Examining Models of Physician Compensation: Proof of Concept

A report by the Urban Institute and SullivanCotter for the Medicare Payment Advisory Commission

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Executive Summary

The Urban Institute and SullivanCotter have been tasked with determining whether data from SullivanCotter's 2017 Physician Compensation and Productivity Survey, a survey of compensation physicians received in 2016, can be used to revise and update earlier simulations of physician compensation as if all payers used the Medicare Physician Fee Schedule. More specifically, the purpose of this proof of concept report is to test alternative statistical models of physician compensation, with compensation modeled as a function of productivity, specialty, and other physician characteristics. The modeling of total cash compensation shows that a very parsimonious model based on work relative value units (RVUs) and specialty can explain over 90 percent of the variation in total cash compensation, across specialty groups or individual specialties. Based on the findings presented here, the data seem well suited for updating the earlier simulations (e.g., Berenson et al., 2010). A follow-up project that would update the earlier simulations could be based on the models presented here.

Introduction

A primary goal of the 1992 Medicare physician payment reforms based on a resource-based relative value scale (RBRVS) was to create an economically neutral fee schedule (i.e. one that rewards all physician work equally). When developing that fee schedule—now referred to as the Medicare Physician Fee Schedule (MPFS)—the Centers for Medicare and Medicaid Services (CMS) refined and expanded William Hsiao's and colleagues' estimates of the work required to perform physician services. The MPFS increased evaluation and management (E&M) service payments and reduced procedure and test payments relative to historical levels. Policymakers expected that these changes would raise per service Medicare payments for primary care and reduce per service Medicare payments for most other specialties (Hogan 1993).

At the time of the MPFS' creation, "resource-based" applied to work but not practice expenses. From 1998 to 2004, policymakers extended "resource-based" to include practice expenses; with these changes, the MPFS is now considered resource-based and designed as neutral across specialties (i.e., payment is supposed to reflect the underlying resource costs associated with reimbursable services). Per hour

compensation differences by specialty are supposed to only reflect differences in practice expenses and the work associated with each specialty's service mix.

Research has found a lack of redistribution beyond what occurred in the initial implementation during which resource-based relative value units were reduced for procedures and tests and increased for E&M services (Maxwell, et al. 2007) . Accelerated service volume growth has counterbalanced modest increases in the RVUs assigned to many E&M services—with the volume of tests (e.g., imaging) and minor procedures increasing at a faster rate than E&M services and major procedures. Additionally, few of the services newly approved for payment under the MPFS fell under the E&M category, further increasing the differential volume growth of reimbursable services (Maxwell, et al. 2007).

The Medicare Payment Advisory Commission (MedPAC) has a longstanding concern that the MPFS and the nature of fee-for-service (FFS) payment has contributed to an undervaluing of primary care and an overvaluing of specialty care. The RBRVS, which forms the basis for the fee schedule, includes mispriced services that can widen the income disparity between primary care and specialty physicians. Additionally, FFS payment allows some specialties to more easily increase their service volume and therefore their Medicare revenue. Such increases are less likely for other specialties, particularly those that spend most of their time providing E&M services.

To address these concerns, MedPAC engaged the Urban Institute to analyze physician compensation using 2007 data from the Medical Group Management Association 's (MGMA's) Physician Compensation and Production Survey (Berenson, et al. 2010). That analysis suggested that the MPFS (specifically, its RVUs) is an important source of the disparities in physician compensation; the disparities among specialists persisted when compensation was simulated as if all physician services were paid under the MPFS. The Urban Institute updated that analysis for MedPAC, using 2010 and 2012 data, and produced similar results.

The Urban Institute and SullivanCotter have been tasked with determining whether more recent data from an alternative source (SullivanCotter's 2017 Physician Compensation and Productivity Survey, which collected compensation data for 2016) can be used to revise and update the methods used in the prior simulations.[1] More specifically, the purpose of this report is to test alternative statistical models of physician compensation, with compensation modeled as a function of productivity, specialty, and other physician characteristics. Future work could involve actually simulating physician compensation as if all physician services were paid under the MPFS.

[1] Previous simulations used MGMA data on total RVUs. The SullivanCotter data include work RVUs but not total RVUs.

SullivanCotter's and MGMA's physician compensation surveys are two of the most widely used industry benchmarks. Not for profit hospitals and health systems make up the majority of SullivanCotter's participant base. MGMA's membership makes up their survey's participant base, of physician-owned, hospital-owned and academic practices, though they do include a sample of non-member organizations. SullivanCotter's 2017 survey included 556 organizations and nearly 135,000 physicians, advanced practice providers, and PhDs; the survey included 97,723 physicians from 388 organizations in 191 specialties. By comparison, MGMA's 2017 survey included 6,644 organizations and 121,000 providers, physicians, and advance practice providers.

Data and Methods

Data

We used data from SullivanCotter's 2017 Physician Compensation and Productivity Survey. Participants report data for employed physicians at the individual physician level. The survey collects physician position level, organization classification (see Appendix 1), specialty, full-time equivalent (FTE) status, total cash compensation, work RVUs, and collections. The 2017 survey is a survey of compensation and physician productivity covering calendar year 2016.

Participants report position level (chair, chief, program director, staff physician) for each physician. Our analysis focuses on staff physicians whose primary work effort is on clinical patient care. The other position levels have significant work effort dedicated to administrative work and their clinical work effort varies.

Our analysis is restricted to large specialties with at least 500 physicians. Aggregating similar specialties and subspecialties so that we have sufficient sample size for analysis leaves us with 29 specialties[2]. These specialties are aggregated further into six specialty groups to observe compensation and productivity trends across broad specialty groups. The six specialty groups are primary care; non-surgical, non-procedural; non-surgical, procedural; surgical, radiology; pathology (see Table 1).

After applying these position level and specialty restrictions, our analysis included 66,279 physicians from 345 organizations with total cash compensation data. Total cash compensation includes base salary, incentive compensation and other cash compensation. Other cash compensation may include honoraria,

[2] For example, the other internal medicine/pediatrics category includes allergy, critical care, infectious disease, and pediatric internal medicine. Other surgical specialties include pediatric general surgery, plastic surgery, transplant surgery, and vascular surgery.

longevity bonuses, retention bonuses, profit-sharing, sign-on bonuses, long-term incentive payments and the like, but does not include on-call pay or pay for extra work such as moonlighting. Work RVUs were reported for 42,280 physicians, so this was the maximum sample size available for the regression analysis. We considered including collections in our analysis; however, due to the number of missing values—collections are reported for only 17,273 physicians—the variable was ultimately excluded.

Methods

We are interested in examining the role of physician productivity, measured by work RVUs, on absolute compensation within specialties and on relative compensation across specialties. We studied physician total cash compensation as a function of productivity, specialty, and organization classification. Prior to analysis, compensation and work RVUs were adjusted by SulllivanCotter so that they are expressed on a per FTE basis. As is typical with compensation data, in which very high reported compensation for some respondents can disproportionately raise the mean, the medians are modestly below the means for nearly all specialties. We observed this pattern in the descriptive statistics presented in Tables 1-3. This pattern of means being higher than medians was also observed in Urban's prior physician compensation analyses. Because medians are better descriptors of central tendencies in compensation data, we discuss predictions based on the compensation regression models presented in Tables 6 and 9, in terms of medians in Tables 6, 7, 10, and 11.

We focus on staff physicians (as opposed to program directors, chiefs and chairs) and compute descriptive statistics by specialty and specialty group for total cash compensation, work RVUs, total cash compensation per work RVU. We also examine organization classification by specialty and specialty group. While reviewing the summary statistics in tables 1, 2, and 3 we noted several specialties where the 99th and maximum values suggested the presence of outliers in the data. To test the impact of potential outliers, we removed TCC, work RVU, and TCC per work RVU data points that were more than two times the 99th percentile. These potential outliers were nearly 260 data points out of 150,000 data points. Since removing these potential outliers had negligible impact on the summary statistics and modeling we retained these data points in the data set.

In our descriptive statistics, we use Pearson correlation coefficients to examine the relationship between productivity (as measured by work RVUs), compensation, and compensation per work RVU. In our regression analysis, we model total cash compensation as a function of work RVUs, specialty or specialty group, and type of organization. Some physician compensation plans include tiers of compensation per work RVU that varies compensation per work RVU based on the total number of work RVUs (MerrittHawkins 2014; Smith and Dietrich 2016). Therefore, we also estimate models with an

additional explanatory variable, work RVUs squared, that can capture the effects of these tiered compensation arrangements. We also considered models that included indicators related to the availability of incentive payment types based on productivity or quality and years since residency, but these additional variables were not widely reported and compromised sample size to a large degree.

We considered models with a logarithmic transformation of total cash compensation as the dependent variable, but we found that this transformation did not improve the model's fit and therefore do not report results of these models. We also considered models with and without a constant. Excluding the constant term improved the model's fit. Exclusion of the constant term is appropriate because we would expect physicians without any work RVUs to earn no compensation. Our analysis focuses on models without a constant value.

However, since the MPFS does not recognize explicit specialty differentials in compensation or differences in organizational classification, we also estimated a model that excludes both of these explanatory variables and explains total cash compensation as a function of only work RVUs. One alternative included only a linear term for work RVUs and another included both a linear and quadratic term for work RVUs, to continue to allow for the presence of tiered compensation arrangements.

Our models use family medicine as the benchmark specialty and primary care as the benchmark specialty group. We iterate through various combinations of these independent variables and compare R-squared values to gauge the model's fit. We also review summary statistics by specialty and specialty group for each model's predicted total cash compensation, predicted total cash compensation per work RVU, and - as a summary measure – the ratio of predicted to actual total cash compensation and total cash compensation per work RVU. A ratio of less than 1 indicates that the model under-predicts the actual value, while a ratio greater than one indicates the value predicted by the model is higher than the actual value.

Results

Descriptive Statistics

Table 1 presents physician total cash compensation overall, by specialty group, and by specialty. Among the six specialty groups included in this analysis, radiologists have the highest mean and median compensation ($479,609 and $466,039, respectively). Surgical specialists have the second highest mean and median compensation ($461,693 and $408,920, respectively), followed closely by nonsurgical, procedural specialists. The specialty group with the lowest mean and median compensation is primary

care ($255,090 and $235,924, respectively). Mean and median compensation for the individual specialists included in this analysis range from a high of $778,261 and $725,985, respectively, for neurological surgeons to a low of $243,647 and $226,853, respectively, for general pediatricians.

Table 2 presents physician work RVUs overall, by specialty group, and by specialty. Among the six specialty groups, radiologists have the highest volume of work RVUs, with a mean of 9,048 and median of 8,771 work RVUs. Surgical specialists have the second highest mean and median volume of work RVUs—7,741 and 7,195, respectively—followed by nonsurgical, procedural specialists, who have a mean of 5,043 and median of 4,590 work RVUs (the lowest of the specialty groups). Primary care specialists have the lowest mean volume of work RVUs (4,955); the median is 4,845. Among individual specialties included in this analysis, cardiovascular and cardiothoracic surgeons generate the most work RVUs, with a mean of 11,145 and a median of 10,038; psychiatrists have the fewest work RVUs, with a mean of 4,256 and a mean of 3,822.

Table 3 shows physician compensation per work RVU overall, by specialty group, and by specialty. Nonsurgical, procedural specialists have a mean and median compensation per work RVU of $72.84 and $68.11, respectively—their compensation per work RVU is the highest of the six specialty groups included in this analysis. Nonsurgical, nonprocedural specialists have the second highest mean and median compensation per work RVU ($65.73 and $61.32, respectively), with surgical specialists following closely behind. Radiologists, pathologists, and primary care specialists are clustered together near the bottom, with primary care specialists having a slightly lower mean and median compensation per work RVU ($55.71 and $50.70, respectively) compared to the other two specialty groups.

Table 4 presents the specialty differential in total cash compensation, work RVU, and total cash compensation per work RVU, by specialty group and specialty. These ratios provide insight into relative compensation, work RVUs, and total cash compensation per work RVU across specialties. Specialty group differentials are determined relative to the primary care specialty group; differentials for individual specialties are determined relative to family medicine. The closer a ratio is to 1.0 the smaller the differential; specialists or specialty groups with ratios greater than 1.0 have higher median total cash compensation, work RVUs, or total cash compensation per work RVU, relative to primary care or family medicine physicians (and vice versa). When assessing these data, it is important to note that these data are adjusted to an FTE basis prior to being analyzed. Table 4 shows that radiologists' median total compensation and work RVUs are almost double those of primary care specialists while radiologists' compensation per work RVU is close to that of primary care specialists—suggesting that radiologists' relatively high compensation is driven largely by their ability to generate a high volume of work RVUs. A similar trend is evident when comparing cardiovascular and cardiothoracic surgeons to family medicine physicians, with cardiovascular and cardiothoracic surgeons' median compensation almost triple that of

family medicine physicians, median work RVU volume twice as large, and median compensation per work RVU only about a third larger than that of family medicine physicians.

The specialty differentials for other specialists or specialty groups indicate that their high median compensation relative to primary care or family medicine physicians is driven in part by differentials in work RVUs and – as a measure of service price - total cash compensation per work RVU. For example, median total cash compensation for oncologists and hematologists is almost two thirds more than that of family medicine physicians while their work RVU volume is slightly lower and median total cash compensation per work RVU is almost double that of family medicine physicians. This pattern suggests that TCC for oncologists and hematologists is greater than would be expected based solely on the number of work RVUs.

Table 5 presents the correlation between total cash compensation and work RVUs by specialty group and specialty. A positive correlation implies that more RVUs tend to generate greater total cash compensation. A better sense of the relationship between total cash compensation and work RVUs will be seen in the regression models presented in the next section.

Regression Models

In the tables below, we present ten alternative models of physician compensation as a function of productivity, specialty, and organization classification, along with summary statistics by specialty and specialty group comparing each model's median predicted total cash compensation to the median actual compensation presented in the previous section. We also show a comparison of each model's median predicted total cash compensation per work RVU to the median actual total cash compensation per work RVU presented in the previous section. In the Conclusion, we explore the implications of these two comparisons for model selection.

The ten alternative models presented in this section broadly fit into 1 of 2 groups, which we refer to as Category 1 and Category 2 (see Appendix 2 for overview of models and relevant tables). The 2 types of models differ in their treatment of physician productivity (work RVUs); Category 1 models estimate a linear regression model while Category 2 models allows for a nonlinear relationship between work RVUs and physician compensation using a quadratic term to allow for the potential effects of tiered compensation plans. Within each category, we present three types of models, one that omits organization classification, one that includes it, and one based solely on work RVUs; the findings based on models using solely work RVU are reported separately in Tables 12-16. And finally, we present two

versions of the four models that include a measure of physician specialty, one version that focuses on the six specialty groups (Table 6) and the other that focuses on individual specialties (Table 9).

Model 1A in Table 6—a linear model that omits organization classification—shows that holding specialty group constant, physician compensation increases by $45.97 per work RVU (Table 6) The model also shows differentials between compensation of the benchmark specialty group (primary care) and the other five specialty groups. Holding the number of work RVUs constant, the compensation differential is highest between nonsurgical, procedural specialists and primary care physicians, with the former having compensation that is $144,800 higher. The second highest compensation differential is between surgical specialists and primary care physicians; holding work RVUs constant, compensation for surgical specialists is $117,200 higher than that of primary care physicians. Pathologists have the smallest compensation differential when compared to primary care physicians; holding work RVUs constant, compensation for pathologists is $41,310 higher than that of primary care physicians. Controlling for the organization type (Model 1B) lowers the work RVU coefficient and, except for radiologists, reduces the specialty differentials but does not improve the model's fit, as measured by the R-squared.

Model 2A, in Table 6, omits organization classification but allows for a nonlinear relationship between work RVUs and physician compensation. This model indicates that the work RVU relationship to compensation appears to be nonlinear; meaning that work RVUs have a larger effect on compensation at lower quantities of work RVUs than at higher quantities of work RVUs. However, it appears that the relationship may not be uniform across all specialty groups, because the impact of allowing for this type of nonlinearity has a smaller impact on the estimated differential for some specialty groups than others when compared to Model 1A. For example, the estimated specialty differential for non-surgical, nonprocedural specialties relative to primary care falls from about $63,000 to $51,000 when we add the quadratic term, while the estimated differential for surgical specialties only falls from about $117,000 to $114,000. The estimated differential for radiology relative to primary care actually increases when we add the quadratic term for work RVUs. Despite these changes, the overall R-Squared for the model is not affected by the addition of the quadratic term for work RVUs. We explore this issue in more detail when discussing the results of the models that include individual specialties (Table 9). Controlling for the organization type (Model 2B) lowers the work RVU coefficient and has a mixed effect on the specialty group differentials but also does not improve the model's fit, as measured by the R-squared.

Table 7 presents summary statistics by specialty group comparing each model's median predicted total cash compensation to the median actual compensation presented from Table 1, using the ratio of median predicted to median actual compensation for comparison. The closer this ratio is to 1, the better the model predicts median actual compensation for a specialty group. This table shows that, with the exception of the primary care specialty group, Model 1A is comparable to or a better predictor of

specialty groups' median cash compensation compared to the other 3 models presented in the table, with the ratio of median predicted to actual compensation closest to 1 for all specialty groups. For the primary care specialty group, Model 2A, which allows for a tiered compensation plan, provides a better prediction of median cash compensation than Model 1A.

Table 8 presents summary statistics by specialty group comparing each model's median predicted total cash compensation per actual work RVU to the median actual total cash compensation per work RVU presented in Table 3. These predictions are based on the total cash compensation predicted by the model for each physician divided by that physician's actual work RVUs, with medians computed within specialty group. Table 8 also shows the ratio of median predicted to median actual total cash compensation per actual work RVU for each model by specialty group. This table shows that all 4 models were similar in predicting a specialty group's median compensation per actual work RVU, with the exception of primary care physicians. Model 1A's ratio of predicted to actual compensation per actual work RVU for primary care physicians was lower than the other models. For primary care physicians, the two models that include organization classification (Models 1B and 2B) are a better predictor of median compensation per work RVU—perhaps an indication that some types of organizations provide extra compensation to primary care physicians beyond what might be expected based on the productivity (as measured by work RVUs).

Table 9 presents the results of the same four alternative models that explore the relationship between the *individual specialties* and total cash compensation. (By contrast, Table 6 examined the relationship between *specialty groups* and total cash compensation.) Model 1C in Table 9—a linear model that omits organization classification—shows that holding the specialties constant, physician compensation increases by $42.26 per work RVU. The model also shows differentials between the compensation of the benchmark specialty (family medicine) and the other specialties; holding the number of work RVUs constant, the highest compensation differential is for neurological surgeons, who have compensation that is $359,200 higher than family medicine physicians. Orthopedic surgeons have the second highest compensation differential relative to family medicine physicians; holding work RVUs constant, compensation for those specialists is $261,300 higher than that of family medicine physicians. Emergency medicine physicians have the smallest compensation differential when compared to family medicine physicians, followed closely by general pediatricians; holding work RVUs constant, compensation for emergency medicine physicians and general pediatricians is $30,070 and $30,490 higher than that of primary care physicians, respectively. Controlling for the organization type (Model 1D) lowers the work RVU coefficient and reduces the specialty differentials but does not improve the model's fit, as measured by the R-squared.

Model 2C, in Table 9, also omits organization classification but allows for a nonlinear relationship between work RVUs and physician compensation. The findings with respect to including the quadratic

term for work RVUs in Model 2C in Table 9 (the individual specialties model) is similar to what we observed in the specialty groups model (model 2A in Table 6). This model also indicates that the increment to compensation is greater at lower quantities of work RVUs than it is at higher quantities of work RVUs. Given the greater degree of specialty disaggregation in the models shown in Table 9 compared with Table 6 (specialty groups), it is not surprising to see even greater variation in the impact of including the quadratic term for work RVUs. Controlling for the organization type (Model 2D) lowers the work RVU coefficient and has a mixed effect on the specialty differentials but does not improve the model's fit, as measured by the R-squared.

Table 10 presents summary statistics for individual specialties comparing each model's median predicted total cash compensation to the median actual compensation presented in Table 1. Table 10 also shows the ratio of predicted to actual compensation for each model by specialty. Consistent with observations about actual and predicted compensation by specialty group (Table 7), Table 10 shows that in general Model 1C is a slightly better predictor of specialties' median compensation compared to the other 3 models presented in the table, with the ratio of predicted to actual compensation closest to 1.0 for most specialties. The most notable exception to this trend is family medicine physicians. For family medicine physicians, the two models that include organization classification (Models 1D and 2D) are better predictors of total cash compensation—perhaps an indication that some types of organizations provide extra compensation to family medicine physicians beyond what might be expected based on the productivity (as measured by work RVUs).

Table 11 presents summary statistics by specialties comparing each model's median predicted total cash compensation per actual work RVU to the median actual total cash compensation per work RVU presented in Table 3. Table 11 also shows the ratio of median predicted to median actual total cash compensation per actual work RVU for each model by specialty. This table shows that Model 1C generally is a slightly better predictor of a specialty's' median compensation per actual work RVU compared to the other 3 models shown in the table; Model 1C's ratio of predicted to actual compensation per actual work RVU is generally closest to 1.0 across all specialties, when compared to the other models. Family medicine physicians are the most notable exception to this trend—a finding that is consistent the results observed in Table 10. For family medicine physicians, the two models that include organization classification (Models 1D and 2D) are a better predictor of total cash compensation per actual work RVU.

Table 12 shows estimates for the two compensation models that include only work RVUs as an explanatory variable. Model 1E includes only a linear term for work RVUs, while Model 2E includes both a linear and quadratic term. The estimates show that the coefficient on work RVUs in Model 1E – 55.37 – is larger than it is in the linear work RVU models that include specialty group (or individual specialty group) and organizational classification indicators. Similarly, when we include a quadratic term for work RVUs

(Model 2E), we also observe a larger coefficient for work RVUs than in the earlier models (63.11). Since neither Model 1E nor Model 2E contain specialty group or individual specialty indicators, the output from these models can be used to predict total cash compensation for either specialty groups or individual specialties.

Based on the two compensation models that include only work RVUs as an explanatory variable, Table 13 shows predictions of total cash compensation at the specialty group level, while Table 15 shows predictions of total cash compensation at the individual specialty level. Table 14 shows predictions of total compensation per actual work RVU at the specialty group level, and Table 16 shows predictions of total compensation per actual work RVU at the individual specialty level. At the specialty group level, these more parsimonious models tend to substantially under-predict total cash compensation for the nonsurgical, procedural group and over-predict compensation for the primary care group (Table 13). This holds for both the linear and quadratic specifications of models and the predictions of total cash compensation (Table 13) and compensation per actual work RVU (Table 14). The prediction ratios also tend to deviate from 1.0 to a greater extent, both in terms of the magnitude of the deviations and the number of specialties or specialty groups with sizable deviations, than they do using the models that included specialty and organizational indicators. This suggests that the models that only include work RVUs as an explanatory variable do not predict patterns of current compensation as the well as the fuller specifications.

The shortcomings of these more parsimonious models to predict total cash compensation is further highlighted when we look at the analyses disaggregated by individual specialties (Table 15). Among the nonsurgical, procedural group, oncologists stand out as being particularly hard to predict, with a ratio of predicted to actual compensation near 0.6 in both the linear and quadratic specifications. However, there are specialties within the other groups that also exhibit compensation predictions ratios that deviate considerably from 1.0. These include: family medicine, pediatricians, emergency medicine, nephrologists, neurologists, gastroenterologists, ophthalmologists, orthopedic surgeons, cardiovascular and cardiothoracic surgeons, and neurological surgeons. These patterns are similar using either the linear or quadratic specifications of the model, but are slightly more muted when predicting compensation per actual work RVU (Table 16).

Conclusion

This analysis of data from SullivanCotter's Physician Compensation and Productivity Survey shows that it contains the information required to update the earlier simulations of how physician compensation might change if all payers used the Medicare Physician Fee Schedule (Berenson et al., 2010). This new data source provides data on physician specialty, compensation and productivity (measured by work RVUs)

that would allow similar simulations to be developed. In addition, SullivanCotter also has information on the types of organizations physicians work in, how performance incentives affect physician compensation and years since residency. Although this study explored how several of these factors explained differences in compensation, the core physician compensation models presented here rely only on productivity, specialty and type of organization as explanatory factors. We considered compensation models that also included years since residency and the presence of productivity or quality incentives, but these variables were not widely reported and their inclusion would have compromised the analytic samples sizes considerably.

The specialty differentials in compensation reported in Table 4 are consistent with the differentials reported in the earlier MGMA analysis. However, for several of the procedural and surgical specialties, total cash compensation differentials are slightly smaller in the SullivanCotter data than they were in the MGMA data. This is not surprising considering the differences between the samples reflected in the two data sets and does not change the fundamental finding that compensation is considerably higher for procedural and surgical specialties than for primary care and nonprocedural specialties.

Specialty differentials in the total number of work RVUs (Table 4) show that the number of work RVUs generated per FTE physician are systematically higher for the procedural and surgical specialties, as well as for radiologists and pathologists, than they are for primary care and nonprocedural specialties. The relatively similar patterns in specialty differentials for compensation and work RVUs are responsible for the high correlations between the two measures shown in Table 5. Although some specialty differentials in work RVUs reflect differences in the intensity of work across specialties, research suggests that inaccuracies in the underlying data on the amount of time it takes for physicians to provide certain services also contribute to distortions in work RVUs in the MPFS (Zuckerman et al., 2016; Wynn et al., 2015; and McCall et al., 2006).

The modeling of total cash compensation shows that a model based on work RVUs and specialty can explain over 90 percent of the variation in total cash compensation, across specialty groups or individual specialties. In the linear version of these models the estimated coefficient on work RVUs is about $46 per RVU, when controlling for specialty group, and about $42 per RVU, when controlling for individual specialties. These estimates can be thought of as an estimate of physician compensation per work RVU. However, the work RVU coefficient estimates in our models differ from the conversion factor in the MPFS because these estimates are derived from models that allow for variation in compensation per RVU across specialties, unlike the MPFS, in which the RVUs per service do not vary by specialty. More complex models that control for the type of organization the physician works for or that allows for nonlinearities in the relationship between work RVUs and compensation do not improve the fit of the models, as measured by

R-squared. The addition of these variables affects the estimates of the specialty differentials, although the direction and magnitude of the change in the estimates is not uniform across specialties.

This proof of concept analysis was designed to assess the usefulness of the SullivanCotter Physician Compensation and Productivity Survey as the basis for updating the previous simulations that used MGMA data. Based on the findings presented here, the data seem well suited for these purposes. A follow-up project that would update the earlier MGMA simulations could be based on the models presented here. If the models presented in this analysis were used, the simulations could be based on the models including the linear work RVU term or the linear and quadratic work RVU terms and specialty (or specialty group) dummy variables. Models that excluded the specialty dummy variables did not perform as well and would not seem like a reasonable foundation for simulations. Given that predictions for some specialties (or specialty groups) are closer to actual compensation for models with the quadratic work RVU term than they are for the purely linear models, it seems reasonable to consider both linear and quadratic specifications in a simulation process to allow for sensitivity analyses. In either case, the estimate of total compensation per work RVU could be replaced by the Medicare conversion factor (adjusted for the physician's geographic area) when deriving simulated compensation as if all payers used the MPFS.

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TABLE 1

Physician Total Cash Compensation by Specialty, 2016

			Physician Total Cash Compensation				
	Organizations	Physicians	Mean	Standard deviation	25th percentile	Median	75th percentile
All specialties	**345**	**66,279**	**335,625**	**166,939**	**226,669**	**292,141**	**398,036**
Primary care specialties	**305**	**23,888**	**255,090**	**89,813**	**199,432**	**235,924**	**292,717**
Family medicine	247	10,236	255,647	87,709	200,235	236,088	293,864
Internal medicine	258	8,766	260,818	92,330	201,604	240,744	299,338
Pediatrics – general	221	4,886	243,647	88,521	187,635	226,853	279,596
Nonsurgical, nonprocedural specialties	**286**	**18,611**	**291,384**	**95,323**	**229,178**	**275,361**	**335,437**
Emergency medicine	128	3,445	338,329	87,861	284,252	326,731	380,000
Endocrinology and metabolism	178	1,020	248,369	73,173	202,139	236,393	275,000
Hospitalist	212	6,867	284,475	81,087	231,310	269,250	319,441
Nephrology Only	62	337	292,121	121,098	212,450	271,800	338,991
Neurology	197	1,978	291,624	98,525	231,000	275,818	325,053
Physical medicine and rehabilitation	128	705	276,619	103,859	206,867	260,838	316,472
Psychiatry	158	1,805	251,779	86,303	197,701	234,173	294,743
Rheumatology	162	667	261,019	81,618	209,421	244,699	293,214
Other internal medicine/pediatrics	186	1,787	308,741	125,890	224,549	278,652	369,080
Nonsurgical, procedural specialties	**239**	**7,534**	**445,696**	**183,150**	**321,952**	**419,088**	**535,018**
Cardiology	171	2,393	462,332	165,861	350,000	447,267	545,334
Dermatology	124	821	470,970	220,484	343,606	423,445	535,285
Gastroenterology	175	1,642	493,183	182,714	366,000	478,689	575,000
Oncology – hematology and oncology	148	1,901	408,569	179,260	295,862	380,446	461,585

			Physician Total Cash Compensation				
	Organizations	**Physicians**	**Mean**	**Standard deviation**	**25th percentile**	**Median**	**75th percentile**
Pulmonology	115	777	358,240	150,591	254,503	324,632	433,736
Surgical	**288**	**12,574**	**461,693**	**224,547**	**314,108**	**408,920**	**550,000**
Obstetrics/gynecology	216	3,657	351,119	131,247	263,021	321,238	402,258
Ophthalmology	101	629	392,017	163,468	283,587	373,068	476,997
Orthopedic surgery	155	1,397	590,800	254,527	439,579	555,000	691,953
Otolaryngology	136	783	438,762	163,191	342,240	407,291	503,751
General surgery	232	2,475	418,876	156,005	319,644	390,017	482,750
Cardiovascular and cardiothoracic surgery	133	529	692,216	266,866	525,000	649,562	836,719
Neurological surgery	127	689	778,261	341,080	571,055	725,985	926,978
Urology	158	956	454,051	153,997	353,668	425,059	510,724
Other surgical specialties	186	1,459	502,137	213,490	375,070	455,510	575,000
Radiology	**96**	**2,398**	**479,609**	**145,312**	**388,889**	**466,039**	**540,000**
Radiology	96	2,398	479,609	145,312	388,889	466,039	540,000
Pathology	**88**	**1,274**	**325,773**	**110,759**	**247,945**	**314,275**	**382,000**
Pathology	88	1,274	325,773	110,759	247,945	314,275	382,000

Source: SullivanCotter's 2017 Physician Compensation and Productivity Survey.

TABLE 2

Work RVUs by Specialty, 2016

			Work RVUs				
	Organizations	**Physicians**	**Mean**	**Standard deviation**	**25th percentile**	**Median**	**75th percentile**
All specialties	**248**	**42,280**	**5,916**	**2,789**	**4,070**	**5,320**	**7,167**
Primary care specialties	**223**	**16,088**	**4,955**	**1,711**	**3,856**	**4,845**	**5,861**
Family medicine	188	7,138	4,963	1,597	3,926	4,873	5,835
Internal medicine	196	5,718	4,793	1,740	3,636	4,646	5,669
Pediatrics – general	170	3,232	5,221	1,861	4,122	5,177	6,192
Nonsurgical, nonprocedural specialties	**213**	**10,913**	**5,043**	**2,305**	**3,493**	**4,590**	**6,027**
Emergency medicine	77	1,784	7,327	2,787	5,268	7,191	9,115
Endocrinology and metabolism	147	664	4,593	1,525	3,489	4,408	5,361
Hospitalist	158	4,383	4,446	1,795	3,291	4,282	5,272
Nephrology Only	50	238	6,339	2,667	4,303	6,159	7,836
Neurology	153	1,216	4,740	2,103	3,310	4,399	5,618
Physical medicine and rehabilitation	103	431	4,831	1,758	3,540	4,589	5,787
Psychiatry	111	740	4,256	1,981	2,843	3,822	5,172
Rheumatology	128	447	4,576	1,408	3,717	4,394	5,257
Other internal medicine/pediatrics	148	1,010	4,829	2,024	3,493	4,462	5,748
Nonsurgical, procedural specialties	**183**	**4,673**	**6,796**	**3,045**	**4,573**	**6,353**	**8,481**
Cardiology	125	1,396	7,604	2,821	5,673	7,257	9,101
Dermatology	103	564	7,421	3,523	5,210	6,863	8,418
Gastroenterology	142	1,120	7,897	2,854	5,859	7,666	9,523
Oncology – hematology and oncology	117	1,120	4,501	1,766	3,293	4,252	5,406

			Work RVUs				
	Organizations	**Physicians**	**Mean**	**Standard deviation**	**25th percentile**	**Median**	**75th percentile**
Pulmonology	86	473	6,490	2,971	4,304	5,717	8,184
Surgical	**219**	**8,356**	**7,741**	**3,257**	**5,527**	**7,195**	**9,267**
Obstetrics/gynecology	175	2,538	6,936	2,578	5,156	6,677	8,361
Ophthalmology	81	387	8,450	2,966	6,287	8,341	10,062
Orthopedic surgery	125	882	8,492	3,453	5,946	7,952	10,239
Otolaryngology	110	574	7,375	2,664	5,634	6,930	8,583
General surgery	182	1,629	7,104	2,887	5,015	6,657	8,694
Cardiovascular and cardiothoracic surgery	106	325	11,145	4,567	7,765	10,038	14,037
Neurological surgery	103	459	10,488	4,572	7,130	9,646	13,065
Urology	126	708	7,650	2,527	5,870	7,276	9,260
Other surgical specialties	145	854	7,800	3,242	5,535	7,226	9,322
Radiology	**76**	**1,691**	**9,048**	**3,232**	**6,772**	**8,771**	**10,830**
Radiology	76	1,691	9,048	3,232	6,772	8,771	10,830
Pathology	**57**	**559**	**6,494**	**2,267**	**4,802**	**6,254**	**7,876**
Pathology	57	559	6,494	2,267	4,802	6,254	7,876

Source: SullivanCotter's 2017 Physician Compensation and Productivity Survey.

TABLE 3

Physician Total Cash Compensation per Work RVU by Specialty, 2016

			Physician Total Cash Compensation per Work RVU				
	Organizations	Physicians	Mean	Standard deviation	25th percentile	Median	75th percentile
All specialties	**248**	**42,280**	**61.99**	**22.55**	**46.20**	**56.75**	**72.74**
Primary care specialties	**223**	**16,088**	**55.71**	**18.98**	**43.88**	**50.70**	**62.18**
Family medicine	188	7,138	54.64	17.58	43.98	49.94	60.01
Internal medicine	196	5,718	59.16	18.99	46.24	54.42	67.32
Pediatrics – general	170	3,232	51.99	20.88	41.25	46.56	55.88
Nonsurgical, nonprocedural specialties	**213**	**10,913**	**65.73**	**24.84**	**48.48**	**61.32**	**77.88**
Emergency medicine	77	1,784	53.52	24.57	35.48	46.96	65.33
Endocrinology and metabolism	147	664	57.08	15.01	47.01	54.09	64.56
Hospitalist	158	4,383	72.41	26.71	53.86	67.17	84.93
Nephrology Only	50	238	52.16	17.34	39.14	49.85	64.44
Neurology	153	1,216	67.17	21.51	51.85	62.41	79.28
Physical medicine and rehabilitation	103	431	62.50	18.68	50.77	59.56	71.66
Psychiatry	111	740	67.06	20.66	52.14	64.80	79.39
Rheumatology	128	447	59.81	16.11	48.93	56.24	68.22
Other internal medicine/pediatrics	148	1,010	68.47	23.92	50.34	64.47	81.85
Nonsurgical, procedural specialties	**183**	**4,673**	**72.84**	**24.85**	**54.82**	**68.11**	**87.84**
Cardiology	125	1,396	64.98	21.89	49.42	60.74	75.96
Dermatology	103	564	66.43	16.26	55.59	64.07	75.83
Gastroenterology	142	1,120	66.74	18.79	53.52	63.73	77.40
Oncology – hematology and oncology	117	1,120	95.94	24.66	77.81	93.97	113.32

			Physician Total Cash Compensation per Work RVU				
	Organizations	**Physicians**	**Mean**	**Standard deviation**	**25th percentile**	**Median**	**75th percentile**
Pulmonology	86	473	63.39	20.62	48.10	59.94	75.88
Surgical	**219**	**8,356**	**63.99**	**21.15**	**48.67**	**60.05**	**75.40**
Obstetrics/gynecology	175	2,538	55.77	18.44	44.09	51.70	62.60
Ophthalmology	81	387	50.95	14.60	40.70	47.43	59.12
Orthopedic surgery	125	882	75.53	19.92	61.77	73.08	86.67
Otolaryngology	110	574	65.19	19.56	52.51	62.02	75.27
General surgery	182	1,629	64.97	19.67	50.69	61.40	76.06
Cardiovascular and cardiothoracic surgery	106	325	68.73	22.65	53.81	64.26	80.91
Neurological surgery	103	459	82.15	24.61	64.21	78.34	96.97
Urology	126	708	62.84	17.00	51.11	60.57	72.49
Other surgical specialties	145	854	69.10	21.79	51.93	65.53	82.84
Radiology	**76**	**1,691**	**59.77**	**21.48**	**43.75**	**56.38**	**71.56**
Radiology	76	1,691	59.77	21.48	43.75	56.38	71.56
Pathology	**57**	**559**	**55.97**	**17.50**	**41.76**	**53.97**	**66.26**
Pathology	57	559	55.97	17.50	41.76	53.97	66.26

Source: SullivanCotter's 2017 Physician Compensation and Productivity Survey.

TABLE 4

Specialty Differential in Median Total Cash Compensation, Work RVU, and Total Cash Compensation per Work RVU, 2016

	Specialty Differential		
	Total cash compensation	**Work RVUs**	**Total cash compensation per work RVU**
Primary care specialties	**1.00**	**1.00**	**1.00**
Family medicine	1.00	1.00	1.00
Internal medicine	1.02	0.95	1.09
Pediatrics – general	0.96	1.06	0.93
Nonsurgical, nonprocedural specialties	**1.17**	**0.95**	**1.21**
Emergency medicine	1.38	1.48	0.94
Endocrinology and metabolism	1.00	0.90	1.08
Hospitalist	1.14	0.88	1.35
Nephrology Only	1.15	1.26	1.00
Neurology	1.17	0.90	1.25
Physical medicine and rehabilitation	1.10	0.94	1.19
Psychiatry	0.99	0.78	1.30
Rheumatology	1.04	0.90	1.13
Other internal medicine/pediatrics	1.18	0.92	1.29
Nonsurgical, procedural specialties	**1.78**	**1.31**	**1.34**
Cardiology	1.89	1.49	1.22
Dermatology	1.79	1.41	1.28
Gastroenterology	2.03	1.57	1.28
Oncology – hematology and oncology	1.61	0.87	1.88
Pulmonology	1.38	1.17	1.20
Surgical	**1.58**	**1.49**	**1.18**
Obstetrics/gynecology	1.36	1.37	1.04
Ophthalmology	1.58	1.71	0.95
Orthopedic surgery	2.35	1.63	1.46
Otolaryngology	1.73	1.42	1.24
General surgery	1.65	1.37	1.23
Cardiovascular and cardiothoracic surgery	2.75	2.06	1.29
Neurological surgery	3.08	1.98	1.57
Urology	1.80	1.49	1.21
Other surgical specialties	1.93	1.48	1.31
Radiology	**1.98**	**1.81**	**1.11**
Radiology	1.97	1.80	1.13
Pathology	**1.33**	**1.29**	**1.06**
Pathology	1.33	1.28	1.08

Source: SullivanCotter's 2017 Physician Compensation and Productivity Survey

Note: Ratios for specialty groups are relative to primary care; ratios for specialties are relative to family medicine.

TABLE 5

Physician Total Cash Compensation vs Work RVUs by Specialty Group and Specialty, 2016

	Organizations	Physicians	Pearson Correlation
All specialties	**248**	**42,280**	**0.724**
Primary care specialties	**223**	**16,088**	**0.648**
Family medicine	188	7,138	0.657
Internal medicine	196	5,718	0.660
Pediatrics – general	170	3,232	0.660
Nonsurgical, nonprocedural specialties	**213**	**10,913**	**0.534**
Emergency medicine	77	1,784	0.225
Endocrinology and metabolism	147	664	0.662
Hospitalist	158	4,383	0.508
Nephrology Only	50	238	0.674
Neurology	153	1,216	0.717
Physical medicine and rehabilitation	103	431	0.690
Psychiatry	111	740	0.720
Rheumatology	128	447	0.589
Other internal medicine/pediatrics	148	1,010	0.562
Nonsurgical, procedural specialties	**183**	**4,673**	**0.704**
Cardiology	125	1,396	0.627
Dermatology	103	564	0.855
Gastroenterology	142	1,120	0.731
Oncology – hematology and oncology	117	1,120	0.772
Pulmonology	86	473	0.757
Surgical	**219**	**8,356**	**0.720**
Obstetrics/gynecology	175	2,538	0.679
Ophthalmology	81	387	0.740
Orthopedic surgery	125	882	0.789
Otolaryngology	110	574	0.609
General surgery	182	1,629	0.724
Cardiovascular and cardiothoracic surgery	106	325	0.615
Neurological surgery	103	459	0.724
Urology	126	708	0.674
Other surgical specialties	145	854	0.692
Radiology	**76**	**1,691**	**0.439**
Radiology	76	1,691	0.439
Pathology	**57**	**559**	**0.554**
Pathology	57	559	0.554

Source: SullivanCotter's 2017 Physician Compensation and Productivity Survey

TABLE 6

Physician Total Cash Compensation as a Function of Productivity, Specialty Group, and Organization Classification, 2016

	Category 1: Linear Models				Category 2: Nonlinear Models			
	Model 1A: Omits organization classification		Model 1B: Includes organization classification		Model 2A: Omits organization classification		Model 2B: Includes organization classification	
Productivity								
Work RVU	45.97030	***	39.02210	***	52.27180	***	38.40850	***
Work RVU^2					-0.00060	***	0.00004	
Specialty Group								
Nonsurgical, nonprocedural	62,850	***	44,290	***	50,780	***	44,560	***
Nonsurgical, procedural	144,800	***	138,300	***	137,500	***	138,600	***
Surgical	117,200	***	116,800	***	113,600	***	117,000	***
Radiology	79,700	***	89,050	***	81,850	***	89,200	***
Pathology	41,310	***	35,890	***	30,710	***	36,460	***
Organization Classification								
Multiple hospital system			51,700	***			53,350	***
Medical group			62,750	***			64,440	***
Single hospital system			68,300	***			69,930	***
Other not for profit			-1,686				-31	
Other			66,890	***			68,320	***
Observations (n)	**42,280**		**42,280**		**42,280**		**42,280**	
R^2	**0.917**		**0.921**		**0.918**		**0.921**	

Source: SullivanCotter's 2017 Physician Compensation and Productivity Survey.
Note: Indicates statistical significance at the 0.10 (*), 0.05 (**), and 0.01 (***) level. Estimated cash compensation for the specialty groups is expressed relative to primary care. Estimated cash compensation for the organizational classification is expressed relative to Acute Care Hospital.

TABLE 7

Median Actual and Predicted Physician Total Cash Compensation by Specialty Group, 2016

		Category 1: Linear Models				Category 2: Nonlinear Models			
		Model 1A: Omits organization classification		Model 1B: Includes organization classification		Model 2A: Omits organization classification		Model 2B: Includes organization classification	
Specialty Group	**Actual**	**Predicted**	**Ratio of Predicted to Actual**	**Predicted**	**Ratio of Predicted to Actual**	**Predicted**	**Ratio of Predicted to Actual**	**Predicted**	**Ratio of Predicted to Actual**
Primary care	235,924	222,709	0.9440	246,794	1.0461	238,197	1.0096	246,470	1.0447
Nonsurgical, nonprocedural	275,361	273,844	0.9945	278,396	1.0110	277,191	1.0066	278,379	1.0110
Nonsurgical, procedural	419,088	436,805	1.0423	440,623	1.0514	443,688	1.0587	440,048	1.0500
Surgical	408,920	447,960	1.0955	452,080	1.1055	456,540	1.1165	451,566	1.1043
Radiology	466,039	482,909	1.0362	485,049	1.0408	491,022	1.0536	484,646	1.0399
Pathology	314,275	328,810	1.0463	329,272	1.0477	332,553	1.0582	328,675	1.0458

Source: SullivanCotter's 2017 Physician Compensation and Productivity Survey.

TABLE 8

Median Actual and Predicted Physician Total Cash Compensation per Actual Work RVU by Specialty Group, 2016

		Category 1: Linear Models				Category 2: Nonlinear Models			
		Model 1A: Omits organization classification		Model 1B: Includes organization classification		Model 2A: Omits organization classification		Model 2B: Includes organization classification	
Specialty Group	**Actual**	**Predicted**	**Ratio of Predicted to Actual**	**Predicted**	**Ratio of Predicted to Actual**	**Predicted**	**Ratio of Predicted to Actual**	**Predicted**	**Ratio of Predicted to Actual**
Primary care	50.7011	45.9703	0.9067	50.7828	1.0016	49.1671	0.9697	50.7139	1.0003
Nonsurgical, nonprocedural	61.3215	59.6639	0.9730	60.4284	0.9854	60.3931	0.9849	60.4127	0.9852
Nonsurgical, procedural	68.1058	68.7557	1.0095	69.0800	1.0143	69.8391	1.0254	69.0195	1.0134
Surgical	60.0466	62.2562	1.0368	62.6646	1.0436	63.4486	1.0567	62.6064	1.0426
Radiology	56.3815	55.0575	0.9765	55.3635	0.9819	55.9824	0.9929	55.3141	0.9811
Pathology	53.9693	52.5763	0.9742	52.7478	0.9774	53.1748	0.9853	52.7435	0.9773

Source: SullivanCotter's 2017 Physician Compensation and Productivity Survey.

TABLE 9

Physician Total Cash Compensation as a Function of Productivity, Specialty, and Organization Classification, 2016

	Category 1: Linear Models				Category 2: Nonlinear Models			
	Model 1C: Omits organization classification		Model 1D: Includes organization classification		Model 2C: Omits organization classification		Model 2D: Includes organization classification	
Productivity								
Work RVU	42.26	***	37.3294	***	49.6002	***	39.4208	***
Work RVU^2					-0.0006	***	0.0001	***
Primary care specialties								
Internal medicine	64,010	***	35,730	***	45,200	***	33,970	***
Pediatrics - general	30,490	***	3,100		11,510	***	1,208	
Nonsurgical, nonprocedural specialties								
Emergency medicine	30,070	***	17,950	***	14,980	***	15,610	***
Endocrinology and metabolism	55,120	***	26,950	***	36,150	***	25,190	***
Hospitalist	102,400	***	73,060	***	84,250	***	71,520	***
Nephrology Only	41,160	***	22,090	***	24,410	***	20,010	***
Neurology	90,970	***	65,630	***	73,100	***	63,820	***
Physical medicine and rehabilitation	83,830	***	55,830	***	65,010	***	54,020	***
Psychiatry	79,930	***	48,460	***	62,560	***	47,310	***
Rheumatology	69,340	***	40,840	***	50,190	***	39,050	***
Other internal medicine/pediatrics	103,200	***	76,630	***	85,060	***	74,880	***
Nonsurgical, procedural specialties								
Cardiology	144,500	***	131,600	***	130,100	***	129,500	***
Dermatology	164,100	***	148,400	***	152,100	***	147,000	***
Gastroenterology	171,900	***	159,700	***	158,300	***	157,700	***
Oncology – hematology and oncology	228,300	***	201,600	***	210,000	***	199,800	***
Pulmonology	109,400	***	91,470	***	93,860	***	89,570	***
Surgical								
Obstetrics/gynecology	70,070	***	52,010	***	53,630	***	49,910	***
Ophthalmology	56,850	***	45,470	***	45,320	***	43,730	***
Orthopedic surgery	261,300	***	252,500	***	251,900	***	251,100	***
Otolaryngology	146,000	***	131,100	***	130,600	***	128,800	***
General surgery	131,500	***	115,100	***	116,400	***	113,100	***
Cardiovascular and cardiothoracic surgery	238,800	***	243,900	***	248,400	***	245,600	***
Neurological surgery	359,200	***	361,700	***	364,700	***	362,700	***
Urology	138,900	***	126,300	***	123,600	***	123,900	***

	Category 1: Linear Models				Category 2: Nonlinear Models			
	Model 1C: Omits organization classification		**Model 1D: Includes organization classification**		**Model 2C: Omits organization classification**		**Model 2D: Includes organization classification**	
Other surgical specialties	175,700	***	166,400	***	163,300	***	164,400	***
Radiology								
Radiology	113,300	***	107,700	***	105,000	***	106,300	***
Pathology								
Pathology	65,410	***	50,320	***	47,530	***	47,590	***
Organization Classification								
Multiple hospital system			48,740	***			43,980	***
Medical group			59,480	***			54,560	***
Single hospital system			58,450	***			53,800	***
Other not for profit			-1,521				-6,281	
Other			56,580	***			52,510	***
Observations (n)	**42,280**		**42,280**		**42,280**		**42,280**	
R^2	**0.931**		**0.934**		**0.932**		**0.934**	

Source: SullivanCotter's 2017 Physician Compensation and Productivity Survey.

Note: Indicates statistical significance at the 0.10 (*), 0.05 (**), and 0.01 (***) level. Estimated cash compensation for the specialty groups is expressed relative to primary care. Estimated cash compensation for the organizational classification is expressed relative to Acute Care Hospital.

TABLE 10

Median Actual and Predicted Physician Total Cash Compensation by Specialty, 2016

		Category 1: Linear Models				Category 2: Nonlinear Models			
		Model 1C: Omits organization classification		Model 1D: Includes organization classification		Model 2C: Omits organization classification		Model 2D: Includes organization classification	
	Actual	Predicted	Ratio of Predicted to Actual	Predicted	Ratio of Predicted to Actual	Predicted	Ratio of Predicted to Actual	Predicted	Ratio of Predicted to Actual
Primary care specialties									
Family medicine	236,088	205,941	0.8723	236,842	1.0032	226,759	0.9605	238,739	1.0112
Internal medicine	240,744	260,369	1.0815	263,067	1.0927	262,071	1.0886	263,201	1.0933
Pediatrics - general	226,853	249,270	1.0988	251,351	1.1080	251,416	1.1083	251,562	1.1089
Nonsurgical, nonprocedural specialties									
Emergency medicine	326,731	333,953	1.0221	332,366	1.0172	339,089	1.0378	333,412	1.0204
Endocrinology and metabolism	236,393	241,393	1.0212	242,468	1.0257	242,548	1.0260	243,049	1.0282
Hospitalist	269,250	283,370	1.0524	284,035	1.0549	285,095	1.0589	284,251	1.0557
Nephrology Only	271,800	301,437	1.1090	298,222	1.0972	306,012	1.1259	299,499	1.1019
Neurology	275,818	276,867	1.0038	278,284	1.0089	279,112	1.0119	278,854	1.0110
Physical medicine and rehabilitation	260,838	277,759	1.0649	281,476	1.0791	279,362	1.0710	281,380	1.0788
Psychiatry	234,173	241,423	1.0310	243,338	1.0391	242,915	1.0373	243,252	1.0388
Rheumatology	244,699	255,028	1.0422	258,748	1.0574	255,967	1.0461	258,353	1.0558
Other internal medicine/pediatrics	278,652	291,792	1.0472	294,035	1.0552	293,823	1.0544	294,362	1.0564
Nonsurgical, procedural specialties									
Cardiology	447,267	451,226	1.0089	453,346	1.0136	456,935	1.0216	454,004	1.0151
Dermatology	423,445	454,165	1.0725	453,977	1.0721	462,902	1.0932	455,389	1.0754
Gastroenterology	478,689	495,841	1.0358	496,492	1.0372	501,534	1.0477	497,567	1.0394

		Category 1: Linear Models				Category 2: Nonlinear Models			
		Model 1C: Omits organization classification		Model 1D: Includes organization classification		Model 2C: Omits organization classification		Model 2D: Includes organization classification	
	Actual	Predicted	Ratio of Predicted to Actual	Predicted	Ratio of Predicted to Actual	Predicted	Ratio of Predicted to Actual	Predicted	Ratio of Predicted to Actual
Oncology – hematology and oncology	380,446	407,982	1.0724	411,168	1.0808	409,491	1.0763	410,784	1.0797
Pulmonology	324,632	351,025	1.0813	354,629	1.0924	356,849	1.0992	355,063	1.0937
Surgical									
Obstetrics/gynecology	321,238	352,238	1.0965	355,549	1.1068	356,742	1.1105	356,419	1.1095
Ophthalmology	373,068	409,344	1.0972	411,727	1.1036	415,235	1.1130	412,650	1.1061
Orthopedic surgery	555,000	597,334	1.0763	596,690	1.0751	606,465	1.0927	598,530	1.0784
Otolaryngology	407,291	438,880	1.0776	443,096	1.0879	444,090	1.0903	443,588	1.0891
General surgery	390,017	412,820	1.0585	415,130	1.0644	418,658	1.0734	416,442	1.0678
Cardiovascular and cardiothoracic surgery	649,562	663,054	1.0208	675,371	1.0397	682,823	1.0512	678,883	1.0451
Neurological surgery	725,985	766,890	1.0563	770,532	1.0614	784,543	1.0807	773,956	1.0661
Urology	425,059	446,321	1.0500	449,180	1.0567	451,112	1.0613	449,659	1.0579
Other surgical specialties	455,510	481,033	1.0560	483,970	1.0625	488,867	1.0732	484,833	1.0644
Radiology									
Radiology	466,039	483,939	1.0384	485,947	1.0427	491,590	1.0548	487,231	1.0455
Pathology									
Pathology	314,275	329,700	1.0491	329,321	1.0479	333,101	1.0599	329,947	1.0499

Source: SullivanCotter's 2017 Physician Compensation and Productivity Survey.

TABLE 11

Median Actual and Predicted Physician Total Cash Compensation per Actual Work RVU by Specialty, 2016

		Category 1: Linear Models				Category 2: Nonlinear Models			
		Model 1C: Omits organization classification		Model 1D: Includes organization classification		Model 2C: Omits organization classification		Model 2D: Includes organization classification	
	Actual	Predicted	Ratio of Predicted to Actual	Predicted	Ratio of Predicted to Actual	Predicted	Ratio of Predicted to Actual	Predicted	Ratio of Predicted to Actual
Primary care specialties									
Family medicine	49.9364	42.2600	0.8463	48.4494	0.9702	46.5321	0.9318	48.8484	0.9782
Internal medicine	54.4221	56.0359	1.0297	56.2321	1.0333	56.4023	1.0364	56.2597	1.0338
Pediatrics - general	46.5621	48.1497	1.0341	48.5377	1.0424	48.5643	1.0430	48.5913	1.0436
Nonsurgical, nonprocedural specialties									
Emergency medicine	46.9579	46.4424	0.9890	46.7107	0.9947	47.1566	1.0042	46.7874	0.9964
Endocrinology and metabolism	54.0923	54.7652	1.0124	55.2160	1.0208	55.0273	1.0173	55.2268	1.0210
Hospitalist	67.1656	66.1770	0.9853	66.3396	0.9877	66.5800	0.9913	66.3817	0.9883
Nephrology Only	49.8503	48.9426	0.9818	49.5183	0.9933	49.6853	0.9967	49.6097	0.9952
Neurology	62.4099	62.9389	1.0085	63.4527	1.0167	63.4491	1.0167	63.4802	1.0171
Physical medicine and rehabilitation	59.5642	60.5270	1.0162	60.4338	1.0146	60.8765	1.0220	60.5653	1.0168
Psychiatry	64.8046	63.1744	0.9748	63.6974	0.9829	63.5646	0.9809	63.7531	0.9838
Rheumatology	56.2398	58.0420	1.0320	58.4094	1.0386	58.2558	1.0358	58.4147	1.0387
Other internal medicine/pediatrics	64.4697	65.4002	1.0144	65.6628	1.0185	65.8553	1.0215	65.7816	1.0203
Nonsurgical, procedural specialties									
Cardiology	60.7377	62.1760	1.0237	62.5952	1.0306	62.9627	1.0366	62.7473	1.0331
Dermatology	64.0731	66.1741	1.0328	66.8071	1.0427	67.4471	1.0527	67.0158	1.0459
Gastroenterology	63.7349	64.6771	1.0148	64.7954	1.0166	65.4198	1.0264	64.9185	1.0186

		Category 1: Linear Models				Category 2: Nonlinear Models			
		Model 1C: Omits organization classification		Model 1D: Includes organization classification		Model 2C: Omits organization classification		Model 2D: Includes organization classification	
	Actual	Predicted	Ratio of Predicted to Actual	Predicted	Ratio of Predicted to Actual	Predicted	Ratio of Predicted to Actual	Predicted	Ratio of Predicted to Actual
Oncology – hematology and oncology	93.9688	95.9507	1.0211	95.9860	1.0215	96.3054	1.0249	95.9722	1.0213
Pulmonology	59.9353	61.3999	1.0244	61.5341	1.0267	62.4187	1.0414	61.6901	1.0293
Surgical									
Obstetrics/gynecology	51.6984	52.7537	1.0204	52.9772	1.0247	53.4283	1.0335	53.0896	1.0269
Ophthalmology	47.4342	49.0761	1.0346	49.4649	1.0428	49.7824	1.0495	49.5644	1.0449
Orthopedic surgery	73.0810	75.1181	1.0279	75.0033	1.0263	76.2664	1.0436	75.2438	1.0296
Otolaryngology	62.0173	63.3297	1.0212	63.3696	1.0218	64.0815	1.0333	63.4751	1.0235
General surgery	61.4041	62.0172	1.0100	62.3221	1.0150	62.8941	1.0243	62.4679	1.0173
Cardiovascular and cardiothoracic surgery	64.2610	66.0540	1.0279	66.3910	1.0331	68.0234	1.0585	66.6907	1.0378
Neurological surgery	78.3426	79.5033	1.0148	79.8653	1.0194	81.3333	1.0382	80.2115	1.0239
Urology	60.5658	61.3456	1.0129	61.5415	1.0161	62.0041	1.0237	61.6566	1.0180
Other surgical specialties	65.5285	66.5702	1.0159	67.0427	1.0231	67.6544	1.0324	67.3082	1.0272
Radiology									
Radiology	56.3815	55.1748	0.9786	55.4062	0.9827	56.0472	0.9941	55.5412	0.9851
Pathology									
Pathology	53.9693	52.7186	0.9768	52.5137	0.9730	53.2625	0.9869	52.6275	0.9751

Source: SullivanCotter's 2017 Physician Compensation and Productivity Survey.

TABLE 12

Physician Total Cash Compensation as a Function of Productivity, 2016

	Category 1: Linear Models	Category 2: Nonlinear Models
	Model 1E: Productivity Only	Model 2E: Productivity plus Productivity^2
Productivity		
Work RVU	55.3728 ***	63.1093 ***
Work RVU^2		-0.0009 ***
Observations (n)	**42,280**	**42,280**
R^2	**0.899**	**0.903**

Source: SullivanCotter's 2017 Physician Compensation and Productivity Survey.
Note: Indicates statistical significance at the 0.10 (*), 0.05 (**), and 0.01 (***) level.

TABLE 13

Median Actual and Predicted Physician Total Cash Compensation by Specialty Group, 2016

		Category 1: Linear Models		Category 2: Nonlinear Models	
		Model 1E: Productivity Only		Model 2E: Productivity plus Productivity^2	
Specialty Group	**Actual**	**Predicted**	**Ratio of Predicted to Actual**	**Predicted**	**Ratio of Predicted to Actual**
Primary care	235,924	268,261	1.1371	285,236	1.2090
Nonsurgical, nonprocedural	275,361	254,149	0.9230	271,253	0.9851
Nonsurgical, procedural	419,088	351,783	0.8394	365,672	0.8725
Surgical	408,920	398,431	0.9743	408,865	0.9999
Radiology	466,039	485,675	1.0421	486,320	1.0435
Pathology	314,275	346,299	1.1019	360,512	1.1471

Source: SullivanCotter's 2017 Physician Compensation and Productivity Survey.

TABLE 14

Median Actual and Predicted Physician Total Cash Compensation per Actual Work RVU by Specialty Group, 2016

		Category 1: Linear Models		Category 2: Nonlinear Models	
		Model 1E: Productivity Only		Model 2E: Productivity plus Productivity^2	
Specialty Group	**Actual**	**Predicted**	**Ratio of Predicted to Actual**	**Predicted**	**Ratio of Predicted to Actual**
Primary care	50.7011	55.37280	1.0921	58.8767	1.1613
Nonsurgical, nonprocedural	61.3215	55.37280	0.9030	59.0994	0.9638
Nonsurgical, procedural	68.1058	55.37280	0.8130	57.5589	0.8451
Surgical	60.0466	55.37280	0.9222	56.8229	0.9463
Radiology	56.3815	55.37280	0.9821	55.4464	0.9834
Pathology	53.9693	55.37280	1.0260	57.6454	1.0681

Source: SullivanCotter's 2017 Physician Compensation and Productivity Survey.

TABLE 15

Median Actual and Predicted Physician Total Cash Compensation by Specialty, 2016

		Category 1: Linear Models		Category 2: Nonlinear Models	
		Model 1E: Productivity Only		Model 2E: Productivity plus Productivity[2]	
	Actual	Predicted	Ratio of Predicted to Actual	Predicted	Ratio of Predicted to Actual
Primary care specialties					
Family medicine	236,088	269,841	1.1430	286,795	1.2148
Internal medicine	240,744	257,287	1.0687	274,373	1.1397
Pediatrics - general	226,853	286,664	1.2637	303,300	1.3370
Nonsurgical, nonprocedural specialties					
Emergency medicine	326,731	398,169	1.2186	408,626	1.2506
Endocrinology and metabolism	236,393	244,071	1.0325	261,198	1.1049
Hospitalist	269,250	237,106	0.8806	254,215	0.9442
Nephrology Only	271,800	341,041	1.2548	355,549	1.3081
Neurology	275,818	243,584	0.8831	260,711	0.9452
Physical medicine and rehabilitation	260,838	254,106	0.9742	271,210	1.0398
Psychiatry	234,173	211,609	0.9036	228,416	0.9754
Rheumatology	244,699	243,300	0.9943	260,426	1.0643
Other internal medicine/pediatrics	278,652	247,053	0.8866	264,179	0.9481
Nonsurgical, procedural specialties					
Cardiology	447,267	401,854	0.8985	411,986	0.9211
Dermatology	423,445	380,034	0.8975	391,978	0.9257
Gastroenterology	478,689	424,510	0.8868	432,473	0.9035
Oncology – hematology and oncology	380,446	235,445	0.6189	252,545	0.6638
Pulmonology	324,632	316,567	0.9752	332,242	1.0234
Surgical					
Obstetrics/gynecology	321,238	369,726	1.1509	382,432	1.1905
Ophthalmology	373,068	461,864	1.2380	465,612	1.2481
Orthopedic surgery	555,000	440,320	0.7934	446,596	0.8047
Otolaryngology	407,291	383,738	0.9422	395,394	0.9708

		Category 1: Linear Models		Category 2: Nonlinear Models	
		Model 1E: Productivity Only		Model 2E: Productivity plus Productivity[2]	
	Actual	Predicted	Ratio of Predicted to Actual	Predicted	Ratio of Predicted to Actual
General surgery	390,017	368,592	0.9451	381,378	0.9779
Cardiovascular and cardiothoracic surgery	649,562	555,835	0.8557	545,462	0.8397
Neurological surgery	725,985	534,127	0.7357	527,463	0.7265
Urology	425,059	402,866	0.9478	412,907	0.9714
Other surgical specialties	455,510	400,121	0.8784	410,407	0.9010
Radiology					
Radiology	466,039	485,675	1.0421	486,320	1.0435
Pathology					
Pathology	314,275	346,299	1.1019	360,512	1.1471

Source: SullivanCotter's 2017 Physician Compensation and Productivity Survey.

TABLE 16

Median Actual and Predicted Physician Total Cash Compensation per Actual Work RVU by Specialty, 2016

		Category 1: Linear Models		Category 2: Nonlinear Models	
		Model 1E: Productivity Only		Model 2E: Productivity plus Productivity^2	
	Actual	Predicted	Ratio of Predicted to Actual	Predicted	Ratio of Predicted to Actual
Primary care specialties					
Family medicine	49.9364	55.3728	1.1089	58.8518	1.1785
Internal medicine	54.4221	55.3728	1.0175	59.0499	1.0850
Pediatrics - general	46.5621	55.3728	1.1892	58.5864	1.2582
Nonsurgical, nonprocedural specialties					
Emergency medicine	46.9579	55.3728	1.1792	56.8271	1.2102
Endocrinology and metabolism	54.0923	55.3728	1.0237	59.2584	1.0955
Hospitalist	67.1656	55.3728	0.8244	59.3683	0.8839
Nephrology Only	49.8503	55.3728	1.1108	57.7284	1.1580
Neurology	62.4099	55.3728	0.8872	59.2661	0.9496
Physical medicine and rehabilitation	59.5642	55.3728	0.9296	59.1001	0.9922
Psychiatry	64.8046	55.3728	0.8545	59.7706	0.9223
Rheumatology	56.2398	55.3728	0.9846	59.2706	1.0539
Other internal medicine/pediatrics	64.4697	55.3728	0.8589	59.2113	0.9184
Nonsurgical, procedural specialties					
Cardiology	60.7377	55.3728	0.9117	56.7689	0.9347
Dermatology	64.0731	55.3728	0.8642	57.1132	0.8914
Gastroenterology	63.7349	55.3728	0.8688	56.4114	0.8851
Oncology – hematology and oncology	93.9688	55.3728	0.5893	59.3945	0.6321
Pulmonology	59.9353	55.3728	0.9239	58.1146	0.9696
Surgical					
Obstetrics/gynecology	51.6984	55.3728	1.0711	57.2758	1.1079
Ophthalmology	47.4342	55.3728	1.1674	55.8221	1.1768
Orthopedic surgery	73.0810	55.3728	0.7577	56.1620	0.7685

		Category 1: Linear Models		Category 2: Nonlinear Models	
		Model 1E: Productivity Only		Model 2E: Productivity plus Productivity^2	
	Actual	Predicted	Ratio of Predicted to Actual	Predicted	Ratio of Predicted to Actual
Otolaryngology	62.0173	55.3728	0.8929	57.0547	0.9200
General surgery	61.4041	55.3728	0.9018	57.2937	0.9331
Cardiovascular and cardiothoracic surgery	64.2610	55.3728	0.8617	54.3394	0.8456
Neurological surgery	78.3426	55.3728	0.7068	54.6819	0.6980
Urology	60.5658	55.3728	0.9143	56.7529	0.9370
Other surgical specialties	65.5285	55.3728	0.8450	56.7963	0.8667
Radiology					
Radiology	56.3815	55.3728	0.9821	55.4464	0.9834
Pathology					
Pathology	53.9693	55.3728	1.0260	57.6454	1.0681

Source: SullivanCotter's 2017 Physician Compensation and Productivity Survey.

Appendix 1

Organization Classifications used in SullivanCotter's 2017 Physician Compensation and Productivity Survey

- Acute care hospital (reference group in regressions): A single hospital entity that provides short- or long-term inpatient medical care and other related services. (this is the organization classification that was excluded from the regression analysis)
- Medical group: A group of two or more physicians and non-physician practitioners legally organized in a partnership, professional corporation, foundation, not-for-profit corporation, faculty practice plan or similar association that provides patients care.
- Multiple hospital system: A hospital system that owns, leases, sponsors or contract manages more than one acute care hospital and may own or operate other health care related entities (e.g., long-term care or assisted living, physician group practice, outpatient or ambulatory care, home health or hospice, fitness center, health plan, durable medical equipment).
- Single hospital system: A single hospital that brings into membership three or more health care related entities that reflect at least 25% of their owned or leased non-hospital revenue (e.g., long-term care or assisted living, physician group practice, outpatient or ambulatory care, home health or hospice, fitness center, health plan, durable medical equipment).
- Other not for profit: A not for profit organization that employs physicians and does not belong to the other organization classifications.
- Other: A for profit organization that employs physicians and does not belong to the other organization classifications.

Appendix 2

Regression Models