THE PRACTICE OF MEDICINE: The Complexity Of Billing And Paying For Physician Care*

By Joshua Gottlieb[1], Adam Hale Shapiro[2], and Abe Dunn[3]

Abstract

The administrative costs of providing health insurance in the US are very high, but their determinants are poorly understood. We advance the nascent literature in this field by developing new measures of billing complexity for physician care across insurers and over time, and by estimating them using a large sample of detailed insurance "remittance data" for the period 2013–15. We found dramatic variation across different types of insurance. Fee-for-service Medicaid is the most challenging type of insurer to bill, with a claim denial rate that is 17.8 percentage points higher than that for fee-for-service Medicare. The denial rate for Medicaid managed care was 6 percentage points higher than that for fee-for-service Medicare, while the rate for private insurance appeared similar to that of Medicare Advantage. Based on conservative assumptions, we estimated that the health care sector deals with $11 billion in challenged revenue annually, but this number could be as high as $54 billion. These costs have significant implications for analyses of health insurance reforms.

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The United States spends a large share of its health care resources on administrative costs, with some authors estimating the share at 30 percent.[1] This far exceeds the share of administrative costs in other countries and drives widespread concern about the efficiency of US medical spending.[2] Administrative expenses take many forms, but one of the most prominent is the process of billing and paying for medical care. For example, hospitals generally have more billing specialists than beds.[3] Physician offices' spending on billing costs totals $30 billion per year.[4] One study estimated that administrative costs make up one-seventh of total health care spending in the US.[5]

Relative to the size of these administrative costs, very little existing research has attempted to shed light on where they arise or how they vary across the US health care system, although the system's complexity has been shown to influence reimbursement structures.[6] In comparisons of overall health care spending between the United States and Canada, the largest source of the difference is administrative costs.[7] But the details of these costs remain opaque.[8]

A primary reason for this dearth of evidence is the limitations inherent in existing data sources. Although administrative claims data are excellent sources for measuring care provision, spending, and prices, they do not capture the full set of interactions between doctors and insurers. To measure billing complexity, a richer set of detail on billing interactions is needed. To examine the origins of administrative costs in the context of billing for physician visits, we used a novel data set with information on all interactions between a group of physician practices and insurers. This approach provided a level of detail not previously available in the literature.

The new data set allowed us to control for numerous detailed characteristics of a visit and the physician involved. Previous analyses, which generally relied on survey data,[9–11] could not attain this level of detail. The controls ensured that the differences we observed in billing complexity were not driven by variation in which practices tend to treat which types of patients. In contrast to payer-specific databases, our data contained billing information for multiple payers within the same physician practice. This allowed us to compare billing complexity across different payers interacting with the same physicians.

Study Data And Methods

Overview Of The Study Design

Our study focused on outpatient visits to physicians. Our goals were to measure the complexity of billing for each patient encounter and to analyze the determinants of that complexity. It is well known that Medicare and Medicaid have substantially lower reimbursement rates for physicians than private payers do.[12–15] However, it is not known whether the public insurers compensate for those lower rates with simplified billing practices.

We used a new data set to construct novel measures of billing complexity. The data came from the IQVIA Real-World Data Adjudicated Claims (from IQVIA) and include information on physician visits in the period 2013–15. IQVIA collects all of the claims submitted and data on subsequent interactions between a sample of physicians and the insurers whom they billed. In contrast with standard claims sources, these data allowed us to observe physicians' requests for payment, insurers' responses to those requests, any resubmissions needed, and the ultimate settlement of the claim. Although

extremely detailed, the data do not offer any way to determine whether the ultimate resolution of the claim was appropriate or inappropriate. Our analysis documents the complexity involved in resolving claims and the extent of the financial disputes, but it cannot determine whether physicians or insurers were correct in their requests and decisions.

The sample primarily consists of claims in five broad specialty categories: cardiology, internal and family medicine, obstetrics and gynecology, orthopedics, and pediatrics. To determine the representativeness of this sample, we built a comprehensive physician reference data set by combining data from private and public sources to capture information on all physicians practicing nationally in our five specialty categories. Details about this combined data set are presented in online appendix exhibit A1.[16] We then compared the characteristics of physicians in the IQVIA Data with those of the physicians in the comprehensive physician reference data set. Specifically, we compared the numbers and ages of physicians in the relevant specialties, the specialty composition among the physicians, physicians' distribution across census regions, and the demographic characteristics of physicians' locations.

Data Details

The IQVIA Data sample is quite large. It contains information about nearly 90,000 physicians, representing about 27 percent of the physicians in the comprehensive national physician reference data set. Our main analysis sample included claims from the 68,000 physicians we observed in the 2015 IQVIA data. We found broad similarities across sources, including a similar mix of specialties, ZIP code median income, and share of the ZIP code population that was elderly. The only notable differences were

that physicians in the IQVIA data were, on average, about three years older than those in the more comprehensive physician reference data set, and that the IQVIA data had a larger share of physicians in the South and a smaller share of them in the West. The differences were modest, so the IQVIA physician sample appeared to be quite representative of the broader physician population.

The IQVIA data specified the insurer to which each bill was submitted. We aggregated the detailed insurer codes into five categories: fee-for-service Medicare, Medicare Advantage (managed care), fee-for-service Medicaid, Medicaid managed care, and private. In appendix exhibit A2,[16] we separately consider claims processed by secondary insurers such as Medigap and Medicaid (for beneficiaries dual-eligible for both Medicare and Medicaid).

To use the most current data available, we relied exclusively on data for 2015 for most of our analyses. When we examined changes over time, we included the complete sample of data for 2013–15.

Study Oversight

This study was approved by the Clinical Research Ethics Board at the University of British Columbia, with a waiver of informed consent requirements.

Definition Of Complexity

For each patient encounter (visit), we began by computing how much of the physician's fee was never paid during the billing process. We computed this in two ways—the amount challenged and the share challenged. These served as our primary measures for this study.

The amount challenged is the difference between the amount actually spent on a visit and the amount that would have been spent had the insurer paid the full negotiated amount for the service provided. To compute this amount, we first determined how much would have been paid for each visit if there had been no denials and every service had been paid for at the full negotiated amount. The full negotiated amount was reduced from the billed amount to reflect contractual adjustments (for example, those due to negotiated discounts), as these discounts are standard in all insurance contracts and do not represent billing difficulty. The amount challenged equals the total authorized revenue minus the amount ultimately paid.

The share challenged is the share of authorized revenue for a visit that was never paid. This is defined as the amount challenged divided by the full negotiated amount.

To understand where exactly the bill was challenged and where other difficulties arose in the billing process, we defined four measures of billing complexity; these served as our secondary measures.

The first measure is time to payment, or the number of days that elapsed from the date the first bill was submitted for a given underlying visit to the date the final bill for that visit was paid or denied.

The second measure is the number of interactions, or the number of additional times a bill was transmitted between the insurer and the physician for a given underlying visit, beyond the minimum of one transmission in each direction. This is measured using the number of unique claim keys per underlying visit. For example, consider a bill that is

submitted and then rejected. Later a new claim is submitted, which the insurer accepts. This visit would have two additional interactions.

The third measure is fraction of claims denied, which is a dummy variable indicating that the insurer denied payment for that claim.

The fourth measure is nonpayment, which is a dummy variable for services (line items) when the doctor was not paid by either the patient or the insurer.

We analyzed some billing complexity measures (amount challenged per visit, share challenged, time to payment, and number of interactions) using means, and we analyzed claim denials and nonpayment using proportions.

Statistical Analysis

Different physicians may treat different types of patients, who could have bills of different complexity. To account for these differences, we ran a multiple linear regression model. This model accounted simultaneously for insurance type, complexity of the bill submitted, and fixed effects for each physician. Our controls for complexity included the following variables that could complicate the billing process: the allowed charge (that is, the total amount expected by the provider for the services performed during a visit after negotiated discounts are accounted for), the number of claims, and the patient's Charlson Comorbidity Index score (a well-validated statistical predictor of mortality in various settings) and age. The last two variables captured differences in the complexity of the billing process that might arise from the patient's health. When analyzing differences within private insurance, we analyzed the five largest insurers separately and grouped all of the others together. (We considered the five largest

insurers whether measured by market capitalization or total premiums.) All regressions were weighted by the allowed amount.

These multivariate regressions eliminated two types of potential confounders. First, if different physicians treated different types of patients, using physician-specific fixed effects to control for each physician would prevent these differences from influencing our estimates across insurers. Second, if different insurers served different types of patients, the insurers covering more complex patients might have more challenges in processing their patients' bills. For example, if Medicare patients were sicker than private patients, the same billing code could require more physician time or be more challenging. By controlling for the complexity of the visit, we eliminated that concern.

To analyze changes in complexity over time, we used the expanded sample of data for 2013–15. We separately modeled time trends for the five payer types to estimate changes over time for each type while controlling for physician identity and bill complexity.

Estimating Total Challenged Amounts

To estimate the total amount challenged in billing processes nationwide, we extrapolated our estimates of amounts challenged to the entire US physician sector. We used data from the National Health Expenditure Accounts from the Centers for Medicare and Medicaid Services to determine the spending on physician and clinical services from each type of insurer.

We assumed that this spending reflected the original negotiated amount reduced by the share challenged that we estimated for that insurance type. That is, the total

challenged amount is equal to the original amount minus the final spending observed in the National Health Expenditure Accounts.

Since we observed the National Health Expenditure Accounts spending, and our results provided an estimate of the share challenged, this relationship allowed us to back out the original spending amount and the aggregate dollars challenged. The specific calculation is described in detail on page 6 of the appendix.[16]

Limitations

Our study had several limitations. First, our data included only claims from the physicians who participated in the data provider's collection process, which focused on a few specialties and might not be nationally representative in other ways. Our controls helped address this concern. We have no reason to suspect that the differences across insurers outside of our sample would be different from the patterns we saw within our sample, once we controlled for the physician who submitted the bill.

Second, at a broader level, the data we studied were limited to one segment of administrative costs and applied exclusively to office visits. We did not observe other costs such as those of preauthorization requirements, which can require significant time and effort from physicians and insurers. Insurance also entails general administrative services, actuarial services, customer service, and marketing.[17] Our methods did not capture these costs.

Study Results

Estimation Sample

We observed 37.2 million visits in 2015, for which 44.5 million claims were submitted. Collectively, these claims contained 99.4 million line items. Fee-for-service

Medicare and private insurance each accounted for around 40 percent of the claims in our sample, with Medicare Advantage accounting for approximately another 15 percent. Our samples for both fee-for-service Medicaid and Medicaid managed care were much smaller, but we still observed over two million claims and over four million service lines in each of these insurer categories..

The summary statistics show stark differences across the five insurer categories in the measures of billing complexity (exhibit 1). Medicaid (both fee-for-service and managed care) had the highest billing complexity by far across the measures. The average share challenged was much higher for Medicaid claims than for claims from any other category of insurer, although because of Medicaid's lower baseline reimbursement rates, the dollar value of the amount challenged per visit was similar to Medicare and private insurers.. It took almost twice as long for a fee-for-service Medicaid claim to be processed and paid than it did for a fee-for-service Medicare claim. Medicaid claims had over three times the denial rate of Medicare claims.

We also observed notable differences in the characteristics of claims across insurer types. Medicare and private insurer claims included more service lines than Medicaid claims did, which indicated more complex visits among the former. Medicare patients were the oldest and had the most comorbidities. These differences emphasize the importance of including controls for patient characteristics and visit complexity in the following statistical analyses.

Billing Complexity Across Insurers

In exhibit 2, we compared measures of billing complexity across each insurance category in 2015, after adjusting the measures via the multi-variate regressions

described above. The full results of these estimates, including all of the control variables, are available in appendix exhibit A4.[16] We generally found that more complex bills, as measured by the number of service lines per claim, billed amounts, and patients' Charlson Comorbidity Index scores, tended to lead to higher administrative costs.

After controlling for these factors in the regression, we found that the share challenged across any insurance type was substantial, ranging from 6 percent for private insurers to 18 percent for fee-for-service Medicaid (exhibit 2). While some of these payment disputes are likely due to legitimate factors, such as fraudulent claims or insurers' utilization controls, the magnitude of the amount challenged clearly indicates that billing practices are important for physicians across all insurer types. Claims for fee-for-service Medicaid exhibited significantly more billing complexity than those for fee-for-service Medicare or private insurers. The share challenged in claims for fee-for-service Medicaid was 10.7 percentage points higher (95% confidence interval: 7.8, 13.6) compared with fee-for-service Medicare. However, since the overall potential payments were lower for Medicaid, the overall dollar amount challenged (shown in appendix exhibit A3)[16] is comparable, and statistically indistinguishable, across the different payers.

When we compared private insurers to fee-for-service Medicare, we found small or insignificant differences in billing complexity. For example, private insurance plans were 1.3 percentage points more likely to deny a claim (95% CI: 0.3, 2.3). Private insurers also paid 4.1 days faster (95% CI: 2.2, 5.9) (appendix exhibit A3).[16]

To understand why the share challenged in Medicaid claims was so high, we delved further into the different types of billing complexity. Exhibit 2 shows that fee-for-service Medicaid's denial rate was 17.8 percentage points above that of fee-for-service Medicare's (95% CI: 12.7, 22.8) and Medicaid Managed Care was 6.1 percentage points above that of fee-for-service Medicare's (95% CI: 3.9 -8.3) These are the numbers referred to in the abstract. Additional complexity measures are shown in appendix exhibit A3.[16] It took fee-for-service Medicaid 19.0 days longer to adjudicate claims than fee-for-service Medicare (95% CI: 12.9, 25.1) but required no additional interactions.

Billing Complexity Over Time

Our next analysis considered how billing complexity changed over time for each of the five insurance types, with physician and patient characteristics adjusted for. The time to payment for Medicaid managed care claims declined significantly from 2013 to 2015, from 72.7 to 36.6 days (exhibit 3). The time to payment for fee-for-service Medicaid claims also declined significantly, from 101.2 to 53.6 days.

Graphs for our other measures appear in appendix exhibit A5.[16] Most notably, Medicaid managed care's share challenged declined from 26.2 percent in 2013 to 20.0 percent in 2015, and its denial rate fell from 17.1 percent to 8.9 percent. Private insurance had a modest decline in denial rates, from 5.6 percent to 3.9 percent. Denial rates in Medicare Advantage fell by a similar amount, from 4.2 percent to 3.0 percent, while the rates for fee-for-service Medicare stayed essentially flat over the study period.

Billing Complexity Across Specific Insurers

Next, we looked at the share challenged for individual insurers compared to fee-for-service Medicare (exhibit 4). As noted above, we show the results for the five largest insurers and group all of the remaining insurers together into the "other private" category. Of the five largest insurers, only Cigna and Humana had higher shares challenged than fee-for-service Medicare did. Cigna's share was 2.1 percentage points above that for fee-for-service Medicare (95% CI: −0.1, 4.3), while Humana's was 2.5 percentage points above (95% CI: 0.9, 4.1). Aetna, UnitedHealthcare, and Anthem had lower values than fee-for-service Medicare, with Anthem 2.1 percentage points lower (95% CI: 0.9, 3.3), Aetna 3.1 percentage points lower (95% CI: 1.5, 4.7) and UnitedHealthcare 3.4 percentage points lower (95% CI: 1.8, 5.0).

Estimated National Amount Challenged

As explained above and described in greater detail on page 6 of the appendix,[16] we used the estimates of share challenged to determine that the contested amount nationally was $54 billion. If the share challenged were reduced to the minimum share that we observed in the data, the total challenged amount would be $11 billion lower. Although the challenged amount and administrative costs are different concepts, our estimates are similar in order of magnitude to previous estimates of administrative costs.[4,18,19] Our overall estimate of $54 billion is near the high end of those previous estimates.

To interpret this number, note that physicians might be able to recover some of these challenged payments by hiring additional personnel or upgrading billing technology. Presumably they would attempt to do this if it were worthwhile. Therefore, the administrative costs are likely to exceed the potential revenue, and our estimated

amount challenged provides a strong indication that the administrative costs are very large.

Discussion

High administrative costs are often identified as a pronounced inefficiency of the complicated US health care system. This analysis focused on a central part of administrative costs that is common across providers and insurance types—claims processing and billing. Using a unique data source, we presented some of the first data to directly compare proxies for the complexity of billing for physician services across insurance providers and over time, while controlling for physician and patient characteristics. We found substantial variation across public and private payers.

Although administrative costs are an essential input in overall health care production, the significantly lower complexity we observed for fee-for-service Medicare billing relative to fee-for-service Medicaid billing indicates that there may be ways for Medicaid to reduce its billing complexity and associated costs. In turn, such reforms might increase physicians' propensity to accept public insurance[20] and use public health care resources more efficiently.[1,3,6]

Despite the declines we found over time, the still-elevated level of billing complexity in Medicaid raises concern. Medicaid pays physicians lower reimbursements than other insurers do.[13,14] In combination with these lower reimbursements, a higher billing complexity—whether arising from stricter documentation requirements or another cause—could make it especially costly for physicians to treat Medicaid patients. If Medicaid billing complexity remained relatively high, it could reduce Medicaid patients'

access to physicians.[20] Improvements in this area could ultimately be beneficial for physicians, insurers, and patients.

This work has significant implications for a range of other national policy discussions. First, improved measurement of administrative costs might affect antitrust policy. Because of the associated administrative costs, physicians care about billing complexity when contracting with insurers.[20] Insurers in turn may set nonprice elements of their physician interactions—such as billing complexity—based on market conditions, just as they do with reimbursement rates.[12] With the data and methods we have introduced, analysts and policy makers can begin to evaluate this possibility and incorporate nonprice aspects of insurer-physician contracts into merger analyses.

Second, administrative costs may have a substantial impact on researchers' understanding of productivity in the health care sector. Some amount of administrative cost is undoubtedly warranted: Billing processes are intended to detect fraud and inappropriate utilization. But our time-series evidence indicated that insurers can and do reduce billing complexity. The improvement in billing speed over time suggests that the US health care system may yet be able to improve its administrative efficiency. These types of improvements might not be captured by traditional measures of productivity. Additional research is needed to determine how changes in billing complexity affect measured productivity in the health care sector.

Administrative costs have implications for health care beyond measurement. When billing complexity declines, both physicians and patients stand to benefit. Time that physicians don't spend on administration could instead be used to treat more patients or extend the length of visits, ultimately increasing the productivity of physician

care. Easier billing processes reduce staffing needs and billing expenses, which could raise physicians' incomes or free up resources for patient care. Savings that accrued to insurers could be used to reduce premiums. Using the methods and data we introduced, future analyses will be able to determine whether the benefits that the current billing system provides justify the resources it requires.

Elements such as sales and marketing are a more fundamental requirement of private insurance, compared to public insurance—a difference that has led previous analysts to conclude that public plans have an advantage in reducing administrative costs.[21] Our results indicate that this is not the complete picture, and that public insurance can involve significant administrative costs as well. Acknowledgment of these costs, and ongoing efforts to quantify them, will be essential to future health care reforms, especially those that envision a growing role for the public sector.

Notes

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List of Exhibits

Exhibit 1 (table)

Exhibit 2 (figure)
Caption: Measures of billing complexity, by insurance type, with patient characteristics and physician identity controlled for
Source/Notes: SOURCE Authors' analysis of data for 2015 from the IQVIA data. NOTES The exhibit shows two billing complexity measures for each category of insurance in 2015, adjusted for differences across physicians and differences in patient complexity. Details on these adjustments are discussed on pages 2 and 3 of the appendix (see note 16 in text). The error bars denote 95% confidence intervals, which tested for differences relative to fee-for-service (FFS) Medicare.

Exhibit 3 (figure)
Caption: Changes in time to payment over time, by insurance type, with patient characteristics and physician identity controlled for
Source/Notes: SOURCE Authors' analysis of data for 2015 from the IQVIA data. NOTES This exhibit shows the time to payment (in days) for each category of insurance from 2013 to 2015, adjusted for differences across physicians and differences in patient complexity. Details on these adjustments are discussed on page 4 of the appendix (see note 16 in text). The error bars denote 95% confidence intervals, which are shown for changes in 2014 and 2015 relative to the level in 2013.

Exhibit 4 (figure)
Caption: Claims share challenged by private insurers, with patient characteristics and physician identity controlled for
Source/Notes: SOURCE Authors' analysis of data for 2015 from IQVIA data. NOTES This exhibit shows the claims share challenged by private insurers in 2015, adjusted for differences across physicians and differences in patient complexity. Details on these adjustments are discussed on page 4 of the appendix (see note 16 in text). As explained in the text, the five insurers shown are the five largest in the country; all other private insurers have been combined. The error bars denote 95% confidence intervals. The dashed horizontal line indicates the share challenged by fee-for-service Medicare, for comparison.

Exhibit

Exhibit 1: Billing complexity measures and control variables summary in IQVIA data, by insurer category

	Medicaid				Medicare					
	Fee-for-service		Managed care		Fee-for-service		Medicare Advantage		Private	
Variable	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Summary statistics by visit										
Number of visits (thousands)	1,628		1,821		12,397		5,742		15,603	
Number of interactions	0.77	1.84	0.32	1.03	0.56	1.34	0.33	1.04	0.34	1.19
Share challenged	0.21	0.40	0.13	0.32	0.07	0.23	0.08	0.26	0.06	0.23
Amount challenged per visit	$18	$160	$22	$401	$21	$555	$19	$315	$21	$420
Time to payment (days)	39.2	56.8	26.5	43.8	18.9	29.7	14.3	30.6	13.7	26.7
Patient age (years)	29.0	24.3	26.1	22.9	72.2	10.9	73.4	9.3	35.6	20.5
Charlson Comorbidity Index score[a]	0.45	1.01	0.32	0.83	0.93	1.32	0.89	1.33	0.21	0.66
Summary statistics by claim										
Number of claims (thousands)	2,239		2,088		15,358		6,647		18,146	
Number of service lines per claim	1.67	2.94	1.73	3.74	1.63	3.66	1.68	3.11	1.70	2.58
Allowed amount	$98	$326	$132	$534	$189	$1,408	$172	$766	$216	$836
Claims denial (proportion)	0.22	0.41	0.10	0.30	0.03	0.18	0.04	0.18	0.04	0.20
Summary statistics by line item										
Number of line items (thousands)	5,014		4,795		34,441		14,799		40,326	
Nonpayment (proportion)	0.29	0.46	0.22	0.41	0.10	0.30	0.14	0.34	0.07	0.25
Summary statistics by physician										
Number of physicians	14,186		19,162		33,029		44,889		42,327	
Number of claims per physician	158	423	109	316	465	936	148	376	429	866

SOURCE Authors' analysis of data for 2015 from the IQVIA data. NOTES Line items are services. FFS is fee for service. SD is standard deviation. [a]Higher numbers indicate greater risk of mortality

Exhibit 2 (figure)
Caption: Measures of billing complexity, by insurance type, with patient characteristics and physician identity controlled for

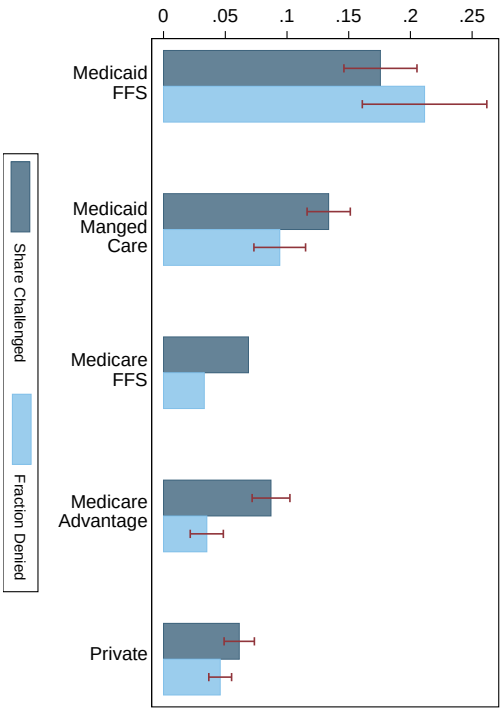


Exhibit 3 (figure)

Caption: Changes in time to payment over time, by insurance type, with patient characteristics and physician identity controlled for

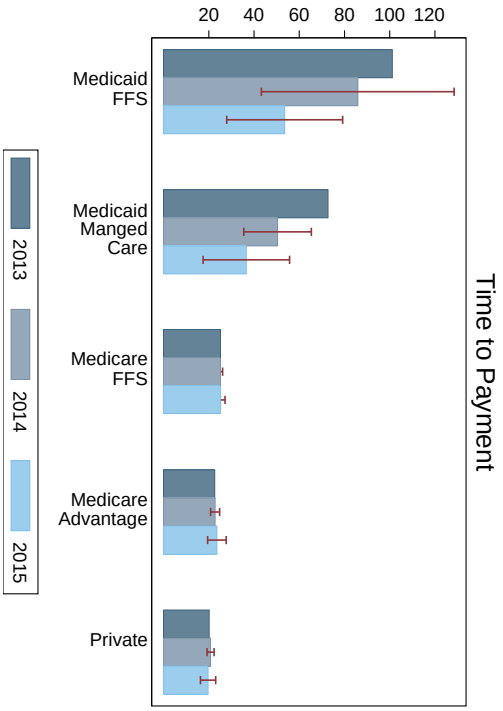
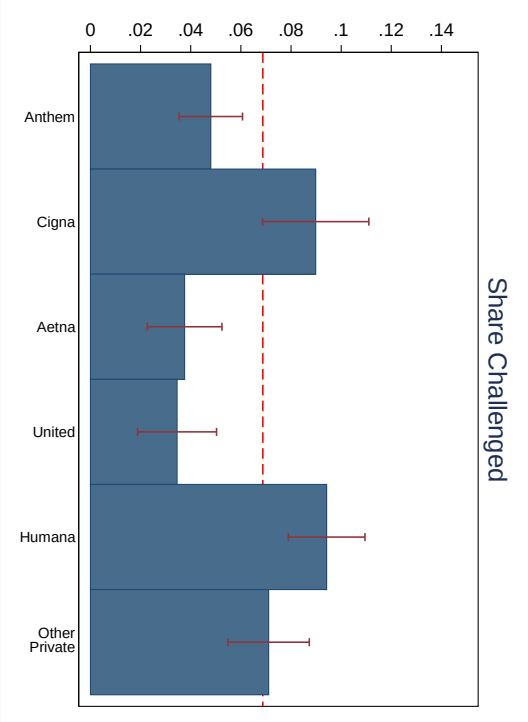


Exhibit 4 (figure)
Caption: Claims share challenged by private insurers, with patient characteristics and physician identity controlled for



Appendix to
"THE PRACTICE OF MEDICINE: The Complexity Of Billing And Paying For Physician Care"

Representativeness of Remittance Data

As described in the paper, to gauge the representativeness of the physician sample in the IQVIA Real-World Data Adjudicated Claims, we compare it to more comprehensive data.

To ensure a comprehensive comparison sample, we build a Physician Reference Dataset by combining a private database from SK&A (Irvine, CA: SK&A) and a public database called the Medicare Data on Provider Practice and Specialty (MD-PPAS). SK&A is a company that collects reference information on physicians and reports covering about 95 percent of actively practicing office-based physicians, including those that do not submit Medicare claims. The MD-PPAS data contains a complete list of physicians that submitted Medicare Part B claims. To combine data sources for the year 2013, we use the National Provider Identifier (NPI) in each database, which uniquely identifies each physician in both databases. For those physicians where the NPI matches in both data sources, we combine the physician observations to avoid double counting. For matched observations we generally use the information provided by SK&A. However, for matched observations that are missing data in SK&A, we use the MD-PPAS data to fill in the missing information. While both data sets are large individually, combining data sources creates a more complete list of physicians to investigate the representativeness of our IQVIA sample.

The comparison with broader data is informative, as it is an alternative and larger database of practicing physicians than the IQVIA data. Over the course of our full 2013-2015 sample, IQVIA contains almost 90,000 physicians, while our Physician Reference Dataset contains about 330,000 for the same specialty categories. Independently reported statistics from the American Medical Association (AMA) (2014 Physician Specialty Data Book – Table 1.1) report the total population of active physicians for the same selected specialty categories. The AMA data also

estimates around 330,000 for these categories, matching the total in our Physician Reference Dataset. Based on these estimates, the IQVIA sample of these specialties is around 27 percent of the U.S. total.

Appendix Exhibit A1 shows that various characteristics of the physicians we observe in the IQVIA data for the year 2015, and of the populations residing in their zip codes, are similar to the population of U.S. physicians in the more comprehensive database. The average zip code median income is $57,909 in the IQVIA sample and $58,367 in the broader national sample. The population share above age 65 is 14.1 percent in IQVIA, compared with 13.7 percent more broadly. The mean physician age differs by 2 years. The IQVIA data sample includes similar proportions of all five specialties, but with a higher share of internal and family medicine physicians. Geographically, the South is over-represented in IQVIA compared with the broader database, and the West is somewhat under-represented. The Midwest and Northeast have a similar representation in the two datasets.

Appendix Exhibit A8 reports the summary statistics from our 3-year data sample (2013 to 2015), which are the data underlying the analysis for Exhibit 3.

Statistical Methods

The statistical analyses in this paper are based on linear regressions estimated using weighted least squares. To account for correlated shocks to complexity measures within insurers, we cluster our standard errors by payer (White, 1984). This accounts for any possibility that multiple observations for the same payer are not independent, for example because they are handled through the same claims adjustment process.

Exhibit 2

Exhibit 2 presents the adjusted billing complexity for both challenged revenue measures and all four complexity measures for

the five detailed types of insurance. To compare adjusted billing complexity across insurers, we first compute four variables to control for the complexity of a claim:

- $NumLines_k$ is the number of individual service line items included in a given claim k;
- $BillAmt_k$ is the natural logarithm of the billed amount for the overall claim k;
- Age_k is the age in years of the patient treated in claim k;
- $Charleson_k$ is the Charleson Comorbidity Index for the patient treated in claim k.

We next separate insurers into five detailed categories (Medicaid Fee-for-Service, Medicaid Managed Care, Medicare Fee-for-Service, Medicare Advantage, and private). We introduce three sets of indicator variables:

- Let i index the detailed insurance types, and $\boldsymbol{\delta}_i$ represent a set of coefficients on the indicator variables for each insurance type excluding the reference category, Medicare Fee-for-Service;
- Let j index physicians, and $\boldsymbol{\psi}_j$ represent a set of coefficients on the indicator variables for each individual physician included in the IQVIA data;
- Let t index calendar years, and $\boldsymbol{\theta}_t$ represent a set of coefficients on indicator variables for each calendar year.

Using all of these variables and indicators together, we estimate the following linear regression, where k indexes individual claims:

$$y_{ijkt} = \alpha + \boldsymbol{\delta}_i + \boldsymbol{\psi}_j + \boldsymbol{\theta}_t + \omega\, NumLines_k + \nu\, BillAmt_k + \sigma\, Age_k + \tau\, Charleson_k + \varepsilon_{ijkt}. \quad (1)$$

In regression (1), y_k represents any one of our four complexity measures or two challenged revenue measures. The constant term α will be the estimated mean outcome for Medicare FFS (the omitted category of insurance).

The insurance indicator variables $\boldsymbol{\delta}_i$ therefore measure the mean differences in billing complexity between Medicare FFS and the other types of insurance, respectively. To determine whether these differences are statistically significant, we conduct t-

tests of the null hypotheses $\delta_i = 0$, for each insurance type i, using the clustered standard errors (White, 1984). Observations are weighted by the allowed amount.

Exhibit 2 and Appendix Exhibit A3 show graphical results, based on the regressions in Appendix Exhibit A4. To produce the graphs, we let μ_M represent the raw mean of y_{ijkt} for Medicare FFS claims. We then add the coefficient δ_i estimated for each insurer respectively to Medicare's raw mean, and plot the set of values of $\mu_M + \delta_i$ in the figures. For Medicare FFS, we plot μ_M.

Exhibit 3

To measure changes over time in adjusted billing complexity by insurer, we estimate regressions similar to equation (1) using subsamples of the data. We split the data into five samples according to insurance type and use time to payment as our complexity measure y_{ijkt}. Since the regression is run separately by insurance type, we eliminate $\boldsymbol{\delta}_i$ from equation (1) and instead estimate:

$$y_{ijkt} = \alpha + \boldsymbol{\psi}_j + \boldsymbol{\theta}_t + \omega\, NumLines_k + \nu\, BillAmt_k + \sigma\, Age_k + \tau\, Charleson_k + \varepsilon_{ijkt}, \quad (2)$$

The coefficients $\boldsymbol{\theta}_t$ on year indicators estimate the changes in billing complexity over time, with 2013 serving as the omitted year. Observations are again weighted by the allowed amount. The results are shown in Table A4.

Let μ_{2013} represent the raw mean of y_{ijkt} for claims from 2013. We plot μ_{2013} for 2013, and $\mu_{2013} + \theta_t$ for each subsequent year. The confidence intervals shown in the plot come are determined based on the standard errors of the estimated θ_t coefficients, again computed based on clustered standard errors.

Appendix Exhibit A5 shows analogous estimates for both challenged revenue measures and all four billing complexity measures

Exhibit 4

The analysis for Exhibit 4 is identical to that for Exhibit 2, except for the use of more detailed controls for insurer identity. We include separate insurance indicator variables $\boldsymbol{\delta}_i$ for each private insurer, which continue to measure the mean differences in billing complexity between Medicare FFS and the individual private insurers. The results are shown in Table A5.

Appendix Exhibit A6 shows analogous estimates for both challenged revenue measures and all four billing complexity measures

Billing Complexity Across Specialties

In Appendix Exhibit A7, we estimate differences in challenged revenue and billing complexity across five physician specialties in 2015, adjusted for payer, patient characteristics, and state.

Estimation Method for Appendix Exhibit A7

To estimate differences in adjusted billing complexity by specialty, we replace individual physician indicators $\boldsymbol{\psi}_j$ in regression (2) with specialty indicators. Let s index specialties, and $\boldsymbol{\xi}_s$ represent a set of coefficients on indicators for each specialty (internal and family medicine, obstetrics and gynecology, orthopedics, and pediatrics). Cardiology is the omitted category. We again use ordinary least square to estimate:

$$y_{ikst} = \alpha + \boldsymbol{\delta}_i + \boldsymbol{\xi}_s + \boldsymbol{\sigma}_k + \boldsymbol{\theta}_t + \omega\, NumLines_k + \nu\, BillAmt_k + \sigma\, Age_k + \tau\, Charleson_k + \varepsilon_{ikst}, \quad (3)$$

where $\boldsymbol{\sigma}_k$ represents indicators for states. The coefficients $\boldsymbol{\xi}_s$ on specialty indicators estimate the differences in billing complexity across specialties, relative to cardiology. Observations are again weighted by the allowed amount. The results are shown in Table A6.

Let μ_C represent the raw mean of y_{ikst} for claims from cardiologists. We plot μ_C for cardiologists, and $\mu_C + \xi_s$ for each

other specialty. The statistical significance reported in the text comes from t-tests of the estimated ξ_s coefficients, again computed based on clustered standard errors.

Results

Appendix Exhibit A7 shows the results. Cardiologists face the highest denial rate at 4.2 percentage points. Pediatricians face a denial rate of only 3 percentage points (95% CI: 2.0–3.9), while the other specialties are statistically indistinguishable from cardiology.

Calculation of Challenged Revenue

To estimate overall amount challenged nationally, we begin with estimates of realized spending on physician and clinical services from the National Health Expenditure Accounts (Washington, D.C.: Centers for Medicare and Medicaid Services). We assume that these amounts reflect a discount off of the true underlying spending based on the share challenged we estimated for the relevant insurance type. That is, the spending we observe for insurer i ($NHE\_Spending_i$) is assumed to arise from the following calculation:

$$NHE\_Spending_i = (1 - ShareChallenged_i) \times BaselineSpending_i$$

Where $ShareChallenged_i$ is our estimated share challenged for insurance type i and $BaselineSpending_i$ is the (unobserved) amount that physicians would have received if no revenue were challenged. Since we have estimated $ShareChallenged_i$ and observe $NHE\_Spending_i$ we can back out $BaselineSpending_i$ as:

$$BaselineSpending_i = \frac{NHE\_Spending_i}{1 - ShareChallenged_i}.$$

The difference between this number and the observed national spending ($NHE\_Spending_i$) is the total challenged revenue. That is,

$$RevenueChallenged_i = BaselineSpending_i - NHE\_Spending_i$$
$$= \frac{ShareChallenged_i}{1 - ShareChallenged_i} \times NHE\_Spending_i.$$

We add this number up across all of the different insurance types to determine the aggregate national challenged revenue of $54 billion.

As an alternative calculation, we ask how much physicians would earn if each insurer's share challenged were reduced to the minimum level we observe across all insurance types, or $ShareChallenged_{Min}$. The potential savings are then given by:

$$PotentialSavings_i = \frac{ShareChallenged_i - ShareChallenged_{Min}}{1 - ShareChallenged_i} \times NHE\_Spending_i.$$

This calculation yields potential savings of $11 billion.

Analysis of Secondary Payers

In addition to the standard categories of insurers that we discuss in the paper, we observe claims processed by two categories of secondary payers: Medigap and Medicaid. Medigap refers to private insurance that covers the copayments normally owed by Medicaid beneficiaries for the part of physician fees that Medicare FFS does not cover. Medicaid provides similar coverage for Medicare recipients with sufficiently low income and assets, known as "dual eligible." We refer to Medicaid secondary insurance as "Medicaid Secondary." Both of these types of plans are considered secondary payers, and they process claims after the primary insurer (Medicare FFS) has completed its claim processing.

Given that Medigap and Medicaid Secondary insurance are providing a very different service from primary insurance, we study them separately. Appendix Exhibit A12 shows summary

statistics for these secondary insurers. Appendix Exhibit A2 shows all of our main results, using the same method as for Exhibit 2 in the paper, when adding these secondary payers to the standard five categories of insurance.

The results shown in this figure are somewhat difficult to interpret. Medicaid Secondary has higher values for the process measures—time to payment, fraction denied, and nonpayment--when compared with either Medigap or Medicare FFS (a primary insurer). In the case of time to payment, Medicaid Secondary is the highest among all seven categories shown in the figure, but for the other measures, Medicaid FFS has higher measured complexity.

The difficulty in interpretation comes from the share challenged measure. For this outcome, Medigap’s value far exceeds all of the other insurers, including Medicaid Secondary. The dollar amount challenged is actually lower for Medicaid Secondary than for all other payers.

Appendix Exhibit A1: Representativeness of Physicians in IQVIA Remittance Data in 2015

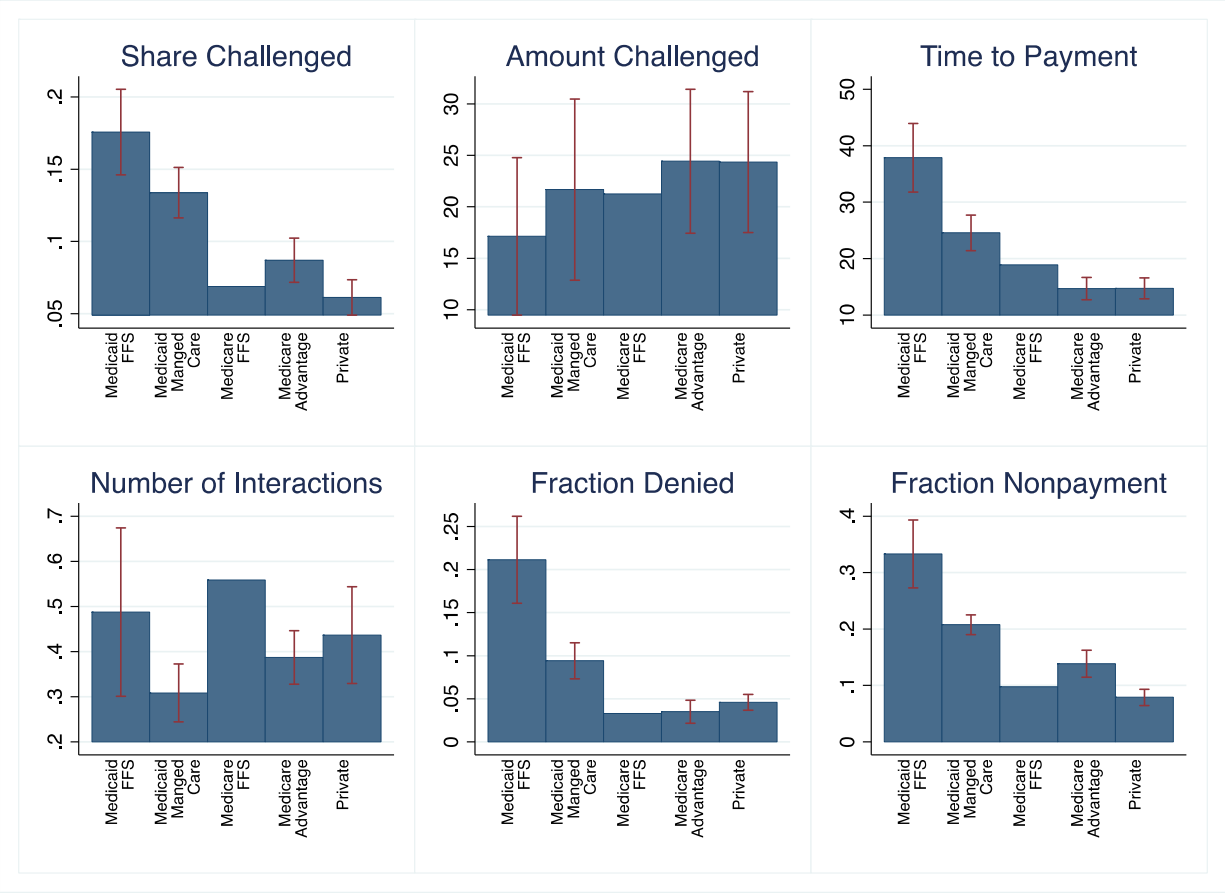
Variable:	Mean (S.D.) in IQVIA sample	National mean (S.D.) in Physician Reference Dataset:
Median income in zip code	57,909 (24,006)	$58,367 ($24,739)
Share above 65 in zip code	0.141 (0.061)	0.137 (0.062)
Physician age	52.5 (10)	50.2 (12)
Specialty:		
Cardiology	0. 07	0.08
Internal and family medicine	0. 68	0.61
Obstetrics and gynecology	0. 07	0.11
Orthopedics	0. 10	0.08
Pediatrics	0.08	0.12
Region:		
Northeast	0.21	0.22

South	0.41	0.34
Midwest	0.25	0.22
West	0.14	0.22
Observations	68,094	329,214

Appendix Exhibit A2: Complexity Measures for Primary and Secondary Payers

This figure shows all six billing complexity measures for each category of insurance—both primary and secondary—adjusted for differences across physicians and differences in patient complexity. The sample period is 2015. Details on these adjustments are in the Appendix text. Confidence intervals are shown for differences relative to Medicare Fee-for-Service.

Appendix Exhibit A3: All Complexity Measures



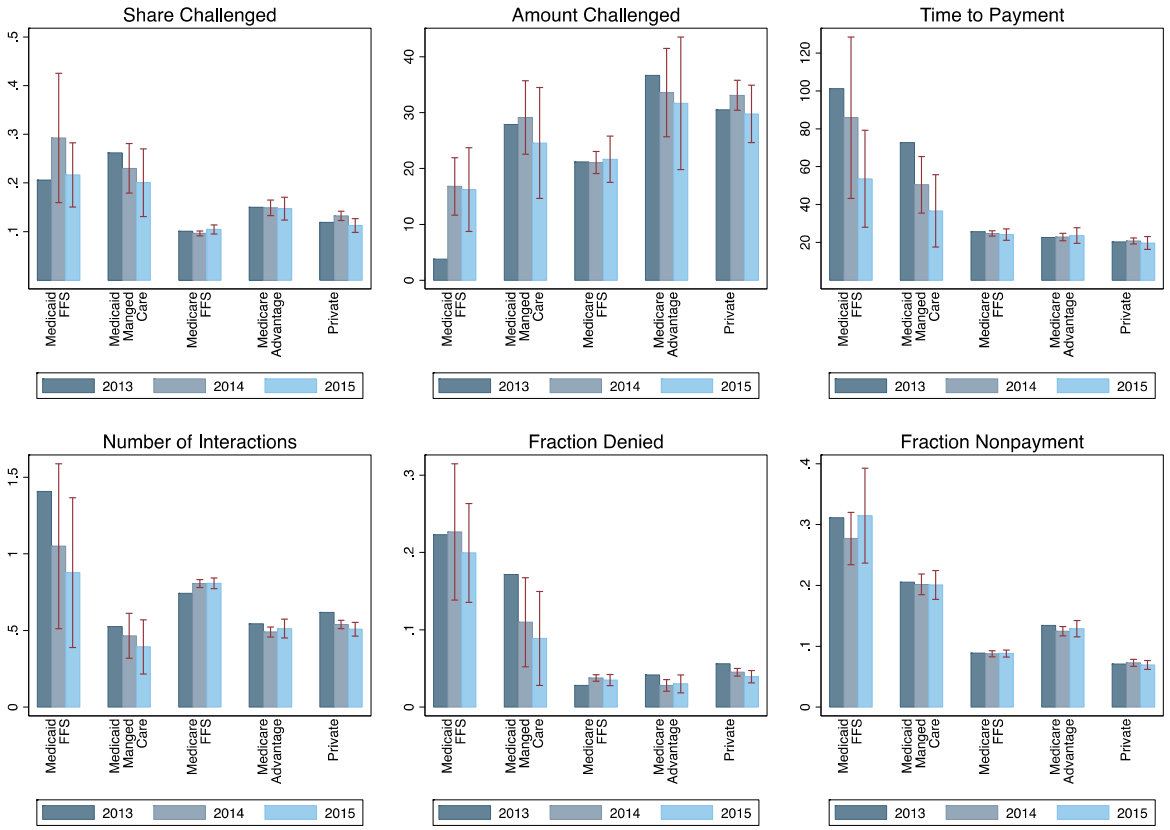
This figure shows all six billing complexity measures for each category of insurance in 2015, adjusted for differences across physicians and differences in patient complexity. Details on these adjustments are in the Appendix text. Confidence intervals test for differences relative to Medicare fee-for-service.

Appendix Exhibit A4: Regressions for Exhibit 2

Regression number:	(1)	(2)	(3)	(4)	(5)	(6)
Complexity measure:	Share challenged	Amount challenged	Time to payment	Number of interactions	Claim denied	Nonpayment
Insurers included:	All	All	All	All	All	All
Medicaid (FFS)	0.107***	-4.118		-0.071	0.178***	0.236***
	(0.015)	(3.901)	(3.101)	(0.095)	(0.026)	(0.031)
Medicaid (MCO)	0.065***	0.422	5.686***	-	0.061***	0.110***
	(0.009)	(4.487)	(1.607)	(0.033)	(0.011)	(0.009)
Medicare Advantage	0.018**	3.179	-	-	0.002	0.041***
	(0.008)	(3.565)	(1.010)	(0.030)	(0.007)	(0.012)
Private	-0.007	3.092	-	-0.122**	0.013***	-0.019**
	(0.006)	(3.492)	(0.941)	(0.055)	(0.005)	(0.007)
Number of Claim Lines	0.003***		1.942***	0.141***	0.011***	0.001***
	(0.001)	(2.365)	(0.191)	(0.019)	(0.001)	(0.000)
Log Total Allowed in			-	-	-0.003**	-
			(0.202)	(0.023)	(0.002)	(0.003)
Patient Age	-	-	-	-0.000	0.000	-0.000
	(0.000)	(0.033)	(0.004)	(0.000)	(0.000)	(0.000)
Charlson Score	0.001	0.777***	0.345***	0.003**	0.002***	0.004***
	(0.001)	(0.171)	(0.088)	(0.002)	(0.000)	(0.001)
Log Avg. Medicare						0.001
						(0.002)
Log Avg. Medicaid						-
						(0.002)
Constant	0.103***	-5.055		0.931***	0.024***	0.165***
	(0.009)	(4.334)	(0.804)	(0.081)	(0.007)	(0.012)
Number of Observations						
R^2	0.14	0.09	0.19	0.27	0.10	0.13
F-statistic	24.13	13.46	42.98	41.64	34.68	59.72
Physician indicators	Yes	Yes	Yes	Yes	Yes	Yes

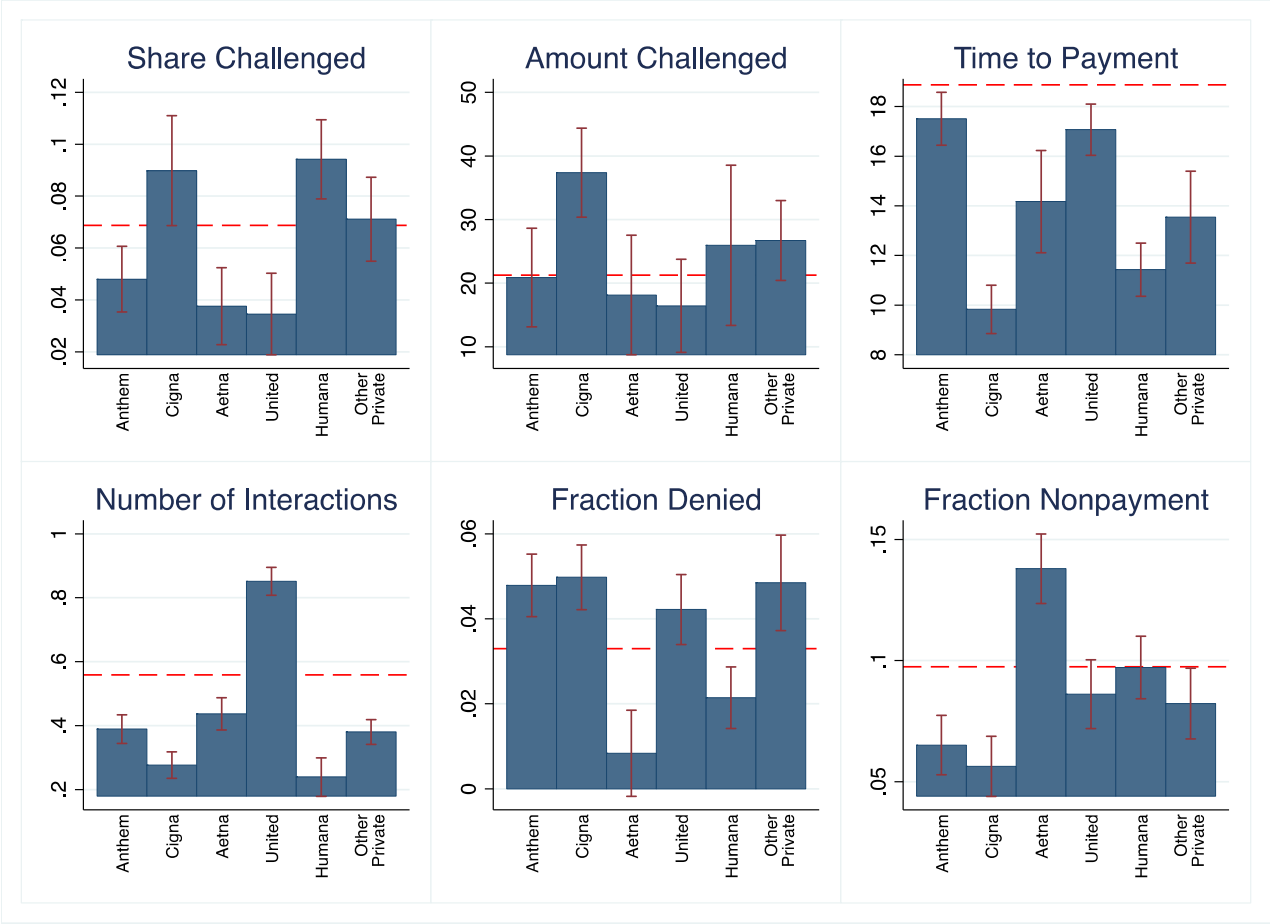
Note: */**/*** indicate statistical significance at the p<0.1, p<0.05 and p<0.01 levels. Sample size changes across regressions because regressions (1), (2), (3), and (4) are at the visit level, regression (5) is at the claim level, and regression (6) is at the service line level. The sample period is 2015.

Appendix Exhibit A5: All Complexity Measures Over Time



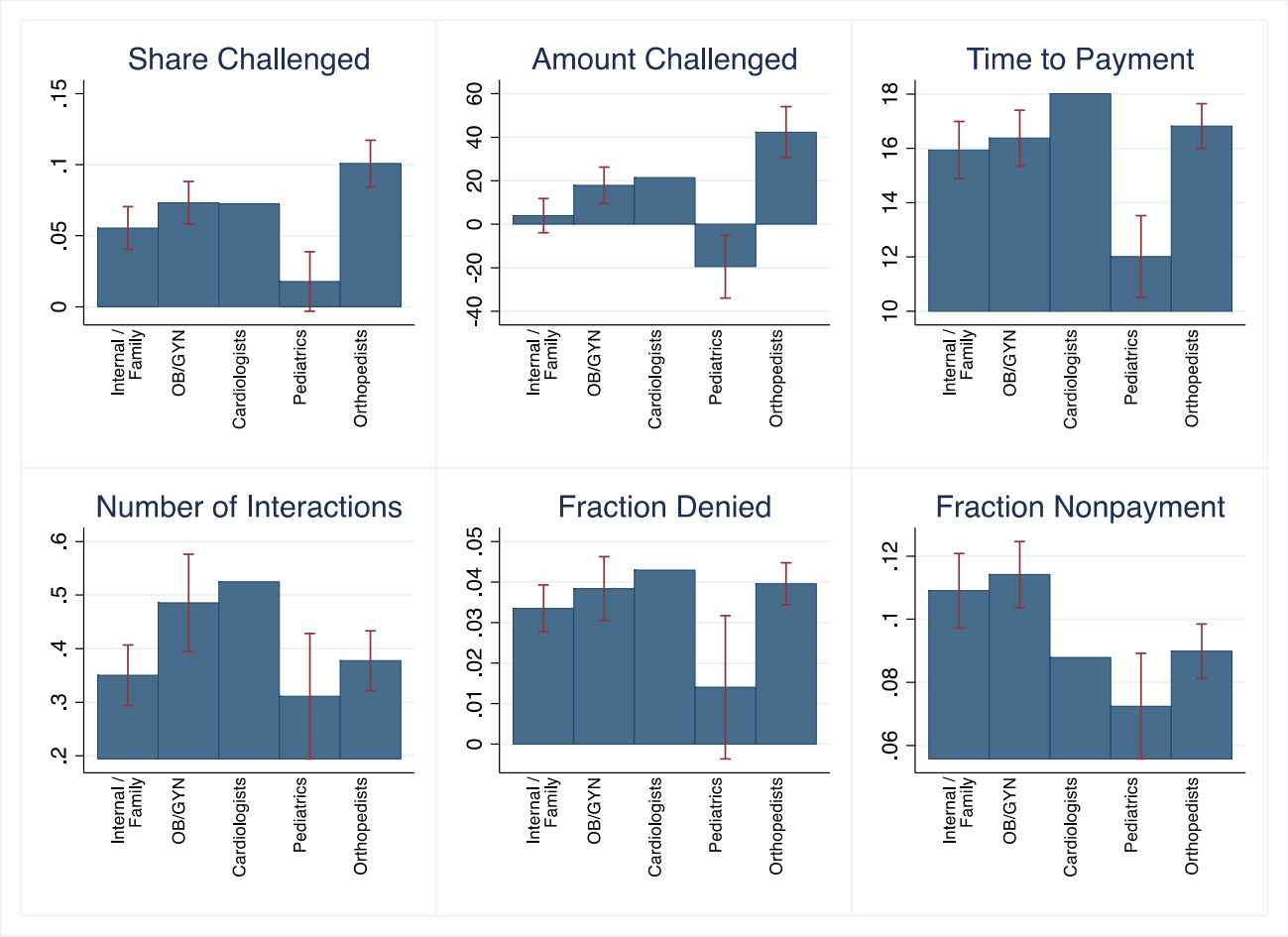
This figure shows all six billing complexity measures for each category of insurance from 2013 to 2015, adjusted for differences across physicians and differences in patient complexity. Details on these adjustments are in the Appendix text. Confidence intervals are shown for changes in 2014 and 2015 relative to the level in 2013.

Appendix Exhibit A6: All Complexity Measures by Private Insurer



This figure shows all six complexity measures separately by private insurer, adjusted for differences across physicians and differences in patient complexity. The sample period is 2015. The dashed red line indicates the level for Medicare fee-for-service, for comparison. Details on these adjustments are in the Appendix text.

Appendix Exhibit A7: All Complexity Measures by Specialty



This figure shows all six complexity measures by specialty, adjusted for differences across insurers and differences in patient complexity. The sample period is 2015. Confidence intervals show differences relative to cardiology, the base category. Details on these adjustments are in the Appendix text.

Appendix Exhibit A8: Summary Statistics for Expanded Sample (2013-2015)

	Data summary by insurance type:									
Variable	Medicaid FFS		Medicaid MCO		Medicare FFS		Medicare Advantage		Private	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Panel A: Summary statistics by visit										
Number of visits (thousands)	5,342		4,318		36,884		16,089		44,902	
Number of interactions	2.81	4.31	0.94	1.96	1.09	2.03	0.68	1.63	0.81	2.01
Share challenged	0.20	0.38	0.21	0.39	0.10	0.28	0.13	0.32	0.11	0.30
Amount challenged (dollars)	$30	$409	$54	$795	$44	$2,837	$62	$954	$44	$627
Time to payment (days)	130.8	150.4	75.6	103.8	39.3	62.7	37.9	67.1	35.6	65.1
Patient age	22.9	23.3	23.7	23.0	72.4	10.9	73.7	9.0	34.6	20.9
Charlson score	0.39	0.94	0.35	0.86	0.98	1.35	0.95	1.37	0.22	0.67
Panel B: Summary statistics by claim										
Number of claims (thousands)	8,875		5,166		45,296		18,490		52,600	
Number of service lines per claim	3.94	4.47	4.17	6.38	3.65	6.81	3.66	5.95	3.45	3.92
Allowed amount (dollars)	$132	$376	$218	$1,513	$309	$2,301	$322	$1,766	$269	$975

Claim denial	0.29	0.45	0.18	0.39	0.05	0.22	0.06	0.23	0.07	0.26
Panel C: Summary statistics by line item										
Number of line items (thousands)	20,854		12,137		100,040		40,247		118,636	
Nonpayment	0.25	0.43	0.21	0.41	0.09	0.29	0.13	0.34	0.06	0.24
Panel D: Summary statistics by physician										
Number of physicians	20,808		26,429		47,587		63,354		62,022	
Number of claims per physician	221	651	114	322	579	1032	145	370	568	946

This table reports summary statistics on the claims, visits, and lines included in the IQVIA data sample in 2013 through 2015.

Appendix Exhibit A9: Regressions for Exhibit 3

Regression number:	(1)	(2)	(3)	(4)	(5)	(6)
Complexity measure:	Share challenged	Amount challenged	Time to payment	Number of interactions	Claim denial	Nonpayment
2014	-0.004	0.317	-0.929	0.063***	0.010***	-0.001
	(0.003)	(1.170)	(0.719)	(0.013)	(0.002)	(0.003)
2015	0.002	0.090	-1.447	0.067***	0.007*	-0.001
	(0.005)	(1.974)	(1.536)	(0.018)	(0.004)	(0.003)
(Medicaid Managed Care)*2014	-0.027	1.703	-	-0.060	-0.062**	-0.003
	(0.026)	(3.380)	(7.639)	(0.074)	(0.029)	(0.009)
(Medicaid Managed Care)*2015	-0.058	-2.933	-	-0.136	-0.082***	-0.004
	(0.035)	(4.948)	(9.763)	(0.091)	(0.031)	(0.012)
(Medicaid FFS)*2014	0.086	12.397***	-15.196	-0.357	0.003	-0.034
	(0.068)	(2.735)	(21.698)	(0.273)	(0.045)	(0.022)
(Medicaid FFS)*2015	0.012	12.678***	-	-0.533**	-0.024	0.003
	(0.033)	(3.768)	(12.976)	(0.249)	(0.033)	(0.040)
(Medicare Advantage)*2014	-0.001	-3.802	0.250	-0.053***	-0.013***	-0.009**
	(0.008)	(4.442)	(1.023)	(0.016)	(0.004)	(0.004)
(Medicare Advantage)*2015	-0.001	-4.813	0.978	-0.032	-0.011*	-0.004
	(0.012)	(6.013)	(2.093)	(0.031)	(0.006)	(0.007)
(Private)*2014	0.012**	1.891	0.571	-0.078***	-0.011***	0.002
	(0.005)	(1.458)	(0.791)	(0.014)	(0.003)	(0.003)
(Private)*2015	-0.004	-0.331	-0.551	-0.111***	-0.017***	-0.001
	(0.007)	(2.460)	(1.708)	(0.023)	(0.004)	(0.004)
Private	0.018***	9.371***	-5.431***	-0.125*	0.028***	-0.018**
	(0.006)	(2.660)	(1.145)	(0.074)	(0.005)	(0.008)
Medicaid Managed Care	0.160***	6.650	47.024***	-0.216*	0.143***	0.116***
	(0.030)	(4.546)	(7.807)	(0.111)	(0.029)	(0.013)
Medicaid FFS	0.106***	-	75.542***	0.669*	0.195***	0.223***
	(0.032)	(5.570)	(13.005)	(0.398)	(0.035)	(0.035)
Medicare Advantage	0.049***	15.757***	-3.000***	-0.198***	0.014*	0.045***
	(0.010)	(5.325)	(1.132)	(0.031)	(0.007)	(0.008)
Number of Claim Lines	0.003***	8.866***	3.135***	0.152***	0.013***	0.001***
	(0.001)	(2.021)	(0.301)	(0.019)	(0.001)	(0.000)
Log Total Allowed in Visit			-1.613***	-0.194***	-0.004**	-0.011***
			(0.352)	(0.029)	(0.002)	(0.003)
Patient Age	-0.000***	-0.250***	-0.106***	-0.001***	-0.000	-0.000
	(0.000)	(0.084)	(0.017)	(0.000)	(0.000)	(0.000)
Charlson Score	0.001**	1.599***	0.218***	0.006***	0.001***	0.004***
	(0.001)	(0.347)	(0.063)	(0.002)	(0.000)	(0.001)
Log Avg. Medicare Payment						0.002
						(0.001)
Log Avg. Medicaid Payment						-0.006***
						(0.001)
Constant	0.111***	4.379	28.149***	1.190***	0.021**	0.153***
	(0.014)	(7.005)	(2.036)	(0.102)	(0.010)	(0.012)
Number of Observations						
R^2	0.15	0.10	0.25	0.32	0.10	0.11

Note: */**/*** indicate statistical significance at the p<0.1, p<0.05 and p<0.01 levels. Sample size changes across regressions because regressions (1), (2), (3), and (4) are at the visit level, regression (5) is at the claim level, and regression (6) is at the service line level. Regressions are run using the expanded sample, from 2013-2015. 2013 is the omitted year.

Appendix Exhibit A10: Regressions for Exhibit 4

Regression number:	(1)	(2)	(3)	(4)	(5)	(6)
Complexity measure:	Share challenged	Amount challenged	Time to Payment	Number of interactions	Claim Denial	Nonpayment
Medicaid (FFS)		-4.187		-0.055		
	(0.015)	(3.859)	(3.154)	(0.089)	(0.026)	(0.031)
Medicaid (MCO)		0.128		-		
	(0.009)	(4.553)	(1.585)	(0.032)	(0.011)	(0.009)
Medicare Advantage	0.019**	3.212	-	-	0.002	
	(0.008)	(3.588)	(1.026)	(0.031)	(0.007)	(0.012)
Anthem	-	-0.347	-	-		-
	(0.006)	(3.954)	(0.544)	(0.023)	(0.004)	(0.006)
United	-	-4.804	-		0.009**	-0.011
	(0.008)	(3.736)	(0.526)	(0.022)	(0.004)	(0.007)
Humana		4.698	-	-	-	-0.000
	(0.008)	(6.427)	(0.548)	(0.031)	(0.004)	(0.007)
Aetna	-	-3.103	-	-	-	
	(0.008)	(4.795)	(1.052)	(0.026)	(0.005)	(0.007)
Cigna	0.021*		-	-		-
	(0.011)	(3.570)	(0.498)	(0.021)	(0.004)	(0.006)
Third (other)	0.002	5.462*	-	-		-
	(0.008)	(3.206)	(0.944)	(0.020)	(0.006)	(0.007)
Number of Claim Lines						
	(0.001)	(2.364)	(0.191)	(0.019)	(0.001)	(0.000)
Log Total Allowed in Claim			-	-	-	-
			(0.208)	(0.021)	(0.002)	(0.003)
Patient Age	-	-	-	-0.000	-0.000	-0.000
	(0.000)	(0.033)	(0.004)	(0.000)	(0.000)	(0.000)
Charlson Score	0.001			0.004**		
	(0.001)	(0.173)	(0.087)	(0.001)	(0.000)	(0.001)
Log Avg. Medicare						0.001
						(0.002)
Log Avg. Medicaid						-
						(0.002)
Constant		-4.886				
	(0.009)	(4.354)	(0.815)	(0.068)	(0.008)	(0.013)
Number of Observations						
R^2	0.15	0.09	0.19	0.28	0.10	0.13
F-statistic	140.54	31.77	173.24	781.53	55.97	105.66

Note: */**/*** indicate statistical significance at the p<0.1, p<0.05 and p<0.01 levels. Sample size changes across regressions because regressions (1), (2), (3), and (4) are at the visit level, regression (5) is at the claim level, and regression (6) is at the service line level. The sample period is 2015.

Appendix Exhibit A11: Regressions for Appendix Exhibit A7

Regression number:	(1)	(2)	(3)	(4)	(5)	(6)
Complexity measure:	Share challenged	Amount challenged	Time to payment	Number of interactions	Claim denied	Nonpayment
Insurers included:	All	All	All	All	All	All
Internal and Family	-0.017**	-	-	-	-	0.021***
	(0.008)	(4.014)	(0.537)	(0.029)	(0.003)	(0.006)
Ob/Gyn	0.001	-3.543	-	-0.039	-0.005	0.026***
	(0.008)	(4.260)	(0.526)	(0.046)	(0.004)	(0.005)
Orthopedists	0.028***		-	-	-0.003	0.002
	(0.008)	(5.989)	(0.421)	(0.028)	(0.003)	(0.004)
Pediatrics	-	-	-	-	-	-0.015*
	(0.011)	(7.365)	(0.768)	(0.060)	(0.009)	(0.009)
Medicaid (FFS)	0.092***	-5.595		-0.093	0.152***	0.184***
	(0.023)	(6.091)	(3.758)	(0.102)	(0.022)	(0.026)
Medicaid (MCO)	0.046***	0.580	7.253***	-	0.066***	0.115***
	(0.017)	(5.997)	(1.854)	(0.040)	(0.012)	(0.016)
Medicare Advantage	0.004	0.125	-	-	0.001	0.042***
	(0.013)	(4.782)	(1.127)	(0.035)	(0.008)	(0.012)
Third (All)	-0.020	-1.212	-	-0.113*	0.011**	-0.028**
	(0.014)	(5.338)	(0.914)	(0.063)	(0.005)	(0.012)
Number of Claim Lines	0.003***		1.726***	0.126***	0.009***	0.001***
	(0.001)	(2.464)	(0.194)	(0.019)	(0.001)	(0.000)
Log Total Allowed			-	-	-0.002	-0.007*
			(0.221)	(0.022)	(0.002)	(0.004)
Patient Age	-	-	-	0.000	-0.000	-0.000**
	(0.000)	(0.079)	(0.006)	(0.000)	(0.000)	(0.000)
Charlson Score	0.001	1.796***	0.435***	0.007***	0.002***	0.005***
	(0.001)	(0.394)	(0.091)	(0.003)	(0.001)	(0.001)
Log Avg. Medicare						0.004*
						(0.002)
Log Avg. Medicaid						-
						(0.002)
Constant	0.133***	17.347**		1.061***	0.031***	0.134***
	(0.020)	(7.182)	(1.141)	(0.077)	(0.009)	(0.015)
Number of R-squared	0.05	0.02	0.10	0.20	0.05	0.05
State indicators	Yes	Yes	Yes	Yes	Yes	Yes

Note: */**/*** indicate statistical significance at the p<0.1, p<0.05 and p<0.01 levels. Sample size changes across regressions because regressions (1), (2), (3), and (4) are at the visit level, regression (5) is at the claim level, and regression (6) is at the service line level. The sample period is 2015.

Appendix Exhibit A12: Summary Statistics for Secondary Payers

	Data summary by insurance type:			
Variable	Medigap		Medicaid Secondary	
	Mean	Standard deviation	Mean	Standard deviation
Panel A: Summary statistics by visit				
Number of visits (thousands)	109		212	
Number of interactions	0.65	1.35	0.61	1.35
Share challenged	0.28	0.43	0.27	0.44
Amount challenged (dollars)	$57.14	$478.90	$14.37	$140.00
Time to payment (days)	18.3	32.9	51.8	52.5
Patient age	72.8	6.9	74.8	6.6
Charlson score	1.01	1.38	1.45	1.58
Panel B: Summary statistics by claim				
Number of claims (thousands)	144		273	
Number of service lines per claim	1.38	3.22	1.20	3.45
Allowed amount (dollars)	$195.73	$904.63	$60.73	$443.83
Claim denial	0.10	0.30	0.21	0.40
Panel C: Summary statistics by line item				
Number of line items (thousands)	288		512	
Nonpayment	0.29	0.45	0.61	0.49
Panel D: Summary statistics by physician				
Number of physicians	8,659		6,812	
Number of claims per physician	17	57	40	113