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RESEARCH ARTICLE

Trends in Medicare Service Volume for Cataract Surgery and the Impact of the Medicare Physician Fee Schedule

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Objective. To calculate the associations between Medicare payment and service volume for complex and noncomplex cataract surgeries.

Data Sources. The 2005–2009 CMS Part B National Summary Data Files, CMS Part B Carrier Summary Data Files, and the Medicare Physician Fee Schedule.

Study Design. Conducting a retrospective, longitudinal analysis using a fixed-effects model of Medicare Part B carriers representing all 50 states and the District of Columbia from 2005 to 2009, we calculated the Medicare payment–service volume elasticities for noncomplex (CPT 66984) and complex (CPT 66982) cataract surgeries.

Data Extraction. Service volume data were extracted from the CMS Part B National Summary and Carrier Summary Data Files. Payment data were extracted from the Medicare Physician Fee Schedule.

Principal Findings. From 2005 to 2009, the proportion of total cataract services billed as complex increased from 3.2 to 6.7 percent. Every 1 percent decrease in Medicare payment was associated with a nonsignificant change in noncomplex cataract service volume (elasticity = 0.15, 95 percent CI [−0.09, 0.38]) but a statistically significant increase in complex cataract service volume (elasticity = −1.12, 95 percent CI [−1.60, −0.63]).

Conclusions. Reduced Medicare payment was associated with a significant increase in complex cataract service volume but not in noncomplex cataract service volume, resulting in a shift toward performing a greater proportion of complex cataract surgeries from 2005 to 2009.

Key Words. Cataract surgery, Medicare Physician Fee Schedule, physician reimbursement

Reducing Medicare payments to physicians has frequently been a policy maker target as a method of reducing national health care expenditures. Particularly as Medicare spending continues to outpace overall economic growth, the unsustainable growth in national debt and diversion of resources away from other domains become increasingly concerning (Emanuel et al. 2012;

Medicare Payment Advisory Commission 2013). Ever since the passage of the Balanced Budget Act of 1997, policy makers have sought to contain Medicare spending by adjusting payment rates for over 10,000 practitioner services using the sustainable growth rate (SGR) formula, a tool that policy makers and physicians alike have viewed as a failed measure both to control health care spending and to promote health care quality (Guterman 2014; McClellan, Patel, and Sanghavi 2014). After repeated postponements in enacting Medicare spending cuts called for by the SGR, Congress finally repealed the SGR formula in 2015 with the passage of the Medicare Access and CHIP (Children's Health Insurance Program) Reauthorization Act (MACRA).

As the U.S. health care system moves into a future of value-based payments, it is worth examining the still relevant central question to the original enactment of the SGR and other measures of adjusting physician reimbursement rates: To what extent can changes in Medicare payment contain health care spending? When the Medicare Fee Schedule (now Medicare Physician Fee Schedule or MPFS) was first implemented under the Omnibus Budget Reconciliation Act of 1989, both the Health Care Financing Administration (HCFA, now Centers for Medicare and Medicaid Services or CMS) and the Congressional Budget Office assumed that in response to fee reductions, physicians would recuperate one-half of lost revenue by increasing the volume and complexity of services, which the HCFA termed the "50 percent behavioral offset" (HCFA 1991). This assumption of a behavioral offset was largely based on empirical work conducted by the Physician Payment Review Commission (PPRC, now the Medicare Payment Advisory Commission or Med-PAC) (Ginsburg and Hogan 1993; PPRC 1993). Subsequent studies by both the HCFA Office of the Actuary and independent researchers have found the "physician volume-and-intensity response" for Medicare payment reductions to be lower at 30–40 percent (Nguyen and Derrick 1997; Codespote, London, and Shatto 2013). Based on these studies, CMS believes that "there is a statistically significant relationship between Medicare price reductions for physicians' services and partially offsetting increases in the volume and intensity of

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such services” (CMS 2013d). However, the last major study to examine this relationship used data from 1994 to 1996. Thus, new research using updated data would be useful to study the extent Medicare price changes influence the volume and intensity of services rendered in today’s health care landscape.

To answer this question, we analyzed the association between Medicare payment and service volume for cataract surgery. The choice to study cataract surgery was made for several reasons. First, it is the most commonly performed surgical procedure among Medicare beneficiaries in the United States, representing a significant proportion of Medicare expenditure (Schein et al. 2012). Second, Medicare is the single largest payer for cataract surgery, and an estimated 80 percent of cataract surgeries are performed on Medicare patients (Erie et al. 2007). Because the vast majority of cataract surgeries are paid for within the Medicare system, there is less concern for non-Medicare policies influencing the association between Medicare payment and Medicare cataract service volume compared to other procedures performed in patient populations with greater diversity in both age and insurance providers. And third, the MPFS contains two different Current Procedural Terminology (CPT) codes for cataract surgeries, one for noncomplex types (CPT 66984) and one for complex types (CPT 66982) wherein the latter—requiring devices or techniques not used in routine cataract surgery—is compensated a higher dollar amount. The existence of two different procedures for a similar indication allows for the comparison of service volume responses during the same time period.

Conceptual Model

In the United States, Medicare reimbursement rates are set annually by CMS; thus, physicians providing services and performing procedures on Medicare patients are price takers in the public health care market. Changes in Medicare fees, which occur exogenously from the standpoint of an individual physician, can result in either an increase or decrease in the volume of services provided, depending on the relative strengths of the substitution and income effects. According to the McGuire and Pauly model of profit-maximizing behavior, the substitution effect, describing the relative price changes across related procedures, dominates the income effect, describing the physician’s ability and desire to induce demand (McGuire and Pauly 1991). However, we argue that in the case of cataract surgery, the income effect may dominate over the substitution effect, whereby decreased Medicare fees result in increased service volume as suggested by Mitchell, Hadley, and Gaskin (2000).

Figure 1: Backward-Sloping Cataract Surgery Supply Function. (A) Non-complex Cataract Surgery Supply Function; (B) Complex Cataract Surgery Supply Function

For the population of patients with advanced cataracts and thus requiring cataract surgery, there is no substitute therapy for treating cataracts except for extraction of the opaque lens. Moreover, because cataract surgeries constitute a significant proportion of a general ophthalmologist or cornea specialist's clinic revenue, the income effect for reductions in cataract surgery reimbursement rates is significant. Due to a large income effect and small substitution

effect, the ophthalmologist's supply function for cataract surgery may be backward-sloping. Within the backward-sloping segment of the cataract surgery supply curve, reducing payments will increase the volume of cataract services rendered. However, there is a difference in the slope of the backward-sloping segments of the supply curves for noncomplex and complex cataract surgeries (Figure 1A and B). Because ophthalmologists may opt to perform more higher paid complex cataract surgeries when Medicare reimbursement rates decline, we argue that there is more room for substitution away from the supplying of noncomplex cataract services. Therefore, the backward-sloping segment of the noncomplex cataract surgery supply curve bends back to a lesser degree compared to that of the complex cataract surgery supply curve. Based on this model, we predict that the same percentage decrease in Medicare fees will lead to a greater increase in complex cataract service volume compared to noncomplex cataract service volume.

Medicare Advantage

The primary focus of our paper was measuring the impact of payment on the volume of cataract procedures. However, within the Medicare payment landscape, there is another important financial consideration when calculating the payment–volume relationship: the impact of the growing non-fee-for-service Medicare population. The number of enrollees in Medicare Advantage plans has grown steadily over time—by 2015, 31 percent of all Medicare beneficiaries was enrolled in a Medicare Advantage plan, and of these enrollees, 64 percent was through health maintenance organizations and 24 percent was through preferred provider organizations (Kaiser Family Foundation 2015b). Controlling for price, we hypothesize that a shift from fee-for-service Medicare plans to Medicare Advantage plans may reduce the volume of cataract surgeries performed. This inverse relationship between Medicare Advantage enrollment and cataract service volume may exist due to the lower price sensitivity for services rendered to Medicare patients that are paid on a capitation model rather than a fee-for-service model.

METHODS

Data Sources

To describe national trends in Medicare service volume for cataract procedures, we extracted data from the CMS Part B National Summary Data Files

corresponding to CPT 66984 (noncomplex cataract surgery) and CPT 66982 (complex cataract surgery) (CMS 2013c). These files contain the total number of allowed services by CPT code, which includes billed services for the surgeon, assistant surgeon, and ambulatory surgery center facility service charge. Using the volume of allowed services is consistent with the methodology used by the Physician Payment Review Commission (Codespote, London, and Shatto 2013). For payment data, we used the Medicare Physician Fee Schedule (CMS 2013a), which listed the facility price and relative value units (RVUs) for both types of cataract procedures.

To describe the relationship between Medicare payment and cataract service volume, we conducted a retrospective longitudinal analysis of Medicare Part B carriers representing all 50 states and the District of Columbia. Part B carriers are organizations contracted by CMS that exercise jurisdiction over a defined geographical area to administer Medicare Part B policies. For each carrier, we extracted service volume data for CPT 66984 and CPT 66982 from the CMS Part B Carrier Summary Data Files (CMS 2013b). For carriers with differing payment schedules according to geographic location, a single fee schedule amount was calculated using weighted population data from the U.S. Census Bureau (2013). All fees were adjusted for inflation according to the overall Consumer Price Index (Bureau of Labor Statistics 2013) using 2005 as the base year.

For each carrier, CMS has published data from 2005 through 2011. In this study, we included data up to 2009 but not beyond due to a change in the MPFS's payment formula midway through 2010. The conversion factor for RVUs into a dollar amount was updated on June 1, 2010, resulting in a different fee schedule for the second half of the year compared to that of the first half (American Medical Association 2013a). Because volume data are provided by year, data for 2010 and 2011 were not included to prevent inaccurate calculations due to mismatch in the timing of payment and service volume data.

Regression Analysis

We calculated payment–volume elasticities—defined as the percent change in Medicare service volume per 1 percent change in Medicare payment—for both noncomplex and complex cataract surgeries using a fixed-effects regression model, a standard technique used by the PPRC and other research groups to assess the volume response to payment changes (Ginsburg and Hogan 1993; Mitchell and Cromwell 1995; Nguyen and Derrick 1997). In our

model, the Medicare Part B carrier where the surgery was performed served as the independent unit of analysis.

For each carrier, the MPFS formula is adjusted by a Geographic Practice Cost Index to account for regional variations in practice costs, resulting in differences in year-to-year Medicare payment changes across carriers (American Medical Association 2013b). This across-carrier variation creates a natural experiment to isolate the association between Medicare payment and service volume within a single carrier. We included a dummy variable representing each Medicare Part B carrier in the regression model to account for carrier-specific characteristics that were stable over time (Allison 2009). Thus, the model controlled for time-invariant regional variations in cataract surgery demand, patient demographics, and physician practices. We included an additional time variable to control for national trends in service volume due to factors that affected the entire country. The regression model also controlled for carrier-level changes in Medicare fee-for-service beneficiary population, number of ophthalmologists, and income per capita using state- and county-level data from the Department of Health and Human Services Area Resource File (U.S. Department of Health and Human Services 2013). Carrier-year level data on the proportion of Medicare beneficiaries in Medicare Advantage plans among the total Medicare population were also included to control for patient selection into Medicare Advantage over time (Kaiser Family Foundation 2015a). To account for nonnormally distributed standard errors as determined by the modified Wald test, the regression analyses were adjusted for heteroskedasticity.

Although the fixed-effects model controls for time-invariant carrier-specific differences, we must be aware of factors that change in an uneven geographic distribution and explicitly account for such factors in our model. For this reason, one additional set of controls was added to the regression model to account for differential rates of technology diffusion across carriers. This is particularly relevant for complex cataract surgeries. Because the billing code for complex cataract surgery (CPT 66982) was only introduced in 2001, there is a possibility that delayed adoption of the new code may occur differentially in highly advanced versus less advanced health care markets which is in turn correlated with Medicare fee growth. Service volume growth in less advanced health care markets may occur rapidly to catch up to other markets, but if these markets are in low-price growth areas, this will impact our calculated Medicare payment–service volume elasticity.

Choosing the right control variable to adjust for this delayed adoption in technology will help isolate the impact of Medicare fees on cataract service

volume. We believe that the most appropriate away to control for this differential adoption of the CPT 66982 code due to differences in health care technology is to use volume data for an ophthalmic procedure that was introduced and adopted over the same time period. In the period leading up to 2005, intravitreal injection (CPT 67028) of medications slowly became popular as treatment modality for age-related macular degeneration after the Food and Drug Administration approval of verteporfin. From 2005 to 2009, intravitreal injection volume then increased dramatically due to the approval and use of pegaptanib, ranibizumab, and bevacizumab (Ramulu et al. 2010), similar to the rise in CPT 66982 volume. Therefore, in our regression model for complex cataract surgery, we included CPT 67028 service volume as a variable, controlling for CPT 67028 payment, to account for the regional rate of adoption of new ophthalmic technologies and billing codes in each Medicare carrier. For the reason that differential rates of technological change across carriers could also affect noncomplex cataract service volume, we have included these sets of controls in the regression models for both procedures.

The carrier and time fixed-effects regression model can be represented mathematically as follows:

$$V_{ijk} = \beta_0 + \beta_1 P_{ijk} + \beta_2 A_{jk} + \beta_3 B_{jk} + \beta_4 C_{jk} + \beta_5 D_{jk} + \beta_6 E_{jk} + \beta_7 F_{jk} + \alpha_j - \gamma_k + \varepsilon_{ijk}$$

In this model, V_{ijk} is the service volume and P_{ijk} is the Medicare fee for procedure i in carrier j and year k . A_{jk} , B_{jk} , C_{jk} , and D_{jk} represent the number of Medicare fee-for-service beneficiaries, number of ophthalmologists, income per capita, and proportion of Medicare beneficiaries in Medicare Advantage plans, respectively, in carrier j and year k . E_{jk} and F_{jk} represent CPT 67028 service volume and payment, respectively, in carrier j and year k . β_0 is the fixed-effects parameter representing the Y -intercept, α_j is the fixed-effects parameter that represents the stable characteristics of each carrier, γ_k is the correction for national trend in service volume, and ε_{ijk} is the error term. β_1 , β_2 , β_3 , β_4 , β_5 , β_6 , and β_7 are the regression coefficients to be estimated and represent the effect of their respective covariates on service volume. Because variables were log transformed, β_1 can be interpreted as the percent change in service volume per 1 percent change in Medicare payment, or the payment–volume elasticity. All regression analyses were conducted using *StataMP 13* (StataCorp LP, College Station, TX, USA) with two-sided significance testing and statistical significance set at .05.

RESULTS

National Trends

From 2005 to 2008, average Medicare payment across carriers representing all 50 states and the District of Columbia decreased every year for both the lower paid noncomplex and higher paid complex cataract surgeries, but 2009 saw a small increase in Medicare fees for both types of procedures. During this 5-year period, average Medicare payment for noncomplex cataract surgery decreased from \$671.22 to \$573.79 (2005 \$), a real value decline of 14.5 percent (Figure 2A). For complex cataract surgery, average payment decreased from \$898.92 in 2005 to \$806.33 in 2009 (2005 \$), a real value decline of 10.3 percent (Figure 2B). In terms of RVUs, payment for physician work increased and payment for practice expenses decreased for both types of cataract surgery. For noncomplex cataract surgery, work RVUs increased from 10.21 to 10.36, whereas practice expense RVUs decreased from 7.42 to 6.96 over 2005 to 2009 (Table 1). For complex cataract surgery, work RVUs increased from 13.48 to 14.83, whereas practice expense RVUs decreased 9.86 to 9.26 over the same time frame. Taken together, the relative price of CPT 66984 to CPT 66982 decreased from 2005 to 2009.

The volume of services billed for noncomplex cataract surgery decreased 5.6 percent from 3,372,757 services/year in 2005 to 3,185,130 services/year in 2009 (Figure 2A), whereas the volume of services billed for complex cataract surgery increased 105.1 percent from 112,331 services/year in 2005 to 230,429 services/year in 2009 (Figure 2B). In aggregate, the total volume of noncomplex and complex cataract services decreased from 3,485,088 services/year in 2005 to 3,415,559 services/year in 2009, a 2.0 percent decline. Due to the increase in the volume of complex relative to noncomplex cataract services, the proportion of total cataract services billed under the complex procedure more than doubled from 3.2 percent in 2005 to 6.7 percent in 2009.

Regression Results

For noncomplex cataract surgery, we found that every 1 percent decrease in Medicare payment from 2005 to 2009 was associated with a nonsignificant change in noncomplex cataract service volume: payment-volume elasticity without accounting for technology diffusion = -0.09 (95 percent CI $[-0.25, 0.07]$), and payment-volume elasticity accounting for technology diffusion = 0.15 (95 percent CI $[-0.09, 0.38]$, Table 2). For complex cataract

Figure 2: Medicare Payment and Service Volume for Noncomplex and Complex Cataract Surgeries. (A) Noncomplex Cataract Surgery; (B) Complex Cataract Surgery

Table 1: Changes in Noncomplex (CPT 66984) and Complex (CPT 66982) Cataract Surgery RVUs, 2005–2009

	2005	2006	2007	2008	2009
CPT 66984					
Work RVU	10.21	10.21	10.36	10.36	10.36
Practice expense RVU	7.42	7.44	7.24	6.93	6.96
Malpractice RVU	0.42	0.39	0.39	0.39	0.39
CPT 66982					
Work RVU	13.48	13.48	14.83	14.83	14.83
Practice expense RVU	9.86	9.89	9.75	9.41	9.26
Malpractice RVU	0.61	0.63	0.63	0.63	0.63
Conversion factor (\$)	37.8975	37.8975	37.8975	38.087	36.0666

Table 2: Association between Medicare Payment and Noncomplex Cataract (CPT 66984) Service Volume, Fixed-Effects Model, 2005–2009

<i>Variable</i>	<i>CPT 66984 Service Volume</i>	<i>CPT 66984 Service Volume (Controlling for Technology Diffusion)</i>
CPT 66984 payment	−0.09 [−0.25, 0.07]	0.15 [−0.09, 0.38]
Total Medicare beneficiary population	1.12 [−0.13, 2.36]	0.88 [−0.30, 2.08]
Medicare advantage proportion	−1.78*** [−2.48, −1.09]	−1.62*** [−2.38, −0.84]
Number of ophthalmologists	0.12 [−0.30, 0.53]	0.19 [−0.23, 0.62]
Income per capita	0.31 [−0.11, 0.74]	0.41 [−0.06, 0.88]
Year		
2006	−0.02 [−0.07, 0.04]	−0.13* [−0.25, −0.001]
2007	−0.01 [−0.10, 0.08]	−0.17 [−0.36, 0.02]
2008	−0.05 [−0.18, 0.08]	−0.24 [−0.48, 0.003]
2009	−0.01 [−0.16, 0.14]	−0.24 [−0.52, 0.05]
CPT 67028 service volume		0.15* [0.02, 0.28]
CPT 67028 payment		−0.08 [−0.25, −0.10]

* $p < .05$, ** $p < .01$, *** $p < .001$.

surgery, the payment–volume elasticity without adjusting for technology diffusion was -1.22 (95 percent CI $[-1.49, -0.96]$). Accounting for technology diffusion, the payment–volume elasticity was -1.12 (95 percent CI $[-1.60, -0.63]$), Table 3): for every 1 percent decrease in Medicare payment for CPT 66982, complex cataract service volume increased 1.12 percent. Thus, from 2005 to 2009, reductions in Medicare payment were associated with a non-significant change in noncomplex cataract service volume but a statistically significant increase in complex cataract service volume.

Table 3: Association between Medicare Payment and Complex Cataract (CPT 66982) Service Volume, Fixed-Effects Model, 2005–2009

<i>Variable</i>	<i>CPT 66982 Service Volume</i>	<i>CPT 66982 Service Volume (Controlling for Technology Diffusion)</i>
CPT 66982 payment	−1.22*** [−1.49, −0.96]	−1.12*** [−1.60, −0.63]
Total Medicare beneficiary population	1.76 [−0.17, 3.69]	1.37 [−0.55, 3.28]
Medicare advantage proportion	−1.11 [−2.39, 0.17]	−0.80 [−2.09, 0.49]
Number of ophthalmologists	−0.46 [−1.63, 0.71]	−0.30 [−1.33, 0.72]
Income per capita	0.25 [−0.57, 1.08]	0.47 [−0.42, 1.35]
Year		
2006	0.17** [0.05, 0.30]	−0.06 [−0.27, 0.15]
2007	0.32** [0.14, 0.50]	−0.03 [−0.32, 0.27]
2008	0.40** [0.16, 0.64]	−0.001 [−0.37, 0.37]
2009	0.58*** [0.33, 0.83]	0.10 [−0.30, 0.50]
CPT 67028 service volume		0.31** [0.10, 0.52]
CPT 67028 payment		0.26 [−0.22, 0.73]

* $p < .05$, ** $p < .01$, *** $p < .001$.

Because our model relies on across-carrier variation in year-to-year Medicare payment changes, we calculated the mean and standard deviation of payment changes using the carrier-year as the basis of analysis for both cataract procedures. When examining the price variation for the four year-to-year dyads from 2005 to 2009 (i.e., 2005–2006, 2006–2007, 2007–2008, 2008–2009), we found the mean payment change on the carrier-year level for non-complex cataract surgery was −2.8 percent with a standard deviation of 4.2 percent ($Q1 = -4.8$ percent, $Q2 = -3.6$ percent, $Q3 = -1.0$ percent, Table S1). For complex cataract surgery, the mean payment change on the carrier-year level was −4.0 percent with a standard deviation of 5.2 percent ($Q1 = -7.7$ percent, $Q2 = -4.9$ percent, $Q3 = -0.7$ percent, Table S1). The variance observed over this time period is comparable to previous work using a similar regression model that examined cataract and other surgical procedures from 1987 to 1989 (Escarce 1993).

In addition to the difference in findings for the payment–volume elasticity between noncomplex and complex cataract surgeries, one other significant difference revealed in our findings was the impact of Medicare Advantage enrollment on cataract service volume. For noncomplex cataract surgery, Medicare Advantage enrollment was associated with a reduction in service volume (Table 2). For complex cataract surgery, there was no significant

relationship between Medicare Advantage enrollment and service volume (Table 3).

DISCUSSION

Our study of two types of cataract procedures found that Medicare service volume for noncomplex cataract surgery decreased slightly from 2005 to 2009, whereas the volume for complex cataract services more than doubled during the same time frame. Analyzing a 100 percent sample of Medicare beneficiary data for the entire country without excluding data from any Medicare Part B carrier or physician, the regression analysis we conducted showed a statistically significant inverse association between Medicare payments and service volume for complex cataract surgery but not for noncomplex cataract surgery.

Because the billing code for complex cataract surgery is relatively new, prior studies did not examine the difference in impact of Medicare fee changes on noncomplex versus complex cataract surgery. However, even findings for noncomplex cataract surgery were mixed. Two different studies conducted on periods of decreasing cataract surgery reimbursement around the time the Medicare Fee Schedule was first implemented found either no association between Medicare payment and surgical volume (Escarce 1993) or a direct correlation between the two (Mitchell, Hadley, and Gaskin 2000). The results from the first study by Escarce are consistent with our study findings for noncomplex cataract surgery. On the other hand, our findings of a significant inverse relationship between payment and volume for complex cataract surgery are consistent with the general procedural findings published by the PPRC and HCFA (Ginsburg and Hogan 1993; Codespote, London, and Shatto 2013).

One of the most common indications to perform the more complex cataract extraction is when patients are taking alpha-blockers, a class of medications known to increase the complexity of cataract operations (Chatziralli and Sergentanis 2011). For the newer procedural code CPT 66982, several factors may explain the observed increase in volume, including (1) improved physician understanding of complex cataract surgery billing codes over time, (2) increased physician awareness of cataract surgery complications in patients taking alpha-blockers, (3) improved history-taking by medical staff to ask about alpha-blocker use in cataract patients, and (4) increased patient awareness to mention alpha-blocker use prior to cataract operations. In addition,

there are multiple factors that may explain why complex cataract service volume is inversely related to reimbursement rates. With declining Medicare payments, ophthalmologists may shift their practice's surgical composition toward more complex cases by taking on more advanced cataract patients or by prioritizing advanced cataract extractions due to relatively higher reimbursement rates for complex cataract surgery. Up-coding by physician practices of previously noncomplex cases has been raised as a concern although it is outside the scope of our data to comment on this possibility.

One way of explaining the difference in the calculated Medicare payment–service volume elasticities for noncomplex versus complex cataract surgery is by interpreting the results in terms of the substitution and income effects. For CPT 66984, declining reimbursement rates may put pressure on ophthalmologists to shift their procedural mix from noncomplex to complex cataract surgeries, thus the lack of association between Medicare payment and service volume may reflect that the income effect and substitution effect for CPT 66984 are similar in magnitude but opposing in direction. For CPT 66982, the previously mentioned factors may contribute to a stronger income effect relative to a possibly nonexistent or minimal substitution effect due to the lack of treatment alternatives for complex cataract surgery or the option to perform a higher paying high-volume procedure, thereby resulting in a backward-sloping supply curve where a decline in reimbursement rates will increase the volume of services rendered. While our empiric findings fit this theoretical model, we also cannot fully exclude alternative explanations that may explain why complex cataract service volume increased substantially from the 2005 to 2009 time period from factors not captured in our regression model. Given the complexity of factors that influence a physician's supply of medical services, our modeling of the substitution and income effect in the context of cataract procedures serves as one possible explanation for the observed Medicare payment–service volume elasticities.

Prior research examining the effect of Medicare payment on the provision of medical care services has referred to this relationship in different ways, but the two most common are “behavioral offset” and “physician response.” Both terms can imply that physicians are the primary, or even sole, agents who are offsetting any decrease in Medicare fees through behavior such as recommending more medical care services to patients. We elected to use “payment–volume elasticity” instead as a descriptive term to refer to the association between Medicare payment and Medicare service volume until more research has been conducted to better characterize the driving forces for

this response. Moreover, patient factors should also be explored as well. For example, lower prices for medical care services can induce Medicare beneficiaries to seek more care due to lower out-of-pocket expenses from reduced coinsurance payment.

One additional finding from our paper is the impact of Medicare Advantage enrollment on cataract service volume and how this effect differs for non-complex cataract versus complex cataract procedures. As Medicare pays most Medicare Advantage plans based on a capitated amount per enrollee, we would expect to see less price sensitivity for services rendered to Medicare Advantage beneficiaries. Our finding of an inverse relationship between Medicare Advantage enrollment and CPT 66984 service volume is in line with previous research that found that switching from a fee-for-service payment model to a contact capitation reimbursement model was associated with a significant decrease in cataract extraction rates (Shrank et al. 2005). However, this effect was not observed for complex cataract surgery. One explanation for this varying effect may be due to differences in the population of patients who undergo noncomplex versus complex cataract surgery. CMS has found that patients with worse health and who require more expensive medical care are more likely to disenroll in Medicare Advantage plans, thus shifting the composition of Medicare Advantage enrollees toward a greater proportion of healthier patients (Riley 2012). As a result, a rise in Medicare Advantage enrollment may have little impact on complex cataract service volume if patients most likely to undergo complex cataract extraction are not enrolling in Medicare Advantage plans.

Our study has several important limitations. Similar to other studies of this nature, the significant findings in this paper can only be interpreted as associations rather than causations. Causal effects can only be hypothesized rather than explicitly tested due to the limitations in using a longitudinal claims-based analysis of Medicare data. Our regression model relied on carrier-years as the unit of observation and used carrier and year fixed-effects to control for omitted variable bias, but no explicit control group was used in our analysis. Misclassification and incorrect coding of Medicare services may also exist in the Medicare National and Carrier Summary Data Files. Additionally, the inclusion of intravitreal injection volume as a proxy for technological diffusion is based on the assumption that the demand and diffusion of intravitreal injections and cataract procedures are similar across carriers. The impact of non-Medicare patients and payments were not included in this study. The inclusion of more variables using data at the individual physician and patient levels may help elucidate other reasons for why complex cataract service

volume may increase with the lowering of Medicare fees and why this effect was not seen for noncomplex cataract surgery.

In our study, we found that there exists a statistically significant inverse relationship between Medicare payments and service volume for complex cataract surgery but not for noncomplex cataract surgery. Based on this analysis, we find that the CMS statement—that there is an inverse relationship between Medicare payments and the volume of Medicare services rendered—is perhaps an overgeneralization of the payment–volume relationship that cannot be applied universally. Two procedures within even the same subspecialty of medicine treating the same disease may have varying Medicare payment–service volume elasticities. A detailed understanding of how this relationship differs across medical procedures may result in more accurate projections of future health care spending.

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SUPPORTING INFORMATION

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

Appendix SA1: Author Matrix.

Table S1. Variation in Medicare Payment Changes at Carrier-Year Level for Noncomplex (CPT 66984) and Complex (CPT 66982) Cataract Surgery, 2005–2009.