MEDICAL EXPENDITURE RISK AND HOUSEHOLD PORTFOLIO CHOICE

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Abstract

As health care costs continue to rise, medical expenses have become an increasingly important contributor to financial risk. Economic theory suggests that when background risk rises, individuals will reduce their exposure to other risks. This paper presents a test of this theory by examining the effect of medical expenditure risk on the willingness of elderly Medicare beneficiaries to hold risky assets. We measure exposure to medical expenditure risk by whether an individual is covered by supplemental insurance through Medigap, an employer, or a Medicare HMO. We account for the endogeneity of insurance choice by using county variation in Medigap prices and non-Medicare HMO market penetration. We find that having Medigap or an employer policy increases risky asset holding by 6 percentage points relative to those enrolled in only Medicare Parts A and B. HMO participation increases risky asset holding by 12 percentage points. Given that just 50 percent of our sample holds risky assets, these are economically sizable effects. It also suggests an important link between the availability and pricing of health insurance and the financial behavior of the elderly.

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1. Introduction

As health care costs continue to rise, medical expenses have become an increasingly important contributor to financial risk. One recent study finds that medical expenses were cited in half of all personal bankruptcy filings in five federal courts in 2001 (Himmelstein et al., 2005). Medical expenditure risk is especially important for older individuals who as they age face worsening health. Although nearly all Americans age 65 and older have Medicare coverage, benefit gaps—especially for catastrophic losses—place them at-risk for large out-of-pocket medical expenses.[1] In 2000, Medicare beneficiaries without additional coverage had a five percent chance that out-of-pocket expenses would exceed $6,367 and a one percent chance that they would exceed $31,751. Because of these potentially high costs, many individuals seek supplemental insurance, either through their former employers, a Medigap policy, or by enrolling in a Medicare HMO. These insurance arrangements offer different degrees of protection, but do not fully insure against the risk of large out-of-pocket medical expenses.

Because medical expenditure risk is not fully insurable and is largely beyond one's control, it can be thought of as background risk. According to economic theory, when individuals face background risk, they should be less willing to bear other risks (Kimball, 1993). For example, theory predicts that an exogenous increase in uninsurable medical expense risk would cause an individual to reduce his exposure to other risks, such as rate-of-return risk.

In this paper, we test the effects of background risk on portfolio allocations by examining the effect of exogenous medical expenditure risk on the decision to hold risky assets. In our

[1] As of 2005, Medicare requires 20 percent coinsurance on many services, and charges a deductible of $912 for a single hospital stay of up to 60 days. After 60 days, beneficiaries are responsible for $228 per day until day 90, and $456 per day for days 91-150. After 150 days, the beneficiary is responsible for all costs (CMS, 2004). In addition, prescription drugs were not covered by Medicare prior to 2006.

analysis, variation in medical expenditure risk comes from different supplemental insurance arrangements for Medicare beneficiaries. Because supplemental insurance choices are potentially endogenous, we jointly model ownership of risky assets and the supplemental insurance decision, allowing for arbitrary correlation in the unobserved heterogeneity affecting both outcomes. Identification comes from factors that explain the decision to hold supplemental insurance but not the decision to hold risky assets; namely, the price of Medigap insurance, the market penetration of HMOs in the non-elderly market, and state supplemental insurance regulations. We find that having Medigap or employer supplemental insurance increases risky asset holding by 6.2 percentage points relative to those enrolled only in basic Medicare Parts A and B. Medicare HMO participation increases risky asset holding by 11.6 percentage points. Both effects are statistically significant. Given that just 50 percent of our sample holds risky assets, these represent economically important effects.

This research also raises important policy issues. The elderly hold a disproportionate share of wealth in the U.S. (Rosen and Wu, 2004), yet are known to invest relatively conservatively. If changes in medical expenditure risk affect their willingness to hold wealth in risky assets, reforms to the Medicare system could have important spillover effects on financial markets. Furthermore, as medical spending continues to absorb a larger fraction of household resources, the financial behavior of households will be increasingly distorted. Families with less wealth also tend to have less health insurance coverage; if they also invest in less risky assets, then their flatter wealth accumulation profiles will exacerbate the gap between high and low wealth households at older ages.

2. Theory and Evidence of Background Risk

In practice, individuals make economic decisions in an environment characterized by multiple risks. It makes intuitive sense that an individual facing one risk should be less willing to bear another risk, even if the two risks are independent. Kimball (1993) formalized this intuition as *standard risk aversion*, building on Pratt and Zeckhauser's (1987) notion of *proper risk aversion*.[2] An implication of standard risk aversion is that any undesirable background risk lowers the absolute value of the optimal level of investment in any other (endogenous) risk (Kimball, 1993).[3] Whether an undesirable background risk also causes precautionary saving to rise is theoretically ambiguous: the direct effect both increases precautionary saving and reduces investment in the endogenous risk, but the induced reduction in the endogenous risk may in turn *reduce* precautionary saving (Elmendorf and Kimball, 2000). Empirically, researchers have found that precautionary saving is positively associated with income risk (Carroll and Samwick,

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[2] A utility function characterized by standard risk aversion is formally equivalent to one with the property of decreasing absolute prudence (DAP), which in turn implies the weaker condition of decreasing absolute risk aversion (DARA). DARA describes risk aversion that decreases as wealth rises, whereas DAP describes a precautionary saving motive that decreases as wealth rises. DARA says that a nonrandom reduction in wealth should increase an individual's sensitivity to risk, whereas DAP says that any undesirable risk should increase an individual's sensitivity to risk, whenever a nonrandom reduction in wealth would. In other words, undesirable risks effectively increase risk aversion just as reductions in wealth do. DAP and DARA describe many commonly used utility functions, such as the class of CRRA utility functions. Standard risk aversion is closely related to proper risk aversion. Formally, proper risk aversion states *every undesirable risk aggravates every statistically independent undesirable risk*, while standard risk aversion states *every loss-aggravating risk aggravates every statistically independent undesirable risk* (Kimball, 1993). In other words, standard risk aversion expands the class of risks that may aggravate an undesirable risk to include not only other undesirable risks but also the larger set of loss-aggravating risks.

[3] An exception would be if the background risk were negatively correlated with the endogenous risk (Elmendorf and Kimball, 2000).

1998, Gollier, 2002, Gourinchas and Parker, 2001, Guiso et al., 1992, Lusardi, 1998) and medical expenditure risk (Kotlikoff, 1986, Levin, 1995, Palumbo, 1999).[4]

With regard to portfolio allocation, the literature finds that background risk has at least a small effect on the willingness of individuals to bear avoidable risks. In a cross-sectional study of Italian households, Guiso, Japelli and Terlizzese (1996) found that households facing above-average subjective income risk held 2.4 percentage points more of their financial assets in risky assets. In a panel data analysis of Dutch households, Hochguertel (2003) found an economically small effect of moderate income uncertainty on the demand for risky assets, but surprisingly no effect of high income uncertainty. We focus on medical expenditure risk since for the elderly the most important background risk is arguably medical expenditure risk stemming from underlying health and mortality risk. Indeed, labor income risk among individuals age 65 and older is relatively unimportant since most are retired.[5] We are not aware of any work that has investigated medical expenditure risk directly; however, two recent studies have examined the effect of health risk on demand for risky assets in older households. Rosen and Wu (2004) found that individuals in fair or poor health hold lower portfolio shares in risky assets and are less likely to own risky assets. Edwards (2002) calculated that a one standard deviation increase in subjective health risk reduced risky portfolio shares by anywhere between 5-25 percentage points.

[4] An exception is Starr-McCluer (1996) who found that those facing greater medical expenditure risk (defined as those lacking health insurance coverage) had lower net worth in a simple bivariate selection model designed to control for the endogeneity of health insurance coverage.

[5] Fewer than 5 percent of respondents in our sample of HRS respondents age 65 and older are working full-time in 2000. Another 9 percent work part-time.

Health risk is an important determinant of medical expenditure risk, but consideration of health risk does not obviate the need to study the effect of medical expenditure risk. Medical expenditure risk is a function of not only health risk but also health insurance coverage. In models that included both health status and insurance coverage, Rosen and Wu (2004) found that both variables retained independent effects on the demand for risky assets. This suggests that health status and medical expenditure risk are related but potentially distinct sources of background risk. Suppose health risk has an indirect effect on portfolio behavior operating through medical expenditure risk, and a direct effect operating through the marginal utility of consumption or the rate of time preference (Edwards, 2002, Rosen and Wu, 2004).[6] The total effect of health risk on portfolio behavior will include both components, making it difficult to assess the role of medical expenditure risk itself. Even if we could isolate the indirect effect of health risk, it would not necessarily reveal an accurate picture of medical expenditure risk, since individuals obtain health insurance precisely to offset part of this risk.

This paper presents an analysis of medical expenditure risk by comparing the demand for risky assets among individuals with different forms of Medicare supplemental insurance. The next section describes in detail the different forms of supplemental insurance and how each serves to offset medical expenditure risk.

3. Supplemental Health Insurance

Nearly all Americans age 65 and older (96 percent) receive health insurance coverage through the Medicare program. Although Medicare coverage is fairly comprehensive, it has some important gaps. Medicare does not cover prescription drugs (but will starting in 2006), has

[6] Because health status may affect the marginal utility of consumption, Hurd (2002) describes health risk as "utility" risk.

been slow to offer coverage for preventive care, requires 20 percent coinsurance on many services, and charges a deductible of $840 for a single hospital stay of up to 60 days.[7]

Because Medicare beneficiaries are still at risk for large out-of-pocket medical expenditures, many choose to purchase supplemental insurance policies known as Medigap plans. As the name suggests, Medigap plans are designed to fill the gaps in Medicare coverage. Since 1992, the federal government has required standardization of Medigap policies in 10 different plans ranging from Plan A, which covers coinsurance payments (but not deductibles), to Plan J, which covers coinsurance payments, deductibles, some prescription drugs and some kinds of preventive care.[8] Despite standardization, prices of Medigap policies vary widely across markets, and even within markets. For example, in 2000 the annual premium for Plan F in Maricopa County, Arizona ranged from $998 to $2,003 (with a mean of $1,406 and standard deviation of $259) and the annual premium for Plan F in Palm Beach County, Florida ranged from $960 to $2,521 (with a mean of $1,687 and standard deviation of $331).[9] Medicare beneficiaries are guaranteed access to Medigap policies during a 6-month open enrollment period, which begins when the individual enrolls in Medicare Part B, usually at age 65.[10] During this period, policies are either community- or age-rated; insurers are prohibited from

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[7] Medicare also does not cover long-term care expenses, but neither do the supplemental insurance policies considered here. Long-term care remains an important source of medical expenditure risk, but one that does not vary over the insurance choices studied here. While Medicaid does cover long-term care, the asset limitations effectively preclude beneficiaries from holding risky assets.

[8] In 2005, two new lower-cost standardized plans were introduced (Plans K and L), which offer fewer benefits and higher out-of-pocket costs subject to annual limits. Three states are exempt from the national standards because they had standardized plans prior to 1992: Massachusetts, Minnesota, and Wisconsin.

[9] Some of the within-market variation is explained by differences in rating methods (e.g., community rating, attained age rating, and issue age rating); however even conditional upon rating method, substantial price variation remains. One potential explanation for the variation is search costs (Maestas et al., 2006).

[10] If an individual delays enrollment in Part B past his 65th birthday because he has health insurance coverage through his current employer, the beginning of the Medigap open enrollment period is also delayed.

either denying coverage or charging higher prices to those with pre-existing conditions. Once the open enrollment period has passed, insurers may take the individual's health history into account in determining whether to offer coverage and at what price.[11]

Another source of supplemental insurance comes through employers in the form of retiree health insurance. Employer supplemental policies generally offer more coverage at less cost than Medigap. For example, annual premiums averaged $600 in 2001, and virtually all retiree health plans offered by employers had prescription drug coverage (Kaiser, 2001). Although employer supplemental policies are not standardized, they operate under the same insurance model as Medigap, acting as secondary payer for Medicare-covered services. Some firms offer retirees a choice of either an employer-sponsored supplemental policy or a subsidy payment with which to purchase a Medigap policy.

Medicare HMOs offer a third way of filling the gaps in traditional fee-for-service Medicare. Whereas Medigap and employer-provided retiree health insurance act as secondary insurance, Medicare HMOs are an alternative to the traditional fee-for-service Medicare program. They provide the basic services of traditional Medicare as well as supplemental benefits such as lower copayments, unlimited hospitalization, prescription drugs, some preventive care, vision, and dental. Most HMO's require little or no premium over and above the premium for Medicare Part B, but require individuals to obtain medical services from providers within the HMO's network. HMOs eliminate the need for a supplemental policy, and insurers are prohibited by law from selling Medigap policies to Medicare HMO enrollees. Finally, Medicaid

[11] Exceptions are made for those whose former employers terminate retiree health benefits, those who voluntarily leave a Medicare HMO within one year of becoming eligible for Medicare, and those whose Medicare HMO has withdrawn from their service area.

provides supplemental insurance coverage for indigent Medicare beneficiaries who meet Medicaid's strict asset and income limitations.

In terms of risk exposure, Medicare HMO's are most protective, followed by employer coverage and Medigap. Because there is heterogeneity in the generosity of employer coverage and the 10 standardized Medigap plans, it is not obvious whether employer coverage is more protective than Medigap on average.

Table 1 shows supplemental insurance coverage rates in 2000 for Medicare beneficiaries in the Health and Retirement Study (HRS).[12] The table shows that 15 percent of Medicare beneficiaries had no supplemental coverage of any kind (i.e., they had only Medicare Parts A and B), 16 percent were enrolled in a Medicare HMO, 33 percent had supplemental coverage through their employer, 29 percent had a Medigap policy, and 8 percent received supplemental coverage through Medicaid. From here forward we drop Medicaid recipients from our analysis since they do not generally invest in risky financial assets owing to the program's strict asset limitations. Medicaid could still indirectly affect our analyses if high-risk individuals systematically spend down their risky assets to meet the program's eligibility criteria, but we find little longitudinal evidence of this in the HRS.[13] Table 2 shows a number of interesting

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[12] Our sample includes individuals aged 65 and older in 1998, drawing from the HRS, AHEAD, and CODA birth cohorts, and constitutes a nationally representative sample of the U.S. population age 65+ in 1998.

[13] Among HRS respondents aged 55-74 in 1994, only two percent of those in the 3rd wealth quartile were on Medicaid eight years later, in 2002. Because only half of this group held any risky assets in 1994, Medicaid spend-down is potentially relevant for only one percent of the quartile. About seven percent of those in the 2nd wealth quartile in 1994 were on Medicaid in 2002, but because only 11 percent of them held any risky assets in 1994, Medicaid spend-down is again potentially relevant for less than one percent. This same pattern holds in the top and bottom wealth quartiles—those at the bottom are quite likely to be on Medicaid eight years later (25 percent), but only three percent of them held any risky assets back in 1994. Those at the top are so unlikely to be on Medicaid eight years later (0.7 percent), that even though 75 percent of them held any risky assets in 1994, only half of one percent is potentially spending down to qualify for Medicaid. We also consider the fraction that move to lower wealth quartiles between 1994 and 2002. Less than one percent move from the top wealth quartile in 1994 to the bottom wealth quartile in 2002, and about five percent fall two quartiles (either top to 2nd or 3rd to

differences across the supplemental insurance groups. Those without any supplemental coverage tend to be somewhat older, have markedly less education (10.6 years), are much more likely to be Black and unmarried, and have lower income and net worth. Nearly 95 percent of those with Medigap coverage are white, and Medigap enrollees have the highest net worth ($467,611) followed by those with employer coverage ($400,515). Surprisingly those without any supplemental coverage are no more likely to have ever been diagnosed with a major health condition (defined as cancer, lung disease, heart disease, or stroke) and the groups show similar probabilities of having experienced a major health shock over the last two years.[14] Nevertheless, those without supplemental coverage are much more likely than the other groups to report themselves in fair or poor health. Notably, reported rates of diabetes are somewhat higher in this group and suggest an elevated risk of diabetes-related complications.[15]

4. Medical Expenditure Risk

Table 3 shows the unadjusted distributions of annual out-of-pocket expenses by supplemental insurance status tabulated from pooled cross-sections of the 1999 and 2000 Medicare Current Beneficiary Survey (MCBS).[16] Mean annual expenses are highest for those without any supplemental insurance ($2,066), and lowest for those enrolled in a Medicare HMO ($942). Those with Medigap pay on average $1,544 per year, while those with supplemental insurance from their employer pay on average $1,217. Examining different points of the

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bottom). Lifecycle dissaving probably explains most of these quartile transitions, not Medicaid spend-down. Norton (1995) finds little evidence of spend-down even among people in nursing homes. Rather, he finds people use transfers from family to avoid becoming eligible for Medicaid. He attributes this to a welfare stigma effect.

[14] Our classification of major health conditions follows Smith (2003).

[15] Diabetes ranks as the fourth most common cause of death among blacks in the U.S., following heart disease, cancer, and stroke (Sahyoun et al., 2001).

[16] For data on out-of-pocket medical expenses, the MCBS is preferable to the HRS. The MCBS asks very detailed questions about service use and reconciles respondent reports with claims data.

distribution's right tail, we note that those without any supplemental insurance always incur the most out-of-pocket expenses, reaching \$31,751 at the 99th percentile. In contrast, the 99th percentile of expenses ranges from \$9,750 for those with Medigap to \$8,548 for those with employer insurance to \$7,778 for those enrolled in a Medicare HMO.

Another way to assess the degree of risk households face is to compare average annual out-of-pocket expenses to wealth. Median net worth in the 2000 wave of the HRS is \$148,000, with an interquartile range of \$46,300 to \$362,000. The 95th percentile of expenses for someone without supplemental coverage is 4 percent of median wealth and 13 percent of 25th-percentile wealth. The 99th percentile of expenses for someone without supplemental coverage is 21 percent of median wealth and 69 percent of 25th-percentile wealth. These figures suggest medical expenditure risk is sizeable, especially considering that wealth is a stock, and medical expenses are a flow likely to be correlated over time.

Figure 1 shows the density of log out-of-pocket expenses across the four insurance groups. Compared to those without supplemental insurance (A&B Only), the distribution of out-of-pocket expenses has noticeably less spread, and also less mass in the right tail. Although the distribution for Medicare HMO enrollees has more spread than the distributions for Medigap and employer insurance, the center of the distribution is noticeably lower. Pair wise Kolmogorov-Smirnov tests reject equality of the distributions.

These descriptive statistics do not control for health status and other characteristics; however they make the basic point that individuals without any supplemental insurance are at significantly greater risk of large out-of-pocket medical expenses than are those with supplemental insurance.[17] Even among those with supplemental insurance, the figures suggest variation across coverage types in line with the relative generosity of each type: HMO enrollees appear to be most protected, followed by those with employer insurance, and lastly those with Medigap policies.[18] The distributions for employer insurance and Medigap are most similar (though still statistically different from one another).

5. Household Portfolios of Older Americans

We next turn to an overview of the portfolio holdings of older Americans. We restrict our analysis to liquid financial assets since illiquid assets (such a primary home or business) are by their very nature less readily adjustable to changes in background risk. We divide liquid assets into two categories: safe and risky assets.[19] Safe assets are checking, saving, and money market accounts, certificates of deposit, government savings bonds, and treasury bills. Risky assets are stocks, bonds, and IRA and Keogh accounts.[20]

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[17] Goldman and Zissimopoulos (2003) reach a similar conclusion based on models that control for covariates.

[18] An alternative explanation for the lower out-of-pocket costs experienced by HMO enrollees is the possibility that HMO's either deliberately encourage or tend to attract enrollments by healthier individuals. In a comparison of HMO enrollees with traditional fee-for-service enrollees, Riley et al. (1989) found that new enrollees at three HMO's were healthier than their fee-for-service counterparts. Nevertheless, the benefit packages typical of Medicare HMO's are generally more generous than Medigap policies, and at least as generous as employer supplemental policies.

[19] The justification for considering just two asset categories comes from a two-fund separation theorem stating that all individuals with mean-variance preferences will hold the same proportionate mixture of risky assets regardless of the overall fraction of their wealth held in risky assets. Although mean-variance preferences imply the absence of a precautionary saving motive (which is defined by a positive third derivative of utility), the literature continues to follow this convention.

[20] It is common to also include defined contribution plans in the definition of risky assets, but analysis of the HRS self-reported pension data reveals that only a handful of observations in our 65+ sample have a defined contribution plan with a positive balance in 1998. A natural explanation is that such plans were less common among older cohorts (our HRS sample includes individuals born between 1896-1934 making up the AHEAD, CODA, and part of the original HRS cohorts). It is also possible that some plans were rolled over into IRA's or cashed out at retirement.

Demand for risky assets can be analyzed on the intensive margin—the share of assets held in risky assets—or the extensive margin—whether the individual owns any risky assets. Our analysis concentrates on the extensive margin (asset ownership) for three reasons. First, even within the category of risky assets, the true riskiness of any particular portfolio is unknowable in the survey data and may vary substantially. For example, one portfolio might be invested in less risky income producing mutual funds, whereas another might be more heavily invested in aggressive growth stocks. Focusing on the extensive margin avoids this problem since it is less ambiguous to conclude that someone who owns risky assets is exposed to more financial risk than someone who does not. Second, the extensive margin is inherently interesting since it relates to one of the more persistent puzzles in empirical finance: why do so many households fail to hold risky assets at all? Known as the equity allocation (or stock-holding) puzzle, this is the microeconomic analog of the equity premium puzzle, and is viewed as the key issue in portfolio analysis (Gollier, 2002, Miniaci and Weber, 2002). Third, variation at the extensive margin represents actual behavior, whereas variation in asset shares reflects both behavior and exogenous price changes.

Table 4 describes the household portfolios of HRS respondents in 2000 by supplemental insurance status. The left panel considers asset ownership, while the right panel shows portfolio shares. Generally, asset ownership of any type is lowest among the group without supplemental coverage and highest among those with supplemental coverage through their employer. This pattern holds even among safe assets, where more than one-quarter of those without supplemental insurance do not own a checking, saving or money market account, compared to just seven percent of those with employer coverage. The stock-holding puzzle is readily apparent: just 50 percent of the sample participates in the stock market. About one-third own stocks directly, whereas another one-third own stocks through an IRA. Bond ownership is relatively low, even among those with employer coverage. Turning to portfolio shares conditional on ownership, we note that checking, saving and money market accounts are the dominant liquid financial asset across all groups. Among those with no supplemental coverage, checking accounts comprise 60 percent of liquid assets, while for those with employer coverage they amount to 40 percent of liquid assets. Not only are those with employer coverage more likely to own risky assets, but they also invest the largest portfolio share in such assets (46 percent), followed by those with Medigap (42 percent), HMO enrollees (38 percent), and those without supplemental coverage (26 percent).

Our analysis of out-of-pocket expenses showed that those without supplemental insurance are at most risk of realizing large out-of-pocket medical expenses. Those without supplemental insurance are also least likely to own risky assets, and conditional on ownership, hold the smallest share of their portfolios in risky assets. This is consistent with standard risk aversion—that those facing greater background risk reduce their exposure to avoidable risks. However, if we look within categories of supplemental insurance, we note that HMO's appear to offer the most protection, followed by employer insurance and Medigap policies. By the logic of standard risk aversion, those in HMO's should have the highest stock market participation rates, and the largest portfolio shares invested in risky assets. Instead, the descriptive statistics show that HMO participants are *less* likely than the two other groups to hold risky assets. The same pattern holds for portfolio shares. In the next section, we will show that once we account for the endogeneity of health insurance choices econometrically, this pattern reverses.

6. Research Design

6.1 Longitudinal v. Cross-Sectional Approaches

As the descriptive analyses in the previous sections show, supplemental insurance status is correlated with a number of observable characteristics, and is likely to be correlated with unobservable characteristics such as risk aversion. To address the endogeneity of supplemental insurance status, we jointly estimate equations for ownership of risky assets and supplemental insurance, allowing for arbitrary correlation patterns in the unobserved heterogeneity across equations. We divide supplemental insurance coverage into two groups: those who participate in a Medicare HMO and those who hold either Medigap or employer coverage. We combine the Medigap and employer insurance choices since they are based on the same insurance delivery model (unlike HMOs), and offer a similar degree of protection against medical expenditure risk.

A seemingly sensible research design would be to regress changes in risky asset ownership on changes in medical expenditure risk associated with transitions in and out of different supplementary insurance arrangements over time. Such an approach is especially appealing because it would capitalize on the longitudinal aspect of the HRS, and easily control for unobserved heterogeneity. However, a panel data approach is not feasible in the context of supplemental insurance choices. Because of regulations limiting the purchase of Medigap plans outside of a non-recurring open enrollment period, most people make a one-time supplementary insurance choice when they enroll in Medicare at age 65 (or when they first enroll in Medicare Part B), and relatively few change their supplementary insurance coverage after age 65.[21] Insurance changes at age 65 are difficult to examine because we have no information about the generosity of insurance coverage prior to age 65. Without detailed information about

[21] Two-year transition rates in and out of HMOs or supplemental coverage are low. Only 9.5 percent either join or leave an HMO, and 16.5 percent either newly obtain or cancel a Medigap policy. This is not surprising since individuals are guaranteed community- or age-rated prices only during their open enrollment period, which occurs when they first enroll in Medicare Part B, or under special circumstances such as if their employer terminates retiree health benefits or their Medicare HMO withdraws from their service area.

respondents' health insurance plans prior to age 65, it is not possible to discern, for example, whether a person who transitioned from employer-provided insurance prior to age 65 to employer-provided supplemental insurance or a Medigap plan after 65 saw an increase, a decrease or no change in out-of-pocket medical expenditure risk. Groups that are easily identifiable as experiencing a reduction in out-of-pocket medical expenditure risk at age 65, such as the uninsured near elderly, are also those who have little financial wealth to invest in risky assets.

Just as changes in supplemental insurance status after age 65 are low-frequency events, so are transitions in and out of risky asset ownership. Just 11.3 percent of households transition in or out of holding any risky assets during the two-year period between 1998 and 2000. In contrast to asset ownership, there is much more movement in asset shares across the 1998 and 2000 waves, but the use of asset shares over time is perhaps even more problematic. First, much of observed changes over time in portfolio shares are passive changes due to changes in stock and bond prices, not active investor behavior. In the HRS, it is not possible to know how much of an observed change in risky assets is due to active portfolio rebalancing. Second, as noted earlier, even in cross-section we have no information about the true riskiness of a given investment portfolio, and any active reallocations made within class (i.e., reallocations made among subcategories of risky assets) would be impossible to identify even if we could distinguish the behavioral component of the change. Third, exacerbating the usual measurement error problem with wealth data is the fact that the wealth data in the HRS are heavily imputed, and all imputations are done on a cross-sectional basis, not over time. We calculate that in both 1998 and 2000 fully 32.8 percent of observations have an imputed value on at least one of the variables used to compute portfolio shares.[22] It is well known that differencing two variables measured with error exacerbates the measurement error present in each alone. An alternative would be to exclude the imputed observations, but this is rarely a satisfactory approach given the potential for non-random item non-response.

6.2 Identification

Given the limitations confronting a longitudinal analysis, we use a cross-sectional research design. We identify the effects of health insurance on portfolio choice using geographic variation in the price of Medigap supplemental insurance and non-Medicare HMO market penetration, neither of which are likely to affect risky asset ownership other than through their effect on supplemental insurance coverage. We obtained county-level prices for Medigap plans as of January 1, 2000 from Weiss Ratings, Inc. Insurance companies voluntarily report their current market prices to Weiss, and approximately 80 percent of the market is represented in their data.[23] The Weiss data reveal that there is a single market leader—United Healthcare—with fully 19 percent of the market nationwide (as measured by premium volume).[24] The second-ranked insurer, Mutual of Omaha Plaza, has just 5 percent of the national market. We use as our instrumental variable the county-wide price of United Healthcare's Medigap Plan F for males ages 65-75 as of January 1, 2000.[25] United Healthcare's Medigap policies are community-rated,

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[22] In contrast, asset ownership is generally measured with less error and many fewer observations have been imputed. Just six percent of observations have an imputed value on any one of our liquid asset ownership items.

[23] For our purposes, the Weiss data are superior to data produced by the National Association of Insurance Commissioners, which includes total premium volume and number of covered lives, but not actual market prices at specific points in time.

[24] United Healthcare underwrites Medigap policies sold through American Association of Retired Persons.

[25] Although we use county-level prices, inspection of the data reveals that most insurers vary prices across states, but not across counties within a state; thus the county variation in the price of United Healthcare's Plan F is essentially state variation.

which means the initial purchase price and any subsequent price increases do not vary with age. Medigap Plan F is the most popular of the 10 standardized plans offered in 2000 (GAO, 2001).[26]

The ideal instrumental variable would be load rather than price, since price reflects not only load but also the cost of care in the county. Price variation induced by county differences in the cost of care is potentially problematic variation since it could be correlated with average health in the county, which may in turn affect demand for risky assets. Thus, we also include per capita Medicare expenditures (Part A and B) in the county to control for county variation in the cost of care in all model specifications.[27]

As a robustness check, we re-estimate our models using an alternative source of variation: the presence of state laws requiring mandatory community rating or prohibiting attained age rating. Currently, seven states require mandatory community rating and another three states prohibit Medigap insurers from using attained age rating.[28] Since premiums for community rated policies are typically higher than premiums under other rating methods, we expect demand for supplemental insurance to be lower in these states.

We computed county-level non-Medicare HMO market penetration in 1998 from the 2003 Area Resource File. Market penetration is defined as the percent of population under age 65 enrolled in an HMO. Non-Medicare HMO market penetration is a good instrument for

[26] Medigap Plan F is a mid-level plan covering: Parts A and B coinsurance, skilled nursing coinsurance, Parts A and B deductibles, Part B balance billing, and foreign travel emergency. It does not cover home health care, prescription drugs, or preventive medical care. Massachusetts, Minnesota, and Wisconsin are omitted from the national standards on account of already having their own standardization schemes prior to 1990. For counties in these states, we calculate the price for the plan nearest in coverage to Plan F.

[27] The Medicare Part A and B expenditure is determined by lagged expenditures plus an adjustment for geographic variation in factor prices.

[28] The seven states requiring mandatory community rating are Arkansas, Connecticut, Maine, Massachusetts, Minnesota, New York, and Washington. The three states prohibiting attained age rating are Florida, Georgia, and Idaho (Lutzky et al., 2001).

Medicare HMO participation because Medicare HMOs have historically entered markets in which the parent firm was already operating an HMO, and there is little reason to expect a contemporaneous correlation between the market penetration of non-Medicare HMOs and ownership of risky assets by the elderly.

6.2 Reduced Form First Stage Relationships

Figure 2 depicts our first stage results at the county level. In the upper left-hand panel we show that a 10 percentage point increase in the 1998 county market share of non-Medicare HMOs is associated with a 5 percentage point increase in 2000 county Medicare HMO participation by HRS respondents. The slope coefficient is significant (t=13.0). The upper right-hand panel shows that a $100 increase in the price of United Healthcare's Medigap Plan F is associated with a 2.4 percentage point increase in Medicare HMO enrollment (t=8.2). This confirms that Medicare HMOs and Medigap policies are substitutes; as the price of the Medigap policy increases, individuals substitute toward Medicare HMOs.

In the lower left-hand panel, we see that the supplemental insurance coverage rate falls as the non-Medicare HMO market share in the county rises; a 10 percent increase in non-Medicare HMO participation yields a 2.5 percent decrease in supplemental insurance coverage (t=-4.4). The lower right-hand panel shows that demand for supplemental insurance falls as the price of United Healthcare's Medigap Plan F increases; a $100 increase in price is associated with a 3 percentage point decline in supplemental insurance coverage (t=-9.9).[29] Overall, Figure 2 suggests a very robust first stage.

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[29] The implied price elasticity is 1.57.

Finally, Figure 3 presents the reduced form relationships between county-level risky asset ownership and our instruments. The fraction holding any risky asset in the county is negatively related to the price of United Healthcare's Plan F, and positively related to the non-Medicare HMO market share in the county. In both cases, the slope coefficients are significantly different from zero (t=-2.0 for Plan F price and t=4.8 for HMO market share). Figures 2 through 3 are consistent with the idea that lower Medigap prices and greater non-Medicare HMO market penetration increase supplemental insurance coverage and Medicare HMO enrollment, which in turn reduce medical expenditure risk and increase risky asset holding. It is unlikely that these reduced form relationships would exist in the absence of the supplementary insurance coverage mechanism.[30]

7. Estimation Strategy

In our model, we have three discrete endogenous variables: whether the individual owns any risky assets, whether the individual is enrolled in an HMO, and whether the individual has purchased a Medigap policy or holds supplemental insurance through an employer. We employ a mixture maximum likelihood technique in which the distribution of the error terms are decomposed into correlated and uncorrelated components. The uncorrelated components are assumed to be independent and normally distributed. A discrete factor approximation for the correlated component enables identification of clustering in the unobserved components. Kiefer and Wolfowitz (1956) prove the consistency of this estimator. Monte Carlo experiments in a simultaneous equation setting demonstrate that these estimators compare favorably to maximum likelihood estimators when the likelihood function is correctly specified, and outperform

[30] One alternative story for the existence of these relationships is that county differences in urbanicity could account for both more insurance options (and hence lower prices) and greater financial sophistication. In our estimation models, we address this by controlling for county population size.

maximum likelihood when the model is misspecified (Mroz and Guilkey, 1999). Using data from self-selected and randomly assigned populations, Goldman, Leibowitz and Buchanan (1998) show that such estimates can effectively recover the structural parameters of the underlying models.

Similar methods have been used to study patterns of unemployment duration (Heckman and Singer, 1984) and the effects of training on employment (Card and Sullivan, 1988, Gritz, 1993). In a very similar application, Bhattacharya, Goldman, and Sood (2003) estimate the impact of private and public insurance on mortality in an HIV-infected population.

Let R_i^* represent an index function that measures the propensity to hold risky assets for individual *i*. Then we write:

$$(1) \qquad R_i^* = c_1 + \gamma_1 \cdot supp_i + \gamma_2 \cdot hmo_i + \beta_1 ' X_i + \rho_{risky,i} - \varepsilon_{risky,i}$$

The vector X_i represents observed exogenous covariates that determine asset holdings, such as age, gender, and education. Asset holdings are also affected by insurance status, where $supp_i$ represents whether the individual was covered by Medigap or employer supplemental insurance, and hmo_i represents whether the individual was covered by HMO insurance. Asset holdings are also assumed to depend on an unobservable heterogeneity component $\rho_{risky,i}$ that will also relate to insurance choices. It is useful to think of this as unobserved financial sophistication or attitudes towards risk, and it is assumed to be orthogonal to the covariates X_i. There is also a random error $\varepsilon_{risky,i}$ that is uncorrelated with X_i and insurance status. We want to consistently estimate the parameters c_1, β_1, γ_1 and γ_2, after accounting for the heterogeneity.

We define R_i as an indicator variable that represents whether individual *i* holds any risky assets:

(2) $$R_i = \begin{cases} 1 & \text{if } R_i^* > 0 \\ 0 & \text{if } R_i^* \le 0 \end{cases}$$

We assume $\varepsilon_{risky,i}$ is distributed normally with zero mean and unit variance. This assumption implies a probit model for R_i, where the probability of holding risky assets, conditional on observed characteristics $\{supp_i, hmo_i, X_i\}$ and unobserved characteristics $\rho_{risky,i}$ is:

(3) $$P[R_i = 1 \mid \{supp_i, hmo_i, X_i\}, \rho_{risky,i}] = \Phi(c_1 + \gamma_1 \cdot supp_i + \gamma_2 \cdot hmo_i + \beta_1 ' X_i + \rho_{risky,i})$$

Here $\Phi(\cdot)$ is the cumulative distribution function for the standard normal distribution.

We model insurance choices using the standard random indirect utility approach. Individuals choose among supplemental status $j = \{supplemental, hmo, none\}$ on the basis of a random indirect utility function:

(4) $$V_{j,i}^* = c_j + \beta_j ' Z_{j,i} + \rho_{j,i} + \varepsilon_{j,i}$$

Here $Z_{j,i}$ represents variables that determine insurance status including our set of instrumental variables (that is, variables that belong in each insurance equation, but not in the asset equation); and $\rho_{j,i}$ is a individual-specific random intercept that reflects the individuals' propensity for insurance status *j* that is unobserved by the researcher. The parameters c_j and β_j are additional parameters to be estimated; and $\varepsilon_{j,i}$ represents the orthogonal error term.

Individuals choose the insurance status that maximizes their indirect utility. We assume that $\varepsilon_{j,i}$ are independently and identically distributed according to the Type II extreme value distribution. This distributional assumption and normalizing $\{c_{none}, \beta_{none}, \rho_{none,i}\}$ to zero yields a multinomial logit model for insurance choice.

(5) $$\Pr\left[supp_i = 1 \mid \mathrm{Z}_{\mathrm{j,i}}, \rho_{supp}, \rho_{hmo}\right] = \frac{\exp\left(c_{supp} + \beta_{supp}'\mathrm{Z}_{supp,i} + \rho_{supp,i}\right)}{1 + \sum_{j \neq none} \exp\left(c_j + \beta_j'\mathrm{Z}_{j,i} + \rho_{j,i}\right)}$$

(6) $$\Pr\left[hmo_i = 1 \mid \mathrm{Z}_{\mathrm{j,i}}, \rho_{supp}, \rho_{hmo}\right] = \frac{\exp\left(c_{hmo} + \beta_{hmo}'\mathrm{Z}_{hmo,i} + \rho_{hmo,i}\right)}{1 + \sum_{j \neq none} \exp\left(c_j + \beta_j'\mathrm{Z}_{j,i} + \rho_{j,i}\right)}$$

To complete the model and allow for correlation between asset holdings and insurance choices, we need to assume a joint distribution for the unobserved heterogeneity vector $\rho = \left(\rho_{risky}, \rho_{supp}, \rho_{hmo}\right)$. Our approach is semi-parametric. We allow the unobserved heterogeneity in each equation to take one of three values—intuitively, there are three types of people that occur with probabilities p_1, p_2, and $1 - p_1 - p_2$. The effect of being a certain type has different effects on each outcome: $\left(\rho^1_{risky}, \rho^2_{risky}, \rho^3_{risky}\right)$ for asset holdings, $\left(\rho^1_{supp}, \rho^2_{supp}, \rho^3_{supp}\right)$ for supplemental insurance, and $\left(\rho^1_{hmo}, \rho^2_{hmo}, \rho^3_{hmo}\right)$ for Medicare HMOs. For example, there is a p_1 probability that a person will be of the first type, which would imply realizations of ρ^1_{risky} for the propensity to hold risky assets, ρ^1_{supp} for the propensity to have supplemental insurance, and ρ^1_{hmo} for the propensity to be in a Medicare HMO.

This discrete factor distributional approach has several advantages over specifying a continuous parametric density for the unobserved heterogeneity vector. First, an incorrect specification of the parametric density function might lead to biased parameter estimates. The discrete factor density allows us to approximate any underlying distribution of heterogeneity. In fact, Monte Carlo studies show that discrete factor distributions with two to four points of support adequately model many distributions (Heckman, 2001, Mroz and Guilkey, 1999).

Second, discrete factor models are computationally simpler than parametric models as they avoid multiple numerical integration in the construction of the likelihood function.

Since all three outcome equations—asset holdings, supplemental insurance, Medicare HMO—have intercept terms, we normalize the mean of each heterogeneity component to be zero. This implies that the third point of support in each equation is not "free." Thus our distributional assumption on the unobserved heterogeneity adds eight additional parameters: two points of support in the asset holdings equation $(\rho^1_{risky}, \rho^2_{risky})$, two points of support in the supplemental insurance equation $(\rho^1_{supp}, \rho^2_{supp})$, two points of support in the HMO equation $(\rho^1_{hmo}, \rho^2_{hmo})$, and two probabilities (p^1, p^2). The resulting variance-covariance matrix for the unobserved heterogeneity may be written as:

$$(7) \qquad Var\left(\rho_{risky}, \rho_{supp}, \rho_{hmo}\right) = \begin{bmatrix} \sum_k p_k \left(\rho^k_{risky}\right)^2 & \sum_k p_k \rho^k_{risky}\rho^k_{supp} & \sum_k p_k \rho^k_{risky}\rho^k_{hmo} \\ & \sum_k p_k \left(\rho^k_{supp}\right)^2 & \sum_k p_k \rho^k_{supp}\rho^k_{hmo} \\ & & \sum_k p_k \left(\rho^k_{hmo}\right)^2 \end{bmatrix}$$

This model not only allows non-zero covariance across asset holdings and insurance propensities but also allows non-zero covariance between the propensities to have supplemental and HMO insurance. Thus our model relaxes the independence of irrelevant alternatives assumption of the standard multinomial logit model and allows a more general variance-covariance matrix. The key correlations in our model may thus be written as:

$$(8) \qquad Corr\left(\rho_{hmo}, \rho_{risky}\right) = \frac{\sum_{k=1}^{2} p_k \rho^k_{hmo}\rho^k_{risky}}{\sqrt{\sum_{k=1}^{2} p_k \left(\rho^k_{hmo}\right)^2 \sum_{k=1}^{2} p_k \left(\rho^k_{risky}\right)^2}}$$

$$(9) \qquad Corr\left(\rho_{supp},\rho_{risky}\right)=\frac{\sum_{k=1}^{2}p_k\rho_{supp}^{k}\rho_{risky}^{k}}{\sqrt{\sum_{k=1}^{2}p_k\left(\rho_{supp}^{k}\right)^2\sum_{k=1}^{2}p_k\left(\rho_{risky}^{k}\right)^2}}$$

$$(10) \qquad Corr\left(\rho_{supp},\rho_{hmo}\right)=\frac{\sum_{k=1}^{2}p_k\rho_{supp}^{k}\rho_{hmo}^{k}}{\sqrt{\sum_{k=1}^{2}p_k\left(\rho_{supp}^{k}\right)^2\sum_{k=1}^{2}p_k\left(\rho_{hmo}^{k}\right)^2}}$$

The model is estimated using maximum likelihood. We have six possible outcomes for the dependent variables: a person can either hold or not hold risky assets, denoted by R_i, while being in one of three insurance states (Maestas, Schroeder and Goldman, 2006). ("None" refers to the case where the individual is covered by Medicare Parts A and B only and is denoted by (1-*supp*)(1-*hmo*)). To construct the contribution to the likelihood function for each individual, we first obtain the likelihood of observing that value of the dependent variables conditional on a realization k of the unobserved heterogeneity $\rho^k=\left(\rho_{risky}^k,\rho_{supp}^k,\rho_{hmo}^k\right)$. We then sum over all the possible realizations to obtain the contribution of individual i to the likelihood function:

$$(11) \qquad \begin{aligned} l_i=\sum_{k=1}^{2}p_k&\left(\Pr\left[R_i=1\,|\,\rho_{risky}^k\right]\right)^{R_i}\times\left(1-\Pr\left[R_i=1\,|\,\rho_{risky}^k\right]\right)^{1-R_i}\times\\ &\left(\Pr\left[supp_i=1\,|\,\rho_{supp}^k,\rho_{hmo}^k\right]\right)^{supp_i}\times\left(\Pr\left[hmo_i=1\,|\,\rho_{supp}^k,\rho_{hmo}^k\right]\right)^{hmo_i}\times\\ &\left(1-\Pr\left[supp_i=1\,|\,\rho_{supp}^k,\rho_{hmo}^k\right]-\Pr\left[hmo_i=1\,|\,\rho_{supp}^k,\rho_{hmo}^k\right]\right)^{(1-supp_i)(1-hmo_i)}\end{aligned}$$

Finally we obtain the weighted log-likelihood function by summing the log-likelihood across individuals:

$$(12) \qquad \ln\left(\Gamma\right)=\sum_{i=1}^{N}w_i\ln\left(l_i\right)$$

Γ is the vector of model parameters; w_i are the analytic sample weights and N is the sample size. Because it is difficult to interpret the magnitude of the parameter estimates directly, we also report the average predicted values if the entire sample had supplemental insurance, Medicare HMO, or neither.

8. Estimation Results

8.1 Simple Probit Model of Risky Asset Ownership

In Table 5, we present a simple probit model of ownership of risky assets in 2000 in which we do not account for the endogeneity of insurance status. Supplemental insurance coverage (through Medigap or an employer policy) and HMO participation are both positively related to ownership of risky assets. The coefficient on supplemental insurance is large and highly statistically significant, whereas the HMO coefficient is about half the size and statistically significant at only the 6% level. Although the coefficients suggest that both supplemental insurance coverage and HMO participation increase demand for risky assets, they also suggest that supplemental insurance does so relatively more than HMO participation, even though, as we showed earlier, supplemental insurance is *less* protective against medical expenditure risk. Thus in this simple model the data do not support the more refined hypothesis that variation in risk should relate negatively to variation in the demand for risky assets.

The model also includes a number of controls for demographic characteristics and health status. Those with more education (high school/GED, some college, college) are significantly more likely to hold risky assets than those without a high school degree, and minorities (black, Hispanic, other) are less likely than whites to hold risky assets. Compared to married respondents, those who are divorced or widowed are less likely to hold risky assets. Conditional on marital status, household size is negatively related to ownership of risky assets. Interestingly, the coefficients on female gender and age are not significant once we control for health and other demographic characteristics.

We model the health risk of respondents and their spouses (if married) by including indicators for whether either spouse has ever been diagnosed with a chronic disease (i.e., high blood pressure, diabetes, cancer, lung disease, heart disease, stroke, psychiatric problems, or arthritis), as well as an indicator for self-reported fair or poor health. We include the spouse's health status to capture risk sharing within the household. To mitigate potential endogeneity of health status, we use two-year lags of the health variables from the 1998 survey. We also include an indicator for having had a serious health shock between 1998 and 2000, which we define as onset of cancer, lung disease, heart disease, or stroke. Most serious health conditions are significant and negatively related to ownership of risky assets, which is consistent with the notion that elevated background health risk should reduce exposure to avoidable risks. An exception is cancer, which is positively related to ownership of risky assets and highly significant. This result is surprising, but may reflect a survivor bias. The coefficient on high blood pressure is insignificant, suggesting people may not fully internalize future health risk, although such an inference warrants further scrutiny. The health shock coefficient is small and statistically insignificant. This may indicate that people take time to adjust their portfolios in response to changes in background health risk. Our measure of overall health status—the indicator for fair or poor health—is negative and highly significant.

We also include indicators for quartiles of total wealth[31] and non-capital income. To mitigate simultaneity bias, we use their two-year lagged values, but we note that this is likely

[31] Total wealth is the sum of all assets including checking, savings and money market accounts, certificates of deposit, government savings bonds, treasury bills, stocks, mutual funds, bonds, IRA and Keogh accounts, housing, other real estate, businesses, collections, and vehicles, less mortgages, other home loans and all other debt.

inadequate given the substantial inertia in risky asset ownership over time. The coefficients show that wealth and income are strongly and significantly related to ownership of risky assets and supplemental insurance choice, but we note that the effect of supplemental insurance choice on risky asset ownership is not sensitive to the inclusion or exclusion of wealth and income from the model. The specification also includes controls for geographic characteristics such as county population and the average Medicare expenditure in the county in 2000 (Parts A and B).[32]

8.2 Discrete Factor Model of Risky Asset Ownership

Table 6 shows results from our three-equation discrete factor model accounting for the endogeneity of insurance status. In the risky asset ownership equation (column 1), both supplemental insurance and HMO participation are statistically significant, and the HMO coefficient is nearly two times larger than the supplemental insurance coefficient, which is itself a bit smaller in magnitude than in the probit model. The results suggest that the HMO coefficient is substantially biased downward in the probit model, perhaps due to omitted risk aversion, whereas the bias in the supplemental insurance coefficient is relatively small. The model includes the same set of covariates as the probit model in Table 5, and the coefficients on the exogenous variables are qualitatively similar. In the supplemental insurance equation (column 2), the Plan F premium is highly significant and takes the expected sign. The "cross-price" effect of the non-Medicare HMO market share is not statistically significant once we control for the Plan F premium. In the HMO participation equation (column 3), the non-Medicare HMO market share is highly significant, but the "cross-price" effect of the Plan F premium is not quite statistically significant.

[32] We obtain average Medicare expenditures from the Centers for Medicare and Medicaid Services and county population from the 2003 Area Resource File.

The pattern of coefficients on the other exogenous variables in columns 2 and 3 tells a story similar to Table 2. Individuals who are married, white and have higher education are more likely to choose supplemental insurance over no insurance, whereas individuals enrolled in HMOs are demographically similar to those with no supplemental insurance. There are also some interesting differences by disease status; for example, individuals with cancer, heart disease, or arthritis are more likely to choose supplemental insurance over no insurance whereas those with lung disease or stroke are less likely to choose supplemental insurance, controlling for SES. Those with diabetes are significantly more likely to choose an HMO over no insurance. Consistent with Table 2, those who say they are in fair or poor health are less likely to be covered by either supplemental insurance or an HMO even after controlling for other covariates.

8.3 Robustness Checks

As we noted earlier, the Plan F premium may reflect undesirable factors such as county health risk, in addition to load. Although we control for average Medicare expenditures in the county, it is possible that this is insufficient. To assess the robustness of that approach, we re-estimate the model using an alternative source of variation: state variation in the presence of mandatory community rating laws. Table 7 presents a comparison of results from the two estimation strategies. Comparing the right- and left-hand panels, the results are notably unchanged, with the effects of supplemental insurance and HMO participation being only slightly larger in the alternative model.

Because the coefficient estimates give little sense of the economic importance of these effects, we show in columns 1-3 of Table 8 the predicted probabilities of risky asset ownership for each insurance category and across the different model specifications presented in Tables 5-7. Implied marginal effects are shown in columns 4 and 5. The discrete factor model including the Plan F premium predicts that those with supplemental insurance are 6.2 percentage points more likely to hold risky assets than those with just Medicare Parts A and B. Those in a Medicare HMO are 11.6 percentage points more likely to own risky assets. In the alternative model with the mandatory community rating instrument, these effects are slightly stronger, rising to 6.5 and 11.8 percentage points respectively.

Our second set of robustness tests is designed to assess whether our results are affected by other risks that households face, but which we do not model. Perhaps most important of all is housing wealth risk. Approximately 79 percent of our sample owns their home, and net housing wealth represents about half of total net worth for our median homeowner. We include an indicator variable for (lagged) home ownership in the model in Table 6 to test whether the probability of holding risky assets is different for those who also face housing risk. The coefficient on the home ownership indicator is negative and statistically significant (results not shown), implying that consistent with standard risk aversion, individuals offset housing wealth risk by investing less in risky stocks and bonds. The coefficients on the supplemental health insurance variables are virtually unchanged with the addition of home ownership to the model. This is not surprising since it is not obvious how medical expenditure risk and housing market risk would co-vary.

We also explore the role of guaranteed annuities, such as Social Security retirement benefits, which provide a “safe” form of income. When we add the total amount of lagged Social Security benefit payments received by the household, we find a positive and statistically significant relationship (not shown). Thus, as standard risk aversion would predict, by effectively raising risk tolerance (all else equal) guaranteed annuities are associated with risky asset ownership. As in the case of housing wealth risk, the coefficients on the supplemental health insurance variables are unchanged with the addition of guaranteed annuities to the model, most likely signifying that income risk and medical expenditure risk are uncorrelated for the elderly.

We undertake a third robustness check by re-estimating our discrete factor models on a sample that is limited to one respondent per household. Because the HRS surveyed both spouses in married couples, our original sample includes some respondent pairs whose unobservables may be correlated.[33] Rather than clustering our standard errors, we re-estimate the model on a reduced sample in which we select a random spouse in the case of married respondents. Our results are largely unchanged and the correctly estimated standard errors are such that statistical significance is retained (Appendix Table 1). Table 8 shows that the marginal effects of supplemental insurance and HMO participation on risky asset ownership in the restricted sample are a bit smaller in the model based on the mandatory community rating instrument.

8.4 Implied Correlations between Unobserved Heterogeneity Components

Finally, as noted in equations 8-10, the discrete factor model has three implied correlations between the unobserved heterogeneity components in each equation. The correlation in unobservables for risky asset ownership and supplemental insurance is positive at 0.126, suggesting that the implied marginal effect of supplemental insurance from the simple probit model is biased upward by an unobserved factor that is positively correlated with both risky asset ownership and the propensity to hold supplemental insurance. This is readily

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[33] In the HRS data, household wealth and its components are measured at the household level, implying that husbands and wives have the same values on the dependent variable. They do not, however, have identical values on the insurance status variables or on the demographic (except marital status) and health variables, though of course these items are correlated. In the model results based on the full sample, standard errors are not adjusted to account for correlation in the errors of individuals in the same household. However, the standard errors in the models based on the restricted sample do not require adjustment, and though somewhat larger, are not large enough to change inference.

apparent from comparison of lines 2 and 3 of column 4 in Table 8. One plausible candidate might be financial sophistication or awareness, such that financially sophisticated individuals are more likely to both invest in risky assets and hold insurance. On the other hand, the correlation in unobservables for risky asset ownership and HMO participation is negative at -0.152, suggesting that the HMO effect implied by the probit model is biased downward by an unobserved factor that is negatively correlated with risky asset ownership but positively correlated with HMO participation. This too is evident from the pattern of marginal effects across models reported in column 5 of Table 8. A likely candidate is risk aversion, such that risk averse individuals are less likely to invest in risky assets, but more likely to hold insurance. Finally, the correlation between the unobservables in the supplemental insurance and HMO equations is near zero in all model specifications. The implied correlations from the restricted model with one observation per household are similar.

9. Conclusion

Our results offer evidence in support of the theory of standard risk aversion. We find that individuals who face less medical expenditure risk, as measured by their enrollment in a Medicare HMO or a supplemental insurance policy, are more likely to hold risky financial assets. Consistent with the evidence that HMOs offer the most protection against catastrophic medical expenses, the marginal effect of HMO participation on ownership of risky assets is larger than the effect of supplemental insurance. We find that HMO participation increases risky asset holding by 11.6 percentage points relative to those enrolled in only traditional fee-for-service Medicare, whereas supplemental insurance increases risky asset holding by 6.2 percentage points. Given that just 50 percent of our sample holds risky assets, these represent sizable effects in percentage terms. We identify the effects of supplemental insurance and HMO participation using exogenous geographic variation in United Healthcare's Medigap Plan F and non-Medicare HMO market penetration. Our results suggest that simple probit estimates that do not account for the endogeneity of insurance choices may be biased by factors such as unobserved risk aversion and unobserved financial sophistication, and the bias can be quite large. Finally, our results suggest that reforms to the Medicare system that appreciably change the degree of medical expenditure risk older households face have the potential to affect demand for risky assets in the economy.

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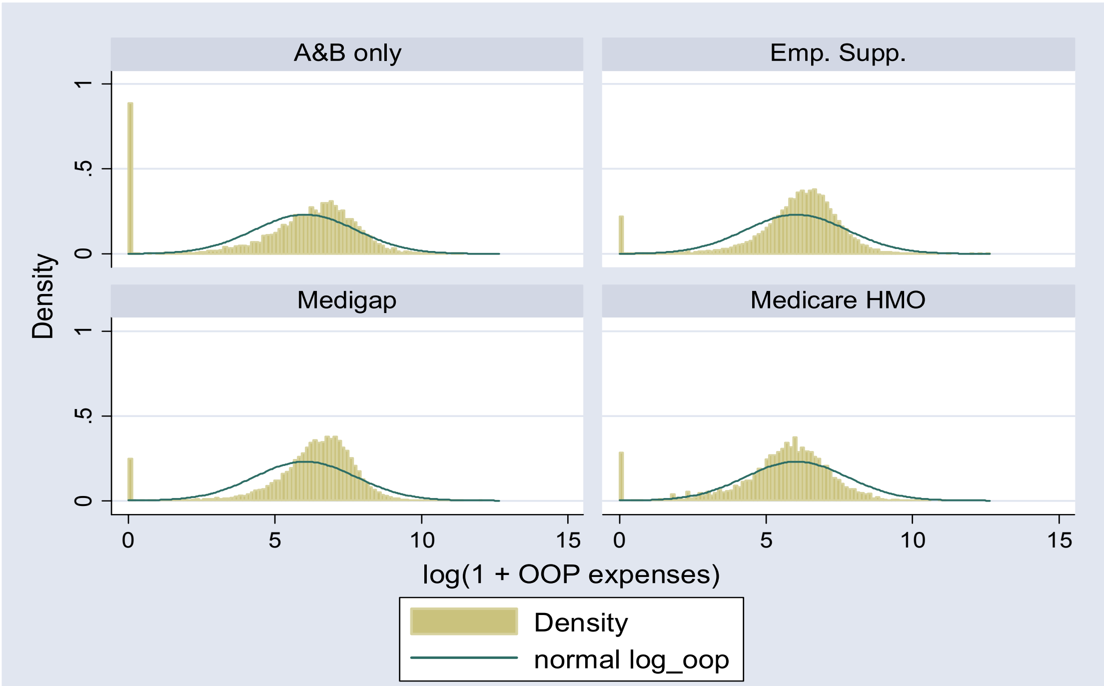
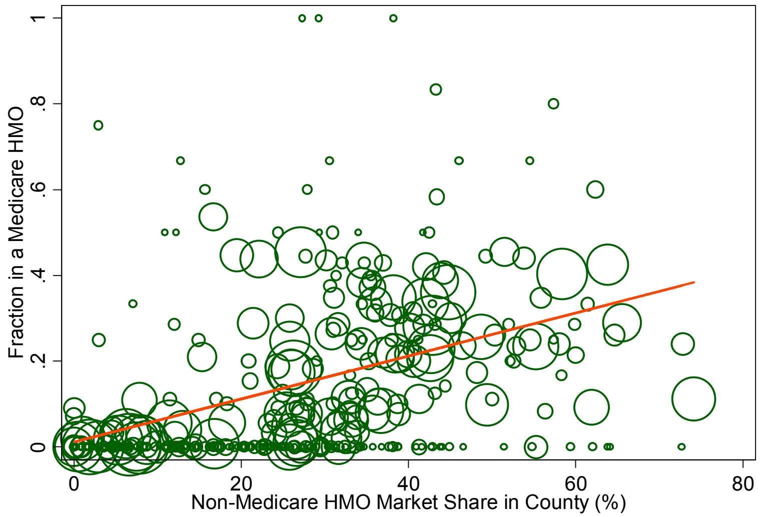
Figure 1. Densities of Out-of-Pocket Medical Expenses by Supplementary Insurance Status

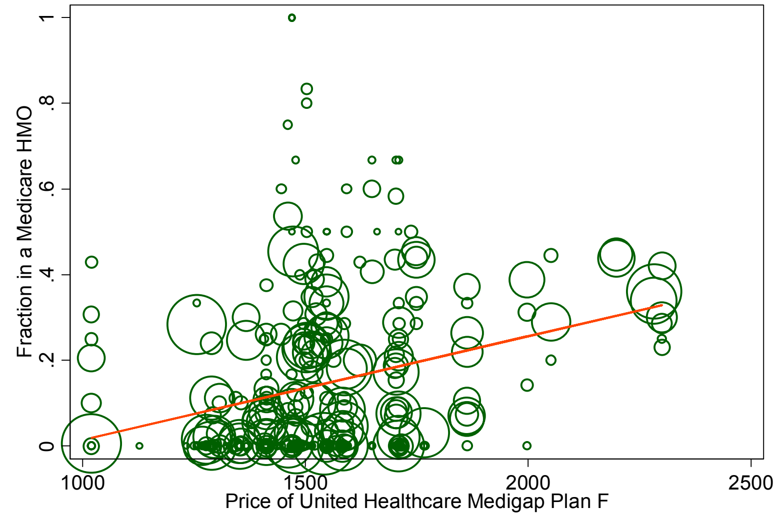


Notes: Data are from the 1999 and 2000 MCBS Cost and Use files and are in 2000 dollars. Spending in 1999 is inflated to 2000 dollars using the consumer price index for medical care. Expenditures for inpatient services, outpatient services, home health care, medical equipment, prescription drugs, dental services, hospice care, skilled nursing facilities, and institutional care are included.

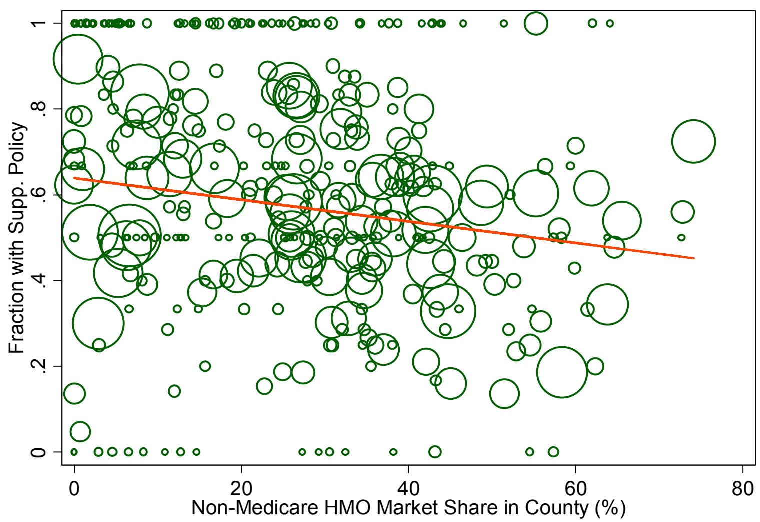
Figure 2. County-Level First Stage Relationships



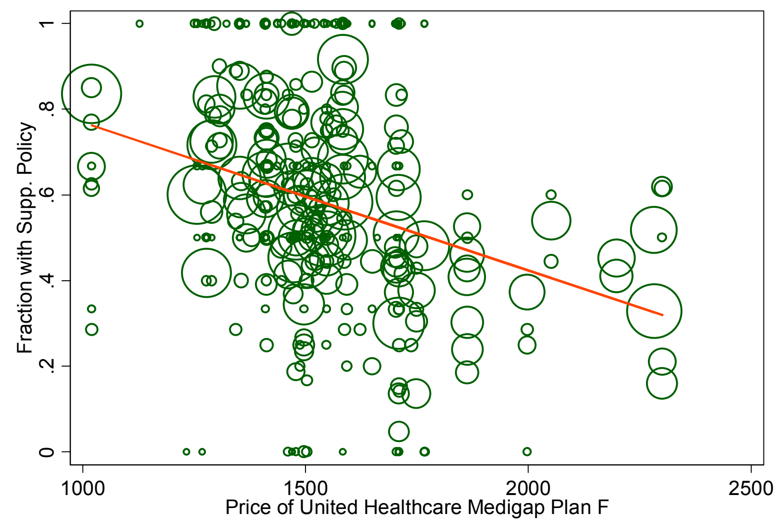
Note: Weighted by no. of obs. in county (slope=.005, t=12.96).



Note: Weighted by no. of obs. in county (slope=.0002, t=8.19).



Note: Weighted by no. of obs. in county (slope=-.0025, t=-4.44).



Note: Weighted by no. of obs. in county (slope=-.0003, t=-9.93).

Figure 3. County-Level Reduced Form Relationships

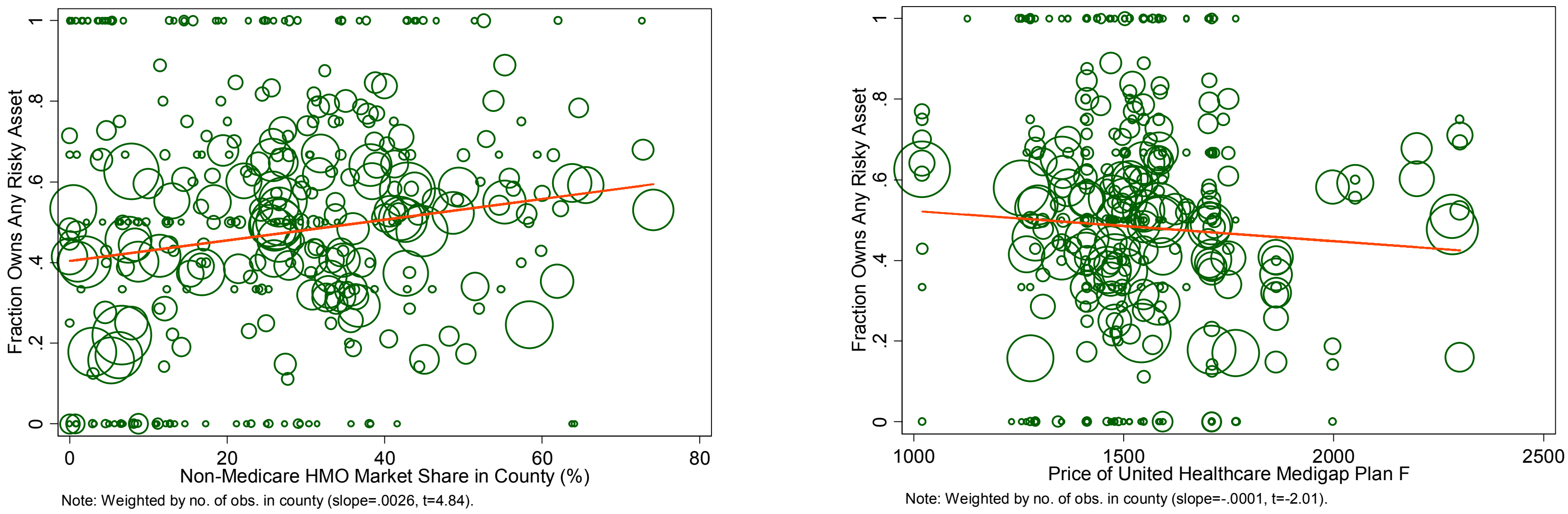


Table 1. Health Insurance Coverage of Medicare Beneficiaries, HRS 2000

Medicare A & B Only	14.8
Medicare HMO	16.2
Medicare + Individual Medigap Policy	28.5
Medicare + Employer Insurance	32.6
Medicare + Medicaid	8.0

Notes: Sample includes respondents in the 2000 wave of the HRS who were age 65 or older in 1998. N=8522

Table 2. Sample Means by Insurance Status, HRS 2000

	All	Medicare A&B Only	Medicare HMO	Medicare + Medigap	Medicare + Employer
Age	75.7	77.3	75.0	76.4	74.8
Male	42.3	39.8	40.6	40.5	45.9
Years of Education	12.1	10.6	12.0	12.2	12.8
White	88.6	74.0	84.8	94.9	91.6
Black	6.9	17.4	7.4	2.8	5.5
Hispanic	3.1	6.5	6.2	1.5	1.5
Married	57.1	44.4	57.2	55.2	64.5
Completely Retired	84.1	85.9	83.7	81.6	85.7
Income	$37,860	$27,204	$31,549	$39,085	$44,756
Net Worth	$376,100	$220,591	$307,848	$467,611	$400,515
Ever Diagnosed with High Blood Pressure	55.4	54.1	55.2	54.4	56.9
Ever Diagnosed with Diabetes	15.4	17.0	16.8	14.0	15.2
Ever Diagnosed with Major Health Condition	51.6	49.8	50.2	53.2	51.7
Major Health Shock in Last 2 Yrs	11.9	11.8	12.0	12.8	11.1
Fair or Poor Health	28.2	37.5	28.3	27.1	24.7
No. of Observations	7774	1324	1375	2324	2751

Notes: Sample includes respondents in the 2000 wave of the HRS who were age 65 or older in 1998. Major health conditions are cancer, lung disease, heart disease, and stroke. Major health shock refers to onset of a major health condition. Completely Retired respondents include those who report themselves as completely retired and not working for pay, those who say they are "not in the labor force," and those who report themselves as disabled.

Table 3. Distribution of Out-of-Pocket Medical Expenses by Supplementary Insurance Status

		Percentile of OOP Expenses			
	Mean	50th	90th	95th	99th
Medicare A & B Only	$2,066	$705	$3,869	$6,367	$31,751
Medicare HMO	$942	$423	$1,883	$3,067	$7,778
Medicare + Individual Medigap Policy	$1,544	$973	$3,221	$4,657	$9,750
Medicare + Employer Insurance	$1,217	$682	$2,575	$3,948	$8,548

Notes: Data are from the 1999 and 2000 MCBS Cost and Use files and are in 2000 dollars. Spending in 1999 is inflated to 2000 dollars using the consumer price index for medical care. Expenditures for inpatient services, outpatient services, home health care, medical equipment, prescription drugs, dental services, hospice care, skilled nursing facilities, and institutional care are included.

Table 4. Household Financial Portfolios in Liquid Assets, HRS 2000

	Ownership					Portfolio Shares				
	All	Medicare A&B Only	Medicare HMO	Medicare + Medigap	Medicare + Employer	All	Medicare A&B Only	Medicare HMO	Medicare + Medigap	Medicare + Employer
Safe Assets										
Checking	84.7	73.6	87.5	89.1	93.6	46.7	60.8	49.0	40.0	40.2
CDs/T-bills	32.1	21.6	31.1	39.2	39.1	14.2	13.2	12.9	18.0	13.9
Risky Assets										
Stocks	34.1	19.3	32.3	38.5	46.1	18.3	12.6	16.8	19.7	22.0
Bonds	9.6	5.3	8.0	11.9	12.8	2.2	1.6	1.8	2.9	2.4
IRA/Keogh Plans	34.5	16.9	35.6	39.2	45.2	18.6	11.7	19.4	19.5	21.6
Any Risky Assets	50.4	30.2	49.7	57.1	65.4	39.1	26.0	38.0	42.0	45.9

Notes: Sample includes respondents in the 2000 wave of the HRS who were age 65 or older in 1998. The category denoted "Checking" also includes saving and money market accounts. Portfolio shares are computed conditional on ownership.

Table 5. Probit Model of Risky Asset Ownership in 2000

	Coef.	St. Err.
Supplemental Insurance	0.286	(0.051)
HMO Participation	0.118	(0.062)
Age	0.007	(0.055)
Age Squared/1000	-0.169	(0.350)
Female	0.011	(0.037)
HS Grad/GED	0.236	(0.044)
Some College	0.368	(0.053)
College or More	0.543	(0.060)
Black	-0.597	(0.081)
Hispanic	-0.490	(0.118)
Other Races	-0.194	(0.148)
Divorced	-0.076	(0.076)
Widowed	-0.191	(0.049)
Never Married	0.108	(0.113)
Household Size	-0.108	(0.022)
High Blood Pressure 1998	0.036	(0.037)
Diabetes 1998	-0.087	(0.044)
Cancer 1998	0.109	(0.043)
Lung Disease 1998	-0.213	(0.051)
Heart Disease 1998	0.029	(0.037)
Stroke 1998	-0.122	(0.053)
Psychiatric Problems 1998	-0.055	(0.050)
Arthritis 1998	0.001	(0.038)
Health Shock Since 1998	-0.020	(0.045)
Fair or Poor Health 1998	-0.188	(0.040)
Non-Capital Income Quartile 2 1998	0.204	(0.053)
Non-Capital Income Quartile 3 1998	0.255	(0.056)
Non-Capital Income Quartile 4 1998	0.394	(0.061)
Net Worth Quartile 2 1998	0.545	(0.054)
Net Worth Quartile 3 1998	1.276	(0.055)
Net Worth Quartile 4 1998	1.780	(0.061)
Average County Medicare Expenditure (A & B)	0.425	(0.248)
County Population/1000	0.031	(0.135)
N=7621		

Notes: Sample includes respondents in the 2000 wave of the HRS who were age 65 or older in 1998.
Standard errors are shown in parentheses.

Table 6. Discrete Factor Model of Risky Asset Ownership in 2000

	Ownership (1)		Supp. Insurance (2)		HMO Participation (3)	
Supplemental Insurance	0.232	(0.064)	--		--	
HMO Participation	0.436	(0.154)	--		--	
United Healthcare Plan F Premium in County	--		-0.0009	(0.0002)	0.0011	(0.0006)
Non-Medicare HMO Market Share in County	--		0.0009	(0.003)	0.097	(0.010)
Age	0.007	(0.055)	0.083	(0.106)	-0.004	(0.277)
Age Squared/1000	-0.171	(0.356)	-0.681	(0.674)	-0.373	(1.782)
Female	0.009	(0.038)	0.085	(0.083)	0.172	(0.188)
HS Grad/GED	0.245	(0.044)	0.458	(0.092)	0.095	(0.217)
Some College	0.367	(0.054)	0.313	(0.116)	0.311	(0.278)
College or More	0.562	(0.061)	0.462	(0.139)	-0.368	(0.303)
Black	-0.610	(0.082)	-1.062	(0.124)	-0.509	(0.393)
Hispanic	-0.502	(0.119)	-1.042	(0.195)	-0.416	(0.540)
Other Races	-0.194	(0.150)	-0.745	(0.273)	-1.436	(0.821)
Divorced	-0.083	(0.077)	0.171	(0.158)	0.048	(0.388)
Widowed	-0.187	(0.050)	0.252	(0.108)	-0.439	(0.251)
Never Married	0.126	(0.115)	0.380	(0.240)	-0.804	(0.679)
Household Size	-0.112	(0.022)	-0.050	(0.039)	0.142	(0.112)
High Blood Pressure (1998)	0.039	(0.037)	0.161	(0.081)	0.076	(0.182)
Diabetes (1998)	-0.096	(0.044)	-0.010	(0.098)	0.484	(0.232)
Cancer (1998)	0.114	(0.044)	0.319	(0.105)	0.249	(0.218)
Lung Disease (1998)	-0.212	(0.052)	-0.122	(0.111)	-0.508	(0.272)
Heart Disease (1998)	0.031	(0.038)	0.238	(0.082)	0.181	(0.185)
Stroke (1998)	-0.126	(0.054)	-0.265	(0.108)	-0.189	(0.262)
Psychiatric Problems (1998)	-0.054	(0.051)	0.110	(0.111)	0.131	(0.253)
Arthritis (1998)	-0.001	(0.039)	0.265	(0.082)	0.545	(0.191)
Health Shock Since 1998	-0.019	(0.046)	0.176	(0.103)	0.032	(0.231)
Fair or Poor Health (1998)	-0.188	(0.041)	-0.218	(0.086)	-0.353	(0.202)
Non-Capital Income Quartile 2 1998	0.212	(0.053)	0.345	(0.099)	-0.257	(0.257)
Non-Capital Income Quartile 3 1998	0.269	(0.057)	0.840	(0.118)	-0.150	(0.281)
Non-Capital Income Quartile 4 1998	0.420	(0.062)	1.286	(0.152)	-0.448	(0.333)
Net Worth Quartile 2 1998	0.556	(0.054)	0.667	(0.098)	0.242	(0.264)
Net Worth Quartile 3 1998	1.302	(0.057)	0.893	(0.113)	-0.008	(0.293)
Net Worth Quartile 4 1998	1.183	(0.064)	1.218	(0.133)	0.299	(0.318)
County Average Medicare Expenditure (A & B)	0.114	(0.275)	-1.300	(0.654)	2.256	(2.158)
County Population/1000	-0.078	(0.143)	0.472	(0.334)	16.898	(2.984)

N=7621

Notes: Sample includes respondents in the 2000 wave of the HRS who were age 65 or older in 1998. Standard errors are shown in parentheses. Specification also includes a constant.

Table 7. Comparison of Discrete Factor Model with Alternative Instrument

	Instruments Include Plan F Premium (Table 6)			Instruments Include Community Rating Indicator		
	Ownership	Supp. Insurance	HMO Participation	Ownership	Supp. Insurance	HMO Participation
	(1)	(2)	(3)	(4)	(5)	(6)
Supplemental Insurance	0.232 (0.064)	--	--	0.241 (0.064)	--	--
HMO Participation	0.436 (0.154)	--	--	0.445 (0.148)	--	--
United Healthcare Plan F Premium in County	--	-0.0009 (0.0002)	0.0011 (0.001)	--	--	--
Mandatory Community Rating in State	--	--	--	--	-0.192 (0.084)	0.910 (0.249)
Non-Medicare HMO Market Share in County	--	0.001 (0.003)	0.097 (0.010)	--	0.0008 0.003	0.105 (0.010)
N=7621						

Notes: Selected coefficients shown. Standard errors are in parentheses. Specification is same as in Table 6 except as noted.

Table 8. Predicted Probabilities and Marginal Effects for Different Model Specifications

Model	Supp. Insurance (1)	HMO (2)	None (3)	Diff Supp-None (4)	Diff HMO-None (5)
1. Raw Means	61.6	50.0	30.7	30.9	19.2
2. Simple Probit	56.7	52.1	48.9	7.8	3.2
Instruments Include Plan F Premium					
3. DF Model	54.7	60.1	48.5	6.2	11.6
4. DF Model, One Obs per HH	51.9	58.0	45.6	6.3	12.4
Instruments Include Community Rating Ind.					
5. DF Model	54.8	60.1	48.3	6.5	11.8
6. DF Model, One Obs per HH	51.9	57.2	46.3	5.5	10.9

Appendix Table 1. Comparison of Discrete Factor Models: One Observation per Household Sample

	Instruments Include Plan F Premium						Instruments Include Community Rating Indicator					
	Ownership (1)		Supp. Insurance (2)		HMO Participation (3)		Ownership (4)		Supp. Insurance (5)		HMO Participation (6)	
Supplemental Insurance	0.232	(0.075)	--		--		0.228	(0.094)	--		--	
HMO Participation	0.462	(0.169)	--		--		0.451	(0.190)	--		--	
County Price of United Plan F	--		-0.0009	(0.0002)	0.0012	(0.0007)	--		--		--	
Community Rating in State	--		--		--		--		-0.162	(0.092)	0.917	0.277
Non-Medicare HMO Market Share in County	--		0.002	(0.004)	0.101	(0.011)	--		0.001	(0.004)	0.104	(0.011)
Age	-0.029	(0.061)	-0.0262	(0.119)	0.028	(0.304)	0.005	(0.068)	-0.019	(0.112)	-0.128	(0.318)
Age Squared/1000	0.057	(0.387)	0.024	(0.750)	-0.570	(1.947)	-0.185	(0.437)	-0.011	(0.705)	0.448	(2.040)
Female	-0.009	(0.045)	0.077	(0.101)	0.234	(0.231)	0.032	(0.048)	0.057	(0.093)	0.409	(0.231)
HS Grad/GED	0.230	(0.051)	0.511	(0.106)	0.062	(0.249)	0.298	(0.060)	0.495	(0.097)	0.051	(0.252)
Some College	0.380	(0.061)	0.329	(0.132)	-0.078	(0.311)	0.435	(0.070)	0.339	(0.123)	0.010	(0.331)
College or More	0.594	(0.070)	0.530	(0.164)	-0.283	(0.352)	0.712	(0.080)	0.489	(0.149)	-0.584	(0.359)
Black	-0.597	(0.091)	-1.082	(0.140)	-0.684	(0.434)	-0.760	(0.131)	-1.083	(0.135)	-0.590	(0.456)
Hispanic	-0.504	(0.133)	-1.046	(0.223)	-0.129	(0.596)	-0.532	(0.151)	-1.062	(0.213)	-0.001	(0.680)
Other Races	-0.117	(0.175)	-0.946	(0.310)	-1.770	(0.858)	-0.161	(0.188)	-0.883	(0.285)	-1.454	(0.892)
Divorced	-0.101	(0.082)	0.155	(0.173)	-0.118	(0.409)	-0.124	(0.091)	0.184	(0.164)	0.303	(0.427)
Widowed	-0.200	(0.056)	0.218	(0.127)	-0.456	(0.278)	-0.242	(0.062)	0.230	(0.116)	-0.355	(0.293)
Never Married	0.099	(0.118)	0.341	(0.259)	-0.682	(0.710)	0.079	(0.131)	0.296	(0.224)	-0.005	(0.755)
Household Size	-0.115	(0.024)	-0.051	(0.043)	0.048	(0.124)	-0.139	(0.029)	-0.056	(0.042)	0.154	(0.131)
High Blood Pressure (1998)	0.042	(0.042)	0.163	(0.092)	0.013	(0.204)	0.058	(0.046)	0.156	(0.085)	-0.118	(0.214)
Diabetes (1998)	-0.128	(0.053)	-0.073	(0.117)	0.518	(0.276)	-0.124	(0.058)	-0.072	0.108	0.354	(0.278)
Cancer (1998)	0.122	(0.051)	0.383	(0.128)	0.365	(0.254)	0.128	(0.056)	0.348	(0.113)	0.491	(0.267)
Lung Disease (1998)	-0.188	(0.061)	-0.088	(0.134)	-0.443	(0.306)	-0.197	(0.068)	-0.131	(0.120)	-0.505	(0.322)
Heart Disease (1998)	0.045	(0.044)	0.218	(0.097)	-0.074	(0.216)	0.063	0.048	0.219	(0.090)	-0.069	(0.223)
Stroke (1998)	-0.122	(0.064)	-0.233	(0.130)	-0.176	(0.320)	-0.166	(0.074)	-0.303	(0.119)	-0.171	(0.321)
Psychiatric Problems (1998)	-0.065	(0.059)	0.039	(0.132)	0.032	(0.290)	-0.079	(0.065)	0.047	(0.119)	0.091	(0.295)
Arthritis (1998)	-0.017	(0.044)	0.283	(0.094)	0.502	(0.216)	-0.017	(0.048)	0.230	(0.086)	0.618	(0.225)
Health Shock Since 1998	-0.009	(0.054)	0.206	(0.124)	0.248	(0.269)	-0.015	(0.059)	0.148	0.112	0.165	(0.285)
Fair or Poor Health (1998)	-0.157	(0.047)	-0.124	(0.100)	-0.381	(0.234)	-0.186	(0.053)	-0.135	(0.093)	-0.526	0.244
Non-Capital Income Quartile 2 1998	0.220	0.057	0.347	(0.107)	-0.253	(0.276)	0.269	(0.066)	0.399	(0.103)	-0.152	(0.285)
Non-Capital Income Quartile 3 1998	0.262	(0.062)	0.878	(0.139)	-0.159	(0.311)	0.297	(0.071)	0.829	(0.124)	0.121	(0.322)
Non-Capital Income Quartile 4 1998	0.365	(0.070)	1.375	(0.194)	-0.366	(0.389)	0.416	(0.077)	1.222	(0.151)	0.034	(0.362)
Net Worth Quartile 2 1998	0.567	(0.059)	0.675	(0.109)	0.265	(0.289)	0.677	(0.080)	0.665	(0.104)	0.118	(0.302)
Net Worth Quartile 3 1998	1.274	(0.063)	0.911	(0.131)	0.041	(0.319)	1.431	(0.093)	0.831	(0.117)	0.008	(0.332)
Net Worth Quartile 4 1998	1.788	(0.072)	1.286	(0.163)	0.277	(0.358)	1.959	(0.101)	1.108	(0.138)	0.160	(0.363)
County Average Medicare Expenditure (A & B)	0.044	(0.307)	-1.330	(0.734)	0.791	(2.490)	0.022	(0.349)	-2.354	(0.664)	4.914	(2.141)
County Population/1000	-0.082	(0.016)	0.384	(0.375)	1.620	(3.235)	-0.050	(0.172)	0.091	(0.371)	14.91	(3.37)
N=5769												

Notes: Sample includes one observation per household. Standard errors are in parentheses. In married couple households, a random spouse was selected. Specifications are same as in Table 7.