WORKING PAPER SERIES*
DEPARTMENT OF ECONOMICS
ALFRED LERNER COLLEGE OF BUSINESS & ECONOMICS
UNIVERSITY OF DELAWARE

WORKING PAPER NO. 2008-05

INCOME-RELATED PATIENT COST-SHARING: SIMULATION FOR PRESCRIPTION DRUGS UNDER MEDICARE

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November 2007

JEL Code: I 18

Key Words: Patient Cost-Sharing, Medicare

ABSTRACT

This paper studies an application of income-related patient cost-sharing. Using data from the Medicare Current Beneficiary Survey, we find that varying patient cost-sharing *rates* with patient income in the Medicare prescription drug program can reduce the severity of two problems: high percent-of-income burdens, and unequal medication due to income. We estimate behavioral responses in the Medicare population and incorporate the estimates into a micro-simulation model which uses data that are representative of the actual Medicare population. We find that introducing income-related patient cost-sharing into a Medicare drug program can dramatically reduce the severity of the two problems.

Introduction

Economists have emphasized that patient cost-sharing would reduce the premiums or taxes required to finance medical care and give doctors and patients an incentive to avoid unnecessary costs (for example, Newhouse, 1993; Feldstein and Gruber, 1995). In the past, however, patient cost-sharing has seldom been varied according to the patient's ability to pay. Such uniform patient cost-sharing has met substantial political resistance on the grounds that it might overburden moderate income people and over deter them from using medical care (Gibson et al 2005; Landsman et al 2005). This paper attempts to overcome this objection by investigating *income-related* patient cost-sharing: the varying of patient cost-sharing *rates* with patient income. Income-related cost-sharing could be implemented by either private insurance companies or government.[1]

We examine how varying a patient's cost-sharing *rate* with income can alter two patterns that result from uniform cost-sharing that would be viewed as problems by many citizens: high percent-of-income burdens, and variation of medical care due to patient income. Although we will refer to these two patterns as problems throughout this paper,

[1] To implement it through private insurance companies, government might require each enrollee to provide the adjusted gross income from the preceding year's tax return to the insurer, and require the insurer to use a specified cost-sharing schedule. If the insurer is the government, there is a precedent for using income tax returns because the Medicare Modernization Act of 2003 has authorized the use of income tax returns to income-relate the premiums under Medicare Part B starting in 2007 as described by Gould 2003.

we recognize that not everyone shares this view.[2] As an empirical illustration of income-related cost-sharing, we take the specific example of prescription drugs under Medicare.

To isolate the effects of varying patient cost-sharing rates with patient income, we simplify by assuming a patient with a given income, regardless of medical condition, pays the same percentage for any medication.[3] Each patient would use a credit card issued by the insurer (private or government) to purchase drugs. The patient would be billed by the insurer at the end of month. The patient would be billed a percentage that depends on the patient's income.[4]

To illustrate, a household with an annual income of $20,000 might be billed 20 percent of its drug bill until its annual bill reaches $2,000 and the household's out-of-pocket financial burden reaches $400 which is 2 percent of its income; that household would not be charged for any additional drug bills incurred that year so its maximum burden would be 2 percent of its income. But a household with an annual income of $40,000 might be billed 40 percent of its drug bill until its annual bill reaches $4,000 and its out-of-pocket burden reaches $1,600 which is 4 percent of its income; that household would not be charged for any additional drug bills so its maximum burden would be 4 percent of its income.

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[2] Variation in the consumption of a good or service with income is generally not a problem, but many citizens view it as a problem in the case of medical care.

[3] It would be possible to consider varying patient cost-sharing rates not only by patient income, but also by other factors such as prevention, chronic illness, demonstrated effectiveness of particular medications, and generic versus brand name. For example, a low-income patient would pay a smaller percentage than a high-income patient, but patients of a given income might be charged a smaller percentage (even zero) for medications likely to prevent much costlier medical services. Or a patient with a costly chronic illness might be charged a smaller percentage to offset the cumulative financial burden and prevent disruption of service.

[4] It would be possible to have patients pay a small co-payment at the pharmacy; if so, the final billing to the patient would be appropriately adjusted.

Based on data from the Medicare Current Beneficiary Survey (MCBS), we simulate the impact of alternative patient cost-sharing plans with approximately the same cost to the insurer. To our knowledge, this study is the first to use actual Medicare data to simulate the impact of introducing income-related patient cost-sharing *rates* into the Medicare prescription drug program. We examine plans in which each patient's cost-sharing *rate* as well as out-of-pocket ceiling would vary with the patient's income (using the previous year's income tax return). The study uses the MCBS data to estimate the response of prescription drug expenditure to changes in the cost-sharing rate or income and incorporates these estimates in the simulations. We evaluate how alternative cost-sharing plans would treat two problems: the problem of a high percent-of-income burdens and the problem of unequal medication due to income.

An important empirical study of patient cost-sharing (Feldstein and Gruber 1995) analyzes the impact of giving households a "major-risk health insurance policy" which consists of a uniform patient cost-sharing rate (such as 50%) until the patient reaches an *income-related* out-of-pocket ceiling (such as 10% of income). The study includes all medical care, excludes the population over 65, and income-relates the out-of-pocket ceiling but not the cost-sharing rate below the ceiling. Our study applies their framework to the population over 65, focuses on prescription drug spending, and considers income-relating the cost-sharing *rate* as well as the out-of-pocket ceiling. Studies have been done of the impact of patient cost-sharing on seniors' demand for medical care and the impact of cost-sharing on prescription drugs, but none of these studies focuses on the impact of *income-relating* patient cost-sharing (Rice and Matsuoka 2004; Coulson et al. 1995; Coulson and Stuart 1995; Shea, Stuart, and Briesacher 2003-2004; Stuart, Simoni-

Wastilia, and Chauncey 2005; Santerre and Vernon 2005; Gibson et al. 2005, Landsman et al. 2005; Goldman et al. 2004; Goldman et al. 2006). Another study analyzes the impact of percent-of-income ceilings for Medicare prescription drugs but does not investigate the consequence of varying the patient cost-sharing *rate* with income (Lewis and Seidman 2006). A recent review of the lessons of patient cost-sharing from the RAND experiment and other empirical studies (Gruber 2006) concludes that the "right way to design health insurance" should include "co-insurance for the typical patient and an income-related out-of-pocket limit." In this paper, we go a step further and consider both income-related out-of-pocket limits and income-related cost-sharing *rates*.

The Two Problems

Table 1 illustrates the two problems and how they can be mitigated by analyzing a hypothetical four-person economy under different patient cost-sharing plans. In the four-person economy each person's medicine use depends on an index of the person's medical condition (the higher the index value, the greater the use), income (the higher the income, the greater the use), and patient cost-sharing (the lower the patient cost-sharing, the greater the use). The four persons are SickRich, SickPoor, HealthyRich, and HealthyPoor. A rich person has four times the income of a poor person ($10,000 versus $2,500) and uses twice as much medicine as a poor person with the same medical condition and patient cost-sharing rate. A sick person has a medical condition index that is four times a healthy person's and uses four times as much medicine as a healthy person who has the same income and cost-sharing rate. We assume each person faces the same

retail price for medicine prior to cost-sharing. There are four columns in the table: a person's expenditure on medication, the person's out-of-pocket burden under the cost-sharing plan given her expenditure, the insurer's cost which equals the rest of the person's expenditure, and the person's percent-of-income burden which equals the person's out-of-pocket burden as a percent of income.

In computing the numbers in Table 1, we assume each person's drug expenditure M is given by the formula $M=Nc^{-e}Y^{?}$ where N is an index of the person's medical condition, c is the cost-sharing *rate*, Y is income, -e is the cost-sharing rate elasticity and ? is the income elasticity (we set e= ?=0.5). A Sick person has a higher N than a Healthy person (in our example, a Sick person has N=10, a Healthy person, N=2.5). Further details of how the numerical values are computed are given in an appendix available from the authors.

Block 0 of Table 1 shows each person's medicine use and financial burden when each person faces a cost-sharing rate of 25% and there is no ceiling on the person's burden so each person's out-of-pocket burden equals 25% of her expenditure. The insurer pays the rest of the bill.

Block 0 reveals two problems. First, SickPoor's percent-of-income burden is 10%, much higher than anyone else's. Second, persons with the same medical condition differ substantially in the medicine they use solely due to their income: as shown in the expenditure column, a rich person uses twice as much medicine as a poor person with the same medical condition. For example, consider SickRich and SickPoor. SickRich spends $2,000 and SickPoor spends $1,000 so their mean expenditure is $1,500 and the

ratio of their standard deviation to their mean, the *coefficient of variation* of drug expenditure, is 47% (the square root of [($2,000-$1,500)^2 + ($1,000-$1,500)^2]/ (2-1)=$707 so $707/$1,500=47%). The coefficient of variation is a useful measure of the dispersion of expenditure among persons with the same medical condition. It is particularly useful in comparing the degree of dispersion in sets of individuals that have different means. For example, HealthyRich and HealthyPoor (which have a mean expenditure of $375 compared to $1,500 for SickRich and SickPoor) also have a coefficient of variation of 47%.

We consider the two problems in turn: SickPoor's high percent-of-income burden and unequal medication due to income. To address these problems, we consider four different plans in Blocks 1 through 4 that each have the same total insurer cost as in Block 0 ($2812.50).

The Percent-of-Income Burden Problem

To handle the percent-of-income burden problem, a percentage ceiling can be imposed on the burden any person can bear. For example, if the ceiling is set at 6%, then once a person's burden reaches the point where the percent-of-income burden equals 6%, thereafter the insurer pays 100% of any additional medical bill, so the person's cost-sharing rate drops to 0% on additional medication (which we assume induces a person to increase medication by 5%). If the cost-sharing rate is kept the same for all persons, the cost-sharing rate needed to keep total insurer spending the same as in Block 0 ($2,812.50) turns out to be 26.7%. The behavior and burdens that would be generated by this plan are

shown in Block 1. SickPoor's burden is reduced to 6% of income (instead of the 10% in Block 0). Each of the three other persons receives somewhat less insurer assistance as the insurer's dollars are reallocated to SickPoor.

Suppose a 6% burden percentage is considered too high for a low-income person. Then instead of a 6% ceiling for everyone—a *"proportional ceiling"*-- consider a ceiling of 8% for the high-income persons (SickRich and HealthyRich) and 4% for the low-income persons (SickPoor and HealthyPoor) -- a *"progressive ceiling."* If the cost-sharing rate is made the same for all persons, the cost-sharing rate needed to keep total insurer spending at target ($2,812.50) turns out to be 27.4%. The behavior and burdens that would be generated by this plan are shown in Block 2. SickPoor's burden is reduced to 4% of income. Each of the three other persons receives somewhat less insurer assistance as insurer dollars are reallocated to SickPoor.

The Problem of Unequal Medication Due to Income

Note that the problem of unequal medication is as severe in Blocks 1 and 2 as it is in Block 0; the coefficient of variation of drug expenditure remains near 47%. Thus, imposing percent of income ceilings does not alleviate this problem.

Because the source of the problem is that medicine use varies with income, this problem can be solved by varying the patient cost-sharing rate directly with income. We adjust the level of the cost-sharing rates so that total insurer spending remains approximately $2,812.50. With the 6% ceiling, it turns out that the cost-sharing rate is 47.4% for a Rich person and 11.8% for a Poor person as shown in Block 3. In our

numerical example, the income-related cost-sharing exactly offsets the difference in income so that SickRich and SickPoor have the same expenditure ($1,525.57) as do HealthyRich and HealthyPoor ($363.23). In Block 3, the coefficient of variation of drug expenditure is 0% for Sick persons and 0% for Healthy persons.

Similarly, with the progressive ceiling (8% for rich persons and 4% for poor persons), it turns out that the cost-sharing rate is 45.2% for a Rich person and 11.3% for a Poor person as shown in Block 4. In our numerical example, SickRich and SickPoor have similar expenditure ($1,488 and $1,562), and HealthyRich and HealthyPoor have the same expenditure ($372.01). In Block 4, the coefficient of variation of drug expenditure is close to 0% (in fact 3%) for sick persons and 0% for healthy persons.

The Micro-Simulation Model Using Medicare Data

We now move from the hypothetical four-person model to a model based on actual Medicare data. We construct a micro-simulation model to study the behavior of individual Medicare recipients in response to alternative cost-sharing and ceiling regimes using the Medicare Current Beneficiary Survey (MCBS) Cost and Use files for calendar year 2002 (Centers for Medicare and Medicaid Services 2005). The 2002 MCBS sample consists of 12,697 Medicare enrollees.

An important feature of our simulation model is the incorporation of empirically estimated responses of medicine use to variations in a person's cost-sharing rate and income. Prior to the simulations, we use the 2002 MCBS data to estimate the responsiveness (elasticities) of medicine use with respect to the cost-sharing rate (-e) and

to income (?). In the estimation, we control for individual characteristics and for utilization of other medical services.

The estimates are presented in Table 2. The left block of three columns presents ordinary least squares estimates. The right block of three columns presents maximum likelihood censored normal (Tobit) estimates as is appropriate when the data set includes individuals (roughly 15% of the sample) whose expenditure is zero. The basic specification is in logarithms, $\ln M = b_0 + b_1 \ln c + b_2 \ln Y$, where M is an individual's total expenditure (the MCBS includes an adjustment in reported total and out-of-pocket spending to correct for any gaps that occur in the interviewing process during the year), c is the ratio of out-of-pocket expenditure to total expenditure, and Y is income from all sources for individual and spouse. With the log specification, b_1 is the cost-sharing rate elasticity (the percentage change in M in response to a 1% change in c), and b_2 is the income elasticity (the percentage change in M in response to a 1% change in Y). The basic specification is reported in the left column of each block.

In order to mitigate the potential effects of omitted variable bias, in the middle column of each block we add these variables: female (1 versus 0), the logarithm of age, and whether the person died during the year (1 versus 0). In the right column of each block we add the following utilization dummy variables: hospice (equal to 1 for one or more hospice bills in the calendar year), inpatient (equal to 1 for one or more inpatient discharges), skilled nursing (equal to 1 for one or more skilled nursing facility admissions), home health (equal to 1 for one or more home health visits), outpatient (equal to 1 for one or more outpatient visits).

Within each block of coefficient estimates in Table 2, the estimated responses remain remarkably stable over both specifications of the statistical model and the coefficient estimates are by and large highly significant. In comparing the elasticities between the two blocks, the estimated Tobit cost-sharing rate and income elasticities are somewhat larger. In the simulations below we use the Tobit cost-sharing rate and income elasticities in the right column of the Tobit block; the cost-sharing rate elasticity (-e) is -0.791 and the income elasticity (?) is 0.589. It turns out that the simulation results are comparable for both the least squares and Tobit elasticities in the table.

Our cost-sharing rate elasticity estimate is roughly consistent with a recent study (Goldman et al. 2006). Although that study finds a lower cost-sharing rate ("plan generosity") elasticity for specialty drugs (from 0.01 for cancer drugs to 0.21 for rheumatoid arthritis), the authors comment: "What is most striking about these results is how inelastic demand is—that is how insensitive patients are to price—in comparison to traditional pharmaceuticals, for which it is not uncommon to see responses from 30-50 percent when copayments double" implying an elasticity of 0.30 to 0.50 (Goldman et al. 2006). The authors add: "More evidence has convincingly shown that demand for prescription drugs is elastic as well. Our own work suggests that doubling copayments in the most common plans will reduce spending by about 33 percent." That study's estimate comes from a sample of fifty five health plans offered by fifteen large employers whereas ours comes from the Medicare sample (MCBS) itself. Two other recent studies (Goldman et al. 2004 and Landsman et al. 2005) of the effect of coinsurance on prescription drug expenditures have similar results.

In conducting the simulations, we use MCBS cross-section weights to expand the sample to 41,742 enrollees which are representative of the entire Medicare population of approximately 42 million, but 1/1000th its size (we use a large FORTRAN program to construct the expanded data set and conduct the simulations). We use the entire sample, based on the assumption that the subsidy from taxpayers is sufficient to induce even affluent seniors to join the Medicare prescription drug plan, just as it does for part B of Medicare for physician coverage.

In the hypothetical four-person economy, we assumed that each person's use of medication depended on just three factors: an assigned index of the person's medical condition, the person's income, and the person's cost-sharing rate. But in the actual data, each person's use of medication varies with the person's medical condition, income, cost-sharing rate, attitude towards the efficacy and risk of medication, and other factors. From actual data on each person's expenditure, income, and cost-sharing (but not on attitude or on other factors), we infer an index of the person's medical condition. Given this index, we simulate how each person's expenditure would change in response to a change in cost-sharing.

To infer the index of a person's medical condition, we use data for each person's total drug expenditure and out-of-pocket burden and assume (as in Goldman et al. 2006) that each person's drug use varies with the ratio of out-of-pocket to total expenditure (the average cost-sharing ratio for the person, which Goldman et. al. call "plan generosity"). Our estimate of each person's medical condition assumes the data have been generated without an out-of-pocket ceiling. Because we do not have data on each person's attitude towards the efficacy and risk of medication, or on other factors that affect medication use,

we can only estimate a likely ("expected" in the statistical sense) medical condition for each person.

We now repeat the experiments we conducted for the four-person model for our expanded data set of 41,742 persons. In the simulations, we compare alternative cost-sharing regimes by adjusting parameters so that total insurer spending equals approximately $50 million (based on a projection that the Medicare drug plan costs roughly $50 billion per year, and the fact that our sample is 1/1000 of the total Medicare population in 2002).

As in the four-person model, there are two problems under uniform cost-sharing with no ceiling. First, some individuals experience a high out-of-pocket burden relative to income. Second, for persons with a similar medical condition, there is significant variation in the use of medication.

Block 0 of Table 3 shows the two problems. Block 0 shows what would happen under uniform cost-sharing with no ceiling. We adjust the uniform cost-sharing rate such that the total insurer expenditure for our sample of 41,742 enrollees is $50 million. The cost-sharing rate turns out to be 26.9%.

The first problem—the high percentage burden for some individuals—is shown in the three percent-of-income burden columns: 5.8% of the population (approximately 2.4 million people based on the 2002 total Medicare population of 41.7 million) has a burden percentage over 10%; 8.9% (3.7 million people), over 7.5%; and 15.1% (6.3 million people), over 5%. Not shown in the table, 1.5% (0.6 million) has a burden percentage over 25%; 0.7% (0.3 million), over 50%, and 0.4% (0.2 million), over 100%.

The second problem— unequal medication due to income-- is shown in the right column. To see the magnitude of this problem, we examine a sub-sample of individuals with a similar medical condition index. Recall that the index is higher for persons who are sicker. For illustration, we take a sub-sample of 91 individuals who have approximately the same high index value—specifically, approximately (within 5%) three times the mean index value for the entire sample-- and then compute the coefficient of variation of drug expenditures for these 91 individuals. In Block 0 the coefficient of variation is 45% (the ratio of the standard deviation $4,020 to the mean $8,948).

The Percent-of-Income Burden Problem

Consider first the percent-of-income burden problem. To handle this problem, suppose a percent-of-income ceiling is set on the burden a person can bear. We consider two alternative ceiling schedules. Under a "*proportional*" ceiling, the percentage ceiling is the same for all persons. Under a "*progressive*" ceiling, the percentage ceiling varies directly with a person's income; specifically, as income rises, the percent-of-income ceiling rises gradually according to a formula until it reaches a limit. The formula that relates the percent-of-income ceiling to the person's income is given in an appendix available from the authors and the results are presented in a table; for example, for an income of $11,750, the ceiling is 3.3%; of $22,500, 5.1%; of $160,000, 7.5%. If a person reaches the out-of-pocket ceiling, additional medication is "free," so we assume that the person increases medicine use by approximately 8% (we assume the percent increase in medicine equals ten times the cost-sharing rate elasticity).

Blocks 1 and 2 of Table 3, which assume that the cost-sharing rate is uniform, show how the two alternative ceiling schedules solve the burden problem. In Block 1 of Table 3, the ceiling is proportional, set at 5% of income; with the cost-sharing rate uniform, the rate needed to keep total insurer spending $50 million for our sample of 41,742 enrollees turns out to be 30.0%. In Block 2 of the table, the ceiling is progressive where the percent-of-income ceiling rises with income until it reaches a limit of 7.5%; with the cost-sharing rate uniform, the rate needed to keep total insurer spending $50 million turns out to be 30.6%.

In Block 1 no enrollee has a burden percentage greater than 5%, and in Block 2, only a small percent (2.2%) have a burden percentage greater than 5% (but less than 7.5% under the progressive ceiling).

The Problem of Unequal Medication Due to Income

But whichever ceiling (proportional or progressive) is chosen, as seen in the right column of Blocks 1 and 2, the coefficient of variation remains 45%. So introducing a ceiling solves the burden problem but not the unequal medication problem.

The unequal medication problem can be mitigated by income-relating the cost-sharing, varying the rate directly with the person's income. Specifically, as income rises, the cost-sharing rate rises gradually according to a formula until it reaches a limit. The formula that relates the cost-sharing rate to the person's income is given in an appendix available from the authors and the results are presented in a table; for example, for an

income of $11,750, the rate is 25.0%; of $22,500, 38.0%; of $160,000, 56.3% (we impose a floor on the rate of 1% for incomes less than about $400).

Blocks 3 and 4 of Table 3 show how income-related cost-sharing mitigates the problem of unequal medication among patients with the same medical condition and the same preference concerning the use of medication. In Block 3 of Table 3, the ceiling is proportional, set at 5% of income, and the cost-sharing rate rises with income according to a formula with the rate limit adjusted so that total insurer spending is $50 million for our sample of 41,742. It turns that the required rate limit is 60.8%. In Block 4, the ceiling is progressive with a limit of 7.5%, and the cost-sharing rate rises with income. The rate limit required to keep total insurer spending $50 million turns out to be 62.1%.

The mitigation of the problem of unequal medication due to income is shown in the right column of Blocks 3 and 4 of Table 3. Recall that in this table we examine a sub-sample of 91 individuals who have approximately the same high medical condition index value and then compute the coefficient of variation for these 91 individuals; and that in Blocks 0, 1, and 2, the coefficient of variation is 45%. By contrast, in Blocks 3 and 4 the coefficient of variation is only 6%.

To summarize the results in Table 3: A percent-of-income ceiling takes care of the burden-percentage problem, but varying a patient's cost-sharing *rate* with patient income is needed to mitigate the problem of unequal medication due to income. Thus, to mitigate both problems there must be a percent-of-income burden ceiling (proportional or progressive) and income-related cost-sharing (so that the cost-sharing rate varies directly with income).

In Table 4 we examine additional sub-samples of individuals. Within each sub-sample, individuals have roughly the same (within 5%) medical condition index value; however, the index value differs substantially between sub-samples. Recall from Table 3 that we calculated the coefficient of variation of drug expenditures for 91 individuals whose medical condition index was approximately (within 5%) three times the mean index value of the entire sample. In Table 4, each sub-sample has an index value roughly (within 5%) equal to a particular *multiple* of the mean index value of the entire sample. A higher multiple indicates a sicker sub-sample. In the fourth row of the table the multiple is 3.0; we have already presented this case in the right column of Table 3.

In each row of Table 4, the number in the right column, the coefficient of variation of drug expenditures under income-related cost-sharing, is substantially smaller than the number in the middle column, the coefficient of variation under uniform cost-sharing. This holds true for a wide range of sub-samples, each with very different medical condition index values (multiples of the mean index value ranging from 0.5 and 5.0). Thus, the results shown above in the right column of Table 3 generalize for additional sub-samples with a wide range of medical conditions.

A Proportional versus a Progressive Ceiling

Given the necessity of using income-related cost-sharing to mitigate the problem of unequal medication, we now compare a proportional ceiling to a progressive ceiling. In Table 3, Block 3, generated by the proportional ceiling of 5%, prevents anyone from exceeding a 5% burden, whereas Block 4, generated by a progressive ceiling (with a

maximum of 7.5%), does permit 2.3% of the sample to exceed a 5% burden, but at the same time, achieves a less than 5% ceiling for lower-income persons. We now examine this trade-off.

Changing from the proportional ceiling (block 3) to the progressive ceiling (block 4) decreases the percent-of-income burden for 19% of the sample while increasing the percent-of-income burden for 66% of the sample (the remaining 15% of the sample used no medication so its percent-of-income burden is zero under either ceiling). However the 19% who are helped with a decrease in the percent-of-income burden have a much lower mean income than the 66% who experience an increase ($10,312 vs $35,546); and the 19% who are helped have a much higher (sicker) medical condition index than the 66% who are hurt (14 vs 1). For the 19% who are helped, their percent-of-income burden on average decreases by 1.74%, while for the 66% who are hurt, their percent-of-income burden on average increases by only 0.03%. Note that the proportional ceiling is binding for 6,530 enrollees (16% of the 41,742) while the progressive ceiling is binding for 8,696 (21% of the 41,742) enrollees.

Conclusion

In this paper we investigated the impact of varying a patient's cost-sharing *rate* according to patient income. We used the Medicare prescription drug program for illustration. We illuminated the properties of our model with a four-person example. Using data from the Medicare Current Beneficiary Survey, we estimated a censored (Tobit) regression model to incorporate the behavioral responses in the Medicare

population into the micro-simulation model and then performed simulations. We found that introducing income-related patient cost-sharing into a Medicare prescription drug program can substantially reduce the severity of two problems: high percent-of-income burdens, and unequal medication due to income.

Of course, patient behavior for medical care is more complex than we have captured in our simplified model and it would certainly not be possible in practice to fine-tune equity among all patients. Nevertheless, our study does suggest that substantial improvement in the equity of medical care might be obtainable by introducing a percent-of-income ceiling and varying a patient's cost-sharing *rate* with the patient's income.

REFERENCES

Centers for Medicare and Medicaid Services. Code Book: Medicare Current Beneficiary Survey, Calendar Year 2002 Cost and Use (January 2005).

Coulson, N.E, .J.V. Terza, C.A. Neslusan, and B.C. Stuart. 1995. "Estimating the Moral-Hazard Effect of Supplemental Medical Insurance in the Demand for Prescription Drugs by the Elderly." *American Economic Association Papers and Proceedings* 85 (2): 122-126.

Coulson, N.E., and B.C. Stuart. 1995. "Insurance Choice and the Demand for Prescription Drugs." *Southern Economic Journal* 61: 1146-1157.

Feldstein, M., and J. Gruber. 1995. "A Major-Risk Approach to Health Insurance." In *Tax Policy and the Economy 9*, edited by J. Poterba, pp. 103-130, Cambridge, MA: MIT Press.

Gibson, T.B., R.J.Ozminkowski, and R.Z. Goetzel. 2005. "The Effects of Prescription Drug Cost Sharing: A Review of the Evidence." *American Journal of Managed Care* 11 (11): 730-40.

Goldman, D.P, G.F. Joyce, J.J. Escarce, J.E. Pace, M.D. Solomon, M. Laouri, P.B. Landsman, and S.M. Teutsch. 2004. "Pharmacy Benefits and the Use of Drugs by the Chronically Ill." *Journal of the American Medical Association* 291 (19): 2335-2343.

Goldman, D.P., G.F. Joyce, G. Lawless, W. H. Crown, and V. Willey. 2006. "Benefit Design and Specialty Drug Use." *Healh Affairs* 25 (5): 1319-1331.

Gould, J.C. 2003. "The Rebirth of an Income-Based Medicare Premium." *Tax Notes* December 22: 1467-1470.

Gruber, J. 2006. "The Role of Consumer Copayments for Health Care: Lessons from the RAND Health Insurance Experiment and Beyond." Kaiser Family Foundation.

Landsman, P.B., W. Yu, X. Liu; S.M. Teutsch, and M.L. Berger. 2005. "The Impact of 3-Tier Pharmacy Benefit Design and Increased Consumer Cost-sharing on Drug Utilization." *American Journal of Managed Care* 11 (10): 621-28.

Lewis, K.A., and L.S. Seidman. 2006. "Replacing the Medicare Drug Doughnut Hole with Percent-of-Income Ceilings Using Tax Returns." *National Tax Association Proceedings 2005*: 386-391.

Newhouse, Joseph P. 1993. *Free For All? Lessons from the RAND Health Insurance Experiment*. Cambridge, MA: Harvard University Press.

Rice, T., and K.Y. Matsuoka. 2004. "The Impact of Cost-Sharing on Appropriate Utilization and Health Status: A Review of the Literature on Seniors." *Medical Care Research and Review* 61 (4): 415-452.

Santerre, R.E. and J.A. Vernon. 2005. "Assessing Consumer Gains from a Drug Price Control Policy in the U.S." National Bureau of Economic Research Working Paper 11139 : 1-27.

Shea, D.G., B.C. Stuart, and B. Briesacher. 2003-2004. "Participation and Crowd-Out in a Medicare Drug Benefit: Simulation Estimates." *Health Care Financing Review* 25 (2): 47-61.

Stuart, B.C., L. Simoni-Wastilia, and D. Chauncey. 2005. "Assessing the Impact of

Coverage Gaps in the Medicare Part D Drug Benefit." *Health Affairs Web Exclusives* Supplement 24 (1): 167-179;

Table 1. Four-Person Model
Uniform and Income-Related Cost-Sharing and Burden Ceilings
Total Insurer Spending = $2,812.5

Characteristics	Expenditure on Medication	Out-of-Pocket Burden	Insurer Spending	Percent-of-Income Burden	Coefficient of Variation of Drug Expenditure
Block 0 – Uniform Cost Sharing (cost-sharing rate 25%) and No Ceiling					
SickRich	$2,000	$500.00	$1,500.00	5.00%	47%
SickPoor	$1,000	$250.00	$750.00	10.00%	
HealthyRich	$500	$125.00	$375.00	1.25%	47%
HealthyPoor	$250	$62.50	$187.50	2.50%	
Block 1 - Uniform Cost Sharing (cost-sharing rate =26.7%) and a 6% Ceiling					
SickRich	$1,933.51	$517.19	$1,416.32	5.17%	44%
SickPoor	$1,015.09	$150.00	$865.09	6.00%	
HealthyRich	$483.38	$129.30	$354.08	1.29%	47%
HealthyPoor	$241.69	$64.65	$174.04	2.59%	
Block 2 - Uniform Cost Sharing (cost-sharing rate =27.4%) and an 8%,4% Ceiling					
SickRich	$1,911.50	$523.15	$1,388.35	5.23%	44%
SickPoor	$1,003.54	$100.00	$903.54	4.00%	
HealthyRich	$477.87	$130.79	$347.09	1.31%	47%
HealthyPoor	$238.94	$65.39	$173.54	2.62%	
Block 3 - Income-Related Cost Sharing (cost-sharing rate for Rich= 47.4%, cost-sharing rate for Poor=11.8%) and a 6% Ceiling					
SickRich	$1,525.57	$600.00	$925.57	6.00%	0%
SickPoor	$1,525.57	$150.00	$1,375.57	6.00%	
HealthyRich	$363.23	$172.07	$191.17	1.72%	0%
HealthyPoor	$363.23	$43.02	$320.22	1.72%	
Block 4 - Income-Related Cost Sharing (cost-sharing rate for Rich = 45.2%, cost-sharing rate for Poor =11.3%) and an 8%,4% Ceiling					
SickRich	$1,488.05	$672.02	$816.03	6.72%	3%
SickPoor	$1,562.46	$100.00	$1,462.46	4.00%	
HealthyRich	$372.01	$168.00	$204.01	1.68%	0%
HealthyPoor	$372.01	$42.00	$330.01	1.68%	

Table 2: Elasticity Estimates
Dependent Variable lnM, Sample = 12697
"t" values below estimates

	Least Squares			Maximum Likelihood Censored Normal* (Tobit)		
Intercept	-0.943	-5.569	-6.008	-2.309	-7.804	-8.285
	(2.98)	(8.11)	(8.82)	(6.14)	(9.57)	(10.26)
Lnc	-0.709	-0.726	-0.694	-0.808	-0.828	-0.791
	(38.72)	(39.65)	(38.24)	(37.65)	(38.59)	(37.25)
lnY	0.531	0.496	0.499	0.629	0.587	0.589
	(16.67)	(15.66)	(15.96)	(16.64)	(15.62)	(15.88)
Female		0.353	0.299		0.395	0.335
		(4.93)	(4.22)		(4.69)	(4.03)
Lnage		1.157	1.143		1.380	1.367
		(7.52)	(7.47)		(7.59)	(7.57)
Death		-3.469	-3.339		-4.216	-4.046
		(21.82)	(18.43)		(21.87)	(18.41)
Hospice			-0.554			-0.638
			(1.94)			(1.84)
Inpatient			0.825			0.925
			(8.06)			(7.71)
Skilled Nursing			-2.562			-3.067
			(13.98)			(13.99)
Home Health			1.093			1.289
			(7.27)			(7.31)
Outpatient			0.702			0.778
			(9.52)			(8.98)
Adj R^2	0.115	0.151	0.176	0.111	0.145	0.170

* 10792 uncensored observations; 1905 left {ln(0.01)} censored observations.

Table 3: MCBS Sample of 41,742 Enrollees
Alternative Ceilings and Cost Sharing Rates

Cost-Sharing Rate	Ceiling	Percent-of-Income Burden Greater than 10%	Percent-of-Income Burden Greater than 7.5%	Percent-of-Income Burden Greater than 5%	Coefficient of Variation of Drug Expenditure
Block 0 - Uniform Cost Sharing with No Ceiling					
26.9%	none	5.8%	8.9%	15.1%	45%
Block 1 - Uniform Cost Sharing with Proportional Ceiling					
30.0%	5%	0%	0%	0%	45%
Block 2 - Uniform Cost Sharing with Progressive Ceiling					
30.6%	Min 0.0% Max 7.5%	0%	0%	2.2%	45%
Block 3 - Income-Related Cost Sharing with Proportional Ceiling					
Min 1.0% Max 60.8%	5%	0%	0%	0%	6%
Block 4 - Income-Related Cost Sharing with Progressive Ceiling					
Min 1.0% Max 62.1%	Min 0.0% Max 7.5%	0%	0%	2.5%	6%

Table 4: Sub-Samples of Enrollees with Similar Medical Condition

Multiple	Enrollees in Sub-Sample	Uniform Cost Sharing Blocks 0, 1 and 2 Coefficient of Variation of Drug Expenditure	Income-Related Cost Sharing Blocks 3 and 4 Coefficient of Variation of Drug Expenditure
0.5	1,277	41%	15%
1.0	813	44%	15%
2.0	263	42%	7%
3.0	91	45%	6%
4.0	43	46%	12%
5.0	56	61%	15%

APPENDIX AVAILABLE UPON REQUEST FROM THE AUTHORS

INCOME-RELATED PATIENT COST-SHARING:

SIMULATION FOR PRESCRIPTION DRUGS UNDER MEDICARE

In the four-person model, the medicine expenditure M of each person is given by the demand equation $M = Nc^{-e}Y^{?}$ where N is an index of medical condition (10 for each Sick person, 2.5 for each Healthy person), c is the cost-sharing rate, Y is income ($10,000 for each Rich person, $2,500 for each Poor person), -e is the cost-sharing rate elasticity (e=0.5) and ? is the income elasticity (?=0.5). Note that the equation gives the M chosen when the person is *not* protected by an out-of-pocket ceiling imposed by the government; if a person hits the out-of-pocket ceiling so that additional medicine is "free" we assume the person increases expenditure by 10e% (5% because e=0.5) above the M given by the equation.

In order to solve the problem of unequal medication due to income, the cost-sharing rate is varied directly with income—that is, the strategy is to reduce c in the demand equation when Y decreases in order to keep M constant. As long as the cost-sharing rate elasticity (-e) is not zero, it counters the effect of the income elasticity ?. From the demand equation, to keep M the same for persons with the same M (with *no* burden ceiling), $c=(N/M)^{1/e}(Y)^{?/e}$. Here, e=? and $Y_{Rich}=4Y_{Poor}$ so $c_{Rich}=4c_{Poor}$.

The variables used in Table 2 are from the following MCBS sources. Total expenditure is variable AAMTTOT and out-of-pocket expenditure is AAMTOOP, both from MCBS, RIC:SS (Service Summary). The income variable is from MCBS, RIC:1 (Survey Identification), INCOME_C. The variables female, age and died are based on data from MCBS, RIC:A (Administrative Identification), for date of death (H_DOD), gender (H_SEX) and age (H_AGE). The utilization indicator variables are based on data from MCBS, RIC:A (Administrative Identification), for hospice bills (H_HOSSW), inpatient discharges (H_INPSW), skilled nursing (H_SNFSW), home health (H_HHASW), and out-patient visits (H_OUTSW).

In conducting the simulations, we use MCBS cross-section weights to expand the sample. The cross-section weights are from MCBS, RIC:X (Cross-sectional Weights), variable CS1YRWGT.

As in the four-person model above, we assume the demand for prescription drugs is given by $M=Nc^{-e}Y^{?}$, but now e = 0.791 and ? = 0.589 for all persons. We have MCBS data on each person's income Y, total expenditure for prescribed medicine M and out-of-pocket burden B for prescribed medicine. We measure each person's initial cost-sharing rate as c = B/M, and assume the data were generated without any out-of-pocket ceiling protection. Using values for M, c, Y, e and ?, we solve the demand equation presented above for N in order to infer its value for each person. Thus, the data set consists of a sample of 41,742 Medicare enrollees each of whom has an income and an N that yields the person's actual drug expenditures M; the data sample has the profile of the Medicare population for a given year but with imputed values for the unobservable N.

Under a "*progressive*" ceiling, the percentage ceiling varies directly with a person's income; specifically, a person's ceiling percentage is given by $e=e_m - [e_m/(a_e)^Y]$, where a_e is a parameter slightly greater than 1, and e_m is a parameter equal to the maximum possible ceiling percentage; thus, if Y is 0, e is 0, and as Y gets very large, e asymptotically approaches e_m. If a person reaches the out-of-pocket ceiling, additional medication is "free," so we assume that the person increases the quantity demanded by 10e % above what it would have been according to formula. The Appendix Table shows how the percent-of-income ceiling e varies for selected Y.

Under income-related cost-sharing, the cost-sharing rate equals $c = c_m - [c_m/a_c^Y]$, where a_c is a parameter slightly greater than 1, and c_m is a parameter equal to the maximum possible cost-sharing rate; thus, if Y is 0, c is 0, and as Y gets very large, c asymptotically approaches c_m. The Appendix Table shows how the cost-sharing rate c (for text Table 3 Block 4's c_m = 62.1%) varies for selected Y.

The sd/m percentages in the right column of text Table 3 are calculated as follows: Block 0, 45%=\$4,020/\$8,947; Block 1, 45%=\$3,691/\$8,214; Block 2, 45%=\$3,635/\$8,088; Block 3, 6%=\$566/\$8,969; Block 4, 6%=\$552/\$8,833. In the fourth and fifth blocks generated by income-related cost-sharing, the standard deviation is almost 85% lower than in the first three blocks generated by uniform cost-sharing (\$566 and \$552 versus \$4,020, \$3,691, and \$3,635). In the last two blocks the standard deviation is only 6% of the mean, whereas in the first in three blocks the standard deviation is 45% of the mean.

Appendix Table: Schedule of Progressive Ceilings and Income-Related Cost Sharing Rates for Selected Incomes

Income Range ($1000)	Selected Incomes	Progressive Ceilings (Blocks 2,4) Max 7.5%	Cost-Sharing Rates (Block 4) Max 62.1%	Percent Enrollees in Income Range	Cumulative Percent Enrollees
0-2.5	$1250	0.5%	3.76%	2.36%	2.36%
2.5-5	$3750	1.3%	10.61%	1.51%	3.87%
5-7.5	$6250	2.0%	16.65%	9.84%	13.71%
7.5-10	$8750	2.7%	21.98%	11.14%	24.85%
10-12.5	$11750	3.3%	27.57%	9.51%	34.36%
12.5-15	$14250	3.8%	31.62%	8.39%	42.75%
15-20	$17500	4.4%	36.18%	12.45%	55.20%
20-25	$22500	5.1%	41.91%	10.90%	66.10%
25-30	$27500	5.6%	46.37%	8.97%	75.07%
30-35	$32500	6.0%	49.85%	4.76%	79.83%
35-40	$37500	6.3%	52.55%	4.73%	84.56%
40-45	$42500	6.6%	54.66%	2.73%	87.29%
45-50	$47500	6.8%	56.30%	3.65%	90.94%
50-75	$62500	7.2%	59.36%	5.61%	96.55%
75-100	$87500	7.4%	61.31%	1.98%	98.53%
100-140	$120000	7.5%	61.94%	0.70%	99.23%
140-180	$160000	7.5%	62.07%	0.28%	99.51%
180+	$220000	7.5%	62.09%	0.49%	100.00%