difference on expenditure between those who get those services and those who do not. It might well be the case that the value of the interventions is diluted by the fact that people for whom they are not truly effective are thrown into the pool. This has been a consistent finding of well designed cost-effectiveness and has been one of the arguments towards emphasizing the design of preventive interventions that target more narrow populations for which a given intervention might be more useful, e.g. more frequent mammograms only for women with a family history of breast cancer.

Finally, this study corroborates many of the arguments that have been purported by Louise Russell throughout the years: there is hardly in any evidence that prevention saves moneys. In light of my findings and the literature that precedes them, it would be wise to stop touting prevention as a panacea by which any health care system might save costs. This does not necessarily mean that prevention is futile. In fact, in many cases it is perfectly legitimate to decide that the better health gained from preventive services is worth the expense. But it does mean that we need to realize that prevention is not going to help reduce the growth of medical spending. It is the opinion of this author that advocates of prevention will do their field much good by acknowledging that the alleged cost-savings of prevention are infrequent yet much wasteful curative treatments.

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