Predictability of Prescription Drug Expenditures for Medicare Beneficiaries

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MCBS data are used to analyze the predictability of drug expenditures by Medicare beneficiaries. Predictors include demographic characteristics and measures of health status, the majority derived using CMS' diagnosis cost group/hierarchical condition category (DCG/HCC) risk-adjustment methodology. In prospective models, demographic variables explained 5 percent of the variation in drug expenditures. Adding health status measures raised this figure between 10 and 24 percent of the variation depending on the model configuration. Adding lagged drug expenditures more than doubled predictive power to 55 percent. These results are discussed in the context of forecasting, and risk adjustment for the proposed new Medicare drug benefit.

INTRODUCTION

Background and Aims

There are two reasons why researchers and policymakers should care about the predictability of prescription drug spending in the Medicare population. First, is the need to incorporate prescription drug expenditures into Medicare spending forecasts in light of the new Medicare drug benefit. The most challenging forecast will be the first one, which must be made without access to actual drug spending data. Instead, the initial predictions will be drawn from simulated scenarios, undoubtedly using data from the MCBS, in much the same manner as that the U.S. Congressional Budget Office and CMS estimated the costs of previous drug benefit proposals. Second, this topic is also important because payments to private plans for administering the benefit must incorporate a reasonable assessment of risk.

There are surprisingly few studies that directly address the issue of predictability of drug spending. This may be explained in part by the facts that private insurers rarely offer free standing drug benefits, and that the public programs that offer these benefits (primarily State pharmaceutical assistance programs) have not sought to develop private risk-based contracts. In general, pharmacy benefits managers do not assume the majority of risk in contracts with either public or private insurers, and there has been a shift away from capitation in this market (Booz Allen Hamilton, 2003). Two studies in the early 1990s (Stuart et al., 1991; Coulson and Stuart, 1992) examined the persistence of drug spending in Pennsylvania's PACE. The authors were able to explain between 2 and 4 percent of the individual variance in spending with only limited demographic characteristics available from PACE enrollment files. However, prior year spending explained nearly 70 percent of the total variance in current year expenditures. This finding leads to the conclusion that drug spending is highly persistent.

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More recently, an unpublished study, (Hogan, 2000) used 1992-1997 MCBS data to estimate the predictability of drug spending using several risk adjusters designed for medical and hospital services. He found R^2 measures of 0.15 for both prospective and concurrent versions of the disability payment system (designed for Medicaid), 0.07 for the prospective principal inpatient diagnostic cost group (PIP-DCG) model, and 0.21 for a prospective model containing claims-based condition indicators. As in the prior study by Coulson and Stuart (1992), adding previous year prescription spending significantly increased the R^2.

This existing research suggests that drug expenditures are predictable and persistent relative to the expenditures currently covered by Medicare. As a comparison, the demographic and health status measures in the prospective DCG/HCC model (CMS's current methodology for predicting Medicare expenditures) explain roughly 9 percent of the variation in Medicare-covered physician, and hospital expenditures for the Medicare population (Ash, Ellis, and Pope, 2000). In the context of Medicare risk adjustment, Newhouse, Buntin, and Chapman (1997), remarked that, "It appears that anyone observing the past spending of a given person could explain about 20-25 percent of the variance in actual annual spending."

The research findings reported in this article build on the aforementioned studies. This study examined the predictability of drug expenditures for the Medicare population using the most recent year of MCBS data (2000), and CMS' current methodology for predicting Medicare Parts A and B expenditures (the DCG/HCC methodology). It analyzed the Medicare population as a whole then separately as individuals with and without drug coverage. Separate models are appropriate because forecasting or risk adjustment on behalf of the Medicare Program ultimately pertain to an insured population, albeit one that may contain individuals who are currently uninsured, and one would expect the marginal impact of drug coverage to vary by condition. The model of greatest interest was a prospective model that used the claims-based condition indicators derived from the DCG/HCC methodology to control for health status; the authors also estimated several other models to provide context for the main results. The emphasis was on attaining a basic finding regarding predictability; the authors did not seek to refine HCCs, conduct a detailed analysis of individual predictors, perform specification tests, or assess multiple measures of fit.

METHODS

Data Source

The analysis is based on 1999 and 2000 MCBS Cost and Use Files. Beginning in fall 1991, the MCBS is a longitudinal panel survey of a representative national sample of the Medicare population conducted under the auspices of CMS. Over 12,000 Medicare beneficiaries, both aged and disabled, living in the community or in institutions are sampled from Medicare enrollment files, and surveyed three times a year using computer-assisted personal interviewing. MCBS interviewers collect extensive information on individuals' use and expenditures for health services including source of payment, as well as information on health insurance, health and functional status, socioeconomic status, and demographic characteristics. The MCBS Files link Medicare claims to survey-reported events, and provide complete expenditure,

and source of payment data on all health care services, including those not covered by Medicare, notably prescription drugs and long-term care.

Prescription drug utilization data in the MCBS are based on self-reports of each prescription filled and refilled during the year. To assure accurate recall, respondents are asked to keep bill records, and prescription containers to show interviewers during the yearly interviews. During return visits, MCBS interviewers provide print-outs of the last recorded prescription use and ask respondents to correct entries, state whether these prescriptions are still being taken, and report new medications added since the last interview. Despite these precautions, there are concerns about underreporting. A recent comparison of MCBS self-reported medication use, and pharmacy claims found under reporting rates of 17.0 percent for annual prescription drug expenditures, and 17.7 percent for number of prescriptions filled (Poisal, 2003/2004). The current study drew on both the survey data (for drug expenditures and individual characteristics), and the inpatient, outpatient, and physician claims (for claims-based measures of health status).

Study Sample

The sample consisted of beneficiaries enrolled in FFS Medicare Parts A and B throughout 1999 and 2000 since a full year of Medicare A and B claims is required to accurately assign DCG/HCC scores. In addition, to be in the sample, beneficiaries were required to have completed three MCBS survey rounds in each year since persons with missed interviews have incomplete prescription records.[1] Finally, respondents in long-term care facilities were excluded because the MCBS does not provide drug expenditure data on institutionalized beneficiaries. Applying these study inclusion/exclusion criteria resulted in a sample of 4,978 beneficiaries (roughly 40 percent of the MCBS total). Individuals were deemed to have drug coverage if they stated they had drug coverage in response to survey questions or if there was indication of third party payment in the drug claims data.

Study Variables

The dependent variable in all models was annual drug expenditures for the year 2000 (including expenditures for drugs currently covered by Medicare) measured in terms of the AWP for each prescription filled during the year. The study used AWP rather than the imputed transaction prices listed in the MCBS to create a standardized measure of individual drug expenditures. Using AWP preserved variation due to differences in beneficiary utilization patterns, and characteristics of individual prescriptions (brand or generic, strength, and days supply). In contrast, transaction prices vary by drug coverage status because of differences in the discounts and rebates negotiated by various payers. While AWP is an inflated measure of drug prices, it is preferable in this context because the emphasis is on the variability of drug expenditures and on relative, rather than absolute, levels of drug expenditure. In addition, there is no alternative approach to drug pricing that is widely accepted. The authors applied AWP to the individual drug events in the MCBS, and used the procedures developed by MCBS staff to create a person-level annual measure of drug expenditure from the claims data.

The independent variables of greatest interest were the summary measure of predicted Medicare expenditures and the

[1] MCBS staff does impute annual drug expenditures for these individuals, but the authors needed claim-level data in order to apply the average wholesale price (AWP) prices.

indicators for individual medical conditions, both produced by the DCG/HCC methodology. This methodology, created by Health Economics Research (now RTI International) is the Medicare Program's current risk-adjustment methodology, and the basis for the selected significant disease model that will be used to reimburse the M+C plans starting in January 2004. In this application, the DCG/HCC model created indicators for the presence of 189 medical conditions based on diagnoses recorded on a patient's Medicare claims (physician, outpatient, and inpatient). The DCG/HCC model then applied previously calibrated weights (based on regression coefficients) to these conditions to create a summary score of the patients' expected Medicare expenditure under Parts A and B including expenditures for the drugs that Medicare currently covers.[2] In the current study, the models with indicators for individual conditions exclude conditions with fewer than approximately 20 cases in the sample; this exclusion eliminated 59 conditions.[3] The purpose of this exclusion was to reduce the degree of over fitting, and establish a more accurate estimate of adjusted R^2.[4,5]

To provide a point of comparison, the project team also estimated models in which self-reported measures of 14 common diseases were used in place of the DCG/HCC indicators. These included heart disease, cancer, arthritis, lung disease, mental illness, Alzheimer's, diabetes, hypertension, osteoporosis, stroke, benign prostatic hypertrophy, paralysis, Parkinson's, and hip fracture. In the majority of models, predictor variables were based on 1999 data. In the concurrent model, however, the HCC condition indicators were derived using diagnoses measured in 2000.

DRUG EXPENDITURE MODELS

The study used ordinary least squares (OLS) regression models with unweighted observations in order to maximize the efficiency of parameter estimates. Linear models were chosen because they are often the basis of risk-adjustment methodologies.[6] Adjusted R^2 was the measure of predictability.

The basic model was:

$$DE_{it}=\alpha+\beta_1 X_i+\beta_2 H_i+\varepsilon_{it}$$

with:

DE=annual drug spending measured using AWP prices

X=basic demographic characteristics (age, sex, basis of Medicare entitlement [disabled, aged, and aged with prior entitlement due to disability], metropolitan status, indicators for 10 detailed census regions).

H=health status.

We estimated six variants of this model. Model 1 omitted the health status measure, and provided a baseline for subsequent results. Model 2 measured health status via the 14 indicators for self-reported conditions. Model 3 replaced the self-reported conditions with 130 indicators for individual conditions derived from 1999 Medicare claims using the HCC methodology. This was the model of greatest interest because it was a prospective model based on Medicare claims data; this is the information that would be appropriate, and

[2] For a discussion on the logic, structure, and coefficients of DCG/HCC models refer to Ash, Ellis, and Pope (2000). Note that there are variants of these models that pertain to other populations, and draw on other data sources. Zhao et al. (2001) describes a DCG model that incorporates information from pharmacy claims.

[3] This number of cases in the sample is approximate because the list of conditions was finalized using a slightly different sample.

[4] Of the conditions eliminated, 48 probably do not entail much drug utilization, e.g., mental retardation and blindness. The remainder does involve significant drug utilization, e.g., AIDS and tuberculosis.

[5] Over fitting occurs when, as a result of small numbers of observations in particular cells estimated coefficients to fit individual observations resulting in inflated estimate of an equation.

[6] The authors also estimated log-linear models; results were consistent with those described in this article.

available for forecasting and risk-adjustment. In addition, Medicare's existing risk adjustment methodology is the natural point of departure for work in this area. The next model replaced the indicators for individual conditions with "ybase," the single summary measure of predicted Medicare expenditure. Model 4 essentially constrained the relative importance of individual conditions in predicting drug expenditure to be the same as their relative importance in predicting the physician, and inpatient expenditures currently covered by Medicare. While this constraint is unlikely to hold, the comparative performance of Models 3 and 4 sheds light on the loss in potential fit in the HCC/DCG risk adjuster is applied to M+C or Medicare Advantage plans that offer drug benefits. (Note that these plans generally do not offer full drug coverage so the measure is far from exact.)

Models 5 and 6 shed some light on the persistence of drug expenditures. Model 5 used the concurrent, rather than prospective, condition indicators, i.e. it drew on the 2000 rather than 1999 diagnoses to predict drug expenditures in 2000. Comparing Models 3 and 5 gives a sense of the relative importance of chronic conditions, which persist from year to year, in driving drug expenditure. Model 6 is a variant of Model 3, which includes an additional regressor, lagged drug expenditures. While lagged drug expenditures may not be available for forecasting, and are typically not appropriate for payment applications (because they blunt incentives for cost containment), this model offers direct insight into the persistence of drug expenditures and, by extension, into the potential for adverse selection on the part of purchasers, and risk selection on the part of insurers in the market for drug insurance. Adverse selection is the tendency of those who are particularly likely to have above average covered expenses to also have an above average tendency to purchase insurance. Adverse selection can drive up premiums and/or cause insurers to lose money. Similarly, risk selection is the tendency of insurers to design their products, direct their marketing, and otherwise act to attract individuals likely to have below average covered expenditures into their pool.

RESULTS

Table 1 presents descriptive characteristics of the sample in 1999. More than one-half the beneficiaries were female (56 percent). About 17 percent were recipients of Social Security disability insurance under age 65. Another 6 percent were beneficiaries age 65 or over who had previously been entitled to Medicare through Social Security disability insurance. Just over one-quarter of the sample was age 80 or over, and about two-thirds of the beneficiaries lived in urban areas. Relative to the population with drug coverage, the population without drug coverage was more likely to be female, 80 years of age or over, and lives in a rural area. The population without drug coverage was less likely to be or have been entitled to Medicare because of disability, perhaps because many of the disabled currently have drug coverage through the Medicaid Program. Similarly, the mean predicted Medicare expenditure (a very rough and somewhat problematic proxy for the burden of illness) for those without drug coverage ($4,769) was 79 percent of the value for those with coverage ($6,054).[7]

Table 2 presents univariate statistics on AWP-priced annual drug expenditures in 2000. The mean expenditure was $1,701 with a standard deviation of $2,091, reflecting the presence of large positive outliers.

[7] Rates of the self-reported, and claims-based condition indicators were included in our final report to CMS, and are available on request from the authors.

Table 1

Demographic Characteristics and Health Status Measures: 1999

Characteristic	All Beneficiaries *N* = 4,978	Beneficiaries With Drug Coverage *N* = 3,659	Beneficiaries With No Drug Coverage *N*=1,319
		Percent	
Sex			
Female	55.8	54.5	59.1
Male	44.2	45.5	40.9
Medicare Entitlement Status			
Disabled	17.0	18.0	14.1
Aged[1]	5.6	6.2	3.9
Age			
Under 65 Years	17.0	18.0	14.1
65-69 Years	17.2	17.7	15.7
70-74 Years	20.8	21.0	20.2
75-79 Years	18.2	18.1	18.6
80 Years or Over	26.8	25.1	31.5
Metropolitan Status			
Rural	34.6	31.7	42.5
Urban	65.4	68.3	57.5
Detailed Census Regions			
New England	2.9	2.9	2.8
Middle Atlantic	16.0	17.7	11.2
East North Central	17.3	17.2	17.6
West North Central	7.3	6.0	10.8
South Atlantic	22.2	21.7	23.7
East South Central	6.7	5.6	9.9
West South Central	11.1	11.3	10.6
Mountain	5.4	5.4	5.6
Pacific	9.6	10.7	6.6
Puerto Rico	1.5	1.5	1.3
Mean Predicted Medicare Expenditure[2]			
HCC Methodology	$5,713	$6,054	$4,769

[1] Previously disabled.

[2] Predicted Medicare Parts A and B payment from the DCG/HCC model.

NOTES: Sample consisted of Medicare beneficiaries enrolled in FFS Medicare in both 1999 and 2000. Sample excluded beneficiaries in long-term care facilities or with missing survey rounds in either year. DCG/HCC is diagnosis cost group/hierarchial condition category.

SOURCE: Centers for Medicare & Medicaid Services: Data from the Medicare Current Beneficiary Survey, 1999-2000.

Almost 8 percent of the sample reported no drug expenditures[8] and about one-fifth of the sample had spending between $1 and $500 for the year. At the other extreme, 16.4 percent had annual expenditures in excess of $3,000. Table 2 also shows dramatic discrepancies in standardized drug expenditures between those with and without drug coverage. Mean expenditures for those without drug coverage ($1,013) were 52 percent of the value for those with coverage ($1,949). Sixteen percent of the sample without drug coverage had no recorded drug expenditures, while only 5 percent of the covered sample lacked these expenditures. At the other extreme, 20 percent of the covered sample had expenditures in excess of $3,000 while 6 percent of those without drug coverage were in this range. These discrepancies represent a combination of underlying differences between the two populations, and differences in drug utilization induced by the presence of insurance.

Table 3 compares the adjusted R^2 statistics associated with the various models.[9] Model 1 only used the age, sex, disability,

[8] In the community dwelling MCBS sample as a whole, this percentage was 9 percent.

[9] Regression output for these models is available on request from the authors.

Table 2

Annual Per Capita Drug Expenditures[1]: 2000

Category	All Beneficiaries *N* = 4,978	Beneficiaries With Any Drug Coverage *N*=3,659	Beneficiaries With No Drug Coverage *N*=1,319
Statistics			
Mean	$1,701 (2,091)	$1,949 (2,270)	$1,013 (1,253)
Median	1,157	1,416	637
Minimum	0	0	0
Maximum	59,647	59,647	14,248
		Percent	
Frequency Distribution			
$0	7.9	5.0	16.2
>$0 to < $250	11.5	9.6	16.7
> $250 to < $500	8.8	7.8	11.8
> $500 to < $1,000	17.3	16.8	18.6
>$1,000 to < $2,000	23.8	25.0	20.6
>$2,000 to < $3,000	14.3	15.9	9.9
>$3,000	16.4	20.0	6.3

[1] Drug expenditures measured using average wholesale price.

NOTES: Standard deviations are shown in parentheses. Sample consisted of Medicare beneficiaries enrolled in FFS. Medicare in both 1999 and 2000. Sample excluded beneficiaries in long-term care facilities or with missing survey rounds in either year.

SOURCE: Centers for Medicare & Medicaid Services: Data from the Medicare Current Beneficiary Survey, 1999-2000.

Table 3

Adjusted R^2 Measures Associated with Models Predicting 2000 Drug Expenditures

Model	Description	Adjusted R^2 (Level Models) All Beneficiaries *N* =4,978	Beneficiaries With Any Drug Coverage *N* =3,659	Beneficiaries With No Drug Coverage *N* =1,319
1	Prospective Model, Basic Demographic Characteristics[1]	0.05	0.06	0.02
2	Prospective Model, Basic Demographic Characteristics Plus Self-Reported Health Conditions[2]	0.10	0.10	0.14
3	Prospective Model, Basic Demographic Characteristics Plus Claims Based Health Conditions[3]	0.23	0.22	0.26
4	Prospective Model, Basic Demographic Characteristics Plus Predicted Medicare Expenditure[4]	0.13	0.13	0.08
5	Concurrent Model[3]	0.24	0.23	0.27
6	Prospective Model 3 Plus Lagged Drug Expenditures	0.55	0.52	0.66

[1] Basic demographic characteristics: age (4 categories), currently disabled, previously disabled, sex, status, metropolitan status, and detailed census regions (10).

[2] Self-reported conditions from the MCBS: heart disease, cancer, arthritis, lung disease, mental illness, Alzheimer's, diabetes, hypertension, osteoporosis, stroke, benign prostatic hypertrophy, paralysis, Parkinson's, and hip fracture.

[3] Claims-based health conditions as defined and calculated by the DCG/HCC model (130 conditions). Conditions with less than approximately 20 cases were excluded.

[4] Predicted Medicare Parts A and B payment from DCG/HCC model.

NOTES: DCG/HCC is diagnosis cost group/hierarchical condition category. Unadjusted R^2 for models 1-6 (all beneficiaries) were 0.05, 0.11, 0.25, 0.13, 0.26, and 0.56, respectively. Sample consisted of Medicare beneficiaries enrolled in FFS Medicare in both 1999 and 2000. Sample excluded beneficiaries in long-term care facilities or with missing survey rounds in either year.

SOURCE: Centers for Medicare & Medicaid Services: Data from the Medicare Current Beneficiary Survey, 1999-2000.

and geographic variables. For the full sample, this model yields an adjusted R^2 of 0.05. This indicates that demographic variables explained little of the variation in the annual drug expenditures of the Medicare beneficiaries. Addition of the 14 indicators for self-reported health conditions (Model 2) doubled the adjusted R^2 to 0.10. Model 3 replaced the self-reported health conditions with the 130 indicators for health conditions derived from the claims and yielded an adjusted R^2 of 0.23. This result is very

close to Hogan's (2000) R^2 of 0.21 when individual conditions were used to prospectively predict 1992-1997 drug expenditures in the MCBS.[10]

In Model 3, 12 conditions were statistically significant, and associated with more than $500 in prescription drug spending. They were diabetes with ophthalmologic manifestations ($627, standard error [s.e.] $234), inflammatory bowel disease ($1,217, s.e. $327), rheumatoid arthritis and inflammatory conditions ($503, s.e. $129), schizophrenia ($1,980, s.e. $206), major depressive bipolar, and paranoid ($1,246, s.e. $155), depression ($512, s.e. $145), Parkinson's and Huntington's diseases ($651, s.e. $260), congestive heart failure ($556, s.e. $106), unstable angina, and other acute ischemic conditions ($565, s.e. $165), chronic obstructive pulmonary disease ($509, s.e. $88), fibrosis of lung and other chronic lung disorders ($546, s.e. $220), and kidney transplant status ($4,292, s.e. $435).[11] These are all chronic conditions.

Model 4 collapsed these indicators to a single measure of expected Medicare expenditure, resulting in an adjusted R^2 of 0.13. This figure was slightly higher than the adjusted R^2 associated with the self-reported conditions in this study, roughly comparable to Hogan's (2000) result for the disability payment system (DPS) adjuster, and higher than his result with the PIP-DCG). A $100 increase in predicted Medicare expenditure (based on diagnoses recorded the year before) was associated with a $12 increase in drug expenditures. The associated s.e. was $0.71. Model 5, the concurrent variant of Model 3, generated an adjusted R^2 of 0.24, which is only 1 percentage point higher than Model 3. Consistent with prior research, this study found that drug expenditures were highly persistent. Model 6, which added lagged drug expenditures to Model 3, led to an adjusted R^2 of 0.55. A $100 increase in prior year's expenditures was associated with an $82 increase in current year's expenditure (s.e. $1.38). In this model, the demographic characteristics and health status measures generally lost significance.

Models estimated separately for beneficiaries with and without any drug coverage offered preliminary evidence that drug expenditures are less predictable for populations with drug coverage than for populations without drug coverage. For the population with drug coverage, Model 3 yielded an adjusted R^2 of 0.22; for the population without coverage, the adjusted R^2 was 0.26. This 4 percentage-point discrepancy essentially persisted in the other models with condition indicators, and became more pronounced when lagged drug expenditures were added as an additional regressor. (The gap also widened in models [not shown] in which the dependent variable was entered in logarithmic form.) The exceptions to this pattern were Model 1 (demographic variables only, of less interest), and Model 4 (health status measured as the single summary measure of predicted Medicare expenditure), in which adjusted R^2 for the covered population was 0.13, and for the uncovered population was 0.08. Further work is needed to determine whether this gap is indeed a true difference in predictability or an artifact of over fitting, the uncovered sample also being the smaller sample.

DISCUSSION AND CONCLUSIONS

The central result of this study is that it was possible to predict approximately 23 percent of the variation in Medicare drug expenditures using a prospective model that included basic demographic characteristics and health status measures. These

[10] Hogan's models included age, sex, and indicators for year and drug coverage as additional controls.

[11] Excluding the ESRD population did not affect the central results of this study.

health status measures were indicators for medical conditions, derived from Medicare claims using Medicare's current risk-adjustment methodology. This figure is high relative to the predictability of the expenditures currently covered by Medicare. The majority of the model's explanatory power stemmed from the health status measures. The basic demographic variables alone explained only 5 percent of the variation in prescription drug expenditures. The claims-based indicators also significantly out-performed indicators for 14 self-reported health conditions and, not surprisingly, the single summary measure of expected Medicare expenditure. This latter result indicates that the relative predictive power of the individual conditions differed between drug expenditures and Medicare Parts A and B spending. In other words, the conditions that predicted high Medicare expenditures were not necessarily the conditions that predicted high drug expenditures and vice versa. Interestingly, the performance of the prospective model was virtually equivalent to the performance of the concurrent model, suggesting that it was persistent, chronic conditions that drove drug expenditures.

This study also confirmed prior work by finding that drug expenditures were highly persistent. This persistence, combined with the variation in expenditures among individuals, suggests the potential for powerful adverse selection if individuals are free to decide whether or not to purchase drug insurance at a single market price. Also, the fact that lagged drug expenditures added significant explanatory power to the expenditure equation even when condition indicators are present means that insurers in competitive markets will retain strong incentives for risk selection even if their rates are case-mix adjusted. The study also contains preliminary evidence that drug expenditures may be more predictable for populations without drug coverage. While this finding requires confirmation, it is consistent with the notion that drug coverage induces additional, discretionary drug spending.

This research had several important limitations. First, the sample exclusion criteria, while necessary to ensure complete and accurate data, mean that the sample was not representative of the Medicare population as a whole, and hence, results cannot be generalized. Second, this study used 2000 data and does not reflect new innovations in drug therapy or in the management of drug benefits. Third, the ideal approach to standardized pricing would be to use a weighted average of the prices paid by beneficiaries and their insurers, not the AWP; unfortunately, there is not a source of such data in common use. Finally, predictability estimates may be slightly inflated due to over fitting especially for the subsample without drug coverage, and for models containing claims-based condition indicators.

Further work on this general topic might seek to refine the condition indicators for the specific purpose of forecasting drug expenditures, and might examine alternative approaches to modeling health care expenditures, such as those proposed by Veazie, Manning, and Kane (2003). Fit could be evaluated using a wider range of metrics and split sample techniques. One might also seek more recent data sources with large sample sizes, potentially drug claims that could be linked to Medicare data. In addition, policy-oriented work with a focus on Medicare drug benefits might replace total expenditures with a variable that incorporated the cost sharing, drug pricing, and utilization management features of the specific option or options under study. Finally, additional research should seek to confirm or refute the finding that drug expenditures are less predi-

cable for insured populations, examine which patients and which types of drugs are most sensitive to insurance, and consider (to the extent possible) the social and clinical value of any expected utilization effects. This information would be useful both to policy design, and to forecasting the impacts of a given policy.

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