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An Analysis of the Medicare Prescription Drug Benefit

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Keywords

Medicare, Prescription drugs, Health production, Dynamic discrete choice, Moral hazard

Disciplines

Demography, Population, and Ecology | Family, Life Course, and Society | Social and Behavioral Sciences | Sociology

Comments

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An Analysis of the Medicare Prescription Drug Benefit

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August, 2006

Abstract

Medicare has recently experienced the largest expansion of benefits since its inception: the inclusion of prescription drug coverage under the Medicare Prescription Drug, Improvement and Modernization Act of 2003. The policy debate has mainly focused on estimating the cost of implementing the new benefit, with little attention to the quantification of its impact on beneficiaries' life expectancy, health status, and health-related behaviors. The policy came into effect in January 2006; therefore, no post-policy data are available yet. This paper develops and estimates a dynamic model of the demand for supplemental health insurance and different types of medical care, and uses the model to forecast the effects of the new Medicare benefit in a way that explicitly takes into account the policy's unique actuarial design and the dynamic features it includes. The results show that the new policy increases expenditure on prescription drugs by 24%, and has a positive effect on health status and life expectancy. There is a corresponding increase in the utilization of inpatient and outpatient care, due to the extension of life for people in poor health. The cost of extending life by a year is estimated to be between \$38,000 and \$62,000. The take-up rate of the new benefit reaches 85% by the fifth year of implementation, and there is a sizable crowding-out effect of private plans offering supplemental prescription drug coverage. The dynamic model is also used to evaluate the impact of alternative designs for the prescription drug benefit.

Keywords: Medicare, prescription drugs, health production, dynamic discrete choice, moral hazard.

JEL Classification: C33, C35, C53, D91, H51, I10, I12, I18

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1 Introduction

Medicare, the main health insurer for the elderly and disabled, was introduced by the U.S. government in 1965 to help the elderly to finance their medical expenses. Its original design was based on the typical health insurance plan existing in 1965, which did not include prescription drug benefits. In the practice of modern medicine, however, prescription drugs play an increasingly important role, and today's private health insurance plans usually include prescription drug coverage. Medicare has only recently adapted to these changes by the enactment of the Medicare Prescription Drug, Improvement and Modernization Act in December 2003, which came into effect in January 2006. This is considered to be the largest expansion of Medicare benefits since its inception. A major policy concern with this new legislation is its cost, which is expected to be about \$700 billion over the next ten years.¹ Advocates of the benefit argue that prescription drugs will improve health, and may even be cost-effective in decreasing the utilization of inpatient and/or outpatient care. This point is emphasized by President George W. Bush: *"Medicare should cover medications to keep our seniors out of the hospitals. The new bill does this... It will save our government and the taxpayers money by providing prescription drugs early so we don't have to pay for it in long hospital stays and invasive surgeries."*² Despite these claims, very little is known about how large these savings will be, or if indeed there will be any at all. In addition, the long-run effects of the policy on life expectancy and health care utilization have not been considered in the administration's cost estimates. If prescription drugs are a substitute for other forms of medical care in the production of health, an increase in prescription drug utilization may improve health outcomes and reduce the utilization of inpatient and outpatient care. However, over the long run it may also increase life expectancy and enlarge the population eligible for Medicare benefits, increasing the cost of the program.

This paper contributes to the policy debate by quantifying the effect of the new prescription drug benefit on mortality, morbidity and the degree of substitution between prescription drugs and outpatient and inpatient care. In addition, it estimates the take-up rate of the

¹Estimates from the Congressional Budget Office, see CBO (2004).

²Speech of November 25, 2003.

new benefit and the crowding-out effect it imposes on alternative sources of prescription drug coverage for the elderly. This paper is the first attempt to evaluate the impact of the policy in a way that accounts explicitly for its unique and unprecedented actuarial design as well as for the scheduled evolution of its premium. In particular, for the elderly with income above 150% of the federal poverty line, the prescription drug benefits can be obtained by paying a premium of \$35 per month (\$420 per year), with an annual deductible of \$250. After the deductible amount is reached, the package provides 75% coverage for the next \$2000. Between \$2250 and \$5100 of total prescription drug costs, the elderly are responsible for 100% of drug expenditures: this \$2850 gap is often referred to as the “doughnut hole.” After this point, at which the out-of-pocket expenditures have reached \$3600, the beneficiary then gets 95% coverage for prescription drugs.³ Figure 1 illustrates the design of the new prescription drug benefit. To provide incentives to sign up for the plan early, the policy has a dynamic component, with plan premiums scheduled to increase by 1% per month after its introduction. The effects of a policy like the one just described have not been studied in the health economics literature.

Medicare is a large program, accounting for 2.7% of the United States’ GDP. Therefore, it is important to understand the behavior of the Medicare population and how their behavior will respond to policy interventions such as the one described above. As has been documented in Arrow (1963), Pauly (1968) and Pauly (2004), the availability of prescription drug insurance may increase prescription drug utilization by lowering the marginal cost of a prescription to the individual, a phenomenon known in the health economics literature as moral hazard. The magnitude of the moral hazard effect that the new prescription drug benefit will induce is not known, as well as the impact of increased prescription drug utilization on health, on mortality, and on the utilization of other types of medical care. Assessment in this case is particularly challenging due to the absence of post-policy data. A behavioral model is required to permit extrapolation from observational data to the new policy regime. In this paper, I adopt the following strategy: first, I develop a model that represents the dynamic

³For the low-income elderly, prescription drugs are available for a small or no premium and deductibles, and there is no doughnut hole in coverage.

optimization problem that the elderly solve when choosing their consumption, supplemental health insurance and medical care utilization. Second, I estimate the parameters of the model using a subsample from the longitudinal Medicare Current Beneficiary Survey (MCBS) and examine the goodness-of-fit of the model in explaining the observed choices.⁴ Third, the estimated model is used to predict the behavior of the elderly under the new environment, which now includes a voluntary and subsidized prescription drug insurance option.

The backbone of the analysis is a dynamic model of investment in health in the tradition of Grossman (1972), which is extended to include health insurance. Previous research in health economics have also structurally estimated Grossman-type models. Two noteworthy contributions are Gilleskie (1998) and Khwaja (2003). Gilleskie (1998) focuses on the working-age population and models the decisions of whether to be absent from work or go to the doctor during an acute health episode. In that paper health insurance is exogenous which is a sensible assumption given the short horizon of the optimization problem. Khwaja (2003) focuses on the Medicare population and studies the effects of Medicare on incentives and outcomes of elderly men by comparing the baseline with a counterfactual in which Medicare did not exist, and also by increasing the age of Medicare eligibility. In that paper, health insurance is treated as a choice, however, medical care is treated as a composite good and therefore, that model cannot be used to study the impact of the new prescription drug benefit. In this paper, at each period the forward-looking individual chooses, conditional on state variables, her supplemental health insurance, which may or may not include prescription drug coverage. The individual also chooses her prescription drug and outpatient care utilization, which, together with inpatient care, are inputs into a health production function. The health production function represents the technological process by which medical care translates into health. Substitutions and complementarities in the production of health are allowed among the medical inputs. The health production function underlies the observed transitions between health states, which in this paper are self-reported health status plus death. Self-reported measures of health and disability have been documented as good predictors of true

⁴Due to data limitations the model is estimated on elderly women living alone. The specific limitations are explained in the data chapter.

health and disability by Benitez-Silva et al. (2004), Rust and Phelan (1997) and Bound (1990). Consistent with Grossman's framework, the demand for medical care is in part derived from the demand for health. The model allows for uncertainty over future health states and survival, as well as for unobserved sources of heterogeneity. Having recovered the behavior structure of the dynamic optimization problem, the new prescription drug benefit is introduced as a counterfactual experiment.

The results of the policy experiment reveal that prescription drug expenditure increases by about 24% when the new Medicare drug program is made available. Prescription drugs have a positive impact on health; however, the improvement in health is not translated into lower outpatient and inpatient care utilization in the aggregate. In fact, outpatient and inpatient care expenditure increase due to the extension of life for the individuals in poor health status, who are the main medical care spenders. As a measure of cost-effectiveness of the new policy, the cost of extending life by one year is calculated to be between \$38,000 to \$62,000, depending on adjustments for quality of life. The take-up rate of the new benefit reaches 85% by the fifth year. The availability of the new drug benefit crowds out demand for existing prescription drug coverage alternatives, although the average risk of people making these insurance choices improves. The 1% increase in premiums over time, which is intended to stimulate early enrollment in the program, is predicted to have no effect in front-loading enrollment. A higher marginal increase in premium would be required to induce changes in the timing of enrollment.

The remainder of the paper is organized as follows. Section 2 presents the institutional background that determines the choices available to the elderly and reviews the existing literature. Sections 3 and 4 present the details of the model and explain how the model is solved. Section 5 provides an overview of the data, and section 6 explains the estimation technique. section 7 comments on the results of the estimation, section 8 discusses the counterfactual experiments, and section 9 concludes.

2 Background and Institutions

When Medicare was introduced in 1965, it was composed of two parts. Part A is the Hospital Insurance, which covers, up to some limit of days, acute hospital care, skilled nursing home after hospitalization, and hospice care for the terminally ill. Enrollment in Part A is automatic once citizens start collecting Social Security. Part B is the Supplemental Medical Insurance, which covers mainly physician services, outpatient diagnostic tests, medical supplies and equipment. Although enrollment in Part B is voluntary and requires paying a premium, about 95% of the elderly enroll in Part B.⁵ The Part B premiums finance around one quarter of total Part B expenditures, and the rest is financed through general taxes.

Even with the two parts, there are gaps in Medicare coverage. The two programs have deductibles and copayments, and the biggest gap is the absence of prescription drug coverage. To fill these gaps, the elderly can buy private plans called “Medigap,” which in addition to covering considerable portions of the Part A and B deductibles and copayments may also include prescription drug coverage. Around 10% of the elderly obtain prescription drug coverage through self-purchased Medigap policies. These policies typically cover 50% of the total prescription drug expenditures and are capped at a limit of either \$1,250 or \$3,000 in total prescription drug expenditures. Another source of supplemental insurance is employer-provided plans, which are offered by former employers as retirement benefits at a reduced premium (typically 50%). These plans may also include prescription drug coverage. Previous employers’ retiree health benefits are currently the main source of prescription drug coverage for the elderly, accounting for 33% of the Medicare beneficiaries.

Since 1973, Medicare beneficiaries have also had the option of enrolling in a Medicare HMO as an alternative to traditional Medicare coverage. Although Medicare HMOs have been an option since the seventies, this option was enhanced in 1982 with the passing of the Tax Equity and Fiscal Responsibility Act (TEFRA), which simplified the contracts between Medicare and the HMOs and allowed the existence of risk contracts between them. The market share of this option was negligible until the early nineties, and its growth coincided

⁵In 2005 the premium is \$78.20 per month.

with the growth of the commercial HMO industry. Medicare HMOs, together with other managed care options, constitute Part C of Medicare, nowadays called Medicare Advantage; however, Medicare HMOs continue to be the most popular option in Part C. If the elderly enroll in a Medicare HMO, the firm receives a capitation payment from the government, and in exchange, the firm must provide benefits equivalent to Parts A and B. In addition, the HMO may charge the beneficiary a small premium and provide additional benefits such as eye care, dental care and prescription drugs. Under Medicare HMOs, the elderly are constrained in their choices of medical care providers to the ones included in the HMO's network. This feature may explain why, despite the HMO plans' generosity, only 17% of the Medicare population enrolls in HMOs. Around 15% of Medicare beneficiaries obtain prescription drug coverage from Medicare HMOs. Drug coverage has been identified by Town and Liu (2003) as a dimension of competition between Medicare HMOs operating in the same county. There is an extensive literature that documents favorable selection in the Medicare HMO industry, i.e., the average risk of the Medicare HMO enrollees is lower than the risk of those enrolled in the traditional fee-for-service sector (see for example Riley et al. (1994), Morgan et al. (1997), Brown et al. (1993)).

Although almost 75% of the elderly have prescription drug coverage of some sort, the typical coverage is far from being comprehensive. Prescription drugs represent only 8% of total medical expenses; however, they constitute a large percentage of the elderly's out-of-pocket payments. It has been documented in the literature that insufficient or absent prescription drug coverage leads to under-utilization of prescription drugs. For example, Steinman et al. (2001) find that the elderly with chronic conditions who lacked drug coverage, were more likely to "stretch" prescriptions by skipping doses, or avoid using medications. Other studies find a positive correlation between prescription drug insurance and prescription drug utilization (see for example Lillard et al. (1999), Davis et al. (1999), Stuart and Grana (1998)). Similarly, Adams et al. (2001) and Blustein (2000) find that the use of anti-hypertensive drugs among Medicare beneficiaries with hypertension is higher among those with more generous drug coverage. This finding is also supported by experimental evidence from the RAND Health Insurance Experiment, reported by Keeler et al. (1985), who find that hyper-

tensive patients with free care had higher utilization of prescription drugs than those who had less comprehensive insurance.⁶ Federman et al. (2001) find that the use of reductase inhibitors (statins), a class of relatively expensive drugs that improve survival probability among patients with coronary heart disease, is higher among those who have prescription drug coverage. Focusing on the Medicare HMO industry Gowrisankaran and Town (2005) find that enrollment in managed care without prescription drug coverage significantly increases county-level mortality, whereas no significant effects were found for Medicare HMOs with drug coverage.

Recent independent work by Yang et al. (2004) study the impact of extending existing drug coverage options such as Medicaid and private insurance to all Medicare beneficiaries. Their paper extends the existing literature by taking into account the effects that universal prescription drug coverage would have on the elderly. The approach followed in Yang et al. (2004), however, does not allow them to study the impact of the actual new policy. Instead, they approximate the policy by assuming that everyone has either a Medigap policy with existing drug coverage benefits, or everyone enrolls in Medicaid with existing coverage. For the policy experiments they perform, they provide estimates of the effect of prescription drugs on health and life expectancy.

In contrast, in this paper, because the optimization problem of the elderly is solved explicitly, the impact of the actual prescription drug benefit can be assessed, taking full account of its actuarial design and the scheduled increase in the premium over time. Because the new prescription drug benefit is introduced as a new choice, the policy experiments performed in this paper can also provide a forecast of enrollment in the new program, and the crowding-out effect it imposes on existing supplemental insurance options. By forecasting enrollment, and characterizing the population that takes up the new benefit, the cost of the program can be estimated. The results of this paper show that enrollment in the new benefit is not universal, particularly during the first five years (the horizon of their forecast). This paper also provides measures of the cost-effectiveness of the policy, and assesses alternative

⁶Although instructive, the RAND Health Insurance Experiment is not directly informative on the behavior of the elderly, given their exclusion from the experiment.

designs of the program.

Medicare has limited its role to the provision of insurance for inpatient and outpatient care. This effectively distorts the relative prices perceived by the Medicare beneficiaries for the different medical care inputs, which may discourage the utilization of prescription drugs in favor of other kinds of inputs. The first attempt to provide a prescription drug benefit was in 1988, with the Medicare Catastrophic Act, which was meant to protect the elderly from large out-of-pocket expenses in prescription drugs. The method used to finance these benefits was unusual in Medicare, because it required the elderly to finance the benefit themselves without any subsidy from the working-age population. Premiums differed by income, i.e., the higher-income beneficiaries would subsidize the lower-income beneficiaries. The dissatisfaction with the new bill among the well-to-do elderly caused the U.S. Congress to repeal this piece of legislation in 1989. Two lessons were learned: cross subsidizing within Medicare was not politically feasible, and the benefits to the elderly should be subsidized by the working age population.

Enacted in December of 2003, the Medicare Prescription Drug , Improvement and Modernization Act, creates a new drug benefit as Part D of Medicare. This new benefit will pay for outpatient prescription drugs through private plans, beginning January 1, 2006. Medicare beneficiaries can remain in the traditional Fee-for-service (FFS) program and enroll in a private prescription drug plan (PDP), or they can enroll in an integrated Medicare Advantage plan for all Medicare benefits. Enrollment in either plan is voluntary, and the contract is for one year. The government expects to finance 25% of the program with premiums collected from the elderly whose income is above 150% of federal poverty line, and the remaining portion with general taxes from the working age population.

This paper provides an ex-ante evaluation of the short-run and long-run impacts of this new benefit, taking into account all the relevant features of the new policy. It also estimates the take-up rate and characterizes the subset of the population taking up the new option, which are important determinants of the cost of the program. It assesses the benefits of the program in terms of changes in health status and increases in lifespan.

3 Model

This section develops the behavioral model that represents the dynamic optimization problem that the elderly face when deciding their supplemental health insurance, medical care utilization and consumption of non-medical goods. The model starts at age 65, at which age the elderly become eligible for Medicare, and represents the behavior of one individual.

Choice set At each age a , the elderly decide, conditional on state variables, the health insurance they will hold during the year, the amount of medical care to be consumed and the consumption of non-medical goods. Their per-period choice of health insurance, hi_a , is one of seven mutually exclusive alternatives, which vary in several dimensions such as premium, coverage, and providers' network size. Figure 2 represents the supplemental insurance options available to the elderly. The first alternative is to hold the traditional Medicare fee-for-service without supplemental insurance. This option includes the benefits of both, Part A and Part B of Medicare.⁷ The second option includes in addition to Parts A and B of Medicare a self-purchased supplemental policy (Medigap) with drug coverage. The third option differs from the second in that the supplemental policy is provided by the former employer as part of retirement benefits. Typically, the employer pays for half of the supplemental insurance's premium. Because of the difference in the elderly's premium expenditure it is important to distinguish between self-purchased and employer-provided supplemental insurance. The fourth option includes, in addition to the benefits of Part A and Part B, a self-purchased Medigap policy without drug coverage and the fifth differs from the fourth in that the supplemental insurance is employer-provided. Option 6 is Medicare HMO with drug coverage and option 7 is Medicare HMO without drug coverage. The main difference between Medicare HMOs and the fee-for-service scheme of options 1 to 5 is that the network of health care providers is more restricted in the case of Medicare HMOs. A summary of the characteristics of each health insurance option is provided in the data section. The size of

⁷Enrollment in Part A is automatic once the elderly start collecting Social Security. Although enrollment in Part B is optional, about 98 % of the sample is enrolled in Part B, therefore modeling its choice separately would unnecessarily complicate the model.

the choice set depends on the eligibility for employer provided health insurance. If available, the elderly are allowed to choose among the seven options described above, however, if not, the choice set will not contain options 3 and 5. The eligibility for employer provided health insurance is not directly observable in the data, therefore, the elderly are assumed ineligible if they are never observed to hold an employer provided supplemental policy in the data.

Medical care consumption decisions are made by choosing, at every age, the expenditure in outpatient care and prescription drugs for the year. It may be argued that prescription drug consumption is not a choice but a passive action after physicians' recommendations, however, it is well documented (see section 2) that the elderly respond to financial incentives by skipping doses or "stretching" their prescriptions because of cost. I assume that inpatient care is not directly a choice, but rather assigned by a doctor, taking into account health status. Thus, from the point of view of the individual, inpatient care is a stochastic process that may be indirectly influenced by prior health input choices. The expenditure on outpatient care at age a , denoted o_a is allowed to take 3 values: low, medium and high. Expenditure in outpatient care is considered low if it is at the lowest third of the distribution of outpatient care. Medium and high outpatient expenditure are similarly defined. In the data, most of the elderly are observed to have at least one outpatient event during the year, therefore, zero expenditures are not allowed. The expenditure in prescription drugs at each age, Rx_a is allowed to take five values, including no consumption. The positive values for the drug expenditure are the average prescription drug expenditures for each of the four regions constituting the policy design, which in Figure 1 are labeled deductible, partial coverage, doughnut hole and catastrophic coverage. The choice of consumption in non-medical goods, C_a is obtained from the budget constraint as the residual from income minus the premiums paid minus the expenditure in medical care.

Preferences The preferences over consumption, health status, health insurance and medical care are represented by the per-period utility function⁸

⁸The exact functional forms are provided in the appendix

$$u_a = u(C_a, H_a, Rx_a, o_a, i_a, hi_{a-1}, hi_a; \varepsilon_a, \mu) \quad (1)$$

where C_a , Rx_a and o_a are, as defined in the previous section, the consumption of non-medical goods, prescription drugs and outpatient expenditure respectively. Inpatient care expenditure is denoted by i_a . The different types of medical care are assumed to enter the utility function to reflect the possible disutility individuals receive from medication's side effects or from undergoing medical procedures. The variable hi_a denotes the health insurance chosen at age a , which can be one of the seven alternatives defined above. The utility function incorporates a psychic switching cost, which is borne when the health insurance choice of the current period differs from the previous period choice. This cost represents the cost of learning a new set of rules and adjusting to a new insurance policy. In addition, there is a cost of being enrolled in a Medicare HMO, which represents the disutility of having restricted access to health care providers. The elderly also derive direct utility from their health status, H_a , which can take one of four values: (0) dead, (1) poor/fair, (2) good and (3) excellent/very good. The utility obtained when dead is normalized to 0. There is a random shock to preferences for health insurance and medical care, ε_a , which is assumed i.i.d. extreme value distributed. μ represents permanent differences across individuals in their preferences for HMO enrollment. In the application, the distribution of the unobserved heterogeneity is assumed to be discrete with a finite number of support points, which are referred to as "types" (see Heckman and Singer (1984)).

Budget Constraint At each age a the elderly spend their income, denoted Y_a , on consumption, C_a , health insurance premiums, π_a and out-of-pocket payments for the portion of medical care expenditure that is not covered by the health insurance chosen at the beginning of the period, x_a .

$$Y_a = C_a + \pi_a + x_a \quad (2)$$

Annual income is modelled as a function of education, e , and age. Educational attainment is classified into five categories: (1) Primary school or less, (2) high school dropout, (3) high

school graduate, (4) college dropout, (5) college graduate. Income is obtained only when alive. The income process includes a random shock, ε_a^y , whose distribution is log-normal

$$Y_a = y(e, a; \varepsilon_a^y, \mu) \quad (3)$$

The premium paid at age a , π_a , depends on the health insurance option chosen at the beginning of the period. Define the dichotomous variable b_a^{hi} to take the value of 1 if health insurance option hi is chosen, 0 otherwise, and denote π^{hi} the value of the premium of alternative hi . The premium paid at age a can be written as

$$\pi_a = \pi^1 b_a^1 + \pi^2 b_a^2 + \pi^3 b_a^3 + \pi^4 b_a^4 + \pi^5 b_a^5 + \pi^6 b_a^6 + \pi^7 b_a^7 \quad (4)$$

The out-of-pocket expenditure at age a also depends on the chosen health insurance option. Define $c^{Rx,hi}$, $c^{o,hi}$, $c^{i,hi}$ as the co-payments for prescription drugs, outpatient care and inpatient care respectively, associated with insurance option hi . These coefficients are contained in the interval $[0,1]$ and represent the fraction of the total expenditure in medical care that the elderly are responsible for. The out-of-pocket expenditure can thus be written as

$$\begin{aligned} x_a = & Rx_a(c^{Rx,1}b_a^1 + c^{Rx,2}b_a^2 + c^{Rx,3}b_a^3 + c^{Rx,4}b_a^4 + c^{Rx,5}b_a^5 + c^{Rx,6}b_a^6 + c^{Rx,7}b_a^7) \\ & + o_a(c^{o,1}b_a^1 + c^{o,2}b_a^2 + c^{o,3}b_a^3 + c^{o,4}b_a^4 + c^{o,5}b_a^5 + c^{o,6}b_a^6 + c^{o,7}b_a^7) \\ & + i_a(c^{i,1}b_a^1 + c^{i,2}b_a^2 + c^{i,3}b_a^3 + c^{i,4}b_a^4 + c^{i,5}b_a^5 + c^{i,6}b_a^6 + c^{i,7}b_a^7) \end{aligned} \quad (5)$$

The value of the premiums and co-payments for each alternative is obtained as the average of the alternative-specific premiums and co-payments observed in the data.

Health production technology In this model, the stock of health is determined endogenously by the elders' decisions about medical care utilization. The stock of health is therefore modelled as an asset the elderly invest in through their medical care utilization,

and the transitions between different health states are governed by a health production function. Prescription drugs, outpatient and inpatient care are inputs of the health production function, and therefore, its demand is in part a derived demand for health (Grossman (1972)). As explained above, the expenditure in prescription drugs and outpatient care are directly chosen by the individual, and the expenditure in inpatient care is modelled as a stochastic process that can be indirectly affected through health by previous choices. Because of the high skewness in the distribution of inpatient care, with many elderly having no hospitalizations during the year, a two-part model is adopted, where the first part represents the probability of having any inpatient event. The logistic functional form is adopted to model this probability, which depends on health status and age.

$$Pr(i_a > 0) = \Lambda(H_a, a) \tag{6}$$

The second part models the value of inpatient expenditure, conditional on any, as a function of health status plus a log-normal shock. An unobserved permanent component is also included.

$$i_a = i(H_a; \varepsilon_a^i, \mu)$$

The measure of health used to model the health state is people's self-reported health status. In the survey the elderly are asked to rank their health in 5 categories: excellent, very good, good, fair, poor, which are ordered. Due to the low number of people reporting extreme health statuses, respondents that report excellent and very good health status are pooled in one category, and also are the ones reporting fair and poor health status. This reclassification keeps the ordered feature of the individuals' responses and simplifies the computation of the solution of the model by decreasing the number of possible health states. Death is added as an extra health state, which is absorbing. It is assumed that the elderly observe a continuous health status, H_a^* , and they report a discrete value H_a , depending on the location of H_a^* with respect to cutoff points that will also be estimated as parameters of

the model. In particular,

$$H_a = \begin{cases} 0 & \text{if } H_a^* < \kappa_1 \\ 1 & \text{if } \kappa_1 \leq H_a^* < \kappa_2 \\ 2 & \text{if } \kappa_2 \leq H_a^* < \kappa_3 \\ 3 & \text{if } \kappa_3 \leq H_a^* \end{cases} \quad (7)$$

Given the ordered feature of the health status, and an extreme value distribution assumption on the health shock, the health state transitions are modelled as ordered logit processes.⁹ The health production function is specified in a flexible fashion, allowing the index of the ordered logit to be different depending on current health status (see the appendix for the precise functional form). This specification allows differences in the productivity of medical care for different health statuses. The different kinds of medical care (prescription drugs, outpatient care and inpatient care) enter the health production function as inputs. Substitutions and complementarities between them are allowed in the production of health, and quadratic terms are also included to capture diminishing marginal product of the health inputs. The specification of the health production function includes also the effect of smoking behavior and the depreciating effect of age on health. Unobserved permanent components are allowed in the depreciation rate of health with age.

$$H_{a+1}^* = f^{H_a}(Rx_a, o_a, i_a, S, a; \varepsilon_a^h, \mu) \quad (8)$$

State space The state space, Ω_a , contains all the information the elderly need in order to solve the dynamic optimization problem described from (1)-(8). The elements of the state space are: the current period's self-reported health status, H_a , which is assumed to be a sufficient statistic for H_a^* in the health production function, the previous period's health insurance choice, hi_{a-1} , education, e , history of smoking behavior, S , access to employer provided supplemental insurance, ep , age, a , the characteristics of the health insurance options

⁹For details on the derivation of the ordered logit's functional form see Small (1987).

summarized in the vectors of premiums, $\tilde{\pi}_a$, copayments for prescription drugs, \tilde{c}_a^{Rx} , for out-patient care, \tilde{c}_a^o , and for inpatient care, \tilde{c}_a^i , the random components known to the individual at the beginning of each period but unknown to the econometrician, and the permanent components of preferences and health production technology, denoted μ .

$$\Omega_a = \{H_a, hi_{a-1}, a, e, S, ep, \tilde{\pi}, \tilde{c}^{Rx}, \tilde{c}^o, \tilde{c}^i; \tilde{\varepsilon}_a, \varepsilon_a^i, \varepsilon_a^y, \tilde{\varepsilon}_a^h, \mu\}$$

The law of motion for the health state is given by the health production technology, the previous period health insurance corresponds to the health insurance decision made at age $a-1$, and age evolves deterministically. Given the advanced age of the individuals, education and smoking history is assumed to be static, therefore, they could be classified as observed permanent components or observed heterogeneity. Because of the data limitations regarding eligibility for employer provided health insurance, which were mentioned in the choice set section, this variable is also assumed to be part of observed heterogeneity.

The optimization problem Although there is a terminal age $A = 100$, at which the elderly are assumed to die with certainty, the model allows for stochastic transitions to death before the terminal age, depending on the amount invested in health in earlier periods. The length of each period is one year. The individuals maximize, subject to the budget constraint and laws of motion presented above, the expected discounted value of their remaining lifetime utility by choosing, conditional on states, Ω_a , the optimal sequence of controls j . A choice consists of all the feasible combinations of hi_a , o_a and Rx_a . The maximized expected discounted value of remaining life time utility at age a , is given by

$$V_a(\Omega_a) = \max_{j \in J} \mathbb{E} \left[\sum_{a=a_0}^A \delta^{a-a_0} u_a | \Omega_a \right] \quad (9)$$

where δ is the discount factor. Define the dichotomous variable d_a^j , which takes a value of 1 if alternative j is chosen at age a , 0 otherwise. The value function in (9) can be written as

$$V_a(\Omega_a) = \max_{j \in J} V_a^j(\Omega_a)$$

with the alternative-specific value functions obeying the Bellman equation

$$\begin{aligned}
 V_a^j(\Omega_a) &= u_a^j(\Omega_a) + \delta \mathbb{E}[V_{a+1}(\Omega_{a+1}) | \Omega_a, d_a^j = 1] && \text{if } a < A \\
 V_A(\Omega_A) &= u(Y_A, H_A) && \text{if } a=A
 \end{aligned} \tag{10}$$

In the last period the elderly are assumed to consume all their income and enjoy their health stock, however, they do not invest in health given that death is realized with certainty. The expectation in (10) is taken with respect to all the random components of Ω_a .

4 Solution Method

The finite horizon dynamic programming model is solved by backwards recursion. For notational simplicity, a partition of the state space is made with $\bar{\Omega}_a$ denoting the set of predetermined components, and $\bar{\bar{\Omega}}_a$ the stochastic components. At age A , the elderly are assumed to die with certainty. The value of death is normalized to 0 and there is no bequest motive. At age $A - 1$, given a particular value of the deterministic components of the state, $\bar{\Omega}_{A-1}$, the elderly draw random shocks from the distribution of the stochastic components of the state space, $\bar{\bar{\Omega}}_{A-1}$, they calculate the alternative-specific utility functions, shown in (1), and choose the alternative that gives the highest reward. At age $A-2$, given $\bar{\Omega}_{A-2}$, the alternative-specific value functions, shown in (10), need to be computed. This requires a high order integration over the distribution of age $A-1$ shocks to obtain $\mathbb{E}[V_{A-1}(\Omega_{A-1}) | \Omega_{A-2}, d_{A-2}^j = 1]$. To simplify this step, the unobserved taste components of the utility function, ε_a in equation (1), are assumed to be additively separable, independent and identically extreme value distributed, which implies a closed form solution for the integrals over the taste parameters.¹⁰ Small and Rosen (1981) show in a consumer surplus calculation context that the expected maximum of utilities that are iid extreme value distributed take the log-sum functional form. Define \bar{u}_a to be the utility function in (1), net of the unobserved taste component. The integral over the shocks to preferences, conditional on shocks to income and inpatient expenditure, can be

¹⁰This assumption has been commonly adopted in the literature dealing with estimation of dynamic programming models, see for example Rust (1987), Khwaja (2003), Gilleskie (1998)

computed as

$$\ln\left[\sum_{m=1}^J \exp\{\bar{u}_{A-1}^m(\Omega_{A-1})|\bar{\Omega}_{A-2}, d_{A-2}^j = 1, \varepsilon_{A-1}^y, \varepsilon_{A-1}^i\}\right] \quad (11)$$

The shocks to the log of income and inpatient expenditure, assumed normally distributed, are integrated out by simulation as follows: I take R draws from the bivariate normal distribution,¹¹ for each of those draws r calculate the expected maximum of utilities in (11), and take the average over draws. Thus, the expectation of the next period value function at period $A - 2$ is obtained as

$$\mathbb{E}[V_{A-1}(\Omega_{A-1})|\Omega_{A-2}, d_{A-2}^j = 1] = \frac{1}{R} \sum_{r=1}^R \ln\left[\sum_{m=1}^J \exp\{\bar{u}_{A-1}^m(\Omega_{A-1})|\bar{\Omega}_{A-2}, d_{A-2}^j = 1\}\right]_r \quad (12)$$

Once (12) is calculated, the alternative-specific value functions are known up to the random shocks of period $A - 2$. The elderly receive such shocks and therefore, the alternative-specific value functions can be computed

$$V_{A-2}^j(\Omega_{A-2}) = u_{A-2}^j(\Omega_{A-2}) + \delta \mathbb{E}[V_{A-1}(\Omega_{A-1})|\bar{\Omega}_{A-2}, d_{A-2}^j = 1] \quad (13)$$

The elderly choose the option with the highest value. Consequently, the expected maximum at period $A - 3$ is $\mathbb{E}[\max\{V_{A-2}^1(\Omega_{A-2}), \dots, V_{A-2}^J(\Omega_{A-2})\}|\bar{\Omega}_{A-3}, d_{A-3}^j = 1]$. In summary, in order to obtain the expected maximum of the alternative-specific value functions at every age a , the alternative-specific value functions at age $a + 1$ should have been computed in advance for all possible values of the predetermined state space, $\bar{\Omega}_{a+1}$, that may be reached from $\bar{\Omega}_a$, given that alternative j is chosen at age a . This procedure continues, until the initial age a_0 . Because the individuals contained in the sample are observed at a point in the middle of their Medicare eligibility period, a_0 corresponds to the first year they are observed, and the initial conditions will be the ones prevailing at that age. In a model where people invest in their health through medical care, the initial health status will be affected by previous investments implying non-exogeneity of the initial conditions. The way I address this problem is explained in section 6.

¹¹In the application $R=50$

5 Data

The data used for estimation comes from the Medicare Current Beneficiary Survey (MCBS), in particular, the Cost and Use files for years 1994 to 1999. The survey is conducted by the Centers for Medicare and Medicaid Services (CMS) and is a stratified random sample of approximately 12,000 Medicare beneficiaries. The MCBS is a rotating panel, and an individual is observed for at most three years. The Survey includes information on demographics, socioeconomic status, health status, and utilization of medical care. The MCBS records utilization and expenditures on various types of medical care, such as physician services, inpatient hospital services, and prescription drugs. The expenditures in these services, the amounts paid by the different insurers and the out-of-pocket payments are available in the survey. Self-reported events are validated by Medicare claims. The elderly were interviewed three times per year. In the first interview, information on demographics, insurance and health status is collected. In addition, in the same interview the elderly are asked to save all their bills for medical care in order to keep track of their expenditures. The information on expenditures is recorded in subsequent interviews.

The focus is on aged Medicare beneficiaries, and therefore, only those 65 years old and above are included in the analysis. Other than the surveyed individual, it is not possible to observe the health insurance, medical care expenditures and demographics of the other members of the household. This prevents the analysis from considering joint decision making of the household members. Moreover, due to the generality of the only question on income, to make sure that the quantity reported is the disposable income for the surveyed individual, I only include in my analysis elderly living alone. Due to the low number of men that live alone, the focus is on elderly women age 68 and older.¹² Institutionalized elderly are also

¹²The model could also be estimated for men living alone, I take women as the first step since they constitute around 60% of the Medicare population. With data on households, the model can be extended to include joint decision making, however no such data with the richness on medical care utilization and health insurance providers as MCBS were available at the beginning of this project. Because few people were observed between the ages of 65 and 67, and those were in an unusually bad health status, in order to avoid misleading conclusions, individuals in that age range were excluded from the sample.

excluded from the sample, because their prescription drugs consumption is not reported. The estimating sample contains 1,805 individuals, each of whom is observed for two to three periods.

Table 1 presents the summary statistics. The insurance option with the highest enrollment is traditional Medicare plus a self-purchased Medigap policy without prescription drug coverage, which accounts for 36% of the sample. Consistent with the population, most of the elderly in the sample are enrolled in fee-for-service Medicare (85%), and the remaining 15% obtain their health insurance through Medicare HMOs. Among those who enroll in Medicare HMOs, 80% do so in plans with drug coverage, which is consistent with findings in Town and Liu (2003), Brown et al. (1993), Morgan et al. (1997) and Riley et al. (1994), who argue that one of the most appealing features of Medicare HMOs plans is the prescription drug coverage. The percentage of individuals in the sample that have prescription drug coverage is 44%. Despite the availability of prescription drug coverage for some elderly, the out-of-pocket expenditures for this input are much higher as a percentage of the total than the other medical inputs. This is true even conditioning on having prescription drug coverage. The expenditure on prescription drugs for the sample is, on average, \$890, with 91% of the elderly filling at least one prescription.¹³ Virtually everyone in the sample has at least one outpatient event, therefore, zero outpatient care is not allowed as a choice in the model. The average expenditure on outpatient care is approximately \$3,120. In contrast to outpatient care, the percentage of people having any inpatient events is only 19%. The average expenditure on inpatient care for the whole sample is \$2,365, however, this value is much higher if the average is calculated conditional on any inpatient care (\$12,214).

The variable used to measure health is the self-reported health status. This measure of health, although subjective, has proven to be a good predictor of true health status (see for example Benitez-Silva et al. (2004)) and is highly and negatively correlated with the number of chronic conditions and number of physical limitations that the elderly exhibit. In the survey the elderly rank their health status into five mutually exclusive categories: Excellent,

¹³All expenditure data is expressed in dollars of 1999 by using the Consumer Price Index of Medical Services.

very good, good, fair, poor. Due to the low number of observations in the excellent and poor categories, these categories are combined with very good and fair, respectively. In the data, 48% of the sample exhibit excellent/very good health, 32% are in good health, and the remaining 20% is in the poor/fair category. Death is added as an additional state. The average age is 79 years and individuals have an average of 11.45 years of schooling. Among the sampled elderly, 33% have access to employer provided health insurance, and 44% have ever smoked.

As expected, and consistent with Grossman's model, the consumption of medical care is decreasing with improvements in health status. The consumption of every medical input decreases monotonically with health state. These facts are shown in Table 2. The elderly in poor/fair health spend, on average, roughly double in prescription drugs and outpatient care than individuals in excellent/very good health. Table 2 also shows the average expenditure in inpatient care by health status, both unconditional and conditional on having an inpatient event.

The transitions between the different health states are shown in Table 3. The transitions to death are more frequent from the worst health state, and the probability of dying decreases as greater health is reported. All three health states exhibit persistence, with the good health state being the least persistent. The health transitions matrix will also be revisited when the results and the model's prediction for the health transition matrix are discussed.

Table 4 shows the health insurance transitions matrix. It can be seen that all health insurance alternatives exhibit persistence, which in the model is captured through a switching cost parameter. Apart from the persistence, two other patterns are worth noticing. (1) The majority of the elderly that held a supplemental plan and switched from it, enroll in an option with supplemental insurance that shares the self-purchased or employer-provided characteristic of the original option. This suggests that if the elderly do not have access to employer-provided benefits, they are not likely to obtain them in the future, and the elderly that have access to employer-provided benefits are likely to take them, either with prescription drug coverage or without. (2) Switches from (to) Medicare HMOs to (from) the fee-for service options are very rare. It is also surprising that despite its generosity, only

13% of the sample enrolls in Medicare HMOs. These facts motivate the inclusion of a cost of enrolling in a Medicare HMO due to restricted access to medical care providers. This cost is assumed type-dependent, i.e., there is a type of person for which enrolling in an HMO implies bearing a smaller restricted access to providers cost.

The characteristics of each insurance option are shown in Table 5. These characteristics are obtained by averaging over the individuals that held the same health insurance over the year and from alternative data sources such as the Centers for Medicare and Medicaid Services and the American Association of Retired Persons. The premiums for the insurance options that include supplemental insurance are the most expensive. Among the elderly that hold supplemental insurance, the ones that hold employer-provided policies, pay less for their insurance because the former employer usually pays half of it as retirement benefits. The lower cost of supplemental insurance premiums and the lower co-payments for prescription drugs for the elderly with employer-provided benefits, creates the need to distinguish them from the self-purchased alternatives in the empirical analysis. The premiums shown for Medicare HMOs correspond to the additional premium that the HMOs may charge the elderly on top of the capitation fee paid by the government. The copayments for outpatient and inpatient care that the elderly with Medigap are responsible for, are lower than the ones the elderly face under the Medicare only option. This is not surprising given that Medigap policies were created to “fill the gaps” of Medicare coverage. The copayments for prescription drugs for the Medigap options are 50% by the mandated design of Medigap policies H, I and J. This shows that despite the availability of prescription drug coverage, they are far from being comprehensive. Moreover, the Medigap policies that cover prescription drugs have a cap at \$3,000 of total expenditure on prescription drugs.

6 Estimation

The model described above, represents the decision process of the elderly. The parameters of the model are estimated by maximizing a likelihood function that specifies the joint probability of observing the sequence of choices and outcomes observed in the data. The observed

choices are health insurance, prescription drugs and outpatient expenditure, and the observed outcomes are the amount of inpatient care consumed, the elders' income and health status. The construction of the likelihood function is described in this section.

The solution of the model, made explicit in section 4, provides the alternative-specific value functions, which are, for given parameter values, known up to the random components of the state space. Therefore, conditional on $\bar{\Omega}_a$, the probability of the elderly being observed to choose alternative j , corresponds to the integral over the region of random shocks such that option j has the highest value.

$$Pr(d_t^j = 1 | \Omega_a, \mu) = Pr(V_a^j > V_a^1, V_a^j > V_a^2, \dots, V_a^j > V_a^J | \Omega_a, \mu) \quad (14)$$

$$Pr(d_t^j = 1 | \Omega_a, \mu) = Pr(u_a^j + \delta \mathbb{E}[V_{a+1}(\Omega_{a+1} | \Omega_a, d_a^j = 1)] > u_a^k + \delta \mathbb{E}[V_{a+1}(\Omega_{a+1} | \Omega_a, d_a^k = 1)]) \quad \forall k \neq j \quad (15)$$

$$Pr(d_t^j = 1 | \Omega_a, \mu) = Pr(\varepsilon_a^j - \varepsilon_a^1 > \bar{u}_a^1 - \bar{u}_a^j + \delta \mathbb{E}[V_{a+1}(\Omega_{a+1} | \Omega_a, d_a^1 = 1)] - \delta \mathbb{E}[V_{a+1}(\Omega_{a+1} | \Omega_a, d_a^j = 1)], \dots, \varepsilon_a^j - \varepsilon_a^J > \bar{u}_a^1 - \bar{u}_a^J + \delta \mathbb{E}[V_{a+1}(\Omega_{a+1} | \Omega_a, d_a^1 = 1)] - \delta \mathbb{E}[V_{a+1}(\Omega_{a+1} | \Omega_a, d_a^J = 1)]) \quad (16)$$

Given the iid extreme value distribution assumption imposed on the unobserved taste component, the choice probabilities can be computed analytically and have the familiar multinomial logit functional form

$$Pr(d_a^j = 1 | \Omega_a, \mu) = \frac{\exp V^j(\Omega_a)}{\sum_{j'} \exp V^{j'}(\Omega_a)} \quad (17)$$

It should be noted that, unlike their static counterpart, the choice probabilities in (17) are not subject to the independence of irrelevant alternatives criticism, because the value functions entering the exponentials contain, in addition to current period utility, the optimal decisions in future periods (Rust (1987), Rust (1994)). For estimation purposes, these

probabilities can be considered as functions of the parameters of the model conditional on the data.

The model represents the behavior of a single agent, and observed differences in the behavior of individuals with the same initial conditions arise due to iid shocks to preferences, income, inpatient expenditure and health. Some behaviors observed in the data, such as HMO enrollment, appear to be more persistent than what observed state variables could capture. To capture this persistence in behavior, the model allows for permanent components that are unobserved to the econometrician. The distribution of the unobserved heterogeneity is assumed to be discrete with finite support points (Heckman and Singer (1984)). In the application, two support points or “types” are allowed.¹⁴ To solve the initial conditions problem pointed out in section 4, it is assumed that the type probabilities can be represented as functions of the initial state variables, therefore, the initial state variables are exogenous conditional on type. The specification of the type probability considers the following trade-off: the more flexible the functional form assumed, the closer to its true structure; however, the more flexibility, the more parameters there are to be estimated. The functional form assumed for the type probability is a logistic function of initial state values for age, HMO enrollment, health, high-school graduation, past smoking, and availability of employer provided health insurance.

The likelihood function is a mixture of the type-specific likelihoods, with weights equal to the probability of being of a certain type. Thus, the contribution to the likelihood from individual n is

$$L_n(\Theta) = \sum_{k=1}^K \tau_{k|\Omega_0} \prod_{a=a_0}^A \{Pr(d_a^j = 1|\Omega_a, \mu)[Pr(i_a > 0|\Omega_a, \mu)\phi_{\ln i}(\cdot|\Omega_a, \mu)]^{\mathbb{I}\{i_a>0\}} \quad (18)$$

$$\cdot [1 - Pr(i_a > 0|\Omega_a, \mu)]^{\mathbb{I}\{i_a=0\}} \phi_{\ln y}(\cdot|\Omega_a, \mu) \prod_{h=0}^3 Pr(H_{a+1} = h|\Omega_a, \mu)^{\mathbb{I}\{H_{a+1}=h\}}\}$$

where the first term is the probability if choosing alternative j , which to be computed, requires the solution of the complete dynamic programming problem. The second term is the

¹⁴In the discussion of the results, they be referred to as the “HMO type” and the “non-HMO type”

probability of having any inpatient care event, and the third is the probability of observing a particular expenditure in inpatient care, with $\phi(\cdot)$ being the normal density function. The fourth term is the probability of not having any inpatient event, and the next term is the the probability of observing a particular income. The last term are the health transition probabilities generated by the health production function. All the parameters of the model enter the choice probabilities. A subset of parameters enter through the other structural equations described in (18).

The likelihood function for the whole sample is

$$L(\Theta) = \prod_{n=1}^N L_n(\Theta)$$

The estimation algorithm alternates between the solution to the dynamic programming model and the computation of the likelihood. At each iteration the optimization routine obtains a new set of parameters for which the model is solved and the probabilities in (18) are computed. The optimization routine uses the Nelder-Mead method.

7 Results

7.1 Parameter estimates

The details about the parameterization of the model are made explicit in the appendix. The parameter estimates and their standard errors are reported in Table 6. Although the parameter values are not easily interpretable on their own, there are some qualitative features of the estimates that are worth emphasizing. The constant relative risk aversion parameter (CRRA) is estimated to have a value of 0.28, implying that the utility function is concave but fairly linear in consumption. This parameter value is close to what previous works in empirical microeconomics have obtained; see for example Todd and Wolpin (2003).¹⁵ As expected, the elderly attach a positive value to their health. The results of the estimation

¹⁵The literature on macroeconomics and finance have obtained more concave utility functions. A summary of the CRRA coefficients obtained by this literature can be found in Ait-Sahalia and Lo (2000).

suggest that the elderly derive disutility from medical care. In the case of prescription drugs, this disutility could be interpreted as side effects, or the inconvenience or restrictions on daily life of having to remember the timing to take their medications. In the case of outpatient and inpatient care, this disutility can be interpreted as the discomfort that some medical procedures generate. Although undesirable, the elderly consume medical care because of its impact on the stock of health, which provides positive utility. The impact of each medical care input on health is presented in Table 7. The first column of the table shows the change in the odds of either staying in the same health status or improving, given a 10% increase in the utilization of prescription drugs, holding constant outpatient and inpatient care. It can be seen that prescription drugs have a positive impact on health, and their impact is inversely related to health status, i.e., their impact is the biggest for people in poor/fair health status, and the smallest for people in the excellent/very good category. A 10% increase in prescription drug utilization improves the odds of either staying in the same health status or transiting to a better one by 2.9%. The same analysis holds for outpatient care. On the other hand, an increase of 10% in inpatient care utilization appears to decrease the odds of either staying in the same health status or improving when the elderly are in the poor/fair health status. This is not surprising given that with considerable frequency, individuals who die present positive inpatient care utilization prior to death, and the probability of dying is higher for those individuals in poor/fair health. The parameters of the probability of being hospitalized show that this probability decreases the higher the health status, but increases with age. The expenditure in inpatient care also decreases the better the health status, and this expenditure differs by type. Individuals of type II (HMO types), spend on average \$4,000 less on inpatient care (conditional on any) than individuals of type I. The depreciation rate of the health stock with age is smaller for the HMO types, which, together with the fact that the probability of being an HMO type increases with initial health, provides additional evidence that Medicare HMOs may be experiencing favorable selection. As an interesting byproduct of the analysis, the cost of joining a Medicare HMO for the non-HMO types, interpreted as the utility loss of having restricted access to medical care providers, is estimated to be around \$24,000.

An important finding is that the different medical inputs are estimated to be substitutes for each other in the production of health, which answers one of the initial questions of this paper.

7.2 Within sample fit

I next describe how the model's predictions compare to the data. Table 8 compares the health transition matrix predicted by the model with its data counterpart. The model captures the persistence in health status, predicting probabilities of remaining in the same health status nearly identical to the ones observed in the data. The increasing probability of dying as health deteriorates is also captured by the model. The off-diagonal elements of the health transitions matrix are also close to the values observed in the data. Table 9 shows the model's fit with respect to the health insurance choices. The model is able to capture the persistence in this choice and also the transition pattern within the HMO choices. The probability of dropping self-purchased Medigap policies is over-predicted by the model. This is to be expected given the parsimony of the model in terms of the supplemental health insurance switching cost (only one parameter).

The performance of the model in predicting prescription drug, outpatient care and inpatient care utilization by age are reported in Figures 3, 4 and 5 respectively. The model is able to predict well the average prescription drug utilization by age, and its decreasing trend, as shown in Figure 3. In the case of outpatient care utilization, the model matches closely the pattern of the data, except for the 95 year-old elderly, who show a sudden increase in outpatient care utilization, which may be explained by the small number of observations in the 95 year-old category (15 observations). With respect to inpatient care utilization, the model predicts the increasing trend with age observed in the data; however, the model is not able to reproduce all the variation observed in the data. Figure 6 shows the predictions of the model for the probability of being hospitalized by age, along with its data counterpart. The model is able to fit quite closely this feature of the data, although the quality of the fit decreases after age 90, at which age the data shows a more pronounced increase in the probability of

being hospitalized than what the model can generate. The poorer fit at very old ages is likely explained by the small number of observations at the top of the age distribution.

As shown in the data section (Table 2), the expenditure in medical care differs by health status, decreasing the higher the health status. Figure 7 shows the average expenditure in prescription drugs by health status and the corresponding predictions of the model. The model captures the decreasing pattern of the expenditure on prescription drugs with health, and also closely matches the levels for each health status. Similarly, the predictions for the average expenditure on outpatient care, conditional on health status, are shown in Figure 8. The figure shows that the decreasing pattern of outpatient care utilization with health is also reproduced by the model, although the model tends to over-predict outpatient care expenditure among those who are in poor/fair health status by 24%, and under-predict the average utilization of the healthiest elderly by about 30%. Figure 9 shows that the basic pattern exhibited by inpatient care utilization is also captured by the model, although the model tends to over-predict the expenditure in inpatient care among the elderly in poor/fair health status by about 18%.

Finally, Figure 10 shows the model's fit for the average income by age. It can be seen that the model performs well, capturing both the decreasing trend of income by age, and the main aspects of the variation in income.

8 Counterfactual experiments

After the parameters of the model are estimated, the impact of the new Medicare prescription drug benefit can be assessed by simulating the decisions of the elderly under the new environment, which now includes a voluntary prescription drug coverage. In addition, alternative policies are evaluated, such as increasing and decreasing the scheduled percentage increase in premium for the new benefit.

8.1 Policy Experiment 1: Implementing Part D

The first policy experiment consists of implementing the policy as it is, including its unique actuarial design (described in the introduction), and the increment in premiums of 1% per month from the benefit's introduction. The policy therefore implies perturbing the budget constraint shown in equation 2. The out-of-pocket payments will now include, if the new benefit is chosen, all the thresholds contained in the design of the policy. In addition, the premium for the new benefit is allowed to increase 9.6% per year in real terms. Therefore, the year of sign-up is now added as a state variable and the model has to be solved again in order to be able to calculate the expected discounted values of future utility, now taking into account that the consequences of not signing up in this period include an increase in the premium paid in the next period. The impact of the policy over a period of ten years is compared to a ten-year baseline, which assumes no changes from the current situation. The policy simulation is performed by simulating 50 replicas of each individual in the data, i.e., 90,250 people are simulated. Figure 11 shows that the new policy will increase the average expenditure on prescription drugs by about 24% with respect to the baseline. In addition, the out-of-pocket payments will be greatly reduced, from about 75% under the baseline to 49% once the new benefit is introduced. The new benefit, contrary to the administration's beliefs, will not induce savings in outpatient or inpatient care, but will increase the expenditure in both of them. Figure 12 shows that outpatient care utilization increases as a result of the policy by about 3.3% . The increase in inpatient care is relatively small (0.3%), but the important point to emphasize is that the simulations do not predict savings as the government expressed in President Bush's speech. Although prescription drugs were estimated to be substitutes for inpatient and outpatient care in the production of health, their positive impact on health causes a reduction of mortality for a small fraction of the elderly. These new survivors are predicted to spend their extra years mainly in the poor/fair health category, and therefore consume large amounts of medical care. The results of the policy experiment are presented in Table 10, which shows the aggregate impact of the policy as well as its impact on two subgroups: those who survive both under the baseline and the policy

experiment (anyway survivors), and those who survive only once the policy is implemented (new survivors). It can be seen in the table that the government's perceptions coincide with the results obtained for the anyway survivors. That is, prescription drugs improve the health status of the elderly, increasing slightly the proportion of people in the excellent/very good category, and decreasing the proportion of people in poor/fair health status. The expenditure in outpatient care for this subgroup declines by 4.2% and the expenditure in inpatient care declines by 13.7% due to the improvement in the general health status. However, those savings are outweighed by the increase in inpatient and outpatient care expenditure of the new survivors. Their increase in expenditures is due to the extension of their lives and the bad health status in which they spend those extra years. In fact, 63% of the new survivors spend the extra years lived in bad health status. The outpatient care expenditure for the new survivors increases by 69.3% and inpatient care expenditure increases by 98.1%. The policy decreases mortality by 0.12 years on average, and as a measure of cost-effectiveness of the new benefit, the average cost of the extra year of life is calculated to be \$38,300. If this cost is adjusted by a crude measure of quality of life, the cost of the extra year lived is about \$62,050.¹⁶ If these values are compared to the standard \$100,000 used in the literature for the value of a year of life (see for example Cutler and Richardson (1998), Gowrisankaran and Town (2005), Cutler and McClellan (2001), the new prescription drug benefit appears to be cost-effective.¹⁷

The enrollment in the new prescription drug benefit is predicted to exhibit a concave profile over time. Figure 13 shows that enrollment starts at about 40% in the first year, and increases at a decreasing rate, reaching 85% by the fifth year. This result is important

¹⁶The literature on quality-adjusted life years (QALY) assumes that a year lived in perfect health has a value of 1, and a year lived with certain condition falls between 0 and 1. This literature calculates coefficients for conditions; however, there are no QALY measures for self-reported health status. For the back-of-the-envelope calculations done in this paper, it is assumed that a year of life in poor/fair health status is 0.5, good health is 0.75 and excellent/very good corresponds to 1.

¹⁷Cutler et al. (1999) argue that the value of life for the elderly may be lower than \$100,000 per year. It is enough that the value attached to the extra year lived is 0.38 of a healthy year for the policy to be cost-effective.

given that the government's estimates have assumed a constant 85% enrollment during the 10-year period. The government expects to finance 25% of the program with the collected premia. To test whether the lower than predicted enrollment will compromise the expected financing of the program, the percentage financed with premia is calculated and reported in Table 11. The table shows that the financial goal of the government is met for every year, but the first. During the first year it is expected that the program will be financed with a higher contribution from the tax-payers, due to the fact that the elderly below 150% of poverty line, who do not pay a premium for the new benefit, react more quickly to the introduction of Part D. This is shown in Figure 14. In addition, the new benefit causes a sizable crowding-out effect over the existing supplemental health insurance alternatives. Figure 15 shows the proportion of people who enroll in the new benefit by the last year of the simulation, categorized by their original supplemental health insurance option. It can be seen that those who were in original Medicare without any supplemental insurance are the ones that react the most to the presence of the new prescription drug benefit. A similar reaction is obtained from the elderly who held self-purchased Medigap policies. This is to be expected, given that when the policy is introduced they can buy a 75%-subsidized prescription drug coverage, which is cheaper than buying the Medigap insurance. The groups that react the least are those who held employer provided health insurance with prescription drugs and those who had Medicare HMO with drug coverage. This can be explained by the fact that these plans are in general more generous relative to the Medigap plans. Although the new benefit imposes a big crowding-out effect on existing supplemental health insurance options, it improves their average risk, defined as the proportion of people in the different health states that enroll in each health insurance alternative. Figure 16 shows graphically that after the introduction of the new prescription drug benefit, there is a considerable increase in the proportion of people in excellent/very good health status who enroll in the previously existing supplemental insurance options, and a corresponding decrease in the proportion of people in poor/fair health status. This change in the risk composition for the existing alternatives may lead to a decrease in their premia. These general equilibrium effects cannot be captured by this partial equilibrium model, and will be explored in future research.

8.2 Policy Experiment 2: Assessing the Effect of the Monthly 1% Increase in Premium

The design of the Part D benefit includes a scheduled 1% nominal increase in premiums per month if the elderly do not enroll in the new benefit at the beginning of the program. The purpose of including this feature is to promote early enrollment in the new benefit, and therefore avoid adverse selection. Because all monetary values are expressed in real terms, it is assumed that the 12.6% nominal increase in the Part D premium per year will be equivalent to an increase of 9.6% per year in real terms. To evaluate the impact on enrollment of this percentage increase in the new benefit's premium, the results of the policy simulation presented in the previous section are compared to a new simulation that keeps the benefit's design in every respect, but sets the annual percentage increase in premium to 0%. No changes in enrollment are observed between the two scenarios. This is to be expected because the premium is 75% subsidized; therefore, the elderly perceive a large expected benefit from a prescription drug insurance that is acquired for a small premium. In fact, to obtain front-loading in enrollment, the policy would need to be made actuarially unfair. Figure 17 shows that an increase in enrollment in the early years of implementation is obtained given that a 400% increase in the Part D premium is introduced. Although early enrollment is obtained, the take-up rate in future years is greatly reduced.

9 Conclusions

This paper developed and estimated a dynamic behavioral model of the elderly's demand for supplemental health insurance and medical care. The model incorporated decisions about supplemental health insurance, prescription drug utilization, outpatient care utilization, and consumption. The decisions about prescription drug utilization and outpatient care utilization, together with inpatient care utilization, were considered as inputs of a health production function, which drives the dynamics of the health status. Health was the only asset in the model, and the elderly invested in their health stock through medical care. The model was

estimated for a sample of elderly women living alone using panel data from the Medicare Current Beneficiary Survey. The estimated model provided a reasonable fit to various relevant features of the data.

The estimated model was used to study the impact of the newly enacted Medicare prescription drug benefit on the elderly's medical care utilization, life expectancy and health outcomes. Because the new prescription drug benefit will come into effect in January 2006, no post-policy data are available, and therefore, the behavioral model is required to permit extrapolation from observational data to the new policy regime. The model was able to incorporate all the relevant features of the actuarial design and pricing of the new policy in doing the assessment. The model forecasts that, as a result of the policy, there will be an increase in the utilization of prescription drugs, which have a positive impact on health and a negative impact on mortality. Prescription drugs were estimated to be substitutes for outpatient and inpatient care in the production of health, and for the majority of the elderly (those who survive both under the baseline and under the new environment), this translates into lower inpatient and outpatient care expenditures. However, the reduction in expenditures for this group are outweighed by the increase in the utilization of inpatient and outpatient care by those elderly who live at least one extra year as a result of the policy. They will spend a big proportion of those extra years in poor/fair health, and will therefore, be big spenders of medical care. This will cause the expenditures on inpatient and outpatient care to increase in the aggregate, contrary to the government's beliefs. The average cost of extending life by one year is estimated to be between \$38,000 and \$62,000, depending on adjustments for quality of life. This cost is small compared to the value attached to an extra year of life that is commonly used in the literature.

The government's predictions were made based on a constant 85% enrollment in the new benefit; however, the model predicts that this level of enrollment will not be reached until the fifth year after implementation. The 1% increase per month in premiums has no effect on front-loading enrollment, and it is shown that to obtain early enrollment the percentage increase in premiums would need to be such that it made the premium actuarially unfair. The new benefit will also impose a sizable crowding-out effect on existing supplemental health

insurance alternatives; however, it improves their average risk.¹⁸ The policy experiments in this paper have taken as given the co-payment structure of the new prescription drug benefit. An open question is what would be the optimal policy, i.e., the one that maximizes the expected benefits subject to spending the same amount as the current policy. Future work will explore this issue by parameterizing the thresholds of the actuarial design of the benefit in order to find the optimal policy.

¹⁸The partial equilibrium approach adopted in this paper is not able to predict the likely decrease in premia of the existing alternatives that may be caused by the improvement of their average risk. Therefore, enrollment in the new option may be overpredicted. Future research using a general equilibrium framework will address this interesting issue.

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10 Appendix

10.1 Utility function

$$u_a = \frac{1}{\theta_1} C_a^{\theta_1} + \theta_2 \mathbb{I}\{H_a = 2\} + \theta_3 \mathbb{I}\{H_a = 3\} + \theta_4 R x_a + \theta_5 o_a + \theta_6 i_a + \theta_7 \mathbb{I}\{hi_a \neq hi_{a-1}\} + \sum_{k=1}^K \theta_{7+k} \mathbb{I}\{type = k\} \mathbb{I}\{hi_a = 6 \text{ or } hi_a = 7\} + \varepsilon_a^J \quad (19)$$

10.2 Income

$$\ln Y_a = \sum_{k=1}^K \theta_{9+k} \mathbb{I}\{type = k\} + \theta_{12} \mathbb{I}\{e_a = 2\} + \theta_{13} \mathbb{I}\{e_a = 3\} + \theta_{14} \mathbb{I}\{e_a = 4\} + \theta_{15} \mathbb{I}\{e_a = 5\} + a(\theta_{16} + \theta_{17}a) + \varepsilon_a^y \quad (20)$$

10.3 Inpatient care

$$Pr(i_a > 0) = \frac{\exp(\theta_{18} + \theta_{19} \mathbb{I}\{H_a = 2\} + \theta_{20} \mathbb{I}\{H_a = 3\} + a(\theta_{21} + \theta_{22}a))}{1 + \exp(\theta_{18} + \theta_{19} \mathbb{I}\{H_a = 2\} + \theta_{20} \mathbb{I}\{H_a = 3\} + a(\theta_{21} + \theta_{22}a))} \quad (21)$$

$$\ln i_a = \sum_{k=1}^K \theta_{22+k} \mathbb{I}\{type = k\} + \theta_{25} \mathbb{I}\{H_a = 2\} + \theta_{26} \mathbb{I}\{H_a = 3\} + \varepsilon_a^i \quad (22)$$

10.4 Health production function

$$\begin{aligned} Pr(H_{a+1} = 0 | H_a = h) &= \frac{\exp(\kappa_1^h - \eta^h Z_a)}{1 + \exp(\kappa_1^h - \eta^h Z_a)} \\ Pr(H_{a+1} = 1 | H_a = h) &= \frac{\exp(\kappa_2^h - \eta^h Z_a)}{1 + \exp(\kappa_2^h - \eta^h Z_a)} - \frac{\exp(\kappa_1^h - \eta^h Z_a)}{1 + \exp(\kappa_1^h - \eta^h Z_a)} \\ Pr(H_{a+1} = 2 | H_a = h) &= \frac{\exp(\kappa_3^h - \eta^h Z_a)}{1 + \exp(\kappa_3^h - \eta^h Z_a)} - \frac{\exp(\kappa_2^h - \eta^h Z_a)}{1 + \exp(\kappa_2^h - \eta^h Z_a)} \\ Pr(H_{a+1} = 3 | H_a = h) &= 1 - \frac{\exp(\kappa_3^h - \eta^h Z_a)}{1 + \exp(\kappa_3^h - \eta^h Z_a)} \end{aligned} \quad (23)$$

$$\begin{aligned} \eta^h Z_a &= R x_a (\theta_{27}^h + \theta_{28}^h R x_a) + o_a (\theta_{29}^h + \theta_{30}^h o_a) + i_a (\theta_{31}^h + \theta_{32}^h i_a) + \theta_{33}^h R x_a o_a + \\ &\quad \theta_{34}^h R x_a i_a + \theta_{35}^h o_a i_a + \theta_{36}^h S + \sum_{k=1}^K \theta_{36+k}^h \mathbb{I}\{type = k\} a \end{aligned} \quad (24)$$

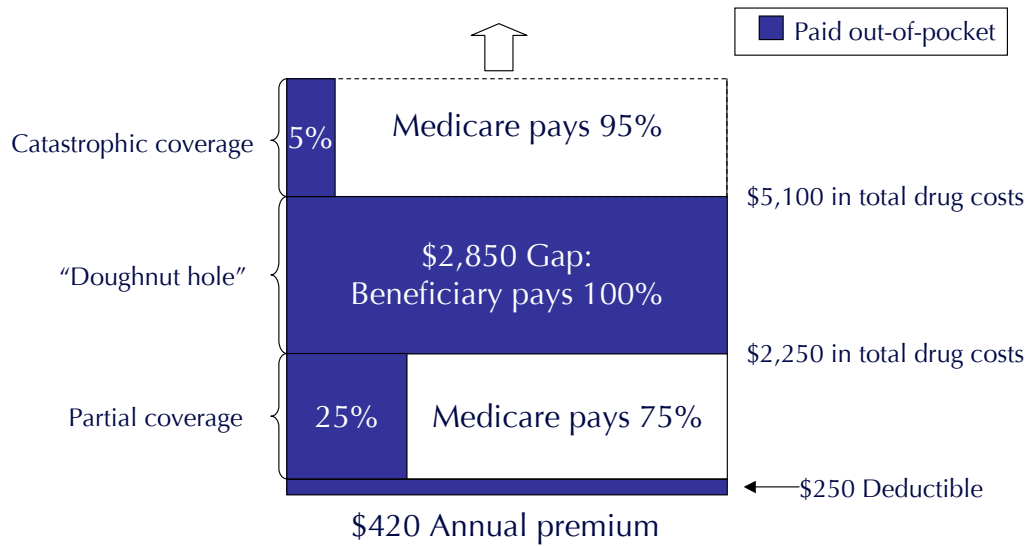


Figure 1: Medicare Part D coverage for seniors with income above 150% of Poverty Line

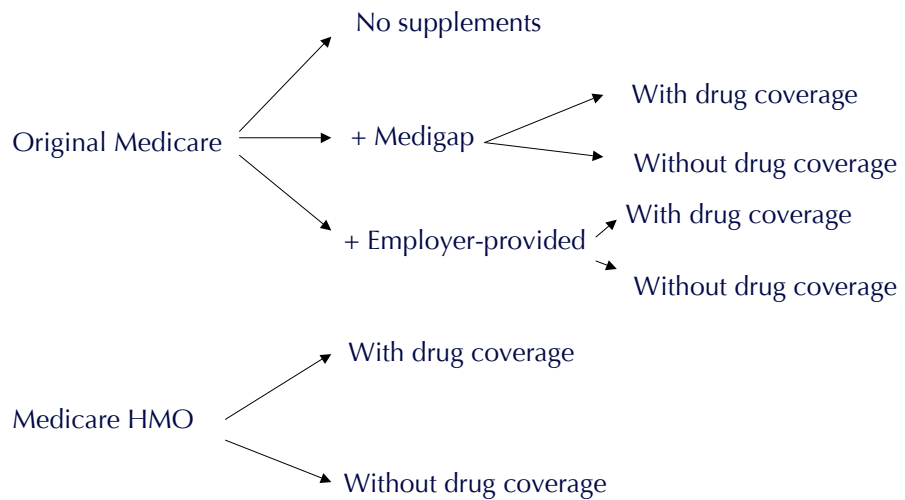


Figure 2: Diagram of supplemental health insurance options available to the elderly

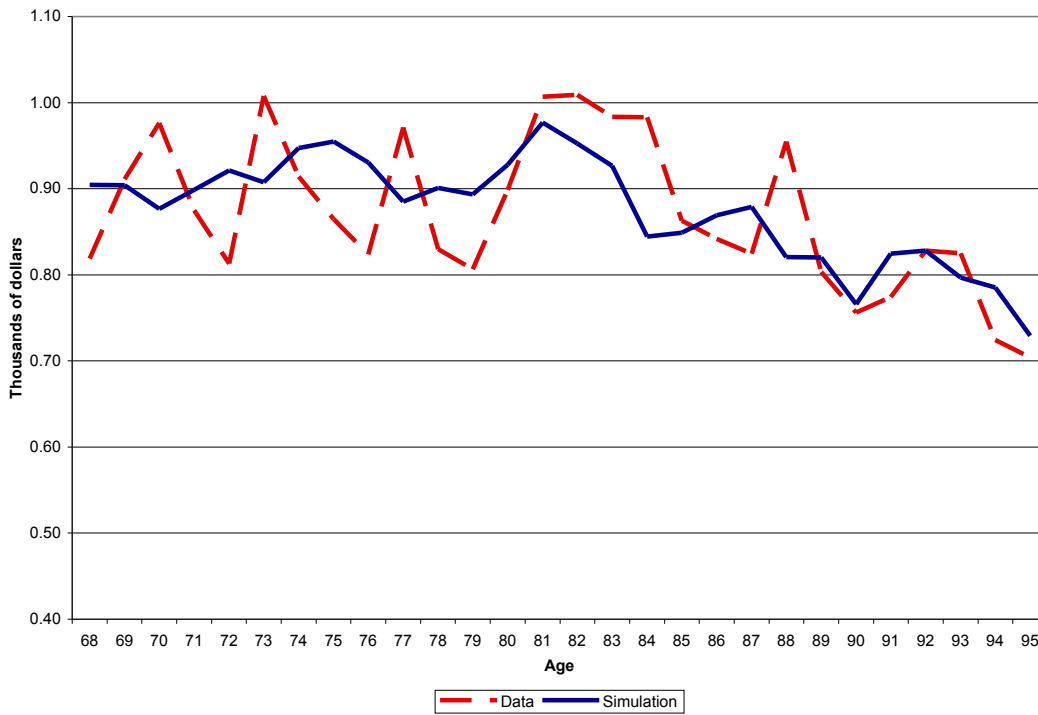


Figure 3: Average prescription drug expenditure by age

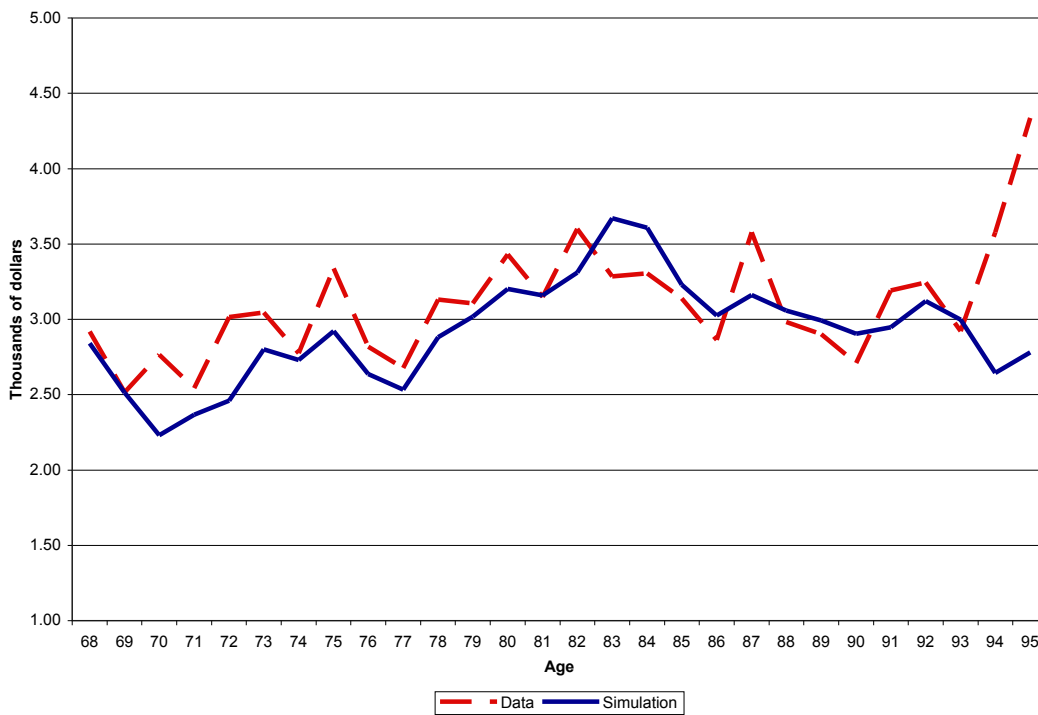


Figure 4: Average outpatient care expenditure by age

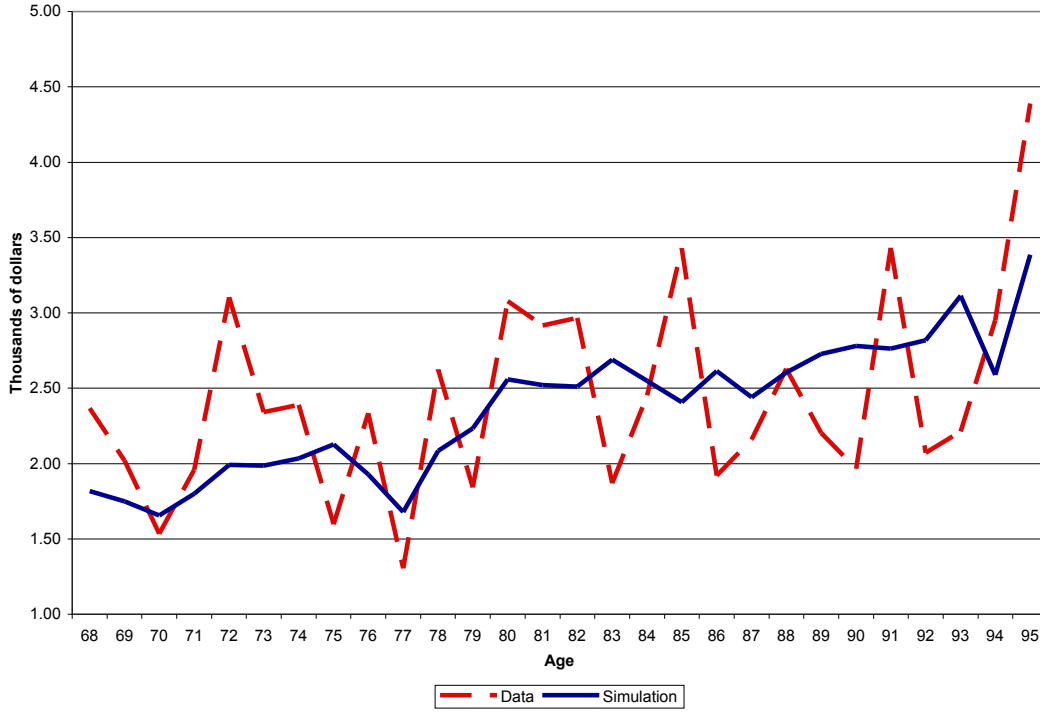


Figure 5: Average inpatient care expenditure by age

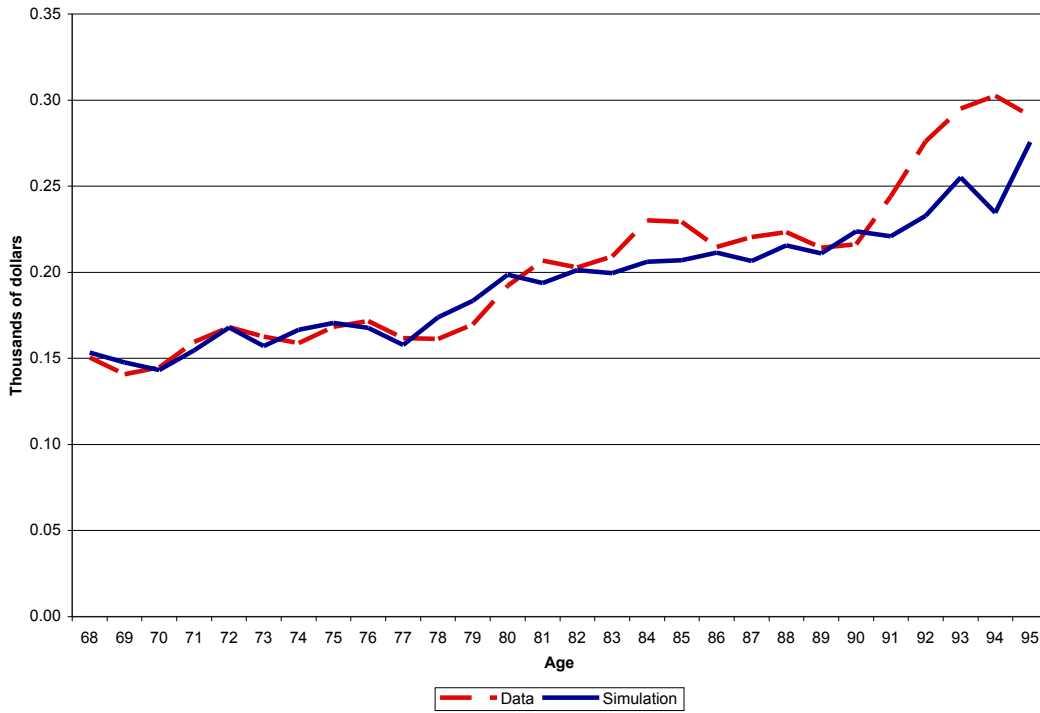


Figure 6: Probability of having any inpatient care event by age

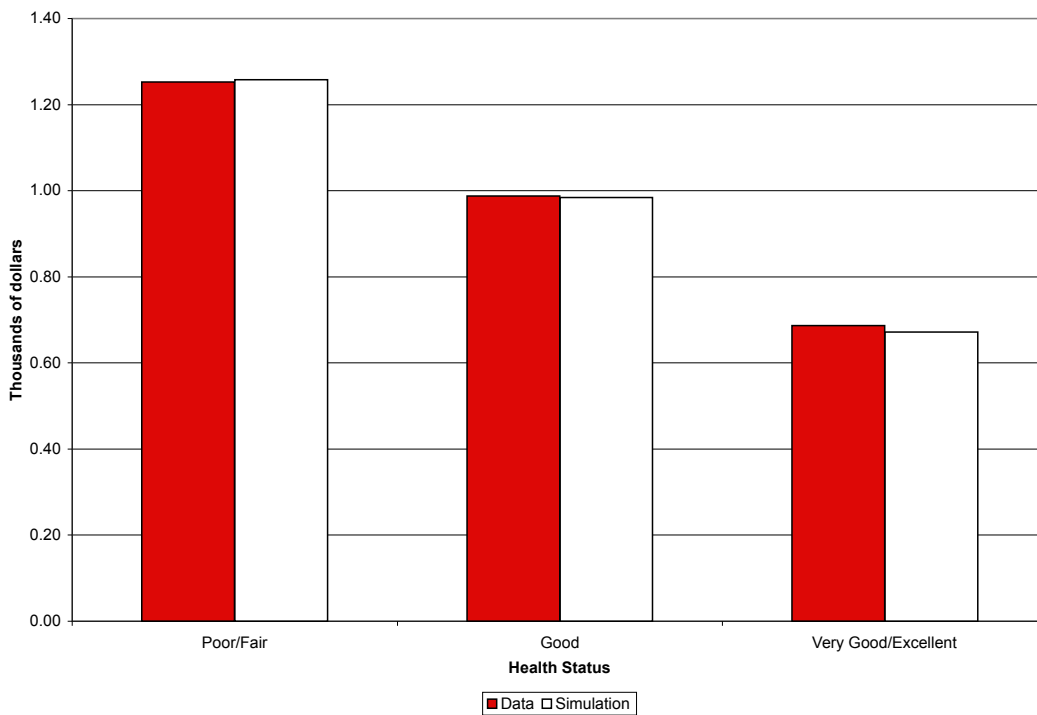


Figure 7: Average prescription drug expenditure by health status

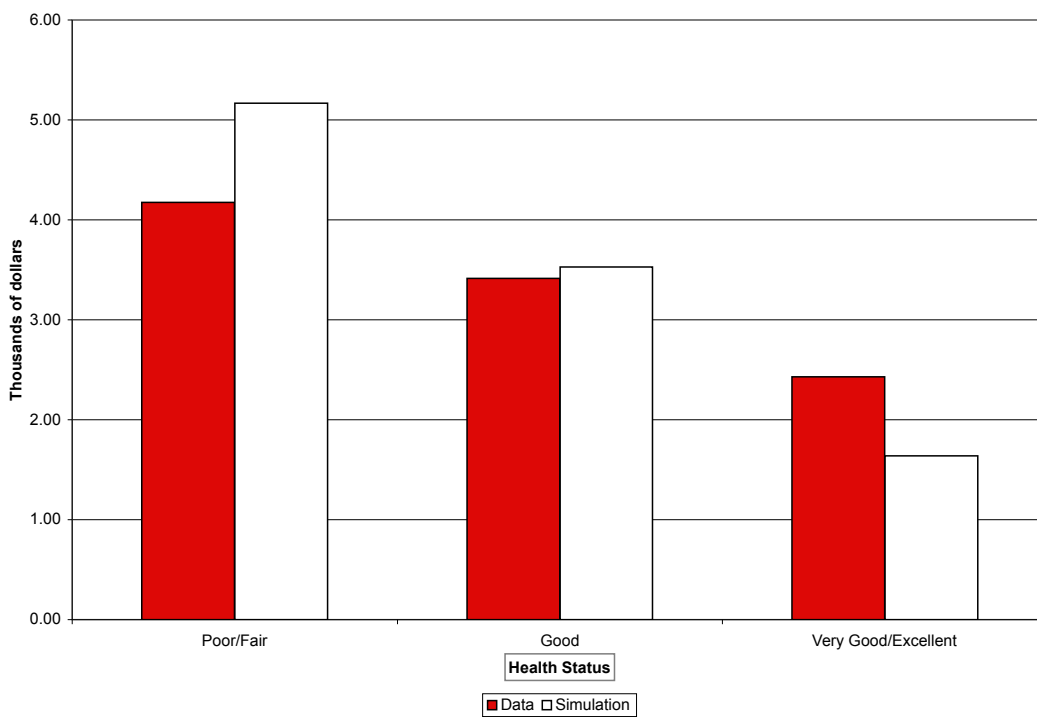


Figure 8: Average outpatient care expenditure by health status

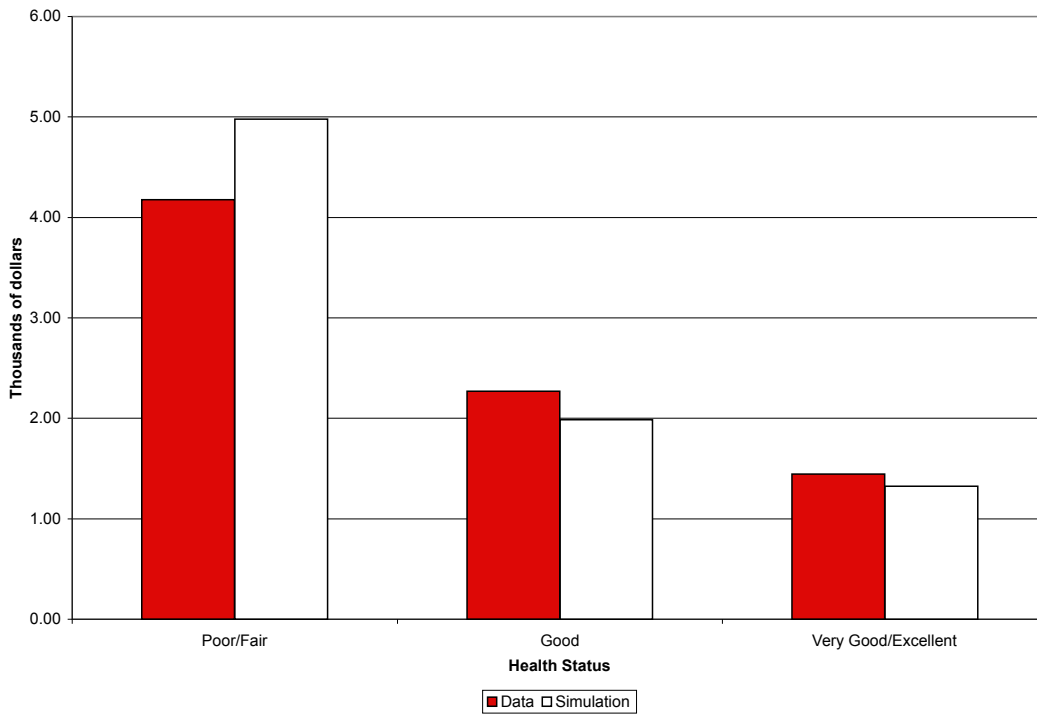


Figure 9: Average inpatient care expenditure by health status

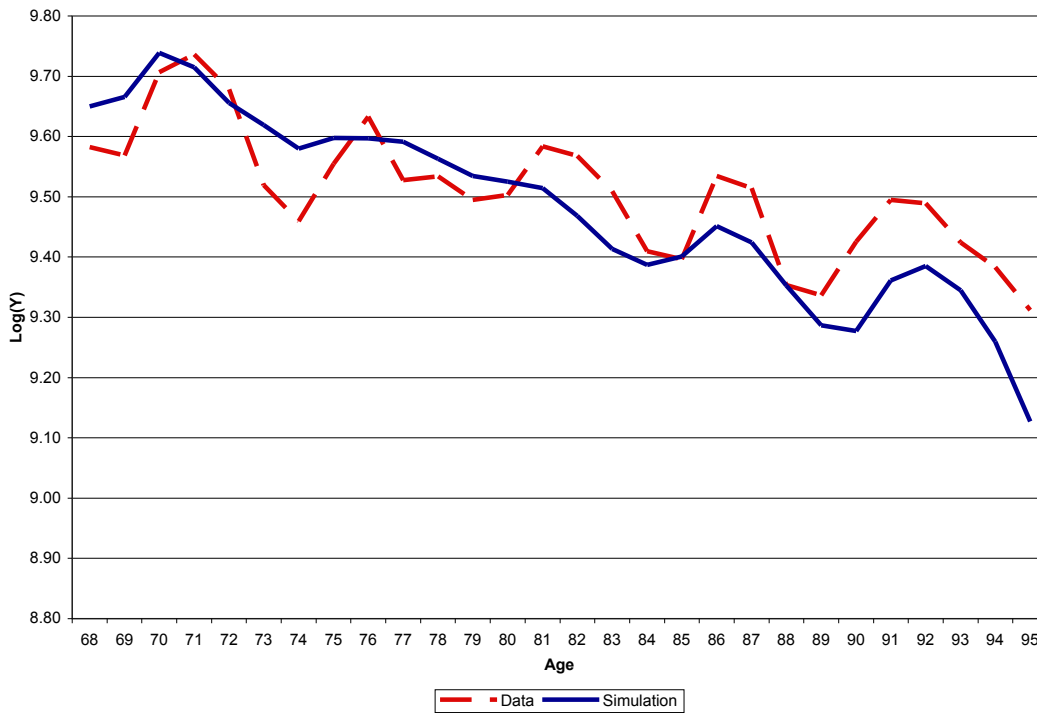


Figure 10: Average income by age

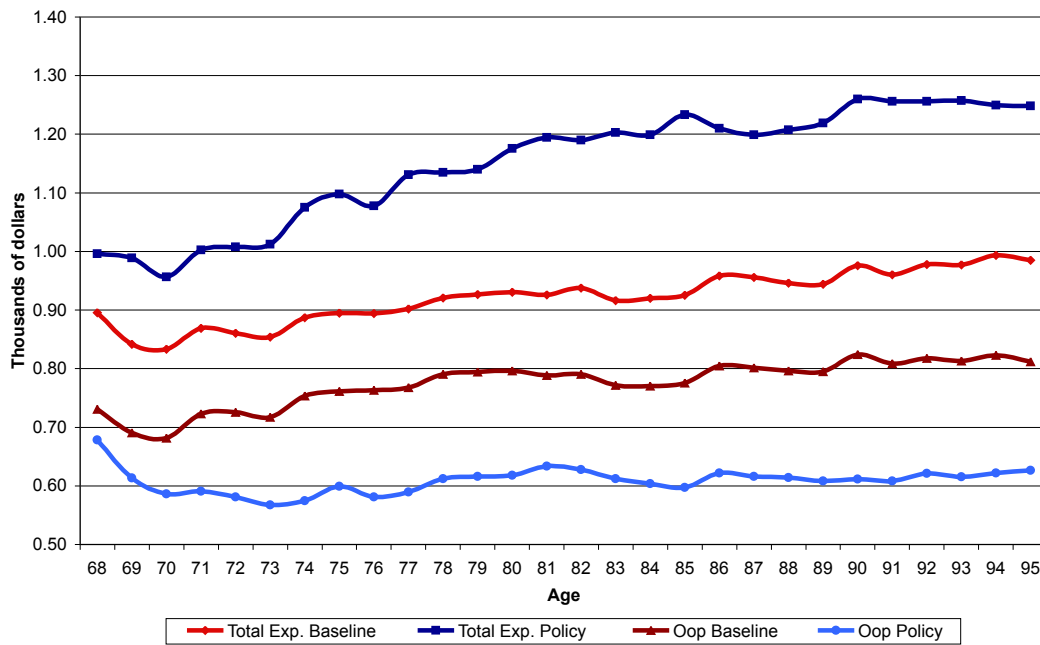


Figure 11: Average and out-of-pocket prescription drug expenditure by age after the policy

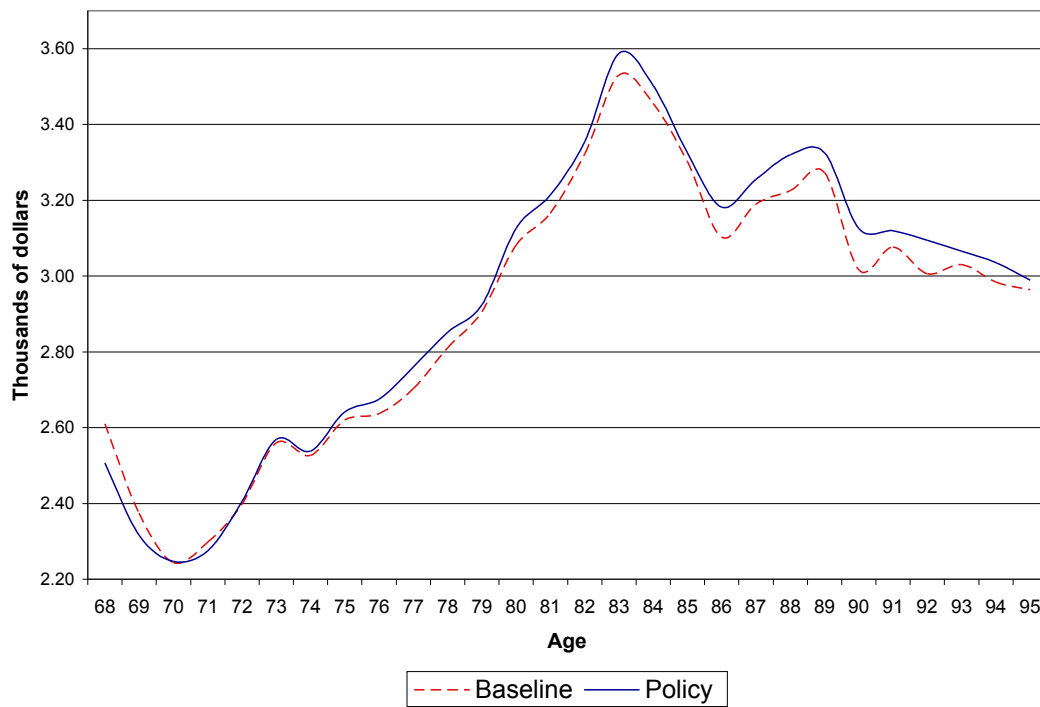


Figure 12: Average outpatient care expenditure after the policy

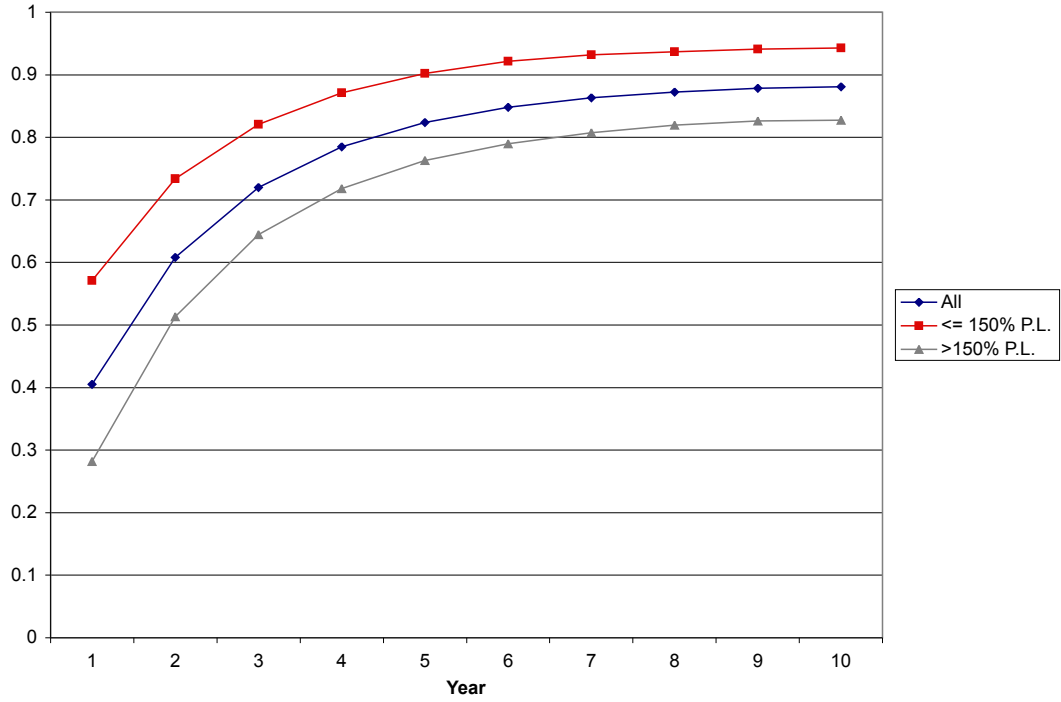


Figure 13: Part D take-up rate by year of implementation

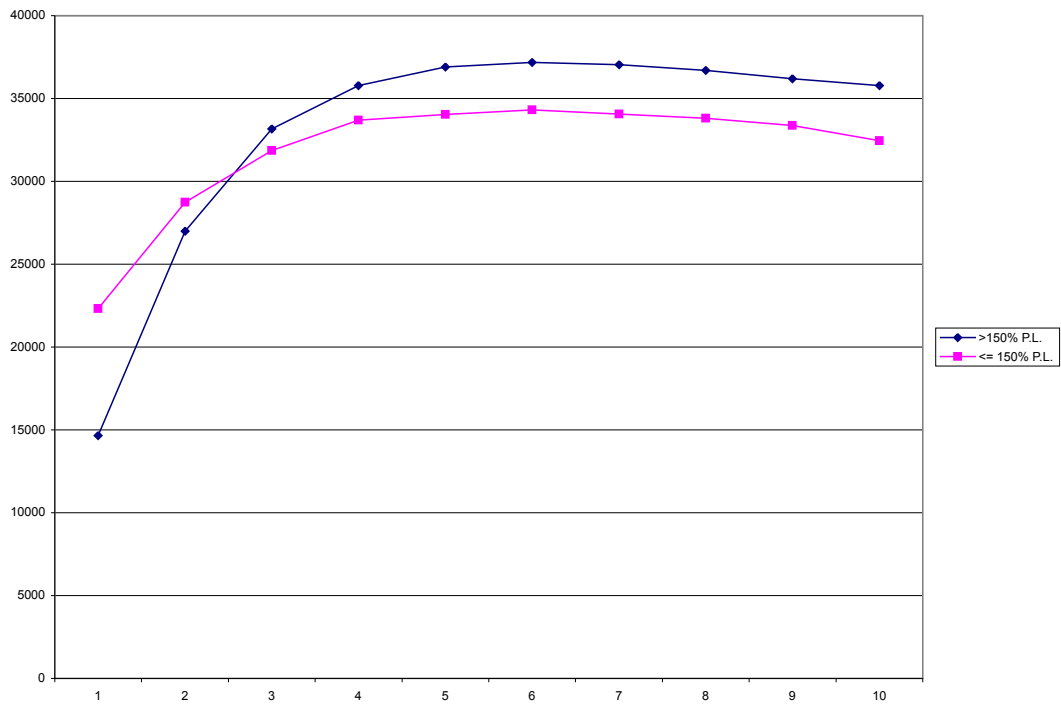


Figure 14: Number of enrollees below and above 150% of poverty line that enroll in Part D

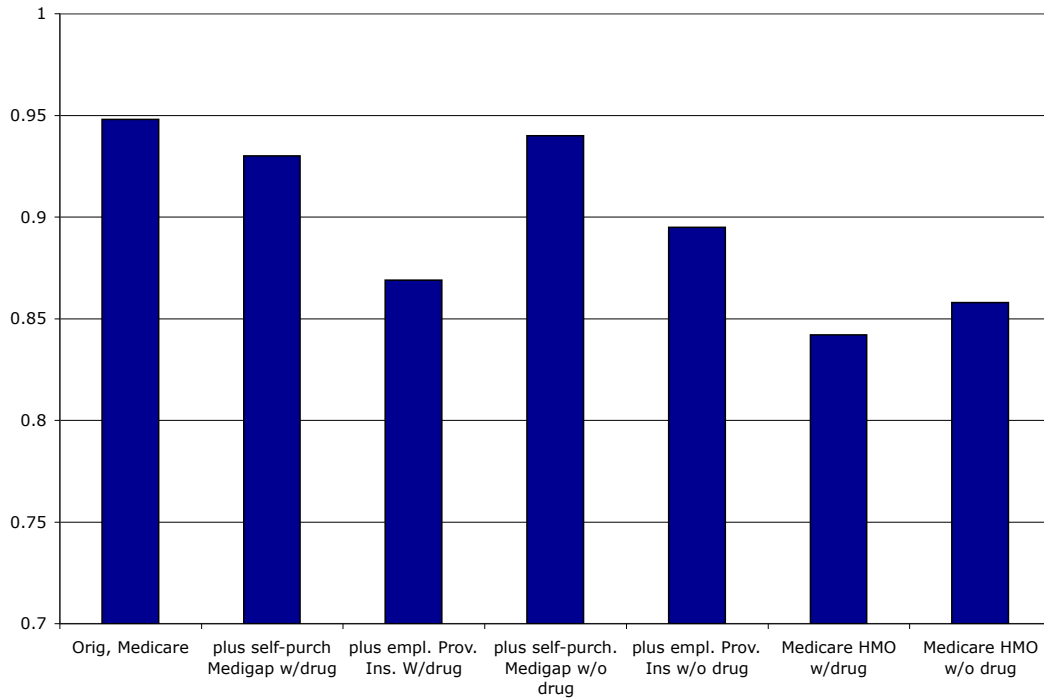


Figure 15: Crowding-out effect on the existing supplemental insurance options

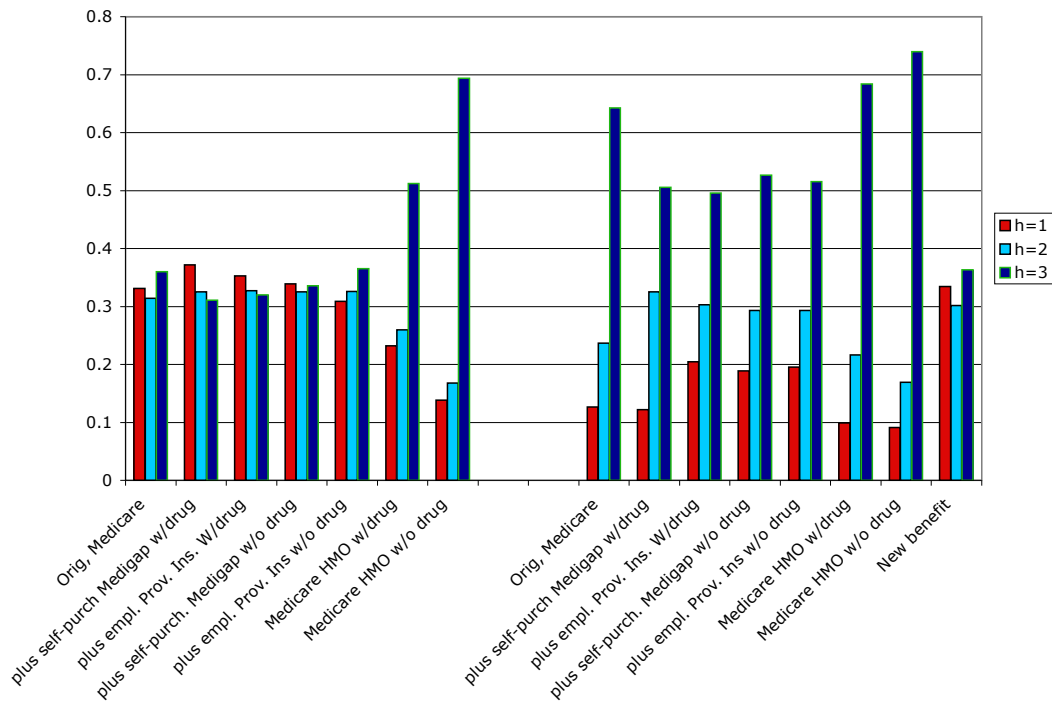


Figure 16: Health status of enrollees by their choice of health insurance

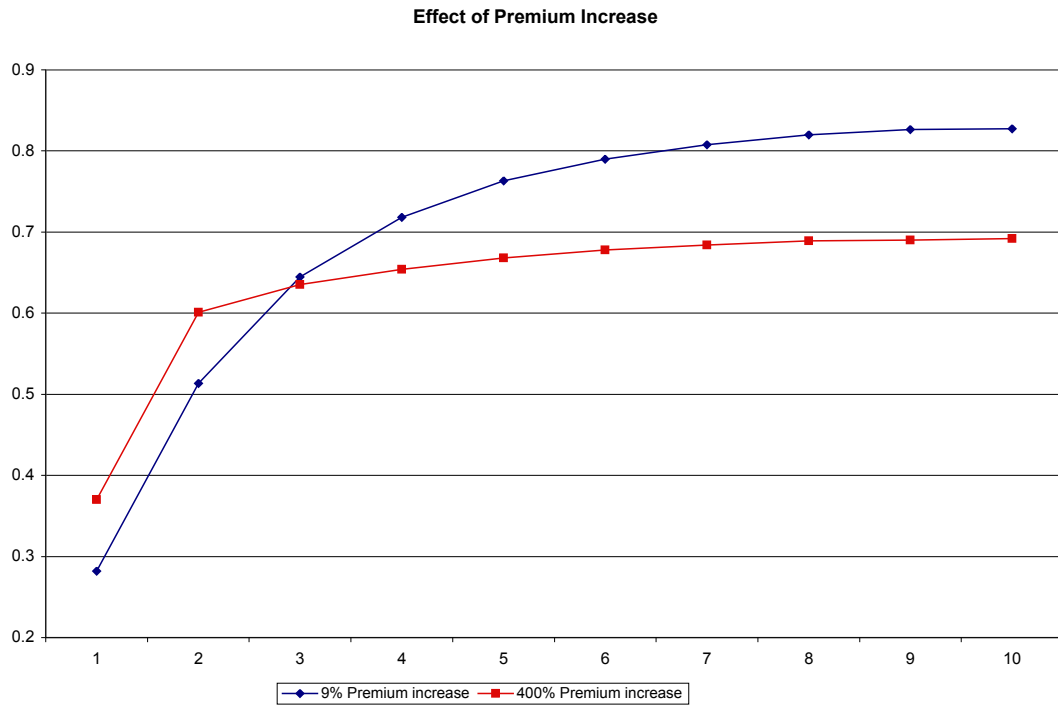


Figure 17: Effect on enrollment of the percentage increase in the Part D premium

Table 1: Summary Statistics

	Average	St. Dev.	Min	Max
<u>Health insurance</u>				
FFS only	0.06			
FFS + self-purch. Medigap w/ Rx covg.	0.10			
FFS + empl.-prov. ins. w/ Rx covg.	0.22			
FFS + self-purch. Medigap w/o Rx covg.	0.36			
FFS + empl.-prov. ins. w/o Rx covg.	0.11			
Medicare HMO w/ Rx covg.	0.12			
Medicare HMO w/o Rx covg.	0.03			
<u>Expenditure on medical care</u>				
Prescription drugs	0.89	0.85	0.00	6.11
Outpatient care	3.12	3.11	0.34	7.52
Inpatient care	2.37	7.34	0.00	89.11
Prob. of any inpatient event	0.19			
Inpatient care condctl. on any	12.21	12.58	0.30	89.11
<u>Percentage paid out-of-pocket</u>				
Prescription drugs	0.71	0.34	0.00	1.00
Prescription drugs condctl. on having coverage	0.49	0.30	0.00	0.65
Outpatient care	0.14	0.25	0.00	1.00
Inpatient care	0.03	0.10	0.00	1.00
<u>Demographics</u>				
Proportion in excellent/very good health	0.48			
Proportion in good health	0.32			
Proportion in poor/fair health	0.20			
Age	79.06	6.66	68	95
Years of education	11.45	3.08	1	18
Log(income)	9.53	0.69	4.99	13.59
Ever smoked	0.44			
Employer-provided health insurance	0.33			

Expenditures in thousands of 1999 dollars

Table 2: Average medical care expenditure by health status

Health status	Drugs	Outpatient	Inpatient	Inpatient > 0
1	1.25 (1.00)	4.17 (3.22)	4.18 (10.2)	13.77 (14.56)
2	0.99 (0.89)	3.41 (3.18)	2.27 (6.83)	11.82 (11.41)
3	0.68 (0.66)	2.43 (2.82)	1.44 (5.69)	10.99 (11.89)

The health states are: 1=poor/fair, 2=good, 3=excellent/very good.

Expenditures in thousands of 1999 dollars.

Standard errors in parenthesis.

Table 3: Health state transitions (percentage)

Health status at age a	Health status at age $a + 1$				Frequency
	0	1	2	3	
1	3.03	63.09	24.21	9.68	661
2	1.70	18.87	50.27	29.16	1,118
3	1.04	4.97	23.43	70.56	1,831

The health states are: 0=dead, 1=poor/fair, 2=good, 3=excellent/very good.

Table 4: Health insurance transitions (percentage)

Health ins. choice at age a	Health insurance choice at age $a + 1$							Frequency
	1	2	3	4	5	6	7	
1	90.99	0.43	0.00	3.43	0.00	3.86	1.29	233
2	0.55	61.88	6.08	26.52	2.76	1.66	0.55	362
3	0.24	3.58	84.71	2.03	8.48	0.96	0.00	837
4	0.91	7.51	0.45	85.29	2.96	2.58	0.30	1,319
5	0.25	1.99	14.18	15.17	66.67	1.74	0.00	402
6	0.26	0.00	0.53	0.79	0.53	86.84	11.05	380
7	0.00	0.00	0.00	2.60	0.00	45.45	51.95	77
Frequency	230	362	796	1,312	390	429	91	

The health insurance options are:

1:Fee-for-service only

2:Fee-for-service + self-purchased Medigap with Rx coverage

3:Fee-for-service + employer-provided insurance with Rx coverage

4:Fee-for-service + self-purchased Medigap without Rx coverage

5:Fee-for-service + employer-provided insurance without Rx coverage

6:Medicare HMO with Rx coverage

7:Medicare HMO without Rx coverage

Table 5: Characteristics of the insurance options

	Premium (\$)	Copayments (percentage)		
		Drugs	Outpat.	Inpat.
FFS only	532	1.00	0.50	0.11
FFS + self-purch. Medigap w/Rx covg.	2,159	0.50	0.21	0.01
FFS + empl.-prov. ins. w/Rx covg.	1,393	0.37	0.23	0.02
FFS + self-purch. Medigap w/o Rx covg.	1,900	1.00	0.23	0.01
FFS + empl.-prov. ins. w/o Rx covg.	1,467	1.00	0.26	0.05
Medicare HMO w/Rx covg.	242	0.47	0.20	0.01
Medicare HMO w/o Rx covg.	430	1.00	0.19	0.01

Table 6: Parameter estimates

Description	θ	$\hat{\theta}$
<u>Utility function</u>		
CRRA parameter	θ_1	0.28 (0.013)
Marginal utility good health	θ_2	11.32 (0.214)
Marginal utility excellent health	θ_3	22.55 (0.134)
Marginal (dis)utility of Rx_a	θ_4	-0.61 (0.021)
Marginal (dis)utility of o_a	θ_5	-0.70 (0.06)
Marginal (dis)utility of i_a	θ_6	-0.00068 (0.010)
Health insurance switching cost	θ_7	-2.87 (0.088)
HMO network cost type I	θ_8	-6.02 (0.136)
HMO network cost type II	θ_9	0.53 (0.113)
<u>Income</u>		
Constant type I	θ_{10}	9.49 (0.045)
Constant typeII	θ_{11}	9.52 (0.063)
Coeff. on high-school dropout	θ_{12}	0.15 (0.003)
Coeff. on high-school graduate	θ_{13}	0.42 (0.002)
Coeff. on college dropout	θ_{14}	0.75 (0.003)
Coeff. on college graduate	θ_{15}	1.16 (0.003)
Coeff. on a	θ_{16}	0.00023 (0.0006)
Coeff. on a^2	θ_{17}	-0.00009 (0.00004)

Table 6: Parameter estimates (continued)

Description	θ	$\hat{\theta}$
<u>Probability of any inpatient event</u>		
Constant	θ_{18}	-1.21 (0.367)
Coeff. on medium health	θ_{19}	-0.80 (0.189)
Coeff. on good health	θ_{20}	-0.92 (0.206)
Coeff. on a	θ_{21}	-0.0074 (0.005)
Coeff. on a^2	θ_{22}	0.00015 (0.00001)
<u>Inpatient expenditure</u>		
Constant type I	θ_{23}	9.37 (0.067)
Constant type II	θ_{24}	8.63 (0.126)
Coeff. on good health	θ_{25}	-0.25 (0.122)
Coeff. on excellent health	θ_{26}	-0.56 (0.110)

Table 6: Parameter estimates (continued)

Description	θ	$\hat{\theta}$	θ	$\hat{\theta}$	θ	$\hat{\theta}$
<u>Health prod. tech.</u>						
Coeff. on Rx_a	θ_{27}^1	0.20	θ_{27}^2	0.11	θ_{27}^3	0.10
		(0.008)		(0.005)		(0.008)
Coeff. on Rx_a^2	θ_{28}^1	-0.0015	θ_{28}^2	-0.0007	θ_{28}^3	-0.004
		(0.002)		(0.0009)		(0.002)
Coeff. on o_a	θ_{29}^1	0.18	θ_{29}^2	0.09	θ_{29}^3	0.09
		(0.011)		(0.005)		(0.007)
Coeff. on o_a^2	θ_{30}^1	-0.0006	θ_{30}^2	-0.0012	θ_{30}^3	-0.0014
		(0.0001)		(0.0005)		(0.001)
Coeff. on i_a	θ_{31}^1	0.02	θ_{31}^2	0.04	θ_{31}^3	0.09
		(0.012)		(0.002)		(0.016)
Coeff. on i_a^2	θ_{32}^1	-0.00009	θ_{32}^2	-0.0001	θ_{32}^3	-0.0001
		(0.0001)		(0.00003)		(0.0004)
Coeff. on $Rx_a o_a$	θ_{33}^1	-0.026	θ_{33}^2	-0.06	θ_{33}^3	-0.05
		(0.0005)		(0.0005)		(0.001)
Coeff. on $Rx_a i_a$	θ_{34}^1	-0.005	θ_{34}^2	-0.008	θ_{34}^3	-0.02
		(0.011)		(0.050)		(0.223)
Coeff. on $o_a i_a$	θ_{35}^1	-0.003	θ_{35}^2	-0.002	θ_{35}^3	-0.005
		(0.002)		(0.004)		0.053
Coeff. on smoke	θ_{36}^1	-0.75	θ_{36}^2	-0.95	θ_{36}^3	-0.74
		0.057		0.037		0.073
Coeff. on a type I	θ_{37}^1	-0.075	θ_{37}^2	-0.09	θ_{37}^3	-0.08
		(0.0009)		(0.0008)		(0.001)
Coeff. on a type II	θ_{38}^1	-0.072	θ_{38}^2	-0.077	θ_{38}^3	-0.05
		(0.0005)		(0.0004)		(0.001)
Cutoff death-poor	κ_1^1	-8.89	κ_1^2	-11.38	κ_1^3	-11.51
		(0.052)		(0.099)		(0.258)
Cutoff poor-good	κ_2^1	-4.35	κ_2^2	-8.57	κ_2^3	-9.29
		(0.082)		(0.059)		(0.145)
Cutoff good-excellent	κ_3^1	-2.61	κ_3^2	-5.92	κ_3^3	-6.88
		(0.147)		(0.050)		(0.098)

Standard errors in parenthesis

Table 6: Parameter estimates (continued)

Description	θ	$\hat{\theta}$
<u>Type probability</u>		
Constant	θ_{39}	-7.67 (0.859)
Previous health ins.	θ_{40}	13.07 (0.397)
Age	θ_{41}	0.07 (0.009)
Good health	θ_{42}	0.29 (0.338)
Excellent health	θ_{43}	0.96 (0.352)
Education	θ_{44}	1.34 (0.222)
Smoke	θ_{45}	0.21 (0.260)
Empl. prov. health ins	θ_{46}	-0.69 (0.249)
S.d. of income shock	σ_y	0.18 (0.023)
S.d. of inpat. exp. shock	σ_i	0.91 (0.024)
Discount factor	δ	0.95

Standard errors in parenthesis

Table 7: Marginal effects of medical care (10% increase)

Health status	Drugs	Outpatient	Inpatient
1	2.9	4.1	-0.1
2	1.2	0.7	1.9
3	0.5	0.3	0.3

The health states are: 1=poor/fair, 2=good, 3=Excellent/Very good.

Table 8: Health state transitions (percentage)

Health status at age a		Health status at age $a + 1$			
		0	1	2	3
1	Data	3.03	63.09	24.21	9.68
	Simulation	3.19	65.16	23.51	8.13
2	Data	1.70	18.87	50.27	29.16
	Simulation	2.69	23.91	48.39	25.00
3	Data	1.04	4.97	23.43	70.56
	Simulation	0.46	3.54	24.78	71.22

The health states are: 0=dead, 1=poor/fair, 2=good, 3=excellent/very good.

Table 9: Health insurance transitions (percentage)

Health insurance choice at age a		Health insurance choice at age $a + 1$						
		1	2	3	4	5	6	7
1	Data	90.99	0.43	0.00	3.43	0.00	3.86	1.29
	Simul.	83.83	6.80	1.47	4.18	1.20	0.58	1.94
2	Data	0.55	61.88	6.08	26.52	2.76	1.66	0.55
	Simul.	3.58	81.59	1.40	10.49	1.04	0.42	1.48
3	Data	0.24	3.58	84.71	2.03	8.48	0.96	0.00
	Simul.	3.29	4.05	81.22	2.81	7.53	0.27	0.82
4	Data	0.91	7.51	0.45	85.29	2.96	2.58	0.30
	Simul.	5.31	7.59	1.57	81.97	1.18	0.54	1.84
5	Data	0.25	1.99	14.18	15.17	66.67	1.74	0.00
	Simul.	5.72	7.5	7.78	4.92	72.22	0.50	1.36
6	Data	0.26	0.00	0.53	0.79	0.53	86.84	11.05
	Simul.	7.05	6.19	1.91	5.00	1.89	65.16	12.8
7	Data	0.00	0.00	0.00	2.60	0.00	45.45	51.95
	Simul.	1.64	1.41	0.51	1.06	0.38	37.79	57.22

The health insurance options are:

1:Fee-for-service only

2:Fee-for-service + self-purchased Medigap with Rx coverage

3:Fee-for-service + employer-provided insurance with Rx coverage

4:Fee-for-service + self-purchased Medigap without Rx coverage

5:Fee-for-service + employer-provided insurance without Rx coverage

6:Medicare HMO with Rx coverage

7:Medicare HMO without Rx coverage

Table 10: Policy impact by survivor category (average)

	Baseline	Policy	% change
<u>All</u>			
Prescription drugs	0.95	1.18	24.2%
Outpatient care	2.68	2.77	3.3%
Inpatient care	2.53	2.53	0.3%
Out-of-pocket payments	1.24	0.64	-48.3%
Consumption	15.52	18.55	19.5%
Mortality (years)	1.07	0.95	-10.6%
<u>Anyway survivors</u>			
Prescription drugs	0.99	1.13	14.1%
Outpatient care	2.83	2.71	-4.2%
Inpatient care	2.77	2.39	-13.7%
Out-of-pocket payments	1.32	0.63	-52.2%
Consumption	16.40	19.18	16.9%
Proportion in bad health	0.304	0.287	
Proportion in medium health	0.303	0.308	
Proportion in good health	0.393	0.405	
<u>New Survivors</u>			
Prescription drugs	0.69	1.45	110.1%
Outpatient care	1.89	3.20	69.3%
Inpatient care	1.59	3.15	98.1%
Out-of-pocket payments	0.84	0.65	-22.6%
Consumption	10.62	16.64	56.6%
Proportion in bad health	0.47*	0.63	
Proportion in medium health	0.43*	0.28	
Proportion in good health	0.10*	0.09	

*Before dying

Expenditures in thousands of dollars

Table 11: Percentage financed with premiums

Year	Percentage financed
1	18.2
2	26.2
3	28.6
4	28.7
5	29.1
6	28.3
7	28.5
8	27.7
9	27.6
10	27.1