INCENTIVE-COMPATIBLE GUARANTEED RENEWABLE HEALTH INSURANCE PREMIUMS

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November 27, 2002

Abstract: Multi-period theoretical models of renewable insurance display front-loaded premium schedules that both cover lifetime total claims of low-risk and high-risk individuals and provide an incentive for those who remain low-risk to continue to purchase the policy. In practice, however, an age profile of premiums that decreases with age might result in such high premiums for younger individuals that may be considered unaffordable. In this paper, we use medical expenditure data to estimate an optimal competitive age-based premium schedule for a benchmark renewable health insurance policy. We find that the amount of prepayment by younger individuals necessary to cover future claims is mitigated by three factors: high-risk individuals will either recover or die, low-risk expected expense increases with age, and the likelihood of developing a high-risk condition increases with age. The resulting optimal premium path generally increases with age. In addition, we find that actual premium paths exhibited by purchasers of individual insurance with guaranteed renewability is close to an optimal schedule.

This research was supported by a grant from the Robert Wood Johnson Foundation. Keith Crocker and John Moran provided helpful comments.

I. BACKGROUND

Not all illness-related events begin and end within the single-year time frame that is typical for private health insurance policies. This means that a person initially in good health who develops a chronic illness may have above-average expenses in subsequent years. If the annual insurance premium is set proportional to expected expense in each year, the person who contracts a multi-year condition would face a substantial and unexpected jump in premiums, something a risk-averse person would prefer to avoid. A potential solution to this problem is for the insurance policy purchased when the individual is still in good health to contain a guaranteed renewability (GR) provision which stipulates that no insured's future premium for the given policy will increase more than any other insured's premium increases. That is, people who become high-risk will pay the same premium as those who remain low-risk.

However, in a world of competitive unsubsidized insurance firms, the insurer faces a dilemma. If some individuals who are low-risk in period one will become high-risk in period two, any resulting second-period premium based only on these higher expected expenses may drive away from the plan those who remain low-risk. They will be attracted to other firms promising to charge them no more than their own expected expenses. In this sense, the promise to "community rate" insurance in the future for the population of initial purchasers is not sustainable in competitive insurance markets.

There is, however, a solution in theory to this problem, as suggested by Cochrane (1995) and Pauly, Kunreuther, and Hirth (1995). The premium the insurer should charge the low-risk individuals in period one should be higher than the expected expenses for that population in period one. The "extra" premium is used to cover the subsequent above-average expenses of those who became high-risk between period one and period two. It would then be possible to charge a premium equal to the low-risk individual's expected expense in period two; at this premium, both those who became high-risk and those who remain low-risk would remain with the insurer. Moreover, in the initial situation risk-averse individuals will prefer paying the somewhat higher premium in period one to paying a lower premium in period one and facing the uncertainty of above-average premiums in period two. The expected lifetime premiums are the same under both scenarios, but "front-loading" the first-period premium produces an "incentive-compatible" schedule of premiums which risk-averse individuals prefer to facing single-period risk-rated insurance.

In just a two-period model, the additional premium in period one need not be large. However, selling insurance to young people that will guarantee premiums in the face of a chronic illness that persists for many years into the future might require charging a substantial extra premium to cover the future expected excess expense for those who become high risk. Even with an insurer's ability to discount future claims, the additional premium to cover 40 or more years of above-average spending might be quite high. If people could borrow in a perfect capital market to pay this premium, they would do so. But, as Frick (1999) points out, with imperfect capital markets, young people—particularly those with lower incomes—might be unable to borrow on reasonable terms and therefore be unable to afford (even if behaving rationally in all other ways) high initial premiums.

However, this pattern of excessively high initial premiums may not be realistic for health insurance. The model that generated the pattern assumed that the expected expenses for low-risk individuals stayed constant over time, that a given proportion of the low-risk population converted to high risk in every period, and that individuals remain high-risk for all remaining periods. These assumptions may well not hold for health insurance. Expected expenses even for healthy or normal people almost surely increase with age. Similarly, the probability of contracting a chronic condition also almost surely increases with age. And finally, the time period over which people remain high-risk, on average, is less than the average lifetime. (These conjectures are confirmed below with medical expenditure data.)

The implication of these modifications is that, in principle, the premium needed to fund GR coverage might actually be moderate at a young age compared to what it will become later. In fact, premiums for guaranteed renewabile coverage for people in their twenties (including enough to cover the excess expense of those who will become chronic high risks) could well be lower than the premiums for healthy people in their sixties, since the latter's expected expenses would be higher and more of them would be becoming high risks (if only until they go on Medicare). Applying a positive interest rate to the excess reserves collected by insurers would also smooth the life-long pattern of premiums.

At a theoretical level, this observation does not, in itself, necessarily provide a solution to Frick's problem of imperfect capital markets. Markets may be imperfect in many ways, and even with premiums that are relatively low for the young, those people may so prefer current consumption that they sacrifice GR protection. The real issue is empirical: what schedule of lifetime premiums related to age would individuals prefer? This paper does not answer that question directly. But it does estimate a feasible breakeven incentive-compatible premium schedule and

approximates the willingness-to-pay for that schedule of lifetime premiums. We also relate these schedules to typical lifetime income patterns; in an informal way this comparison may suggest how "affordable" an incentive-compatible schedule would be.

There is another empirical fact that is relevant. GR health insurance policies (as well as GR term life and nursing home insurance) *do* exist in (and dominate) the market, even in the absence of regulation, and appear to be stable (Pauly, Percy, and Herring, 1999; Harrington and Niehaus, 1999). We want to see whether that apparent stability is consistent with an incentive-compatible premium schedule. In a sense, we are elaborating on the old joke: "Sure, it works in practice, but could it work in theory?" because developing the theory that fits with practice may further illuminate both.

The existence of GR features can also help to explain a seeming paradox in the relationship between nongroup insurance premiums actually paid and risk. The nongroup insurance market is thought to tailor premiums to risk, but in our previous research, we discovered that, although insurance premiums increase with age, the increase is much less than proportional to the increase in expected expenses with age (Pauly and Herring, 1999; Herring and Pauly, 2001). Expected expenses approximately quadruple between the ages of 25 and 60, but premiums (for the same level of coverage) increase only about two-and-a-half times. But such a "dampening" of the age-related pattern of premiums is exactly what would be predicted if GR were in effect and insurers were pricing rationally.[1] One implication of this is that what an insurer would charge a 50-year-old applying for new insurance will generally be more than what the average 50-year-old, protected by GR, pays for "old" renewed insurance.

Overview: In this paper, we explicitly estimate the age profile of a GR premium schedule predicted by the theory outlined above, using the individual-level data in the Medical Expenditure Panel Survey (MEPS). We consider a benchmark insurance policy after estimating expected medical expenses based on age, gender, and health status, and we "piece together" the ideal GR premium schedule for that policy which will cover lifetime expected claims for both low-risk and high-risk individuals yet will provide an incentive for the low-risk individuals to remain with the policy. We also compare this GR premium schedule we estimate to actual nongroup insurance premiums from the Community Tracking Study's Household Survey. Finally, we examine the willingness-to-pay for this GR feature by

[1] Even before the Health Insurance Portability and Accountability Act (HIPAA) of 1996 requiring guaranteed renewability of all nongroup insurers, many states had their own GR regulations in effect (Pauly, Percy, and Herring, 1999). Although the HIPAA law is somewhat incomplete in that it does not require premiums to be the same for all individuals within a rating class, Patel and Pauly (2002) find, in a national survey of insurance regulators, that 47 states have this requirement.

producing estimates of both the benefits from avoiding the uncertainty of future-period risk-rated premiums and the "capital constraint" cost associated with prepayment of GR premiums. Finally, we make some general observations about the feasibility of GR health insurance.

II. METHODS AND RESULTS

Estimating Expected Expense: We use data from the 1996, 1997, 1998, and 1999 Medical Expenditure Panel Surveys (MEPS) to produce individual-level estimates of expected expense for individuals of various ages and health risk levels. The MEPS is a nationally-representative household survey containing information on demographic characteristics, health conditions, insurance status, and medical expenses. We first identify a pooled sample of 33,884 privately-insured individuals ages 18 to 64 from the four survey years and inflate each year's expenditure data to 2002 dollars. Since individuals in the MEPS held various types of plans, we apply the American Academy of Actuaries (1995) induction methodology to standardized each individual's expenditures (i.e., total expenses, benefits, and out-of-pocket payments) to a benchmark plan, assumed to have a $200 deductible, 25 percent coinsurance, and a $2500 out-of-pocket maximum.

We then use these data on actual insurance benefit payments to estimate individual-level expected benefits using a two-part model. The first part is a logit model predicting any nonzero benefits, and the second is an OLS model predicting (untransformed linear) benefits for the sample of those with nonzero benefits.[2] The individual characteristics include binary variables for five-year age intervals interacted with gender and binary variables identifying the absence of any prior chronic conditions or the presence of the following twelve different medical conditions: cancer, diabetes, emphysema, high cholesterol, hypertension, heart disease, stroke, arthritis, asthma, gall bladder disease, stomach ulcer, and back problems. The MEPS identifies the year the condition was discovered, and since we are interested in obtaining *forecasts* of expected expense using pre-existing conditions, we include only those conditions that were discovered prior to the survey year.[3] Because high risks on average either die relatively

[2] We use a traditional two-part methodology for estimating expected expenses to handle the clustering of zero actual expense (Duan et al., 1983), but we decide *not* to use a transformed dependent variable in the second stage model estimating nonzero expenses. We have found that using untransformed linear expenses increases the model's ability to more accurately estimate the right tail of the expense distribution (Pauly and Herring, 1999; Herring and Pauly, 2001).

[3] The year that an existing condition was discovered is missing for a fraction of the observations in the MEPS. (There is, however, complete data for whether an individual has even been made aware by a physician about a condition.) Rather than delete these observations and re-weight those

soon after their conditions are discovered or recover from their illnesses, the median period of unusually high expenses is only about four years (Eichner, McClellan, and Wise, 1998). Obviously some people who become high risks do remain that way for a longer period of time. For this reason, we identify each of the twelve conditions in our regression model by whether it was discovered less than five years ago or more than five years ago.

The results from this regression analysis are presented in Table 1. The second column of this table shows mean statistics for the privately-insured MEPS sample, the third column shows results for the logit model predicting any insurance benefits, the fourth column shows OLS results for untransformed "conditional" insurance benefits, and the final column shows the combined marginal effect from combining the logit and OLS estimates. (We produce this combined marginal effect for each variable holding the other relevant variables to their mean values.) The coefficients on age suggest that, even after controlling for higher expenses related to the presence of a high-expense condition, expected expense increases with age (aside from the slight decrease in expense for women after child-bearing age). Moreover, the results also demonstrate the dampening of the magnitude of condition-related expenses over time for many conditions: that is, a more-recent condition's effect on *conditional* expense is often higher than a less-recent condition's average effect; these patterns are much less dramatic than what would be observed if we included the conditions discovered *during* the survey year. However, for a few conditions, particularly stroke and gall bladder disease, the pattern of condition-related expense over time is the reverse.

Age-Related Premium Schedules and the Distribution of Risk: Using the predicted values from these two regression models shown in Table 1, we produce estimates of expected expense based upon an individual's age, gender, and health status. After incorporating administrative loading equal to 30 percent of the premium, this expected expense measure represents how risk-rated "spot market" insurance premiums (albeit rated by the set of risk characteristics identified in our empirical model) for our benchmark plan would appear.[4] Since our theoretical interest is in the schedule of renewable premiums for individuals who are all initially low risk, we exclude from the analysis individuals whose high-risk condition was discovered before the age of 18; the MEPS data indicate that only 2.5 percent of eighteen-year-olds have one or more preexisting conditions.

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observations with non-missing data, we wish to retain as many high-risk observations in the data as possible; we therefore impute the date discovered for those with missing data using the age distribution of conditions discovered *during* the MEPS sample year.

[4] We should note that neither the assumptions about the AAA induction methodology, the inflator parameter to generate expenses in 2002 dollars, nor the magnitude of the administrative loading affects the *patterns* of the resulting premium gradients by age. Instead these assumptions are made simply to generate overall *magnitudes* that appear realistic.

Since the total number of high-risk individuals is (by definition) small, we increase the sample size for further analysis by using the full sample of non-elderly adults (regardless of their current insurance status) in the MEPS with non-missing data, producing a distribution of expected benefits *as if* this full sample was insured by the benchmark plan. Since number of high-risk observations is still somewhat limited for any given age, the estimates we present below use a weighted average of the surrounding ages to produce "smoother" patterns. Specifically, observations within seven years in age are used, but they are given a weight inversely proportional to the number of years' difference between the observation and the specific age being estimated. The size of our resulting sample is 57,282 individuals.

Figure 1A and Figure 1B show the resulting estimated age profile of low-risk and high-risk premiums for females and males respectively. Single-period risk-rated premiums would be less than $1000 for younger low-risk males, about $3000 for older low-risk males, but about $2000 for younger high-risk males and about $7000 for older high-risk males. (It should be noted that these hypothetical "high-risk" premiums shown here are actually *averages* of the different rated premiums high-risk individuals would face based on the number and nature of their high-risk conditions.) The profile for average expense (from both low-risk and high-risk individuals together) by age is also shown. The premium schedule represents how a "modified community rating" (i.e., permitting rating by age but not by health status) premium schedule would appear.

We then examine in more detail how the number of high-risk individuals increases. The first row of Table 2 shows the proportion of the population who are high-risk by age; for simplicity, we present six selected ages at (roughly) ten-year intervals. Approximately a quarter of both males and females (who are all initially low-risk at age eighteen) have developed a high-risk condition by age 55, and almost 40 percent are high risk by age 64.

The probability of a low-risk individual developing a high-risk condition during any given year that is implied by these estimates, however, is complicated by deaths. Since deaths occur more frequently to people with high-risk conditions, the per-period probability of becoming high-risk is larger than the value that would result from examining a static population without deaths. To be specific, the annual probability of a low-risk individual becoming high-risk during age T can be expressed by the following:

$$P_{H,T} = (N_{H,T+1} - (1 - D_{H,T})N_{H,T}) / (1 - D_{L,T})N_{L,T}), \text{ where}$$

$N_{i,T}$ is the number of individuals of risk-type i at age T, and $D_{i,T}$ is the mortality rate of risk-type i at age T.

We produce a "standardized" population by adjusting the "point-in-time" MEPS sample weights (which fluctuate, for example, with the "Baby Boom" population) using age/gender mortality rates from the National Center for Health Statistics (Anderson, 1999). By age 64, a cohort of 100 low-risk males will have about 47 low-risk members and 32 high-risk members, and will have had 21 deaths. We then use MEPS data for deaths that occurred within the sample to determine the ratio of low-risk to high-risk mortality, $D_{i,T}$, for several selected age cohorts. We apply this ratio to the NCHS age/gender mortality rates to determine age/gender/risk mortality rates needed to estimate the above expression for $P_{H,T}$.

The remainder of Table 2 shows the results of these calculations. Conditional on age, mortality rates for high-risk individuals are almost ten times as high as mortality rates for low-risk individuals. The resulting annual likelihood of a low-risk individual developing a high-risk condition is less than 0.5 percent in the early stage of life but increases considerably to over 2.5 percent in the later stage of life. This result has two direct implications for the gradient of the GR premium schedule. The first is that many of those who develop a high-risk condition in their earlier years will die rather than continuing to cause high claims. The second is that the pre-payment necessary to cover future claims is decreased by the relatively fewer individuals developing high-risk conditions during the earlier stages of life.

The Ideal Renewable Premium Schedule: Now consider the breakeven GR premium schedule implied by the theoretical work of Cochrane (1995) and Pauly, Kunreuther, and Hirth (1995). These models specify that the premium at age *T* simply equals the low-risk expected expense at age *T*, plus the expected lifetime difference between low-risk and high-risk expected expense for all those individuals who become high-risk *during* age *T*. That is, the GR premium in each period is front-loaded by an additional amount that essentially insures the consequences (until the person goes on Medicare at age 65) of becoming high-risk during the period. For example, the premium at age 64 is equivalent to the low-risk expected expense at age 64. (All individuals who are high-risk before age 64 have already covered their excess claims through higher prior-period premiums.) The premium at age 63 is the sum of the low-risk expense at age 63 plus the difference in expected expense between high-risk expected expense and low-risk expected expense at age 64 for the cohort of 63-year-old low-risk who becomes high risk during age 63.[5]

[5] To be clear, the premium at age 62 is the sum of the low-risk expense for 62-year-olds plus the difference in lifetime expected expense between high-risk expected expense and low-risk expected expense (for both 63-year-olds and 64-year-olds) for the proportion of 62-year-old low-risks who develop a condition during age 62.

As a result, low-risk individuals in any given year have no incentive to exit the pool of individuals covered by the GR policy for the risk-rated "spot market" since the sum of their remaining expected lifetime GR premiums equals the sum of their remaining expected lifetime risk-rated premiums. High-risk individuals, of course, also have no incentive to leave the pool for risk-rated insurance. And even if some low-risk individuals did leave for other reasons, their departure would not affect the insurer's ability to cover high risk claims, since the funds for this purpose have already been prepaid by all insureds.

As discussed above, many individuals developing a high-risk condition may eventually recover from their illness, within five years, if at all. What matters for the incentive-compatibility criteria to hold is only whether any individual gains by exiting the pool. A formerly high-risk person who has recovered from a condition will have a lower expected expense than a person still suffering from that condition, but it is highly unlikely that the expected expense for individuals who have recovered from a condition is actually lower than the expected expense for low-risk individuals who have never had a high-risk chronic condition.[6] In other words, if the GR premium schedule is low enough so that a low-risk individual will not exit the pool to seek a risk-rated policy, it must be low enough for a formerly high-risk recovered individual not to exit.

It is not a problem that we cannot obtain separate estimates of expected expense for recovered individuals and non-recovered individuals. Determining the average of the two is sufficient because the excess premium that must be collected at age *T* is the sum of the lifetime difference in future expected expenses for all those developing a condition in *T+1*: those who recover, those who die after a time, and those who remain chronically ill. This sum is the same whether it is a sum of the average excess expected expenses (of both recovered and non-recovered individuals) essentially estimated by our regression model, or a sum of lower recovered individuals' average expense and higher non-recovered individuals' average expense. However, there will be an overall effect of illness recovery on the steepness of the optimal GR premium schedule, since the average per-period expected expense for recovered and non-recovered individuals *combined* (i.e., the "more than five years" measures) is often lower than the expected per-period expected expense for newly-discovered conditions (i.e., the "one to five years" measures). The future high-risk claims for the former will be more concentrated in the younger cohort's premiums while the future high-risk claims for the latter will be more concentrated in the older cohort's premium—simply because an older individual has less time to recover before the age of 64.

[6] We cannot verify this empirically with the MEPS, however, because it is not feasible to accurately distinguish *ex ante* a formerly high-risk recovered individual from a currently high-risk non-recovered individual with a two-year panel.

Finally, we assume that insurers can earn a three percent real rate of return on the early-life "overcharges." Hence, the excess premium we calculate is actually a discounted value. That is, we assume that an insurer has to only collect $100 in excess premiums today, for example, to pay out $103 in excess claims or premiums during the next year.

Figure 2A and Figure 2B graph the incentive-compatible breakeven GR premium schedule we estimate, for females and males, respectively; Table 3 shows the magnitude of the premiums for several selected years. The excess premium (above the low-risk premium) collected per year for the GR feature averages about $375 for both males and females, and is actually relatively level throughout one's lifetime. The total excess annual premium for GR coverage (relative to the low-risk premium without GR) is about $200 for younger individuals, increases to about $500 for middle-aged individuals, and then decreases to about $300 for older individuals. Over the course of one's lifetime, the excess premium collected for the GR feature averages about 20 percent above the low-risk premium, but decreases over time. As a result, the total GR premium is only modestly higher than the average expense (i.e., for low-risk and high-risk individuals) during the early years of adulthood but is significantly lower than the *average* expense during the older years—especially during the last ten years before Medicare eligibility.

Comparison to Actual Nongroup Premiums: We next compare our estimated GR premium schedules to actual data for nongroup insurance premiums. The data source for these premium actually paid is the nationally-representative 1996-1997 and 1998-1999 Community Tracking Study's (CTS) Household Surveys. The sample we use consists of all of the persons with single-coverage nongroup plans (N = 776) identified in the survey, so we make no adjustment for variation in generosity between these plans and our hypothetical benchmark plan, for whether a person is initiating or renewing coverage, for variation between the generosity of plans chosen and age-related expected expense, nor for state-level rating regulations. However, we do select an inflation adjustment (for males and female separately) to update the older CTS premium which makes the average premium from the CTS sample equal our benchmark plan's average premium.

These mean nongroup premiums by age from the CTS data are shown in Figures 3A and 3B for females and males, respectively; Table 3 shows the magnitude of the premiums for several selected years. While we have no objective measure of comparing the gradient of our hypothetical premium schedules with the premium schedule from actual nongroup purchases, there does appear to be surprising consistency between the age profile of actual

nongroup premiums and the GR premium schedule we estimated. Nongroup premiums do not increase proportionately with average age-related expense and the magnitude tapers off considerably during the ten years before Medicare eligibility.[7] However, since the CTS premium schedule also happens to be similar in shape to the low-risk premium schedule (because the expected expenses for those who remain lowrisk also increases less rapidly with age than do average expected expenses), an alternative hypothesis would be the existence of strict underwriting to exclude *all* high-risk individuals from nongroup insurance. The publicly-available CTS survey does not contain information on specific chronic health conditions but does contain self-reported health status: 9.4 percent of individuals between age 18 and 64 (excluding those receiving public insurance) report their health as fair or poor, while 7.0 percent of the nongroup sample report their health as fair or poor. Such strict underwriting to exclude all high risks from out nongroup sample, therefore, is not likely. While the existence of underwriting may have some effect on the pattern on nongroup premiums we observe, we conclude that the pattern of actual premiums is consistent with the hypothesis that insurers are actually charging lifetime GR premiums.

III. OTHER ISSUES

Consumer Willingness-to-Pay for GR: Up to this point, we have examined breakeven GR schedules that cover lifetime insurer costs and only ensured that low-risk consumers are indifferent between the future costs of the GR schedule and the future costs of the alternative risk-rated schedule. However, risk-averse insureds would in principle be willing to pay more than the cost for something that protected them from uncertainty. However Frick (1998) has argued that capital market imperfections may limit a younger individual's ability to afford the excess front-loading that must be collected. Thus, consumers might react by choosing policies without GR. Is this likely to happen? One way to answer this question is to estimate the valuation of the reduction in uncertainty associated with the GR feature and compare it with an estimate of the "costs" of assumed capital market constraints. The difference between these two is then the net utility gain from GR.

[7] One comparison can be made by separately regressing the average actual nongroup premium from the CTS on both the age-related average expense and the hypothetical GR premium schedule. Using logs to generate an elasticity estimate, the elasticity of actual premiums with respect to age-related average expense (in results not shown) was 0.45 for males and 0.57 for females, while the elasticity of the CTS premiums with respect to the GR premium schedule was 0.63 for males and 0.80 for females. This informal comparison implies that the GR premium schedule provides a better fit to the actual nongroup premium pattern than does the age-related average expense.

The benefit to consumers is the reduction in the uncertainty associated with random future-period premiums that one would face in a risk-rated spot market in the absence of GR insurance. The value of this benefit can be estimated as $\frac{1}{2} AP\ var(P)$, where AP is the Arrow-Pratt absolute risk-aversion coefficient and $var(P)$ is the variance of the alternative set of risk-rated premiums one faces. (See, for example, Feldman and Dowd (1991) for a derivation of this expression.) Marquis and Holmer (1986) produced estimates of the Arrow-Pratt absolute risk-aversion coefficient of 0.0011 and 0.00084 in 1982 dollars. Taking the average of these two estimates and multiplying it by the ratio of the 1982 CPI (96.5) to the 2002 CPI (179.3) taken from the Bureau of Labor Statistics (2002) gives an estimate of the Arrow-Pratt absolute risk-aversion coefficient equal to 0.00052 in 2002 dollars.

The relevant uncertainty a low-risk individual faces at age T is the variation in future-period wealth related to becoming high risk *during* age T. (The variation in future premiums for a low-risk individual opting out of the GR pool before age T that would result from becoming high risk during age $T + 1$ or later is not included in the measure for age T, so as to not "double count" the gain in utility from the GR feature.) Specifically, for age T, we identify the distribution of risk-rated premiums an individual who is low-risk at age T faces in *each* remaining year (i.e., $T+1$, $T + 2$, …, 64) if that individual either stayed low-risk or became high-risk *during* age T. We then estimate the variance for each of these 64 - T years faced at age T , use each to compute that year's Arrow-Pratt valuation of uncertainty, and calculate the total discounted sum to give the value for age T. (The consumer discount rate we use is discussed below.)

Now consider the "capital constraint" cost associated with the prepayment of future-period excess premiums. That is, there is an opportunity cost to the consumer of foregone consumption resulting from the prepayment of the GR feature; however, this opportunity cost is offset by the return-on-investment that insurers earn on their reserves. We examine three different assumptions for the magnitude of consumers' discount rate: three percent, five percent, and ten percent. These consumer discount rates are applicable not only to the capital constraint cost, but also to the valuation of the reduction in all future-period premiums.

If individuals have the same discount rate as insurers (i.e., three percent), the opportunity cost of the early-life "overcharges" will simply offset the return-on-investment that insurers earn on early-life "overcharges." The net utility gain of the GR feature then is solely the benefit from the reduction in uncertainty. For a discount rate of three percent, the valuation in the reduction in uncertainty (in results not shown) averages over $1100 per year. However, this value is considerably lower for younger individuals (ranging between $250 and $1000) than for older

individuals (ranging between $1000 and $1500), although this value reduces towards zero during the final ten years before age 65. Although younger individuals face a potentially longer lifetime of high premiums if they develop a chronic condition while young, the increasing pattern for the valuation in risk with age is driven primarily by the higher per-period probability of becoming high-risk condition as age increases. Moreover, this differential effect between younger and older individuals is more pronounced for males than for females. Generally speaking, if consumers face no capital constraints, the net utility gain from the GR feature will be high.

Figure 4A and Figure 4B show estimates for the willingness-to-pay for the GR feature assuming a consumer discount rate of five percent, for females and males respectively. The higher discount rate considerably decreases the valuation of the reduction in uncertainty, and introduces a capital constraint cost averaging about $60. This capital constraint cost slightly decreases with age but does not differ between males and females. As a result, the net utility gain of the breakeven GR schedule for females averages about $800 and ranges between about $500 for younger females and about $1000 for older females. The net utility gain for males has about the same average but has a wider range of values.

Figures 5A and 5B show the estimates of the utility gain from the breakeven GR premium schedule if the discount rates is a higher value of ten percent. The patterns for younger versus older individuals and male versus female individuals remain the same, but the net utility gain is decreased considerably. For females, the valuation of the reduction in uncertainty decreases to about $650 and the capital constraint cost increases to almost $150, thus lowering the average net utility gain to just over $500. For males, the valuation of the reduction in uncertainty decreases to about $700 and the capital constraint cost increases to $150 (as was the case for females) so that the average net utility gain from the GR feature for males is about $550. However, since the range of willingness-to-pay for the GR feature is wider for males, the net utility gain for the youngest group of males approaches zero.

Another way of modeling the possible role of capital constraints builds on Frick's (1998) insight that individuals should generally seek to smooth lifetime consumption, but the typical pattern of lifetime savings combined with capital constraints limits their ability to do so. If we think of the relevant consumption as total spending minus medical insurance premiums, the pattern of premiums (which are lower when younger) is offset by the typical earnings pattern (which is also lower when young). As already noted, the net cost of GR is modest relative to risk-based insurance premiums, most especially at young ages.

We obtain data for total annual income from the March 2002 Current Population Survey (CPS) for fulltime workers.[8] Table 4 describes the feasible consumption patterns assuming neither borrowing nor lending for a typical production worker. Specifically, we show the non-medical consumption (i.e., total income minus the premium) as a percentage of total income for each of these four premium schedules: low-risk premiums, high-risk premiums, average premiums, and breakeven GR premiums. With or without GR, medical premiums as a percentage of wage income are actually lower when young (except for the youngest workers earning much lower incomes) than when a person gets older. However, these data suggest that the consumption pattern is slightly more level if a plan with the GR feature is obtained.

***Underwriting and GR*:** We have assumed to this point that the population of potential insurance purchasers consists of low risks. This is approximately true at young ages. Less than ten percent of people in their twenties have a pre-existing medical condition. If the process of underwriting is costly to insurers, it may even be the case that the costs of screening younger applicants for many high-risk conditions would outweigh the consequences resulting from adverse selection, and hence it is conceivable that almost all young applicants would be enrolled. If the purchase of insurance is contemplated at an older age, however, we would expect to see underwriting to screen out high-risk applicants. Since the optimal GR premium schedule is defined by the incentive-compatibility of low-risk individuals at each age, older low-risk applicants could join an existing GR pool and pay the same premium schedule. High-risk applicants who are underwritten could still perhaps take advantage of a GR feature. Since risk level is actually a continuum, it is conceivable that a population of middle-age applicants who are moderate risk (e.g., one pre-existing conditions) could form their own GR pool to insure against the uncertainty of becoming even higher risk (e.g., two or more pre-existing conditions).

V. Conclusion

Using empirical models of expected expense based upon detailed chronic condition data from the MEPS, we estimate the optimal GR premium schedule suggested by the theoretical models of Cochrane (1995) and Pauly,

[8] We thank Peter Joski for providing these estimates from the CPS.

Kunreuther, and Hirth (1995). The degree of front-loading required for incentive-compatible lifetime premium schedules is mitigated by three factors: younger high-risk individuals either recover or die, low-risk expected expense increases with age, and the likelihood of developing a high-risk condition increases with age. Therefore, the cost of the GR feature is relatively modest during younger ages, thereby resulting in premiums that increase in age, roughly consistent with the age pattern in earnings.

This paper therefore draws optimistic implications for GR in individual health insurance. The feature is virtually universal even without regulation in term life insurance, so health insurers should be and probably are familiar with the need for some frontloading of premiums. But what is less clear is whether they are aware of the need to tailor that front-loading to the desires of the low risks who need to be kept in the pool. Despite the relatively low cost of the GR feature, younger individuals who place a high value on current levels of consumption may still not be willing to pay this low cost unless the breakeven GR premium is subsidized. Regardless, it does seem that existing breakeven schedules come reasonably close to optimal incentive compatible patterns.

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TABLE 1
Expected Expenses for Non-Elderly Insured Adults[a]

Variable	*Mean*	*Logit*[c] *Coefficient*	*OLS*[d] *Coefficient*	*Combined Effect*
Total expenditures[b]	1897.7			
Total benefits[b]	1504.2			
Any positive benefits[b]	0.6	-0.897***		
Total nonzero benefits[b]	2700.9		1654.6***	
Male ages 18 to 24	0.0554	0.005	-224.9	-78.37
Male ages 25 to 29	0.0461	-0.097	-271.2	-132.82
Male ages 30 to 34	0.0585			
Male ages 35 to 39	0.0700	0.208***	-130.9	40.49
Male ages 40 to 44	0.0735	0.260***	404.2	286.94
Male ages 45 to 49	0.0634	0.529***	674.2	571.57
Male ages 50 to 54	0.0547	0.805***	965.9**	911.21
Male ages 55 to 59	0.0385	0.878***	2006.0***	1557.32
Male ages 60 to 64	0.0303	1.316***	2286.5***	2147.84
Female ages 18 to 24	0.0554	0.856***	-102.0	342.61
Female ages 25 to 29	0.0496	1.423***	503.1	1001.66
Female ages 30 to 34	0.0612	1.309***	784.8**	1131.3
Female ages 35 to 39	0.0707	1.174***	842.5**	1086.64
Female ages 40 to 44	0.0762	1.276***	715.2*	1065.6
Female ages 45 to 49	0.0671	1.382***	488.4	970.24
Female ages 50 to 54	0.0579	1.725***	711.5*	1303.64
Female ages 55 to 59	0.0402	1.861***	1427.9***	1926.67
Female ages 60 to 64	0.0313	2.004***	1840.5***	2336.99
Cancer, one to five years ago	0.0039	1.665***	11021.0***	10391.86
Cancer, more than five years ago	0.0055	1.817***	5583.7***	5758.97
Diabetes, one to five years ago	0.0061	1.894***	1642.3***	2299.8
Diabetes, more than five years ago	0.0104	2.037***	595.9	1400.33
Emphysema, one to five years ago	0.0007	1.156*	5426.8***	4990.76
Emphysema, more than five years ago	0.0006	11.501	-1297.8	-221.78
High cholesterol, one to five years ago	0.0070	1.702***	-24.4	762.95
High cholesterol, more than five years ago	0.0120	1.492***	-297.8	468.73
Hypertension, one to five years ago	0.0171	1.802***	636.7*	1392.73
Hypertension, more than five years ago	0.0364	1.671***	-256.1	572.98
Heart disease, one to five years ago	0.0047	2.255***	5887.0***	6330.44
Heart disease, more than five years ago	0.0110	2.279***	3700.5***	4316.95
Stroke, one to five years ago	0.0005	1.329	3417.2*	3512.89
Stroke, more than five years ago	0.0006	11.567	9437.1***	10511.29
Arthritis, one to five years ago	0.0077	0.889***	1406.4***	1554.92
Arthritis, more than five years ago	0.0153	1.051***	967.1**	1317.47
Asthma, one to five years ago	0.0018	1.183***	5197.9***	4824.66
Asthma, more than five years ago	0.0152	1.184***	1174.4***	1558.4
Gall bladder disease, one to five years ago	0.0006	2.806***	3239.6*	4064.17
Gall bladder disease, more than five years ago	0.0007	2.058***	6110.6***	6434.99
Stomach ulcer, one to five years ago	0.0007	0.539	1126.6	1098.02
Stomach ulcer, more than five years ago	0.0017	1.339***	889.1	1407.03
Back problems, one to five years ago	0.0139	0.721***	506.8	773.58
Back problems, more than five years ago	0.0331	0.830***	680.1**	966.64
Number of observations	33,884	33,884	18,622	
-2 Log Likelihood		-41130		
Adjusted R-squared			0.0418	

Source: 1996, 1997, 1998, and 1999 Medical Expenditure Panel Surveys.

p-values: Statistical significance at 0.01 or better (***); between 0.01 and 0.05 (**); between 0.05 and 0.10 (*)

[a] Sample includes all privately-insured adults between 18 and 64, excluding those with public insurance.

[b] Total expenditures are in 2002 dollars and are standardized to a benchmark insurance policy with a $200 deductible, 20 percent coinsurance, and a $2500 upper limit on out-of-pocket expenses.

[c] Model predicts the likelihood of having any positive insurance benefits.

[d] Model predicts the magnitude of total benefits, conditional on having non-zero benefits.

TABLE 2
Distribution of Low-Risk and High-Risk Individuals

	Age:						
	18	25	35	45	55	63	64
Females:							
Proportion that are high-risk	0.0	3.9	8.5	16.6	27.5	38.4	0.0
Number that are alive[a]	100.0	99.7	98.9	97.5	94.3	88.7	100.0
Number that are low-risk[a]	100.0	95.7	90.5	81.3	68.3	54.7	100.0
Number that are high-risk	0.0	3.9	8.4	16.2	25.9	34.1	0.0
Probability of dying, low-risk[b]	0.05	0.04	0.06	0.09	0.16	0.27	0.05
Probability of dying, high-risk[b]	0.44	0.38	0.57	0.83	1.48	2.49	0.44
Probability of becoming high-risk[b]	0.80	0.51	0.85	1.67	3.17	2.56	0.80
Males:							
Proportion that are high-risk	0.0	3.0	7.9	15.3%	26.9	38.4	39.3
Number that are alive[a]	100.0	99.0	97.2	94.3	88.9	80.3	78.8
Number that are low-risk[a]	100.0	96.0	89.5	79.9	65.0	49.4	47.8
Number that are high-risk[a]	0.0	3.0	7.7	14.5	23.9	30.8	30.9
Probability of dying, low-risk[b]	0.13	0.12	0.14	0.18	0.28	0.46	n/a
Probability of dying, high-risk[b]	1.16	1.12	1.28	1.67	2.55	4.18	n/a
Probability of becoming high-risk[b]	0.41	0.54	0.78	1.64	1.93	2.80	n/a

Sources: 1996, 1997, 1998, and 1999 Medical Expenditure Panel Surveys. National Center for Health Statistics (Anderson, 1999).

[a] The MEPS sample weights are normalized to examine an initial population of 100 eighteen-year old females and 100 eighteen-year-old males. More details about the sample weight modification is presented in the text.

[b] The probabilities of dying and the probability of becoming high-risk are all annual rates; e.g., the probability of becoming high risk at age 25 is the likelihood of a low-risk 25-year old individual developing a high-risk condition before age 26.

TABLE 3
Magnitude of Selected Premiums by Age

	Age:					
	18	25	35	45	55	64
Females:						
Low-risk premium	1109	1637	2043	1981	2788	3685
High-risk premium	n/a	4713	4876	4830	6289	7505
Average premium	1109	1757	2284	2455	3751	5192
GR premium	1331	1933	2524	2476	3179	3685
CTS nongroup premium	1758	1904	2283	2772	3442	3956
Males:						
Low-risk premium	592	572	730	1219	2216	3294
High-risk premium	n/a	1987	2837	4133	6412	8480
Average premium	592	615	897	1666	3345	5331
GR premium	733	775	1137	1783	2752	3294
CTS nongroup premium	1062	1242	1377	1982	2660	3016

Sources: 1996, 1997, 1998, and 1999 Medical Expenditure Panel Surveys; 1996-1997 and 1998-1999 Community Tracking Study Household Surveys.

TABLE 4
Non-Medical Consumption as a Percentage of Income

	Age:					
	18	25	35	45	55	64
Females:						
Total income (I)[a]	12901	25868	35371	37810	39097	34434
C/I:[b] low-risk premium	0.91	0.94	0.94	0.95	0.93	0.89
C/I:[b] high-risk premium	n/a	0.82	0.86	0.87	0.84	0.78
C/I:[b] average premium	0.91	0.93	0.94	0.94	0.90	0.85
C/I:[b] GR premium	0.90	0.93	0.93	0.93	0.92	0.89
Males:						
Total income (I)	13446	29605	49053	58715	62811	62588
C/I:[b] low-risk premium	0.96	0.98	0.99	0.98	0.96	0.95
C/I:[b] high-risk premium	n/a	0.93	0.94	0.93	0.90	0.86
C/I:[b] average premium	0.96	0.98	0.98	0.97	0.95	0.91
C/I:[b] GR premium	0.95	0.97	0.98	0.97	0.96	0.95

Sources: 1996, 1997, 1998, and 1999 Medical Expenditure Panel Surveys; 2002 Current Population Survey.
[a] Total income (I) is for fulltime workers.
[b] Consumption (C) is defined as total income minus the relevant health insurance premium.

FIGURE 1A
Female Risk-Rated Premium Schedules

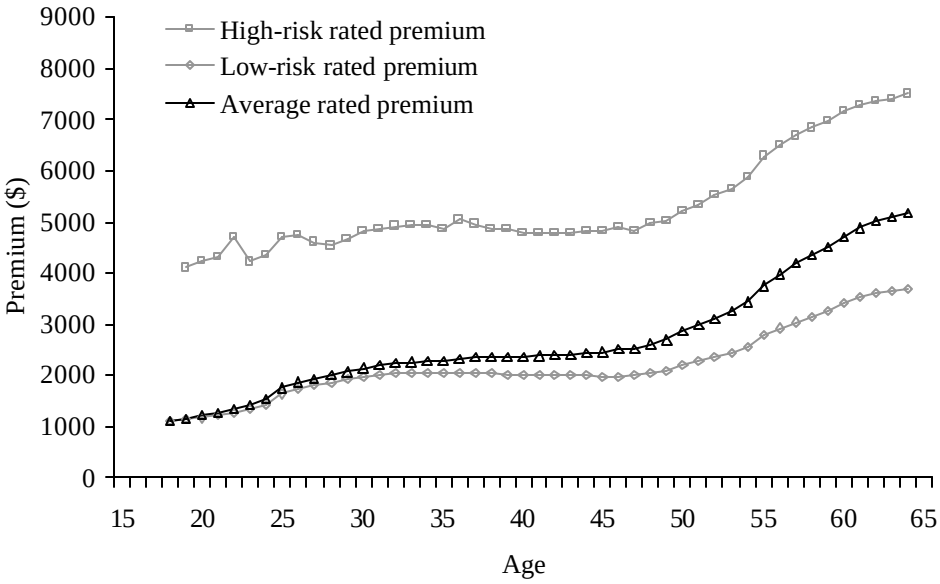

FIGURE 1B
Male Risk-Rated Premium Schedules

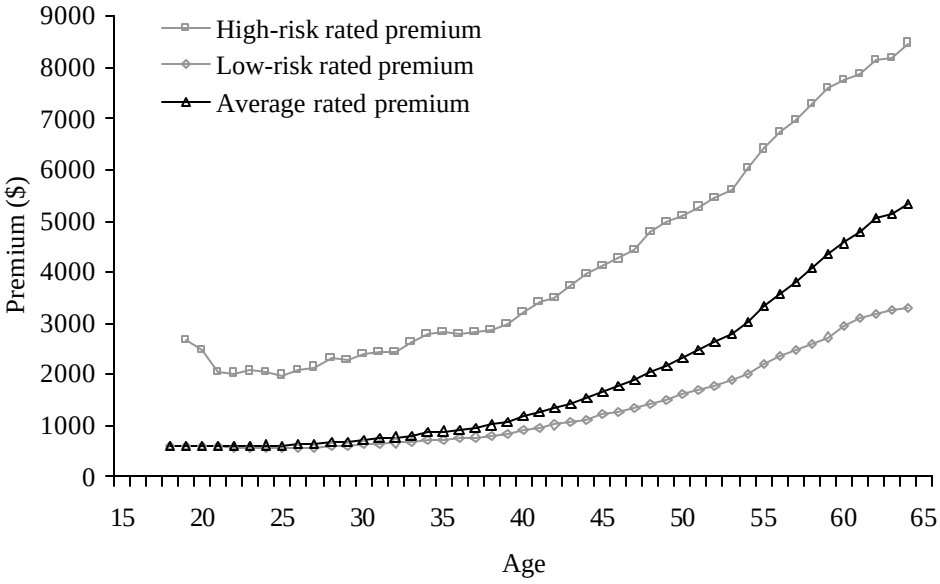

FIGURE 2A
Female GR Premium Schedule

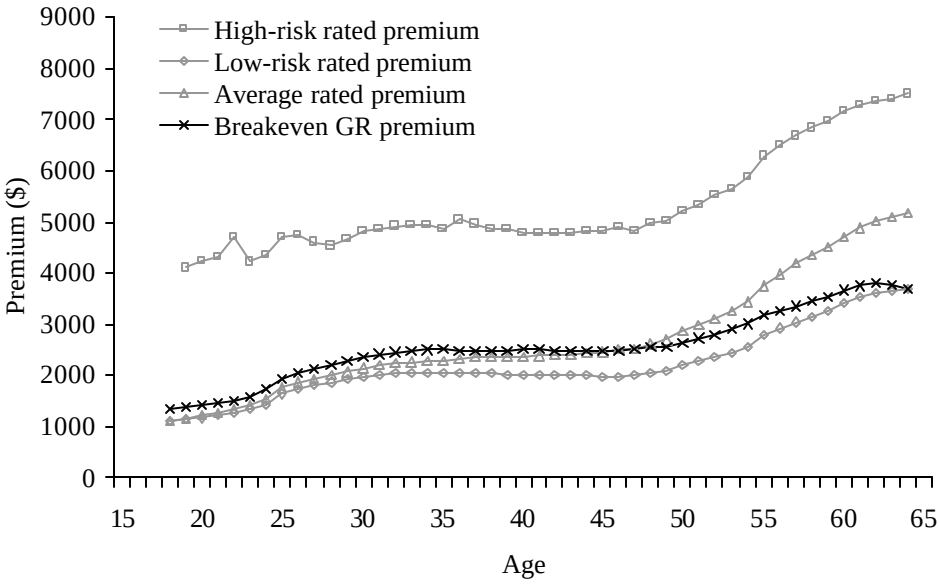

FIGURE 2B
Male GR Premium Schedule

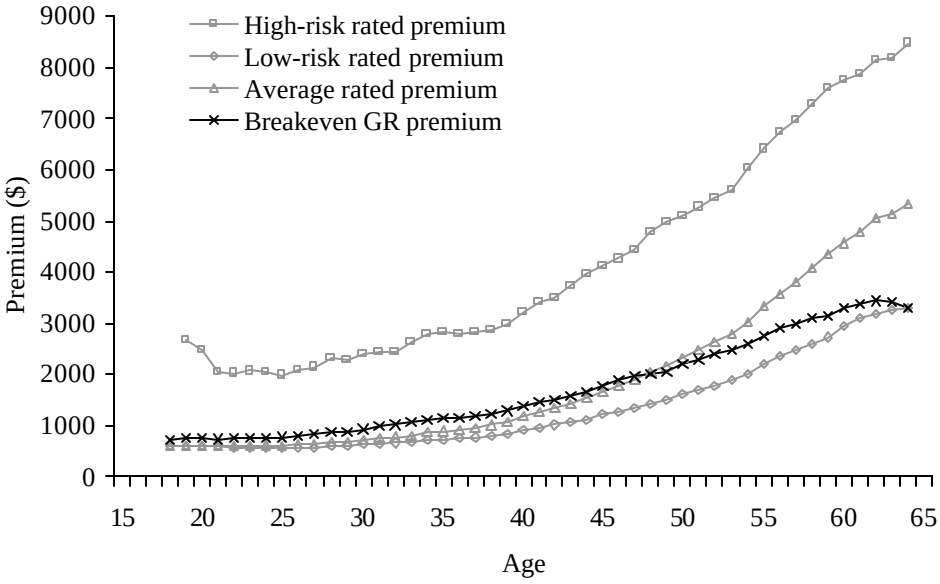

FIGURE 3A
Female Actual CTS Nongroup Premiums

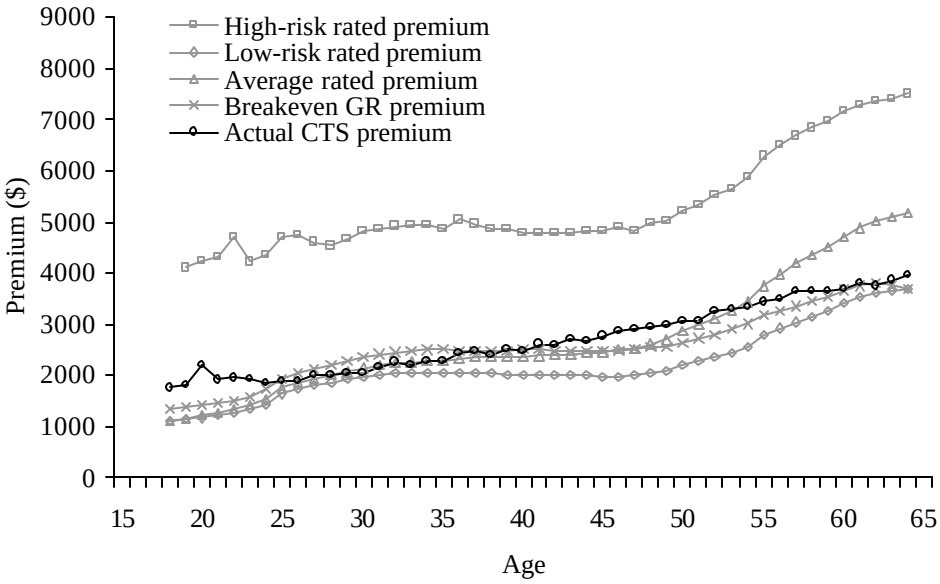

FIGURE 3B
Male Actual CTS Nongroup Premiums

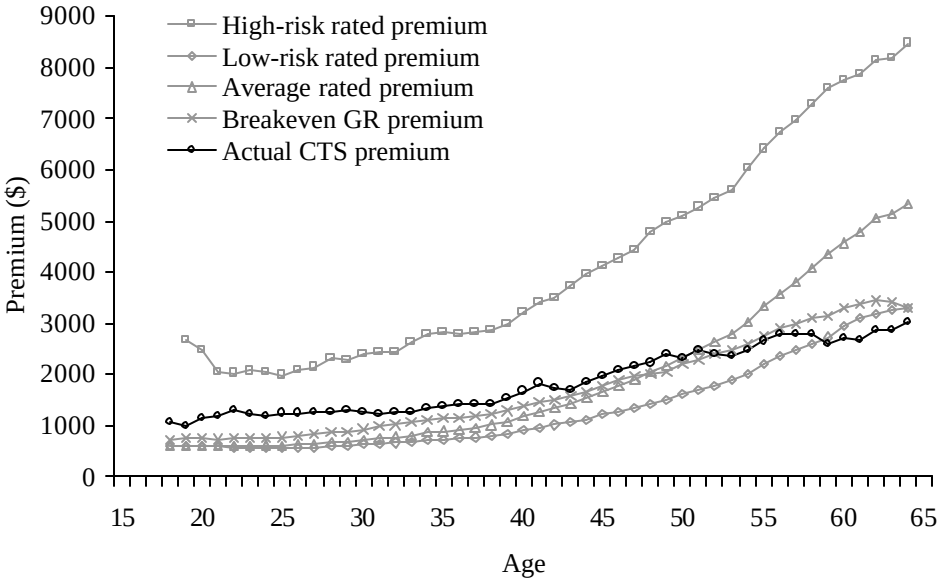

FIGURE 4A
Female Willingness-to-Pay for GR: Five Percent Discount Rate

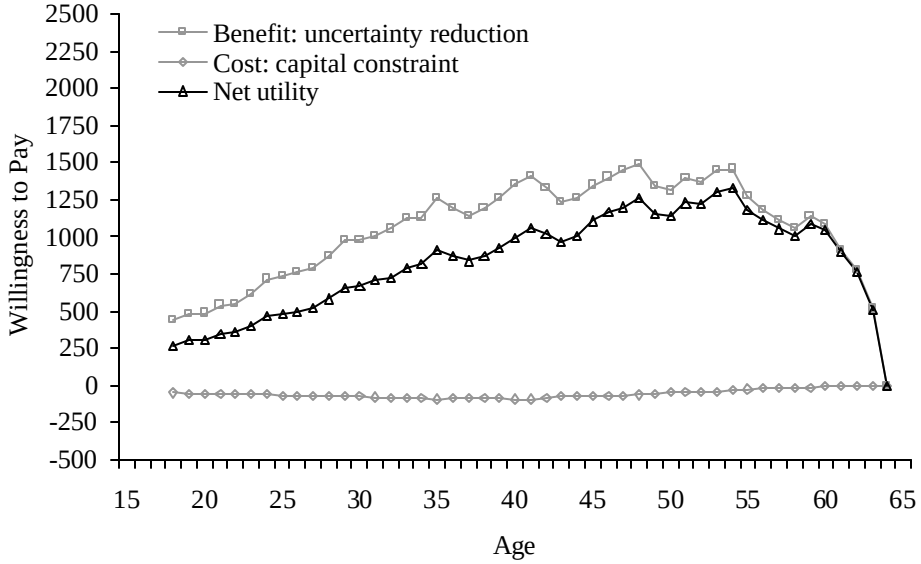

FIGURE 4B
Male Willingness-to-Pay for GR: Five Percent Discount Rate

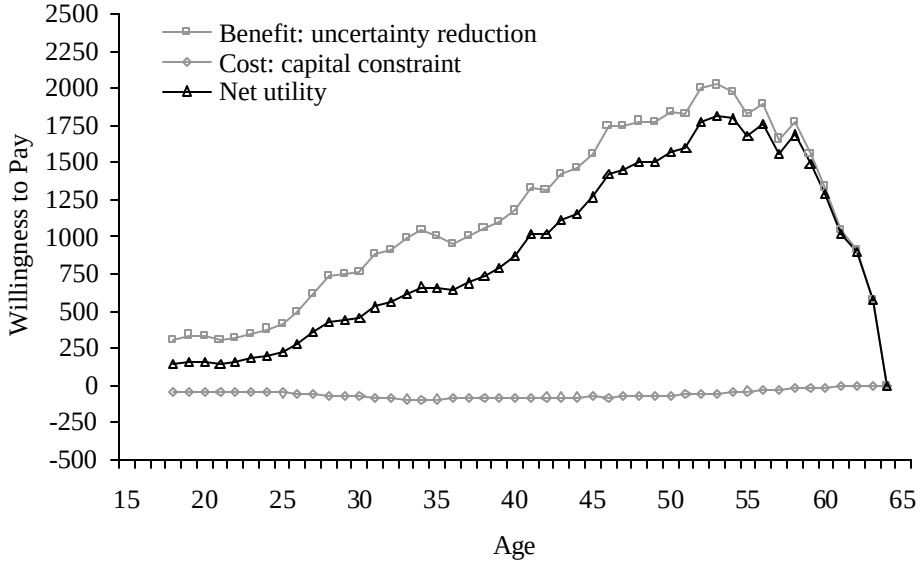

FIGURE 5A
Female Willingness-to-Pay for GR: Ten Percent Discount Rate

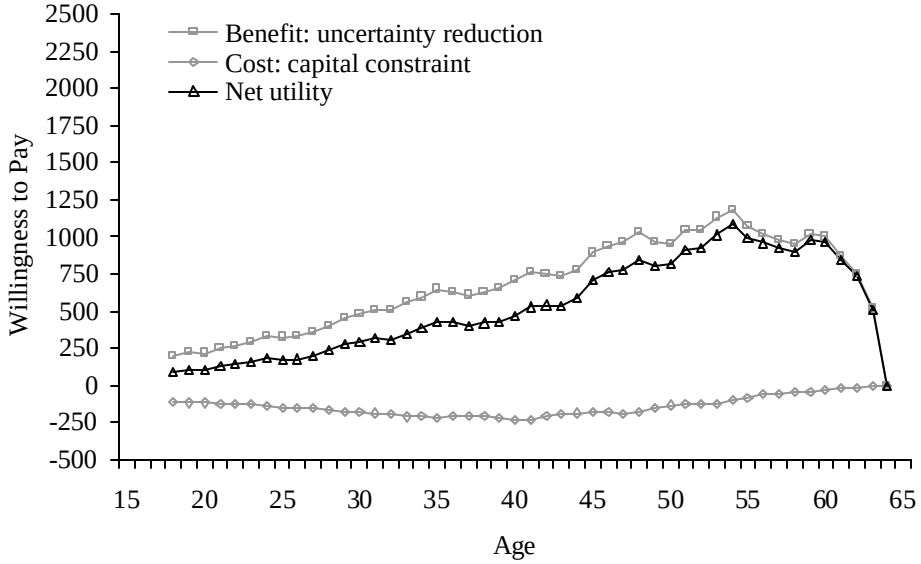

FIGURE 5B
Male Willingness-to-Pay for GR: Ten Percent Discount Rate