Association of Medicare Part D Medication Out-of-Pocket Costs with Utilization of Statin Medications

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Objectives. To examine the association between statin out-of-pocket (OOP) costs and utilization among the Medicare Part D population.

Data Sources/Study Setting. 2006–2008 administrative claims and enrollment data for the 5 percent Medicare sample.

Study Design. Sample included 346,583 beneficiary-year observations of statin users enrolled in stand-alone prescription drug plans, excluding low-income subsidy recipients. We estimated the association between a plan's OOP statin costs and statin utilization using an instrumental variable approach to account for potential bias due to plan selection. Adherence was defined as percentage of days covered (PDC) of at least 80 percent. Plan OOP costs were constructed for a representative market basket of statin medications. Analyses controlled for demographic characteristics, cardiovascular disease risk, co-morbidity presence, and regional characteristics.

Principal Findings. About 67 percent of the sample had a PDC of at least 80 percent. An increase in annual statin OOP from \$200 (50th percentile) to \$240 (75th percentile) was associated with a reduction in the rate of adherent beneficiaries from 67 percent to 56 percent ($p < .001$).

Conclusions. Greater OOP costs for statins are associated with reductions in statin utilization.

Key Words. Statins, utilization, Medicare part D

INTRODUCTION

The Medicare Part D voluntary prescription drug benefit is available today to about 49 million beneficiaries. Previous studies focusing on drugs commonly used by Medicare beneficiaries have shown significant variation in coverage across plan formularies and other benefit design features, including

deductibles, cost sharing, and coverage in the standard coverage gap known as the donut hole (Hoadley et al. 2006, 2008a,b; Hoadley, Hargrave, and Merrell 2007).

Older adults subject to higher pharmacy coinsurance rates use fewer prescription medications (Harris, Stergachis, and Ried 1990; Smith 1993; Lillard, Rogowski, and Kington 1999; Joyce et al. 2002; Goldman et al. 2004; Goldman, Joyce, and Zheng 2007), which, in turn, may lead to increased risk of hospitalizations, emergency department visits, or outpatient visits (Tamblyn et al. 2001; Fairman, Motheral, and Henderson 2003; Tseng et al. 2004; Mahoney 2005; Cole et al. 2006; Gibson et al. 2006; Goldman, Joyce, and Karaca-Mandic 2006; Hsu et al. 2006; Chandra, Gruber, and McKnight 2010). Introduction of Medicare Part D is associated with improved medication adherence and reduced nondrug health services utilization among Medicare beneficiaries with limited prior drug coverage (Afendulis et al. 2011; McWilliams, Zaslavsky, and Huskamp 2011). However, concerns have been raised about the adverse effect of the donut hole on the use of medications (Hsu et al. 2008; Raebel et al. 2008; Zhang et al. 2009; Fung et al. 2010; Gu et al. 2010; Hales and George 2010).

No study has investigated whether the medication cost sharing of Part D plans relates to prescription drug therapy utilization in the Medicare population. Using an innovative method to quantify medication cost sharing of Part D plans that captures expected out-of-pocket (OOP) costs for a fixed basket of representative drugs separately in the pre-initial coverage limit (pre-ICL) and donut (gap) phases, we examined how plan OOP costs were associated with drug therapy utilization among aged-qualified Medicare Part D enrollees in stand-alone prescription drug plans (PDPs).

This analysis focused on beneficiaries who used statins, which are commonly prescribed to treat hypercholesterolemia. Because they are purely preventive and address no symptoms, they are especially vulnerable to price effects. Statins accounted for 9.7 percent of all prescription drug expenditures in the Part D program in 2007 (MedPAC 2010). Despite the efficacy of statin use in preventing coronary heart disease (Pfeffer et al. 1995; Shepherd et al. 1995; Sacks et al. 1996; Pyorala et al. 1997; Downs et al. 1998, 2001; Gold-

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berg et al. 1998; Lewis et al. 1998; Pedersen 1998; Plehn et al. 1999; Clearfield et al. 2001; ALLHAT Collaborative Research Group 2002; Collins, Peto, and Armitage 2002; Heart Protection Study Collaborative Group 2002; National Cholesterol Education Program (NCEP) 2002; Simes et al. 2002; Sever et al. 2003; Cannon et al. 2004; Ford et al. 2007; AIM-HIGH Investigators 2011), 1-year adherence rates (as measured by a proportion of days covered ≥ 80 percent) range from 60 percent to 80 percent (Goldman et al. 2004; Rasmussen, Chong, and Alter 2007; Schneeweiss et al. 2007; Ketcham and Simon 2008).

We investigated how the plan OOP cost for statins related to utilization of statins. We hypothesized that greater OOP costs for statins are associated with reductions in statin utilization. Our models controlled for beneficiary characteristics (age, gender, race, ethnicity), cardiovascular disease risk, presence of co-morbidities, whether the beneficiary reached the gap phase during the previous year, geographic region, and other zip-code-level characteristics. To account for potential bias due to plan selection based on unobserved beneficiary characteristics, we used an instrumental variables approach.

METHODS

Data

We merged the *Prescription Drug Event (PDE)* and enrollment data for the 5 percent Medicare sample from 2006 to 2008 with the *Medispan Drug Database* (Wolters Kluwer Health, Inc, 2009) to identify claims corresponding to National Drug Codes (NDCs) for statins and to construct our measure of therapy adherence. We used information on the drug utilization of other therapeutic classes for each beneficiary from the PDE data to construct measures of co-morbidities. We used enrollment data in the *Beneficiary Summary* file to identify beneficiary zip-code and demographic characteristics. From the *MedPAR* data, we identified hospitalized stays to adjust our drug utilization measure. We used the *Plan Characteristics File* to construct our measure of plan OOP costs. Finally, we used the *Census 2000 Summary File 3* data to control for socioeconomic and demographic characteristics corresponding to beneficiaries' five-digit zip code.

Study Sample

For each calendar year (2007 or 2008) cohort, we included statin users if they were aged-qualified beneficiaries and continuously enrolled in a PDP.

In addition, we required that beneficiaries were Part D enrolled by at least October 1 of the previous calendar year to capture statin fills with pill counts that would carry over into the calendar year. We did not consider beneficiaries enrolled in Medicare Advantage plans, due to the lack of inpatient utilization data needed for adjusting the drug cost sharing utilization measure. We also excluded beneficiaries receiving the low-income subsidy (LIS), because they face uniform cost sharing based on their LIS qualification group and do not have a phased benefit design. The resulting 346,583 beneficiary-year observations (170,029 in 2007 and 176,554 in 2008) represent 213,791 unique beneficiaries. Of these, 74,731 were observed either only in 2007 or in 2008; the remaining beneficiaries were observed in both calendar year cohorts.

Outcome Variable

Statin Utilization. We defined adherence to statin therapy as having a proportion of days covered (PDC) of 80 percent or more over a calendar year (Insull 1997; Avorn et al. 1998; Benner et al. 2002; Howell et al. 2004; Schultz et al. 2005; Sokol et al. 2005; Goldman, Joyce, and Karaca-Mandic 2006). We used information on fill date and days supplied in each fill and flagged each day during the calendar year that had statin active ingredient coverage, where the active ingredient is defined as the generic formulation (e.g., atorvastatin calcium). If the beneficiary refilled a different statin active ingredient before exhausting all days supplied in the previous active ingredient, we limited the accumulated stock from the previous fill to 30 days of supply. In such cases, it was not possible to know without clinical data whether the switch to the new active ingredient implied that the beneficiary intended to switch immediately as of the new fill date, or after finishing up the days supplied of the previous active ingredient. The rule on maximum stock accumulation permitted consistency across all cases. We also accounted for the presence and timing of hospitalizations during the calendar year and characterized the days spent in the hospital as adherent.

Explanatory Variables

Beneficiary Characteristics. We included age, gender, race, ethnicity, and indicator for rural residence. To capture co-morbidities, we constructed 17 indicators that identify a beneficiary's use of prescription drugs from other therapeutic classes.¹ We classified beneficiaries who exceeded the pre-ICL phase and reached the gap during the previous year as having "high medication cost."

We characterized high cardiovascular disease risk as having a history of diabetes, hypertension (based on drug utilization) in current or previous years, or cardiovascular hospitalization in previous years. We also controlled for zip-code-level socioeconomic characteristics, including median household income, percentage of elderly persons in poverty, and percentage of elderly persons with a bachelor's degree.

Plan Statin OOP Costs. Capturing plan cost sharing poses a challenge, because plan designs include multi-tier formularies and can vary with respect to deductible size, coinsurance or copayments, purchase point (in network, mail order), and coverage in the gap phase. In the context of Medicare Part D, OOP costs may be nonlinear as beneficiaries pass through different phases of the benefit structure (deductible, pre-ICL, gap, and catastrophic coverage). In turn, this makes it even more complex to construct an index of plan cost sharing. Moreover, patient expectations on total medication spending in a given year can influence total OOP costs. For example, coverage of medications and cost sharing in the gap phase may not be relevant for beneficiaries who do not expect to reach the gap. On the other hand, gap coverage is likely very important for those who expect to reach the gap.

Building on prior work (Joyce et al. 2002; Goldman et al. 2004; Goldman, Joyce, and Karaca-Mandic 2006; Karaca-Mandic et al. 2010, 2012), we constructed a summary measure for plan cost sharing that represents the plan's average OOP cost for a representative basket of statins used by Medicare Part D beneficiaries. Our summary measure captures the plan's OOP costs both in the pre-ICL and gap phases independent of any individual beneficiary's statin drug choice or utilization. The analyses also incorporate information on the plan deductible. In sensitivity analyses, we added the deductible into our measure of plan OOP costs. We omitted the catastrophic phase because only 4 percent of the beneficiaries in the sample reached that phase and because there is no variation in OOP costs across plans once a beneficiary reaches the catastrophic phase.

We focused on the OOP costs for the standardized basket of statins for each plan rather than average OOP costs by individual beneficiary because the latter would reflect a beneficiary's preferences regarding lower versus higher cost medications given his/her particular plan design, leading to misleading plan generosity comparisons. For example, consider two plans: Plan A covers both drugs 1 and 2 with a copayment of \$30, while plan B covers drug 1 with copayment of \$30, and drug 2 with a copayment of \$60. If most

patients choose the cheaper drug in plan B, there is little difference observed in the average OOP that beneficiaries pay in the two plans. However, a comparison of the benefit designs suggests otherwise; plan A has more generous coverage.

We linked each beneficiary to the *Plan Characteristics File* using their encrypted plan and contract identifiers. This file provides general plan attributes, including deductible size, gap coverage indicators (e.g., none, generic only), and monthly copayment/coinsurance rate information for multiple tiers, separately by phase (the pre-ICL and gap). For each tier, we also observed the tier type (generic, preferred/nonpreferred brand). We could infer the monthly OOP for an active ingredient in the plan if it had at least one 30-day equivalent (30 DE) fill. However, what makes the standard market basket approach used in previous studies difficult in the context of Medicare Part D is that only a small random sample of the data is available for researchers. In our case, data capture only 5 percent of the entire Part D population. Therefore, some active ingredients may not be observed in each plan. For such active ingredients, we examined all plans in the 5 percent sample and identified the tier types most commonly associated with that active ingredient. Next, for that active ingredient, we assigned the weighted average of the reported monthly copayment for those tiers in the plan. Coinsurance rates were converted to copayment amounts using the total paid for the active ingredient in the full sample. For example, atorvastatin calcium is observed under the following tier types for all users—94 percent preferred brand, 6 percent nonpreferred brand. A plan with copayments of \$30 and \$60 for preferred and nonpreferred brand tiers, respectively, would be assigned monthly OOP of \$32 ($0.94 \times 30 + 0.06 \times 60$) for atorvastatin.

A general complication is that if a fill for a drug is not observed in a given plan, it may also be that the drug is not in the plan's formulary. Unfortunately, Part D formulary data are not available for linking with the plans. While we are unable to rule out this possibility, the Part D formulary literature suggests that generic statins are close to 100 percent covered by PDPs and brands consistently hit 93 percent coverage (Hoadley et al. 2008b). Moreover, we conducted a sensitivity analysis by extracting information on drug coverage of other plans within the same contract in the same PDP region (detailed under the Results section).

We conducted the exercise of constructing monthly OOP for the pre-ICL and gap phases separately for each active ingredient. For plans with no gap coverage, the total cost of the active ingredient in the 5 percent sample was assigned as the monthly OOP in the gap. Similarly, if the plan covered

only generic drugs in the gap phase, the cost of the branded drug was inferred by its total cost.

Having constructed monthly OOP for each active ingredient in the plan, both in the pre-ICL and gap phases, we then identified the relative shares of each active ingredient based on the number of 30 DE fills from the 5 percent Part D sample for the pre-ICL and gap phases for each year. We used these shares as weights to compute the average monthly OOP for the statin basket by phase. Therefore, utilization weights used to construct the representative basket for each phase varied only by year, not by plan or by beneficiary. This is important because plan- or beneficiary-level utilization of the active ingredients would be endogenous. In particular, patient responses to OOP prices of active ingredients in the plan would alter the composition of medications in each plan. The fixed basket of medications across individuals allows for a comparison of the OOP costs across different plans.

If the beneficiaries had perfect foresight to predict whether they would reach the gap phase, we could construct beneficiary-level plan statin OOP costs based on the number of months beneficiary expected to spend in each phase. However, beneficiaries likely are not able to foresee all future medication needs and incorporate them in their current medication decisions (Abaluck and Gruber 2011a). Therefore, we focused on the average beneficiary and estimated that, on average, a statin user in our sample spent 9.5 months in the pre-ICL phase and 1.5 months in the gap phase (remaining month was primarily in the deductible phase). Using 9.5 and 1.5 as weights, we computed the weighted annual OOP combined for the pre-ICL and gap phases, as our final measure of annual OOP statin costs. Using fixed weights across all beneficiaries for plan OOP for the pre-ICL phase and gap phases also has the advantage that our final measure of statin OOP is not endogenous to the beneficiary phase selection. Nevertheless, in a sensitivity analysis, we constructed a measure that varies by whether the beneficiary expects to reach the gap.

Statistical Models

We estimated probit models to relate dichotomous statin therapy adherence to plan statin OOP costs and beneficiary characteristics described above. To capture systematic regional differences, we included indicators for PDP regions, and to capture trend, we included an indicator for 2008. In analyses such as this, there is a general concern that individuals may select their plans based on unobserved beneficiary characteristics, biasing the estimates. For example, individuals with higher unobserved co-morbidity may choose plans with lower

statin OOP costs and also have higher medication adherence. This would create a spurious correlation between statin OOP costs and adherence (upward bias on the magnitude of the coefficient estimate on statin OOP costs) that should not be interpreted as a causal effect. In contrast, beneficiaries with higher co-morbidity likely have multiple chronic conditions and may have poorer adherence to a particular therapy given the challenges of managing multiple therapies. In addition, beneficiaries who are not as health conscious or those who are not as educated on the benefits of the drug therapy may choose plans with lower generosity and at the same time have poorer adherence. These would bias the magnitude of estimate on plan statin OOP costs downward toward zero. A priori, it is not possible to gauge the sign of the bias.

We approached this issue using instrumental variables estimation. In our application, the instrumental variable needed to be correlated with the plan's statin OOP costs, but uncorrelated with unobserved factors that may affect the statin utilization of the beneficiary. A possible candidate instrumental variable is the fraction of competitor plans that have gap coverage. We defined competitor plans as plans that operate in the same PDP region. We conjectured that a given plan's generosity would be correlated with the generosity of other plans with which it competes. However, the generosity of competitor plans should not directly influence the drug therapy utilization of the beneficiary, making it a valid instrument. Previous studies on health plan enrollment have used information from competitor plans as the instrumental variable to account for endogenous plan selection (Mello, Stearns, and Norton 2002; Dowd et al. 2010). While a potential alternative instrument could be based on the market shares of competitor plans, the 5 percent sample cannot support such an approach.

We estimated separate models by type of beneficiary population (all users, high/low cardiovascular risk users, and high/low medication cost users). Standard errors were clustered at the beneficiary level. All analyses were conducted using STATA version 11.2 (STATA Corp, College Station, TX, USA). The 95 percent CI reflects 0.025 in each tail or $p \leq .05$.

RESULTS

The average PDC was 82 percent; 67 percent of the sample had adherence levels above 80 percent. About 71 percent of the sample had high cardiovascular risk and 40 percent had high medication cost. The average deductible for the 24 percent of beneficiaries in plans with any deductible was \$264. About

16 percent of all beneficiaries had gap coverage. The mean annual statin OOP for the representative basket was \$200 for the overall sample, \$169 for beneficiaries in a plan with gap coverage, and \$210 for those in a plan without gap coverage (Table 1). The average actual observed statin OOP cost (mean: \$192, SD: \$202 for the overall sample) was similar to our measure for the annual statin OOP for basket of the representative statins. While the OOP based on the market basket approach assumed utilization of one thirty-day equivalent statin medication every month during the year, in reality beneficiaries on average had 8.84 thirty-day equivalent scripts (standard deviation, 3.79) during the year with an average cost of \$22 per script.

The association of statin OOP costs with statin adherence based on the instrumental variable model is presented in Table 2, by type of beneficiary population (all, high/low cardiovascular risk, high/low medication cost). Diagnostics tests for the first stage and the Hausman test of endogeneity supported the instrumental variables model specification relative to one without. In the first-stage regression of statin OOP costs on the instrumental variable and other explanatory variables, the coefficient estimate on the instrumental variable was statistically significant with $p < .001$ across all specifications ($F = 1512.65$ for all beneficiaries, $F = 1067.98$ for high cardiovascular risk, $F = 406.85$ for low cardiovascular risk, $F = 635.21$ for high medication cost, $F = 787$ for low medication cost), verifying the strong correlation of the instrumental variable with the OOP burden. Next, Hausman tests rejected that the models without the instrumental variable achieved consistent estimates ($p < .001$) for each specification (Table 2).

Beneficiaries in plans with higher statin OOP had a lower likelihood of statin adherence. An increase of \$100 in annual OOP statin costs was associated with reduction of 0.27 ($p < .001$) in the probability that the statin user would be adherent for the calendar year, controlling for sociodemographic characteristics, co-morbidities, regional characteristics, and PDP indicators. Statin users with high cardiovascular risks had a smaller reduction in the probability of adherence (-0.22 , $p < .001$), while those with low cardiovascular risk had a much larger response as expected (-0.41 , $p < .001$). For beneficiaries with high medication costs, the probability of adherence decreased by 0.23 ($p < .001$) for each \$100 increase in annual OOP costs. The effect of plan cost sharing was similar for low medication cost beneficiaries. The presence of a plan deductible was associated with an increase in the probability of statin adherence (except for high medication cost beneficiaries). However, conditional on having a positive deductible, for each \$100 increase in the deductible amount, the probability of adherence was lower for each beneficiary type.

Table 1: Selected Characteristics of the Beneficiaries in the Study Sample ($N = 346,583$)

	Mean	SD
Adherence		
Proportion of days covered (PDC) (%)	82	22
PDC $\geq 80\%$ (%)	67	47
<i>Explanatory variables</i>		
Demographic and health		
Age	75.23	6.96
Female (%)	64	48
Rural (%)	26	44
High cardiovascular risk (%)	71	45
High medication cost (%)	40	49
Medication use among other common therapeutic classes (%)		
Anti-infective agents	57	50
Endocrine and metabolic drugs	59	49
Cardiovascular agents excluding statins	87	33
Respiratory agents	26	44
Gastrointestinal agents	36	48
Central nervous system drugs	31	46
Analgesics and anesthetics	44	50
Plan benefit design		
Any deductible (%)	24	43
Deductible amount conditional on positive deductible (\$)	264	29
Plan has gap coverage (%)	16	37
1-month pre-ICL OOP for statin basket (\$)	15	4
1-month gap OOP for statin basket (\$)	41	14
For beneficiaries in a plan with gap coverage	9	4
For beneficiaries in a plan without gap coverage	47	1
Annual Statin OOP costs (pre-ICL & gap combined) (\$)	200	40
For beneficiaries in a plan with gap coverage	169	39
For beneficiaries in a plan without gap coverage	210	36

Note. Unit of observation: beneficiary-year. Number of observations: 346,538. High cardiovascular risk is defined as utilization of medications for diabetes or hypertension in current or previous years or cardiovascular hospitalization in previous years observed in the data. High medication cost characterizes beneficiaries who reached the gap during previous calendar year. Pre-ICL, pre-initial coverage limit.

Table 3 shows adjusted rates of statin adherence with an increase in annual statin OOP costs from \$170 (25th percentile) to \$200 (observed mean and the 50th percentile) and to \$240 (75th percentile). The increase in statin OOP from the 50th percentile to the 75th percentile was associated with a reduction in the rate of adherent beneficiaries from 67 percent to 56 percent ($p < .001$), while the decrease in the statin OOP to the 25th percentile was associated with an increase in the rate of adherent beneficiaries to 75 percent ($p < .001$). At the observed mean of \$200 statin OOP, beneficiaries with

Table 2: Change in Adjusted Probability of Adherence (PDC ≥ 80%)

	All		High Cardiovascular Risk		Low Cardiovascular Risk		High Medication Cost		Low Medication Cost	
	(95% CI)	p-value	(95% CI)	p-value	(95% CI)	p-value	(95% CI)	p-value	(95% CI)	p-value
Plan's annual statin OOP (in \$100)	-0.27 (-.34, -.21)	<.001	-0.22 (-0.29, -0.14)	<.001	-0.41 (-0.53, -0.30)	<.001	-0.23 (-0.32, -0.13)	<.001	-0.23 (-0.32, -0.13)	<.001
Any deductible (1/0)	0.10 (0.06, 0.13)	<.001	0.06 (0.02, 0.10)	.004	0.21 (0.14, 0.28)	<.001	0.04 (-0.01, 0.09)	.12	0.12 (0.07, 0.17)	<.001
Deductible amount conditional on positive deductible (in \$100)	-0.07 (-0.09, -0.05)	<.001	-0.05 (-0.07, -0.02)	<.001	-0.14 (-0.18, -0.10)	<.001	-0.03 (-0.06, -0.004)	.03	-0.08 (-0.11, -0.05)	<.001
Number of observations	346,583		246,048		100,535		116,949		229,634	
Test of endogeneity Ho: Annual statin OOP is exogenous	F = 45.36, p < .001		F = 19.70, p < .001		F = 30.10, p < .001		F = 14.87, p < .001		F = 16.18, p < .001	
First stage of the instrumental variables regression	F = 1512.65, p < .001		F = 1067.98, p < .001		F = 406.85, p < .001		F = 635.21, p < .001		F = 787, p < .001	

Note. High cardiovascular risk is defined as utilization of medications for diabetes or hypertension in current or previous years or cardiovascular hospitalization in previous years observed in the data. Low cardiovascular risk is defined as the absence of these risk factors. High medication cost characterizes beneficiaries who reached the gap during the previous year. Low medication cost characterizes beneficiaries who did not reach the gap during the previous calendar year. All models were estimated using instrumental variables probit regression controlling for age, gender, indicators of race/ethnicity, rural residence, medication use among other therapeutic classes as risk adjusters, zip-code characteristics, an indicator for 2008, and indicators for PDP regions. Standard errors were clustered at the beneficiary level. Instrumental variable was the share of competitor plans that cover medications in the gap. Model for “All” includes indicators for high cardiovascular risk and high medication use intensity. Models for “High/Low Cardiovascular Risk” include an indicator for high medication cost. Models for “High/Low Medication Use Cost” include an indicator for high cardiovascular risk.

Table 3: Adjusted Rates of Adherence (% with PDC ≥ 80%)

	\$170 (25th Percentile) (A)	Annual Statin OOP Costs \$200 (50th Percentile) (B)	\$240 (75th Percentile) (C)	Difference of Adjusted Estimates (p-value)		
				B-A	C-B	C-A
Adjusted rate of adherent beneficiaries (%) (95% CI)						
All	75.04 (73.34, 76.74)	67.26 (67.06, 67.46)	55.66 (52.58, 58.73)	<.001	<.001	<.001
High cardiovascular risk	73.84 (71.74, 75.95)	67.53 (67.28, 67.78)	58.29 (54.58, 62.00)	<.001	<.001	<.001
Low cardiovascular risk	78.23 (75.47, 80.99)	66.96 (66.63, 67.29)	49.32 (44.04, 54.61)	<.001	<.001	<.001
High medication cost	76.71 (74.64, 78.28)	70.17 (69.57, 70.76)	60.35 (55.52, 65.17)	<.001	<.001	<.001
Low medication cost	72.33 (69.56, 75.10)	65.82 (65.54, 66.09)	56.38 (52.47, 60.29)	<.001	<.001	<.001

Note. High cardiovascular risk is defined as utilization of medications for diabetes or hypertension in current or previous years or cardiovascular hospitalization in previous years observed in the data. Low cardiovascular risk is defined as the absence of these risk factors. High medication cost characterizes beneficiaries who reached the gap during the previous year gap. Low medication cost characterizes beneficiaries who did not reach the gap during the previous year. All models were estimated using instrumental variables probit regression controlling for age, gender, indicators of race/ethnicity, rural residence, medication use among other therapeutic classes as risk adjusters, zip-code characteristics, an indicator for 2008, and indicators for PDP regions. Standard errors were clustered at the beneficiary level. Model for “All” include indicators for high cardiovascular risk and high medication cost. Models for “High/Low Cardiovascular Risk” include an indicator for high medication cost.

cardiovascular risk had slightly higher adherence rates relative to those with low cardiovascular risk (68 percent vs 67 percent). Beneficiaries with high cardiovascular risk had a smaller response to changes in statin OOP likely reflecting their more immediate need for statins. For beneficiaries with high medication costs, the inter-quartile increase in statin OOP costs from \$170 to \$240 was associated with a reduction in the adherence rate from 77 percent to 60 percent ($p < .001$). The adherence rate of beneficiaries with low medication cost reduced from 72 percent to 56 percent ($p < .001$) for the corresponding increase in statin OOP costs.

We conducted several sensitivity analyses of our baseline models (Table 4). First, instead of clustering standard errors at the beneficiary level, we clustered them at the plan level to account for unobserved factors that may be common to beneficiaries in the same plan. The association of the statin OOP costs and utilization remained statistically significant with $p = .04$. We also re-estimated our models excluding beneficiaries who were new statin users (as defined with no prior history of statin use until the calendar year of study). These individuals may have different utilization behavior and price response than beneficiaries who have been using statins for a longer period of time. This exclusion also yielded similar estimates to our baseline model.

Table 4: Sensitivity Analyses of the Change in Adjusted Probability of Adherence ($PDC \geq 80\%$)

<i>Plan's Annual Statin OOP (in \$100)</i>	<i>(95% CI)</i>		<i>p-value</i>	<i>Number of Observations</i>
(1) Baseline (Table 2, All)	-0.27	(-0.34, -0.21)	<.001	346,583
(2) Clustering at the plan level	-0.27	(-0.53, -0.01)	.040	346,583
(3) Exclude new users	-0.26	(-0.51, -0.02)	.036	297,961
Assessing robustness of the statin OOP measure				
(4) Impute statin OOP using drug coverage information at the contract level	-0.25	(-0.47, -0.03)	.027	346,583
(5) Exclude beneficiaries in plans with imputed statin OOP	-0.15	(-0.21, -0.09)	<.001	76,802
(6) Include the plan deductible to the annual statin OOP	-0.27	(-0.34, -0.21)	<.001	346,583
(7) Differentiate statin OOP for low and high medication cost users	-0.33	(-0.40, -0.26)	<.001	346,583

Note. All models were estimated using instrumental variables probit regression controlling for age, gender, indicators of race/ethnicity, rural residence, medication use among other therapeutic classes as risk adjusters, indicators for high cardiovascular risk and high medication cost, zip-code characteristics, an indicator for 2008, and indicators for PDP regions. Standard errors were clustered at the beneficiary level.

Next, we conducted several sensitivity tests on our measure of statin OOP. As discussed in the Methods section, some statin medications may not be observed in each plan because the data capture only a 5 percent random sample of the entire Part D population. For such medications, we imputed the OOP costs based on tier types most commonly associated with that active ingredient in the entire sample. In a sensitivity analysis, we used information from other plans under the same contract in a given region to impute the type of coverage tier. Rather than imputing information from the entire sample, this sensitivity test imputes the type of tier from values observed from other plans within the same contract offering. For active ingredients not filled in a given plan, we searched for whether they were filled in any other plan within the same contract. If so, we identified the type of tier under which it was covered. Next, for the plan without the fill for that active ingredient, we used the cost sharing corresponding to that tier for that plan. This resulted in a modified imputation of plan statin OOP for 212,799 of the 269,781 beneficiary-year observations for which we had imputed the OOP for at least one active ingredient. However, our final measures of monthly statin OOP were similar in both approaches: Mean: \$14.99 (SD: \$3.84) under our original approach, and Mean: \$15.08 (SD: \$3.92) under the new approach. We re-estimated our model using this modified statin OOP, and the results were robust (specification 4, Table 4). In an additional check, we excluded beneficiaries in plans for which we had to impute the OOP for at least one statin medication. This exclusion reduced our sample size substantially from 346,583 to 76,802, but our estimates were similar to our baseline model (specification 5, Table 4).

In another sensitivity analysis, we incorporated the plan deductible into our measure of the statin OOP instead of including the deductible as an additional covariate. The deductible is spent across all drugs the beneficiary utilizes, not just statins. Therefore, we first estimated the share of the deductible spent on statins for the sample of statin users (17 percent). Next, for each plan, we added 17 percent of the deductible amount to our final measure of annual statin OOP, and re-estimated our models with this new measure of plan statin OOP costs. Our results were robust as shown in specification 6 of Table 4.

Finally, we differentiated the statin OOP for high and low medication cost users. If the beneficiaries had perfect foresight to predict whether they would reach the gap phase or not, we could construct beneficiary-level plan statin OOP costs based on the number of months expected to spend in each phase. In a sensitivity analysis, we constructed a statin OOP measure that varied by whether the beneficiary expected to reach the gap. On average, users who never exceeded the pre-ICL period spent 11 months in that phase, while

those who reached the gap phase spent 7.7 months in the pre-ICL and 3.9 months in the gap phases, respectively. For beneficiaries who reached the gap in the previous year—"high medication cost group" (our best guess for beneficiaries who are likely to reach the gap in the current year as well), we constructed the final measure of statin OOP as the weighted average of the monthly OOP in pre-ICL and gap phase using 7.7 and 3.9 as the weights. For beneficiaries who did not reach the gap in the previous year—"low medication cost group," we used 10.8 and 0 as weights in calculating our final statin OOP measure. Our results were similar to that of our baseline model (specification 7 of Table 4).

DISCUSSION

The observation that greater prescription drug cost sharing is associated with reduced drug utilization among adults is confirmed here for the Medicare population. This study introduces an approach for quantifying Part D plan cost sharing—a method that can be applied to future research on other therapeutic classes. Our method also extends earlier applications of the basket OOP cost approach (Joyce et al. 2002; Goldman et al. 2004; Goldman, Joyce, and Karaca-Mandic 2006; Karaca-Mandic et al. 2010, 2012), by adapting it to account for the pre-initial coverage limit (pre-ICL) and donut (gap) phases. An important contribution of this method is that it offers an approach for imputing OOP costs of medications when they are unobserved in the plan because the 100 percent Medicare data are never available to researchers.

Even a modest degree of cost sharing may have a meaningful impact on medication adherence in the aged population. Increasing a plan's annual OOP costs for statins by \$40 from the mean cost of \$200 was associated with a reduction in the adjusted rate of adherent users from 67.26 percent to 55.66 percent ($p < .001$) among all users.

The recently published Post-Myocardial Infarction Free Rx Event and Economic Evaluation (MI FREEE) trial Choudhry et al. 2011 showed that eliminating copayments of drugs prescribed after myocardial infarction led to a statistically significant increase in adherence (by 6.2 percent points for statins). The MI FREEE trial focused on 5,855 privately insured nonelderly adults discharged after myocardial infarction. Although its findings are not directly generalizable to the Medicare population, our estimates are comparable.

Also consistent with prior research that demonstrates that beneficiaries falling into the Medicare coverage gap decrease their use of medications (Hsu et al. 2008; Raebel et al. 2008; Zhang et al. 2009; Fung et al. 2010; Gu et al. 2010; Hales and George 2010), our study also provides evidence regarding the economic and health rationale for closing the coverage gap. The negative association of plan cost sharing with adherence was large among those beneficiaries who reached the gap (high medication cost). Statins are cost-effective therapies for reducing cardiovascular hospitalizations (Pfeffer et al. 1995; Shepherd et al. 1995; Sacks et al. 1996; Pyorala et al. 1997; Downs et al. 1998, 2001; Goldberg et al. 1998; Lewis et al. 1998; Pedersen 1998; Plehn et al. 1999; Clearfield et al. 2001; ALLHAT Collaborative Research Group 2002; Collins, Peto, and Armitage 2002; Heart Protection Study Collaborative Group 2002; National Cholesterol Education Program (NCEP) 2002; Simes et al. 2002; Sever et al. 2003; Cannon et al. 2004; Ford et al. 2007; AIM-HIGH Investigators 2011). In 2009, charges for an average cardiovascular hospitalization were \$30,178 with an average Medicare reimbursement of \$5,989.² Thus, higher statin cost sharing may generate additional Medicare Part A costs, and this may be particularly salient for beneficiaries who reach the gap. Insights from the value-based insurance design programs suggest that closing the gap could improve adherence rates and decrease adverse outcomes (Chernew et al. 2010; Gibson et al. 2010, 2011; Kim et al. 2011; Cohen, Christianson, and Feldman 2012).

The 2012 Affordable Care Act provisions provide more support during the coverage gap, but beneficiaries still pay a portion of the manufacturer prices for drugs purchased in this period (50 percent for brand-name drugs and 86 percent for generic drugs). Using our basket OOP cost approach, we estimated the annual OOP cost for the representative basket of statins under the discounts. For beneficiaries without gap coverage, statin OOP costs decrease on average from \$210 to \$170 with the 2012 discounts.³ The estimates from our models (Table 2) suggest that such a policy will likely be associated with an increase in adjusted adherence rate of beneficiaries from 65 percent to 75 percent ($p < .001$).

Our study has several limitations. As beneficiaries were not randomized to plans with varying prescription drug coverage, there is a general concern that unobserved beneficiary characteristics may also explain estimated associations. Our instrumental variables approach accounted for such spurious correlations. The identifying assumption was that our instrument, the fraction of competitor plans that have gap coverage, was not correlated with unobserved factors that could influence patient medication utilization other than its

correlation with the plan OOP costs of the beneficiary's plan. Recent economics literature provides evidence of inconsistencies in plan choice among Medicare Part D plans such that beneficiaries do not necessarily select plans that offer the best risk protection at a given cost (Domino et al. 2008; Abaluck and Gruber 2011b). Our measure of plan OOP costs in the baseline models do not vary beneficiary choice of drugs, utilization, and spending (which determines whether the beneficiary reaches the gap and/or the catastrophic phases, and thus the OOP prices faced). A more complete, structural model would incorporate the dynamics of beneficiary utilization and phase selection. In such a model, our instrument that relies on benefit generosity of competitor plans would not be sufficient.

Our measure of plan statin OOP costs represents the OOP cost required to purchase a fixed, representative basket of statins within a plan. Patients certainly respond to prices in a drug plan by altering the composition of medications, in particular by shifting toward less expensive medications. Therefore, our estimate of the association between OOP costs and medication utilization may be underestimated.

As another limitation, our study focuses on PDP enrollees and our results may not necessarily generalize to beneficiaries enrolled in MA-PD plans. Inpatient hospitalization data are not available for these enrollees, which is necessary to adjust PDC and construct our key outcome measure of adherence. Similarly, we did not include LIS beneficiaries as they face uniform cost sharing based on their LIS qualification group and do not have a phased benefit design.

Despite these limitations, our results suggest that among Medicare Part D beneficiaries using statins, greater prescription drug cost sharing may lead beneficiaries to reduce utilization of important medications.

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NOTES

1. The full list of indicators included anti-infective agents, biologicals, anti-neoplastic agents, endocrine and metabolic drugs, cardiovascular agents excluding statins, respiratory agents, gastrointestinal agents, genitourinary agents, central nervous system drugs, ADHD/anti-carcotic/anti-obesity agents/anorexic agents, psychotherapeutic/neurological agents, neuromuscular agents, nutritional products, hematological agents, topical products, and miscellaneous products.
2. Medicare Fee for Service for Parts A&B Summary Statistics, 2009 (<http://www.cms.gov/MedicareFeeforSvcPartsAB/Downloads/DRG09.pdf>), accessed on October 8, 2011.
3. In the pre-ACA period, average monthly statin OOP in a plan without gap coverage was \$47. The ACA discounted that amount to \$21. For a beneficiary without gap coverage in the pre-ACA period, assuming an average of 1.5 months spent in the gap, this implies a reduction of \$39 for an average beneficiary's annual statin OOP from \$210.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Appendix SA1: Author Matrix.