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ABSTRACT

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This paper illustrates the impact of moral hazard for estimating relative rates of underinsurance and to present an adjustment method to correct for this source of bias. Individuals or households are often classified as underinsured if out-of-pocket spending on medical care relative to income exceeds some threshold. We show that, without adjustment, this common threshold measure of underinsurance will underestimate the number with low levels of insurance coverage due to moral hazard. We propose an adjustment method and apply it to the specific case of estimating the difference in rates of underinsurance among small- versus large-firm workers with full-year, employer-sponsored insurance. Using data from the 2005 Medical Expenditure Panel Survey, we find that after applying the adjustment, the underinsurance rate of small-firm households increases by approximately 20% with the adjustment for moral hazard and the difference in underinsurance rates between large firm and small firm households widens substantially. Adjusting for moral hazard makes a sizeable difference in the estimated prevalence of underinsurance using a threshold measure.

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I. Introduction

Health care spending in the United States has increased dramatically over the last few decades -- averaging 3.7% real growth per year from 1995 to 2005 -- and rapid growth is predicted to continue (Congressional Budget Office, 2008). In response to this growth, many employers are making changes to their health insurance benefit design to include more cost-sharing provisions, such as higher deductibles and co-insurance. Because of these trends, there is growing concern that merely having some form of health insurance is insufficient and that insured households are becoming less able to afford the cost of their medical care. That is, in addition to a large number of households not having health insurance, a large number of households may be "underinsured."

In order to quantify the number of households that face difficulties in paying for medical expenses, researchers have defined various measures of underinsurance. Underinsurance is typically understood as health insurance failing to provide adequate protection against health care expenditures (for example, see Bashshur et al. (1993)). Several measures of underinsurance have been adopted since there is no consensus on how to apply this concept to health insurance. In pioneering work, Farley (1985) and Short and Banthin (1995) defined underinsurance by combining the risk of a high-expenditure illness and the adequacy of insurance coverage for this event. Others have defined underinsurance using the size of specific insurance benefits (e.g., annual deductible) relative to family income (Schoen et al. (2005)) or the actuarial values of policies. For example, Gabel et al. (2006) documented that the actuarial value of policies provided by small firms was less than that of large firms.

The most common underinsurance measure is a threshold measure. A threshold measure indicates whether a household has spent a certain percentage or more of income on out-of-pocket health care expenditures (see Shearer (2000), Merlis (2002), Schoen et al. (2005), Collins et al. (2009), Banthin and Bernard (2006), Ziller et al. (2006), Banthin et al. (2008), Schoen et al. (2008)). Threshold measures of underinsurance are used because they are easy to compute given available data and are easy to explain. A commonly used threshold for working-aged populations is 10% of household income.

Of course, there are normative assumptions built into this measure just as in any threshold measure of well-being.[1] Different thresholds can be applied to different populations, for example, households in poverty or elderly families. Regardless of the level of threshold used, or whether the same threshold is applied to all populations, this method for measuring underinsurance fails to take into account the fact that households with less comprehensive coverage tend to consume less medical care than they would if they had better insurance, or alternatively, that generously insured households tend to consume more medical care than they would if they has less generous insurance.

Economic theory (see Cutler and Zeckhauser (1999)), non-experimental studies (e.g., Newhouse and Phelps (1972), Bhattacharya, et al. (1996)), and experimental studies (Manning, et al. (1987)) all find that health insurance expenditures respond positively to the generosity of health insurance; this responsiveness is referred to as "moral hazard."

Any threshold measure of underinsurance is a function of actual expenditures for out-of-pocket health care relative to household income. Coverage generosity affects out-of-pocket

[1] For example, the poverty guidelines similarly imply a threshold level of well-being (Federal Register, January 23, 2008, pages 3971-3972).

expenditures in two ways: directly – through co-insurance, deductibles, out-of-pocket spending limits, etc. – and indirectly – through the effect of moral hazard. The concept of underinsurance refers to the direct effect: less generous benefit designs will translate into higher out-of-pocket expenditures for a given level of total spending. However, because of the indirect effect, less generous insurance also will tend to decrease households' medical care utilization and expenditures through a "reverse" moral hazard effect. Therefore, a threshold measure of underinsurance will underestimate the extent to which households have less generous plans. Moreover, when comparing the rate of underinsurance across two populations, the one with less generous coverage will be less likely to have high out-of-pocket spending relative to income than they would in the absence of a moral hazard effect, causing an underestimate of the difference in underinsurance between the two groups.

In this paper, we show that a threshold measure of underinsurance typically will not accurately measure the degree of underinsurance in one population relative to another and propose an adjusted threshold measure of underinsurance that takes account moral hazard. To demonstrate this problem and how our proposed adjustment would work, we consider the specific case of estimating the difference in rates of underinsurance between households who receive their insurance from small-firms versus large-firms.[2] While the adjustment method we propose would apply to any threshold measure of underinsurance, we use the 10% threshold measure as our baseline case and test the sensitivity of our results using alternative definitions.

We find that adjusting for moral hazard makes a noticeable difference in relative underinsurance rates. According to a 10% threshold measure of underinsurance, which does not

[2] Another application of this method would be to a comparison of underinsurance rates between persons with individual coverage and persons with group coverage.

account for moral hazard, the underinsurance rate among households whose policyholder is employed by a small firm is 90% of that among households whose policyholder is employed by a large firm. That is, despite substantial evidence that small-firm households tend to have less generous coverage, these households appear to have relatively lower rates of underinsurance. We show, however, that this comparison is misleading because of the moral hazard effect. After adjusting for moral hazard, the underinsurance rate among small firm households is 33% greater than that among large firm households.

II. Insurance Generosity in Small and Large Firms

Small firms, when they do offer health insurance, tend to offer less generous insurance (Gabel et al. 2006). According to data from the 2005 Medical Expenditure Panel Survey (MEPS) Insurance Component List Sample (see Table 1), while there is variation in generosity within both firm-size groups, on average small firms offer insurance with higher deductibles, higher copayments, and higher out-of-pocket maximum limits than do larger firms. For example, deductibles among small-firm plans average almost $800 higher than deductibles among large-firm plans ($1,875 vs. $1,076). Hospital co-insurance rates average 19% among small-firm plans and average 17% among large-firm plans; drug co-insurance rates average 40% among small-firm plans and average 24% among large-firm plans. Similarly, the family maximum annual out-of-pocket limit averages more than $500 higher among small-firm plans than among large-firm plans ($5,174 vs. $4,667).

These plan coverage provisions directly affect the out-of-pocket costs incurred by households. Since small-firm plans tend to provide less generous insurance in terms of deductibles, co-payments, co-insurance, and annual out-of-pocket limits, one might expect higher rates underinsurance among small-firm households than among large-firm households.

In contrast to what one might expect, a higher percentage (5.2%) of large-firm households are underinsured (using a 10% threshold measure) than of small firm households (4.7%), according to our analysis, which we describe below. The explanation for this puzzling result is that moral hazard matters for the measurement of relative rates of underinsurance. That is, small-firm households reduce their utilization and expenditure in response to the relatively high cost-sharing they face (as a result of having less generous insurance) though a "reverse" moral hazard effect. Having less generous insurance leads many small-firm households to reduce their total medical care spending by enough so that they are not counted as underinsured by a threshold measure.

III. The Problem and a Stylized Solution

In this section, we demonstrate the effect of moral hazard on the measurement of underinsurance with a simple example. We also present a stylized version of the solution we propose for the calculation of adjusted underinsurance rates that account for this moral hazard effect. Consider two households, Household X and Household Y, which are identical in all ways except in terms of plan generosity. As a consequence of moral hazard, Household X (with the generous health insurance plan) spends more on medical care than Household Y (with the stingy plan) -- $5,000 versus $3,500 (see Table 2, Panel A). However, due to the differences in plan generosity, their out-of-pocket expenditures are nearly identical: Household X spends $1,500 out-of-pocket while Household Y spends $1,400 out of pocket. The income for each household is $15,000, so that Household X spends 10% of its income, out-of-pocket, on medical care while Household Y spends only 9.3%. If we were to use a 10% threshold measure of underinsurance, Household X (with the generous plan) would be classified as underinsured while Household Y

(with the stingy plan) would not be. We will apply our method to small- and large-firm households but as the example indicates this is a general result for any two populations with different average levels of generosity of coverage.[3]

How might one adjust the threshold measure of underinsurance to account for moral hazard? If we knew how much medical spending Household Y would incur if it had generous health insurance, we could use the benefit characteristics of Household Y's actual (stingy) health insurance plan to determine what their out-of-pocket spending would be, accounting for moral hazard. We demonstrate how to make such an adjustment in the context of our example (see Table 2, Panel B). In the example, we use Household X's spending as an estimate of how much medical spending Household Y would incur if it had generous health insurance since, by assumption, Households X and Y are identical except for the generosity of their health plans. Therefore, Household Y's expected total medical care spending if it had a generous plan is $5,000. To determine the amount of out-of-pocket spending Household Y would incur if it spent as much as Household X, but if it also faced the cost-sharing rate of the stingy plan, we multiply its expected total spending by its actual average cost-sharing rate.[4] To determine the average cost-sharing rate, recall that Household Y spends $3,500 on medical care and spends $1,400 out-of-pocket. Thus, the average cost sharing for Household Y (stingy plan) is 40% (=$1,400/$3,500). Adjusted out-of-pocket spending for Household Y is, therefore, $2,000 (=0.40*5,000). We propose basing the threshold measure of underinsurance on the ratio of

[3] While in our simple example we assume that there are only two plans, one for small firms and one for large firms, there is, obviously, substantial heterogeneity in plans within both types of firms. Our method does not rely on there being only one type of plan for each group. Rather it applies to a comparison of two groups whose generosity of plans differs on average. Our method could also be expanded to include more than two groups.

[4] Here we are assuming a constant cost-sharing rate across all spending levels. In our empirical application, we allow for the cost sharing rate to vary by total spending.

adjusted out-of-pocket spending to income. In this example, this ratio is 0.133 (=$2,000/$15,000) for Household Y, meaning that this household is underinsured once we account for moral hazard. If we compare this ratio across the two households, Household Y is now correctly identified as having less generous coverage and is "more underinsured" than Household X.

By using the total health care spending of Household X (with the generous plan) in our calculation of Household Y's adjusted out-of-pocket spending, we do not mean to imply that a generous health plan represents the "standard" for optimal health insurance. We could, alternatively, adjust the out-of-pocket spending of Household X (with generous insurance) by determining how much medical spending it would have incurred if it had stingy health insurance (estimated by Household Y's spending). Since the average cost-sharing rate for Household X is 30%, adjusted out-of-pocket spending for Household X using the less generous plan as the baseline amounts to $1,050 (=0.30*$3,500) and the ratio of adjusted out-of-pocket spending to income is 0.07 (=$1,050/$15,000), compared to the ratio of 0.093 for Household Y. Thus, using either the more generous or the stingy plan as the base case leads to an adjustment that increases the relative underinsurance rate for the less generously insured household.

IV. Data and Measures

A. Data

We use the 2005 MEPS, Household Component (MEPS-HC) for our analysis. The MEPS-HC sample is drawn from respondents to the National Health Interview Survey, which is a nationally representative sample of the U.S. civilian, non-institutionalized population.

Our sample is restricted to households that report having employer-sponsored insurance (ESI) for all members during the entire 2005 calendar year.[5] Our definition of a household is based on a relationship unit constructed to include adults plus family members who typically would be eligible for dependent coverage under private family plans. We drop households for which we cannot confirm ESI status or that do not have any active workers (e.g., early retirees or COBRA enrollees). After removing observations with missing information, we have data on 10,384 individuals in 4,642 unique households (corresponding to 119.6 million individuals residing in 55.8 million households).

B. Measures

The MEPS-HC contains data on medical care spending, income, employment status, establishment size, health insurance coverage, human capital and demographic information, and medical conditions for individuals and households.

Medical Spending: We use information on two types of medical care spending: total and out-of-pocket. We aggregate individual-level spending across household members to get household-level out-of-pocket and total medical care spending. We then inflate the measures to $2007 and re-scale them into thousands of dollars.

[5] We do not include households with part-year coverage because it is difficult to distinguish households that are uninsured for part of the year and underinsured for part of the year from households who are uninsured for part of the year and "fully" insured for part of the year. Also, we do not include households that have multiple types of coverage (e.g., ESI for parents, public for children) for a similar reason. These restrictions help to explain why our estimates of underinsurance rates may differ from other recent studies.

Income: We use after-tax household income in the denominator of our threshold measures of underinsurance. Pre-tax household income is aggregated from person-level income for the calendar year; we use TAXSIM (version 8.6) to estimate after-tax income.

Small-Firm / Large-Firm Household: To designate households that obtain ESI through a small firm or through a large firm, we first identify the ESI policyholder(s) in the household. Second, we construct an indicator for whether the policyholder was employed at a small establishment (50 or fewer workers). Finally, we define small-firm households as those in which all ESI coverage (whether through one policyholder or two) was obtained through a small establishment.[7]

Human Capital and Demographic Measures: In our total spending models, we include a set of measures to capture demographic and human capital attributes of policyholder(s) in the household. In households with two policyholders, we use the higher valued outcome. In particular, we include the age of the policyholder (years), highest education (years), race (white, black, Asian/Pacific islander, other (reference category))[8], whether the household is married, and number of children in the household who are 17 or under. We also include a set of dummy variables to capture the income quartile of the household. Since there may be geographic differences in benefits, labor market conditions, and provider prices, we also include four region dummies (Northeast, Midwest, South, West (excluded)) and an indicator for whether the household resides in a metropolitan statistical area to control for these differences.

[6] The public-use version of the MEPS does not contain state identifiers. As a result, we were not able to simulate state income tax burden on households meaning that we overestimate after-tax income, leading to more conservative estimates of underinsurance.

[7] We use "establishment" and "firm" interchangeably. The data measure establishment size.

[8] We re-coded multi-race households to reflect the less prevalent race in the population.

Medical Conditions: We control for a set of serious medical conditions that household members reported because medical care spending is positively related to the presence of such medical conditions. Using the Medical Conditions file in the MEPS, we construct a set of variables corresponding to the number of household members reporting the following: cancer, diabetes, high cholesterol, hypertension, heart disease, arthritis, asthma, depression or anxiety, and back problems.

Table 3 provides variable definitions and summary statistics for the sample of households. As can be seen, the underinsurance rate (based on the 10% threshold) is lower among small-firm households than among large-firm households (4.72% vs. 5.23%). Similarly, there is only a small difference in the underinsurance rate between the two groups – 5.92% vs. 6.01% -- when using a graduated threshold measure of underinsurance. This latter measure classifies low-income households (< 200% FPL) as underinsured if they spend more than 5% of after-tax income on medical care and applies the 10% threshold to all other households. These results are puzzling given the large differences in the characteristics of plans offered by small and large firms (described in Table 1), highlighting the potential importance of moral hazard.

V. Method of Adjusting the Underinsurance Measure to Account for Moral Hazard

In this section, we present our method of adjusting for moral hazard when calculating the relative underinsurance rates between any two populations that differ in the average generosity of their health insurance. Our method requires five steps, which are described below.

First, we estimate the conditional distribution of total household medical care spending separately for the sample of large-firm households (that have, on average, more generous plans) and small-firm households (that have, on average, less generous plans). Specifically, we estimate

the distribution of spending by estimating quantile regressions at the 10th, 30th, 50th, 70th, and 90th quantiles.[9] We use quantile rather than mean regression because the relationship between household characteristics and spending varies at different points of the spending distribution. The variables we condition on include household demographics, human capital, income, medical conditions, and geographic region.

Second, for each household type, we generate two predicted values of total spending. The first measure ("predicted") is predicted total spending using each household's demographic, income, medical, and geographic characteristics and the parameter estimates from the quantile regressions for their own household type (small-firm or large-firm household). The second measure ("adjusted") captures what total medical care spending of small-firm (large-firm) households would have been had they had the more (less) generous health plans. That is, we predict total spending for each household based on each observation's characteristics but using the estimated coefficients from the quantile regressions from the other household type.[10] We thus have four unique distributions of predicted spending: (i) predicted small-firm household spending based on small-firm household characteristics and coefficients from the small-firm household models, (ii) adjusted small-firm household spending based on small-firm household characteristics and coefficients from the large-firm household models, (iii) predicted large-firm household spending based on large-firm household characteristics and coefficients from the

[9] All analyses are estimated using sampling weights. We have tested the sensitivity of our results to estimating these models at other quantiles and, in our application, the results were robust. It is possible that in other applications the choice of the set of quantiles could matter.

[10] We generate predicted total spending values using each of the five quantile regression models, yielding five observations per household. The predicted distribution of total spending thus depends on estimates from each of the quantile regression models as is recommended by Machado and Mata (2005).

large-firm household models, and (iv) adjusted large-firm household spending based on large-firm household characteristics and coefficients from the small-firm household models.

Since small-firm households tend to have less generous insurance and, as a result, likely cut back on their spending (due to "reverse" moral hazard), we would expect their adjusted spending distribution to be shifted to the right (i.e., to yield higher predicted spending levels) relative to their predicted actual spending.[11] Similarly, since large-firm households tend to have more generous insurance and likely increase their spending due to moral hazard, we would expect their adjusted spending distribution to be shifted to the left (i.e., to yield lower predicted spending levels) relative to their predicted actual spending.

While the predicted spending measure does not, of course, capture unobservable differences between small- and large-firm households, given that we have a rich set of explanatory variables, including a large set of medical conditions, we believe we have captured most of the critical characteristics that determine health care spending and which might differ by firm size. Our predicted spending measures also do not account for adverse selection in the choice of health plan. Future applications of this method could yield improved estimates of predicted spending and of adjusted predicted spending with an even more complete set of controls.

Our third step is to estimate cost-sharing parameters for the small-firm and large-firm households in our data. Cost sharing differs across the total spending distribution due to differences in benefit design features such as deductibles and out-of-pocket maximums. To capture this variation, we calculate the average fraction of out-of-pocket spending to total spending by households' reported total spending decile (separately for small-firm and large-firm

[11] This corresponds to Column (E) of Table 2, Panel B of the stylized example presented in Section III.

households). Among small firm households, these cost-sharing parameters range from 0.533 among households in the first decile of total spending to 0.166 among households in the tenth decile. The range is somewhat narrower for large-firm households: 0.379 among households in the first decile to 0.141 among households in the tenth decile). Each household is assigned the cost-sharing parameter that corresponds to its firm-size and its decile of predicted total spending.

The fourth step is to compute the expected out-of-pocket medical spending for each household. To do this, we multiply the value of the household's predicted and adjusted total medical spending values by their cost-sharing parameter.

Finally, we calculate the ratio of expected out-of-pocket spending to actual after-tax income. This ratio is then compared to the threshold relevant to the particular measure of underinsurance being used. For example, under a 10% threshold measure, if this ratio exceeds 0.10, a household would be classified as underinsured under the adjusted measure.[12]

VI. Results

We calculate observed rates of underinsurance and, using the method described in the previous section, rates of underinsurance for small-firm and large-firm households that take into account the effects of moral hazard. We present two sets of estimates: "predicted" and "adjusted."[13] Predicted rates are based on households' predicted out-of-pocket spending relative

[12] The ratio corresponds to Column (H) of Table 3 and the underinsurance indicator corresponds to Column (I).

[13] Actual underinsurance rates are presented in Table 3. We cannot compare actual underinsurance rates with "adjusted" rates because they are not strictly comparable.

to their own income; adjusted rates for small-firm (large-firm) households are based on households' predicted out-of-pocket spending estimated using large-firm (small-firm) model parameters as the baseline. We calculate two measures of underinsurance: (1) a straight 10% threshold and (2) a graduated threshold based on FPL.

Based on their predicted spending, only a slightly larger percentage of small-firm households are underinsured than are large-firm households, using either the 10% threshold measure (4.3% versus 3.9%) or the graduated threshold (5.9% versus 5.5%); see Table 4.[14] However, because moral hazard leads households with less generous coverage to cut back on their spending relative to households with more generous coverage, the differences in predicted underinsurance are misleading.

Adjusting for moral hazard leads to a 5.7% increase in predicted total spending for small-firm households ($5,813 versus $5,499), consistent with our expectation that these households respond to their less generous coverage by cutting back on spending.[15] Moral hazard also has the effect of reducing out-of-pocket spending among small-firm households. Adjusting for moral hazard leads to a 5.3% increase in predicted out-of-pocket spending among small-firm households.

We also present the effects of this adjustment on underinsurance rates in Table 4. The result of these adjustments leads to a 21% increase in the underinsurance rate among small-firm households (using large-firm household spending as a baseline) using the 10% threshold

[14] The results from the quantile regressions are presented in Appendix Tables A1-A2.

[15] Similarly, adjusting for moral hazard leads to a 5.6% decrease in predicted total spending for large-firm households ($5,629 versus $5,961), consistent with households' spending more in response to generous coverage (results in Appendix Table A3).

measure. Adjusting for moral hazard also substantially affects the measure of underinsurance that uses the graduated threshold, increasing it by 15%.

The effects of moral hazard lead to a highly misleading picture of the difference in underinsurance rates between small- and large-firm households. The differences in predicted underinsurance rates between small-firm and large-firm households are very small -- 0.004 based on either threshold measure. Adjusting for moral hazard, however, leads to a 225% increase in this difference (from 0.004 to 0.013) when using large-firm spending as the baseline.

Our adjustment methods illustrate that the puzzle of relatively greater underinsurance rates among large-firm households can be explained by small-firm households' cutting back on care in response to their less generous coverage relative to what they would have spent if they had the more generous coverage enjoyed by large firm workers. Not accounting for the reverse moral hazard associated with less generous coverage reduces the relative underinsurance rates among groups with less generous coverage. We also find the corresponding but opposite effect when examining the issue from the large-firm household's perspective. That is, underinsurance rates of large-firm households fall when the effect of moral hazard is taken into account (see Table A3.)

VII. Conclusions

Underinsurance, the phenomenon of insured households' being unable to afford the out-of-pocket cost of their medical care, is a growing policy concern. In this paper, we show that moral hazard matters for measures of underinsurance. That is, the fact that people with more extensive health insurance coverage tend to increase their health care expenditures can impact

measures of underinsurance. Adjusting for this moral hazard effect is necessary when estimating the relative rates of underinsurance across groups. We show that in the absence of this adjustment, roughly the same percentage of households who obtain their insurance coverage from a large firm are underinsured as the percentage of households who obtain their insurance coverage from a small-firm. This result would be puzzling because small firms typically offer less generous insurance in terms of deductibles, co-insurance rates, and annual out-of-pocket limits. Adjusting for the effects of moral hazard, we find that our estimate of the percentage of small-firm households who are underinsured increases substantially — by roughly 20%. Moreover, the difference in underinsurance rates between small-firm and large-firm households under our corrected measure is 225% larger than the unadjusted difference.

Our application addresses the measurement of disparities in coverage of small- versus large-firm workers but the problem, as well as our method to correct it, is more general. Moral hazard could affect comparisons between any groups with differing levels of coverage generosity. Our application shows that adjusting for moral hazard can make a substantial difference in the number of households identified as underinsured and in the relative rates of underinsurance across groups.

REFERENCES

Banthin, Jessica, P. Cunningham, and D. Bernard, "Financial Burden of Health Care, 2001-2004, 2008, Health Affairs, 27(1): 188-195.

Banthin, Jessica and D. Bernard. "Changes in Financial Burdens for Health Care: National Estimates for the Population Younger than 65 Years, 1996 to 2003." December 13, 2006, JAMA, 296(22): 2712-2719.

Bashshur, Rashid, D. Smith, and R. Stiles. "Defining Underinsurance: A Conceptual Framework for Policy and Empirical Analysis." Summer 1993, Medical Care Review, 50(2): 199-218.

Bhattacharya and Vogt (1996) The Utilization of Outpatient Medical Services in Japan Journal of Human Resources Vol. 31, No. 2, (Spring, 1996), pp. 450-476

Collins, Sara, J. Kriss, M. Doty, and S. Rustgi. "Losing Ground: How the Loss of Adequate Health Insurance Is Burdening Working Families." Commonwealth Fund Publication 1163. Accessed at www.cmwf.org, August 2009.

Congressional Budget Office, "Technological Change and the Growth of Health Care Spending." Accessed at www.cbo.gov, August, 2008.

Cutler, David, and R. Zeckhauser, "The Anatomy of Health Insurance," in Handbook of Health Economics, A.J. Culyer and J.P. Newhouse (eds), New York: Elsevier, 2000.

Farley, Pamela. "Who Are the Underinsured?" Summer 1985, *Milbank Memorial Fund Quarterly* 63(3): 476-503.

Gabel, Jon, R. McDevitt, L. Gandolfo, J. Pickreign, S. Hawkins, and C. Fahlman. "Generosity and Adjusted Premiums in Job-Based Insurance: Hawaii is Up, Wyoming is Down." May/June 2006, Health Affairs, 25(3): 832-843.

Machado, Jose A. and Jose Mata, "Counterfactual Decomposition of Changes in Wage Distributions Using Quantile Regression," *Journal of Applied Econometrics*, vol. 20, no. 4 (2005), pp. 445–465,

Manning, Willard, J. Newhouse, N. Duan, E. Keeler, A. Leibowitz, and M. Marquis., "Health Insurance and the Demand for Medical Care: Evidence from a Randomized Experiment, American Economic Review, 77(3): 251-277.

Merlis, Mark. "Family Out-of-Pocket Spending for Health Services: A Continuing Source of Financial Insecurity." Commonwealth Fund Report, June 2002. Accessed at www.cmwf.org, 2008.

Newhouse, Joseph P., and Charles E. Phelps. 1976. "New Estimates of Price and Income Elasticities of Medical Care Services." In The Role of Health Insurance in the Health Services Sector, ed. R. N. Rossett. New York: National Bureau of Economic Research.

Schoen, Cathy, M. Doty, S. Collins, and A. Holmgren. "Insured But Not Protected: How Many Adults are Underinsured?" June 14, 2005, *Health Affairs*, W5-289-302.

Schoen, Cathy, S. Collins, J. Kriss, and M. Doty. "How Many are Underinsured? Trends Among U.S. Adults, 2003 and 2007. July/August 2008, *Health Affairs*, 27(4): w298-309.

Shearer, G. "The health care divide: Unfair financial burdens. Consumers Union, 2000. Available at http://www.consumersunion.org/health/divide/divide.htm.

Short, Pamela and J. Banthin. "New Estimates of the Underinsured Younger than 65 Years." October 25, 1995, JAMA, 274(16): 1302-1306.

Ziller, Erika, A. Coburn, and A. Yousefian. "Out-of-Pocket Health Spending and the Rural Underinsured." November/December 2006, Health Affairs, 25(6): 1688-1699.

Table 1: Summary Statistics on ESI Plan Characteristics, by Firm Size

	Mean			25th Percentile			75th Percentile			95th Percentile		
Firm Size (# of Employees)	Small (< 50)	Large (50 +)	Differ-ence	Small (< 50)	Large (50 +)	Differ-ence	Small (< 50)	Large (50 +)	Differ-ence	Small (< 50)	Large (50 +)	Differ-ence
Deductibles												
Single Deductible ($)	$917	$543	$374	$500	$250	$250	$1,000	$500	$500	$2,500	$1,500	$1,000
Family Deductible ($)	$1,875	$1,076	$799	$600	$500	$100	$2,500	$1,200	$1,300	$6,000	$3,000	$3,000
Co-Payment and Co-Insurance												
% with Office Co-payment	79%	76%	3%	--	--	--	--	--	--	--	--	--
Office Copay ($)	$20	$18	$3	$15	$15	$0	$25	$20	$5	$35	$30	$5
% with Office Co-insurance	16%	21%	-5%	--	--	--	--	--	--	--	--	--
Office Coinsurance (%)	20%	18%	2%	20%	10%	10%	20%	20%	0%	40%	30%	10%
% with Hospital Co-payment	32%	30%	2%	--	--	--	--	--	--	--	--	--
Hospital Copay ($)	$584	$355	$229	$100	$100	$0	$500	$300	$200	$2,000	$1,250	$750
% with Hospital Co-insurance	47%	54%	-7%	--	--	--	--	--	--	--	--	--
Hospital Coinsurance (%)	19%	17%	2%	20%	10%	10%	20%	20%	0%	30%	30%	0%
% with Drug Co-payment	93%	89%	4%	--	--	--	--	--	--	--	--	--
Drug Copay ($)	$13	$10	$2	$10	$8	$2	$15	$10	$5	$25	$20	$5
% with Drug Co-insurance	8%	13%	-5%	--	--	--	--	--	--	--	--	--
Drug Coinsurance	40%	24%	17%	20%	20%	0%	50%	25%	25%	100%	50%	50%
Annual Out-of-pocket Limits												
% with Single OOP Limit	68%	73%	-5%	--	--	--	--	--	--	--	--	--
Single Max OOP limit	$2,380	$2,102	$278	$1,250	$1,250	$0	$3,000	$2,500	$500	$5,000	5000	$0
% with Family OOP Limit	60%	70%	-10%	--	--	--	--	--	--	--	--	--
Family Max OOP limit	$5,174	$4,667	$507	$2,600	$3,000	-$400	$6,000	$6,000	$0	$10,500	$10,000	$500

Source: John Sommers, AHRQ based on the 2005 MEPS - Insurance Component

Table 2: How Moral Hazard Matters: An Example

Panel A: How Moral Hazard Matters for Measuring Underinsurance: An Example

	Plan Type	Total Expenditures	Out-of-Pocket Expenditures	Income	Ratio of OOP to Income (C) / (G)	Threshold (10%) Underinsurance Measure
	(A)	(B)	(C)	(G)	(H)	(I)
Household X	Generous	5000	1500	15000	0.10	Yes
Household Y	Stingy	3500	1400	15000	0.093	No

Panel B: Adjusting a Measure of Underinsurance to Account for Moral Hazard

	Plan Type	Total Expenditures	Out-of-Pocket Expenditures	Cost-Sharing (C) / (B)	Expected Total Expenditures if Had a Generous Plan	Expected OOP Expenditures: Spending from Generous Plan but Cost-Sharing from Own Plan (D) * (E)	Income	Ratio of Expected OOP to Income (F) / (G)	Adjusted Threshold (10%) Underinsurance Measure
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H) =(F)/(G)	(I)
Household X	Generous	5000	1500	0.3	5000	1500	15000	0.100	Yes
Household Y	Stingy	3500	1400	0.4	5000	2000	15000	0.133	Yes

Note: Household X and household Y are identical except for their plan type (generous; stingy). Underinsurance is defined here as having out-of-pocket expenditures that exceed 10% of household income.

Table 3: Descriptive Statistics

Variable	**Mean**	**Standard deviation**
Underinsurance rate (%) (10% threshold) for small firm households	4.72	21.2
Underinsurance rate (%) (10% threshold) for large firm households	5.23	22.3
Underinsurance rate (5% threshold < 200% FPL, 10% above 200% FPL) for small firm households	5.92	23.6
Underinsurance rate (5% threshold < 200% FPL, 10% above 200% FPL) for large firm households	6.01	2.38
Household Total Medical Expenditures (1000s, $2007) for small firm households	6.264	12.964
Household Total Medical Expenditures (1000s, $2007) for large firm households	7.212	15.450
Household Out-of-Pocket Spending (1000s, $2007) for small firm households	1.407	2.051
Household Out-of-Pocket Spending (1000s, $2007) for large firm households	1.330	2.209
Small Establishment Household	0.366	0.482
Age of policyholder	43.977	12.256
Education of policyholder	14.038	2.413
White	0.830	0.376
Black	0.108	0.310
Asian	0.043	0.204
Hispanic	0.087	0.281
Married	0.530	0.499
Number of children < 18	0.560	0.946
Household after tax income (1000s, $2007)	57.738	37.027

First income quartile (< $32.0)	.250	.433
Second income quartile ($32.0, $48.89)	.250	.433
Third income quartile ($48.90, $73.32)	.250	.433
Fourth income quartile (> $73.32)	.250	.433
MSA	0.859	0.348
Northeast	0.207	0.405
Midwest	0.240	0.427
South	0.329	0.470
Policyholder is a union member	0.212	0.409
Number of household members with cancer	0.068	0.267
Number of household members with diabetes	0.094	0.308
Number of household members with high cholesterol	0.212	0.474
Number of household members with hypertension	0.296	0.535
Number of household members with heart disease	0.088	0.292
Number of household members with arthritis	0.025	0.165
Number of household members with asthma	0.107	0.346
Number of household members with mental health condition	0.295	0.584
Number of household members with back problems	0.212	0.467

Table 4: Predicted and Adjusted Medical Care Spending and Underinsurance, Small- Firm Households

	Predicted for Small-Firm HHs[1]	Adjusted For Moral Hazard Using Large-Firm Spending as the Baseline[2]	% Difference Between Small Firm Predicted and Adjusted	Predicted for Large-Firm HHs[1]	Difference between Predicted Underinsurance Rates between Small-Firm and Large-Firm Households	Difference in Underinsurance Rates between Small-Firm and Large-Firm Households adjusting for Moral Hazard Using Large-Firm Spending as the Baseline (Adjusted Small-Firm vs. Predicted Large-Firm)	Percentage Increase in Small-Firm vs. Large-Firm Difference in Underinsurance due to Adjustment for Moral Hazard
Mean, Total medical care spending	$5,499	$5,813	5.7%	$5,961			
Mean, Out-of-pocket medical care spending	$1,371	$1,444	5.3%	$1,286			
Underinsurance rate (10% threshold)	0.043	0.052	21%	0.039	0.004	0.013	225%
Underinsurance rate (5% for < 200% FPL; 10% others)	0.059	0.068	15%	0.055	0.004	0.013	225%

[1]Predicted values of total medical care spending from the quantile regression model of total spending. Predicted for small-firm households uses both small-firm characteristics and estimated coefficients from small-firm regressions. Predicted for large-firm households uses both large-firm characteristics and estimated coefficients from large-firm regressions. Predicted out-of-pocket spending uses predicted total spending multiplied by estimated cost-sharing. Estimated cost-sharing is the average fraction of out-of-pocket spending to total spending by households' reported total spending decile (separately for small-firm and large-firm households). Predicted underinsurance is based on the ratio of predicted out-of-pocket spending to actual income.

[2] Adjusted values are predictions of total medical care spending using small-firm household characteristics and estimates from the *large-firm* quantile regression model.

Table A1: Quantile Regressions of Total Medical Care Spending, Large Firm Households					
	10th	30th	50th	70th	90th
Age of oldest policyholder in household	0.0035025	0.01	0.0190806	0.048351	0.103483
	-0.0020503	(0.0031649)**	(0.0047365)**	(0.0071216)**	(0.0223848)**
Highest education years of policyholders in household	0.0309034	0.068055	0.0840637	0.1463639	0.1436388
	(0.0084950)**	(0.0133228)**	(0.0206183)**	(0.0307850)**	-0.0895383
White race/ethnicity	-0.0066583	0.1327721	-0.1499751	-0.5335571	0.7820083
	-0.1166869	-0.1800579	-0.3139043	-0.4553603	-1.2489493
Black race/ethnicity	-0.2112099	-0.2160321	-0.539119	-1.0190408	-0.442692
	-0.1263253	-0.1949371	-0.3314155	(0.4798441)*	-1.3276333
Asian race/ethnicity	-0.4136599	-0.294201	-0.7644882	-1.0520534	0.8715989
	(0.1395081)**	-0.2181539	(0.3648671)*	-0.540844	-1.5711847
Hispanic race/ethnicity	-0.4849624	-0.2396492	-0.3233902	-0.5540547	-1.1115463
	(0.0646813)**	(0.1056158)*	(0.1593825)*	(0.2463230)*	-0.6869551
Policyholder is married	0.4318964	0.8174658	1.248957	2.2839752	3.4199297
	(0.0555744)**	(0.0829693)**	(0.1269008)**	(0.1908073)**	(0.5847211)**
Number of children younger than 18	0.2385319	0.2441289	0.4723554	0.6861885	1.6479616
	(0.0232931)**	(0.0362571)**	(0.0557259)**	(0.0823575)**	(0.2595329)**
First income quartile	-0.0211624	-0.1769761	-0.2312394	0.2509493	1.7059176
	-0.0719181	-0.1094789	-0.1678553	-0.2528206	(0.7665998)*
Second income quartile	-0.0372836	-0.2592783	-0.378163	0.0065724	1.1506693
	-0.0628531	(0.0953270)**	(0.1473235)*	-0.2254993	-0.652841
Third income quartile	-0.0608837	-0.2554456	-0.2336489	0.1781744	1.0088286
	-0.0600508	(0.0890578)**	-0.1355108	-0.2022955	-0.59992
=1 if lives in MSA, 0 if non MSA	0.1511822	0.0015933	-0.0442073	-0.3215069	0.5811325
	(0.0618251)*	-0.0906806	-0.1359927	-0.2070243	-0.5843475
=1 if lives in Northeast census region	-0.0133726	-0.0112326	-0.01831	-0.5783121	-2.1994606
	-0.0639993	-0.0992286	-0.1484734	(0.2242259)**	(0.6686817)**
=1 if lives in Midwest census region	-0.0165174	0.1785517	0.3248609	0.1860745	1.2004322
	-0.0565773	-0.09235	(0.1409432)*	-0.2132143	-0.6432694
=1 if lives in South census region	-0.0395981	0.0445862	-0.1163862	-0.5617678	-1.6912973
	-0.053836	-0.0899191	-0.1365844	(0.2057697)**	(0.6134180)**
=1 if union household, 0 ow	0.0133726	0.2438073	0.28592	0.4572171	1.2455997
	-0.0487863	(0.0743637)**	(0.1120412)*	(0.1709162)**	(0.5121359)*
Number in household with cancer diagnosis	0.992983	2.4655846	3.3541369	4.6039117	18.3728581
	(0.0781165)**	(0.1148307)**	(0.1776600)**	(0.2641845)**	(0.8458655)**
Number in household with diabetes diagnosis	1.1060872	1.3455187	2.176344	3.1053304	4.3627576
	(0.0689055)**	(0.1030258)**	(0.1546945)**	(0.2249842)**	(0.6759991)**
Number in household with high cholesterol diagnosis	0.766666	0.939623	1.0429396	1.0366125	3.2550057

	(0.0514618)**	(0.0749349)**	(0.1096763)**	(0.1617087)**	(0.4893018)**
Number in household with hypertension diagnosis	0.4763056	0.91114	1.2887162	1.7891107	2.7715712
	(0.0416718)**	(0.0640599)**	(0.0969952)**	(0.1441591)**	(0.4498661)**
Number in household with heart disease diagnosis	0.9957451	1.6007056	2.1337608	5.3272863	13.287302
	(0.0722688)**	(0.1071257)**	(0.1565000)**	(0.2329596)**	(0.7223229)**
Number in household with arthritis diagnosis	1.690255	2.1737852	4.6871519	7.4643835	11.5214327
	(0.0969726)**	(0.1740456)**	(0.2589924)**	(0.3805768)**	(1.3007496)**
Number in household with asthma diagnosis	0.8038603	0.9982606	1.058909	1.0995602	0.8427959
	(0.0562632)**	(0.0924689)**	(0.1336248)**	(0.1925751)**	-0.5972283
Number in household with depression or anxiety diagnosis	0.6402517	1.3713798	2.1407505	2.8687967	6.0591686
	(0.0331231)**	(0.0531865)**	(0.0815719)**	(0.1202964)**	(0.3571227)**
Number in household with back pain diagnosis	0.3455024	1.0416031	1.6496641	2.9150632	5.1373314
	(0.0501850)**	(0.0687861)**	(0.1008201)**	(0.1480319)**	(0.4282482)**
Constant	-0.6400697	-1.0876031	-0.866934	-1.5862833	-3.7321068
	(0.2079340)**	(0.3290063)**	-0.5290207	(0.7806541)*	-2.3771067
Observations	2957	2957	2957	2957	2957
Pseudo-R^2	0.11	0.16	0.18	0.20	0.21

Source: Authors' calculations based on data from 2005 MEPS-HC.
Notes: Standard errors in parentheses;
*** significant at 5%; ** significant at 1%. Dependent variable is total spending in $1000s.**

Table A2: Quantile Regressions of Total Medical Spending, Small-Firm Households					
	10th	**30th**	**50th**	**70th**	**90th**
Age of oldest policyholder in household	0.0003929	0.0068506	0.0130341	0.0313286	0.0730499
	-0.0037484	(0.0027341)*	(0.0059810)*	(0.0100390)**	(0.0359718)*
Highest education years of policyholders in household	0.0243422	0.0402951	0.0848184	0.0937261	-0.0971992
	-0.0170142	(0.0132246)**	(0.0280666)**	-0.0483748	-0.1703214
White race/ethnicity	-0.1196953	0.0627295	-0.303349	0.4587277	-1.9541189
	-0.2243969	-0.1853988	-0.4193419	-0.6760834	-1.9233453
Black race/ethnicity	-0.2363149	-0.0400344	-0.2697548	0.3849686	-0.4209563
	-0.2477609	-0.2029221	-0.4546334	-0.7324802	-2.218516
Asian race/ethnicity	-0.6643337	-0.7813309	-0.6522051	0.1063159	-3.6425418
	(0.2639447)*	(0.2319698)**	-0.5207092	-0.8308526	-2.5406553
Hispanic race/ethnicity	-0.0343341	-0.1464253	-0.0651707	-0.1412499	2.0369842
	-0.1352285	-0.0977347	-0.2199975	-0.3775533	-1.2693071
Policyholder in household is married	0.5521387	0.8911352	1.7423961	2.4056005	3.3443905
	(0.1203041)**	(0.0793651)**	(0.1691156)**	(0.2793685)**	(0.9642480)**
Number of children younger than 18	0.1447115	0.2821033	0.2620185	0.6394138	1.3244871
	(0.0506228)**	(0.0339186)**	(0.0751674)**	(0.1301343)**	(0.4543822)**
First income quartile	-0.3883334	-0.5341883	-0.7427138	-0.5412879	-0.6767219
	(0.1704270)*	(0.1075034)**	(0.2252552)**	-0.364697	-1.1788965
Second income quartile	-0.445438	-0.5766784	-0.8600211	-0.7596623	-1.2886873
	(0.1449141)**	(0.0938096)**	(0.1974593)**	(0.3264855)*	-1.1000392
Third income quartile	-0.4340627	-0.472561	-0.7866756	-0.9276264	-0.540482
	(0.1248752)**	(0.0835875)**	(0.1826380)**	(0.3023582)**	-1.0453626
=1 if lives in MSA, 0 if non MSA	0.0718479	0.1410626	-0.1883463	-0.0629301	-0.9485389
	-0.1130951	-0.0765491	-0.1685573	-0.2815753	-1.0773282
=1 if lives in Northeast census region	0.2878949	-0.0579699	-0.1337929	-0.5432242	-1.1946479
	(0.1322695)*	-0.089602	-0.1904487	-0.3156439	-1.0940222
=1 if lives in Midwest census region	0.3728687	0.1182144	0.1821198	0.3167646	3.8177311
	(0.1238143)**	-0.0857414	-0.1866467	-0.3037118	(1.0675526)**
=1 if lives in South census region	0.3468536	0.036448	-0.0912132	-0.2161575	-0.9889983
	(0.1144042)**	-0.078633	-0.1706544	-0.2818369	-0.9680906
=1 if union household, 0 ow	0.096089	0.1658009	0.1851084	0.1767706	0.8598079
	-0.1209194	(0.0785514)*	-0.1720053	-0.2789449	-0.9665964
Number in household with cancer diagnosis	1.0639222	2.2132064	3.1814325	6.5099136	19.2210774
	(0.1617812)**	(0.1056527)**	(0.2317751)**	(0.3834357)**	(1.2630135)**
Number in household with diabetes diagnosis	0.9198312	1.5006372	2.0401436	3.145749	4.90993

	(0.1178430)**	(0.0919558)**	(0.2037296)**	(0.3104451)**	(1.2039943)**
Number in household with high cholesterol diagnosis	0.8433641	1.012128	1.15881	1.1976621	2.5394451
	(0.0889495)**	(0.0672350)**	(0.1459794)**	(0.2382858)**	(0.8198816)**
Number in household with hypertension diagnosis	0.4447175	0.6757838	0.755925	1.0721023	3.1009246
	(0.0899100)**	(0.0590513)**	(0.1304222)**	(0.2203847)**	(0.8355261)**
Number in household with heart disease diagnosis	1.0319847	1.2720755	1.510054	5.8764238	8.8478838
	(0.1243148)**	(0.1039900)**	(0.2211381)**	(0.3551167)**	(1.1979462)**
Number in household with arthritis diagnosis	0.5365644	0.8081419	2.6165649	1.7285411	-0.9854191
	(0.2116967)*	(0.1808293)**	(0.3900993)**	(0.5963089)**	-2.2314471
Number in household with asthma diagnosis	0.6726139	0.8694534	1.2458381	1.4936613	1.9842026
	(0.1233384)**	(0.0834651)**	(0.1859437)**	(0.3094979)**	-1.0952183
Number in household with diagnosis of depression or anxiety	0.7007196	1.6708697	2.1424059	2.5193984	5.291325
	(0.0699122)**	(0.0490458)**	(0.1083030)**	(0.1831422)**	(0.6549096)**
Number in household with back pain	0.3533694	0.7740665	1.7510722	2.1159615	4.2137322
	(0.0875931)**	(0.0676735)**	(0.1404808)**	(0.2233888)**	(0.7341923)**
Constant	-0.2779957	-0.4126587	-0.0440942	-1.0938986	5.5160919
	-0.4439392	-0.3290469	-0.7112031	-1.1650146	-3.9901765
Observations	1591	1591	1591	1591	1591
Pseudo-R^2	0.12	0.18	0.21	0.22	0.24

Source: Authors' calculations based on data from 2005 MEPS-HC.
Notes: Standard errors in parentheses;
*** significant at 5%; ** significant at 1%. Dependent variable is total spending in $1000s.**

Table A3: Predicted and Adjusted Medical Care Spending and Underinsurance, Large- Firm Households

	Predicted for Large-Firm HHs[1]	Adjusted for Moral Hazard Using Small-Firm Spending as the Baseline[2]	% Difference Between Large Firm Predicted and Adjusted	Predicted for Small-Firm HHs[1]	Difference between Predicted Underinsurance Rates between Small-Firm and Large-Firm Households	Difference in Underinsurance Rates between Small-Firm and Large-Firm Households adjusting for Moral Hazard Using Small-Firm Spending as the Baseline (Predicted Small-Firm vs. Adjusted Large-Firm)	Percentage Increase in Small-Firm vs. Large-Firm Difference in Underinsurance due to Adjustment for Moral Hazard
Mean, Total medical care spending	$5,961	$5,629	-5.6%	$5,499			
Mean, Out-of-pocket medical care spending	$1,286	$1,214	-5.6%	$1,371			
Underinsurance rate (10% threshold)	0.039	0.032	-18%	0.043	0.004	0.011	175%
Underinsurance rate (5% for < 200% FPL; 10% others)	0.048	0.03	-38%	0.059	0.011	0.029	164%

[1]Predicted values of total medical care spending from the quantile regression model of total spending. Predicted for large-firm households uses both large-firm characteristics and estimated coefficients from large-firm regressions. Predicted for small-firm households uses both small-firm characteristics and estimated coefficients from small-firm regressions. Predicted out-of-pocket spending uses predicted total spending multiplied by estimated cost-sharing. Estimated cost-sharing is the average fraction of out-of-pocket spending to total spending by households' reported total spending decile (separately for small-firm and large-firm households). Predicted underinsurance is based on the ratio of predicted out-of-pocket spending to actual income.

[2] Adjusted values are predictions of total medical care spending using large-firm household characteristics and estimates from the *small-firm* quantile regression model.