ANALYSIS OF MEDICARE OUTPATIENT PAYMENTS

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Abstract:

In this project, we conducted an analysis on 2015 payment and demographic data we obtained separately through the “Centers for Medicare & Medicaid Services” (CMS) website regarding payments from Medicare to hospitals and the US Census Bureau, Population Division. After merging the two datasets and choosing our dependent variable (Revenue) we split the rest into independent and control variables. Then we ran a correlation test to identify which variables are strongly correlated with revenue and analyze them at a univariate level. Next step to our analysis was to run a hypothesis test that certain services have a more positive affect to the revenue than others. We performed an ANOVA test followed by a Tukey test and found out that the type of service and the Hospital Referral Region (HRR) have a strong impact to the amount of revenue generated from Medicare. At the end, we also ran multiple linear models trying to predict revenue by APC Category and reimbursement %, revenue by APC category and beneficiary population size and revenue predicted by APC Category, reimbursement percent, and outpatient service number with the last one being the best of our three models. Moreover, the slopes of the linear models fit lines appear to move downwards, indicating a weak negative correlation between reimbursement rate and beneficiary population size.

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Introduction

Since its inception in 1966, Medicare has become one of the largest components of the social safety net in the United States, providing health insurance for millions of older and disabled Americans. Medicare acts as a significant source of reimbursement for medical procedures to hospitals around the country. Understanding how this money is paid out to hospitals is critical for hospital administrators and managers when making determinations about what services to offer and to what extent, what cash flow can be expected from providing those services, and how to allot resources accordingly. In this report, we will analyze data that Medicare releases to the public regarding its reimbursement for Outpatient services.

Research Question and Hypotheses

The question we are researching in this analysis is: “What affects Hospital Revenues from Medicare specifically for Outpatient Service?” We first hypothesized that services billed under the classification exam services would provide more revenue for hospitals than services billed under other categories. After our analysis, we found that services billed under complex imaging codes provided more revenue, on average, than those billed under exam services. Additionally, we hypothesized that in areas with a lower patient population, there would be a higher reimbursement percentage rate to compensate for the lower number of services that can be provided with smaller patient populations. However, we hypothesized that the difference in reimbursement rate would not affect revenue because of a higher number of outpatient services could be billed in regions of high population. This second hypothesis is supported by our analysis.

Description of Datasets

In 2015, the Center for Medicare and Medicaid (CMS) released data collected by more than 3,000 hospital outpatient centers about money paid to the hospitals for outpatient services. The only state that was excluded was the state of Maryland as it has an independent contract with Medicare to arrange payments. The dataset includes the number of outpatient services submitted under each Ambulatory Payment Classification (APC) Group from a specific hospital, the average submitted charges from each hospital, the average payments by Medicare, the Provider address, and the Provider ID number.

The second dataset we used contained data for each “Hospital Referral Region” (HRR). HRRs are how Medicare classifies hospitals into geographical regions, and there are about 300 in total across the country. For each HRR< Medicare released data including, the population, the number of Medicare beneficiaries, the total Medicare costs for 2015, the cost per Capita, and the average beneficiary age.

Also, we decided to group together similar APC codes, from 29 we went down to 10 so we can identify what services the hospitals should focus on and find out what revenue they would generated for each one of these services. We will discuss this in more detail later on in this report. Lastly, we added population per state from the US Census Bureau, Population Division).

Analysis of Individual Variables

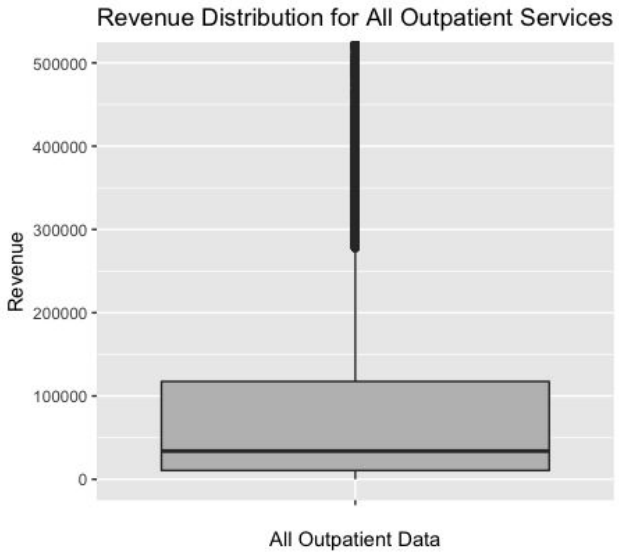
We started our analysis by running a correlation plot to identify any strong relations between our dependent variable and the other variables:

We were able to identify some strong and weak correlations to our dependent variable we examined, which is Revenue, such as 0.96 correlation with No_of_Services and 0.14 with Payment_Percent, but nothing very exciting. Next step was to make sure our variables and their format were sufficient for our analysis.

On the dataset provided by Medicare, revenue from each APC code billed by each hospital was not included as a variable. However, it could be calculated by multiplying two different variables that are provided: the number of outpatient services times the average payment per service. For instance, on line 8384 of the dataset, Northwestern Memorial Hospital in Chicago, Illinois billed Medicare 2,626 times under APC Code "0336 - Magnetic Resonance Imaging and Magnetic Resonance Angiography without Contrast," and the average payment by Medicare for each service was approximately $284.86. By multiplying these numbers together,

we calculate that the revenue earned by Northwestern Memorial Hospital under this APC code is $748,039.58.

In 2015, the mean amount of revenue received per APC code was $167,348.60, with a median of $33,890.96 and standard deviation of $677,945.90. The range was from a minimum of $33.38 to a maximum of $31,912,553. These numbers point to a heavy skew, as is shown by plotting the revenue variable:



One of the independent variables we closely examined is APC code. These codes are broad classifications, and different services can be billed under the same APC code. In the dataset, there are 28 different APC codes used throughout. For purposes of examining the data and analyzing the different revenue obtained by different types of procedures, we further grouped the codes into 10 different APC Categories, as follows:

APC Code	APC Category
0019 - Level I Excision/ Biopsy 0020 - Level II Excision/ Biopsy	Biopsy Services
0690 - Level I Electronic Analysis of Devices 0692 - Level II Electronic Analysis of Devices	Device Analysis Services
0073 - Level III Endoscopy Upper Airway 0074 - Level IV Endoscopy Upper Airway	Endoscopy Services
0631 - Level 1 Examinations & Related Services 0632 - Level 2 Examinations & Related Services 0633 - Level 3 Examinations & Related Services 0634 - Hospital Clinic Visits	Exam Services

0698 - Level II Eye Tests & Treatments 0231 - Level III Eye Tests & Treatments	Eye Test Services
0096 - Level II Noninvasive Physiologic Studies 0209 - Level II Extended EEG, Sleep, and Cardiovascular Studies 0369 - Level II Pulmonary Tests	Monitoring Services
0204 - Level I Nerve Injections 0206 - Level II Nerve Injections 0207 - Level III Nerve Injections 0203 - Level IV Nerve Injections	Nerve Injection Services
0336 - Magnetic Resonance Imaging and Magnetic Resonance Angiography without Contrast 0377 - Level II Cardiac Imaging	Other Imaging Services
0265 - Level I Diagnostic and Screening Ultrasound 0267 - Level III Diagnostic and Screening Ultrasound 0270 - Level II Echocardiogram Without Contrast 0269 - Level I Echocardiogram Without Contrast	Ultrasound Services
0012 - Level I Debridement & Destruction 0015 - Level II Debridement & Destruction 0017 - Level IV Debridement & Destruction	Wound Care Services

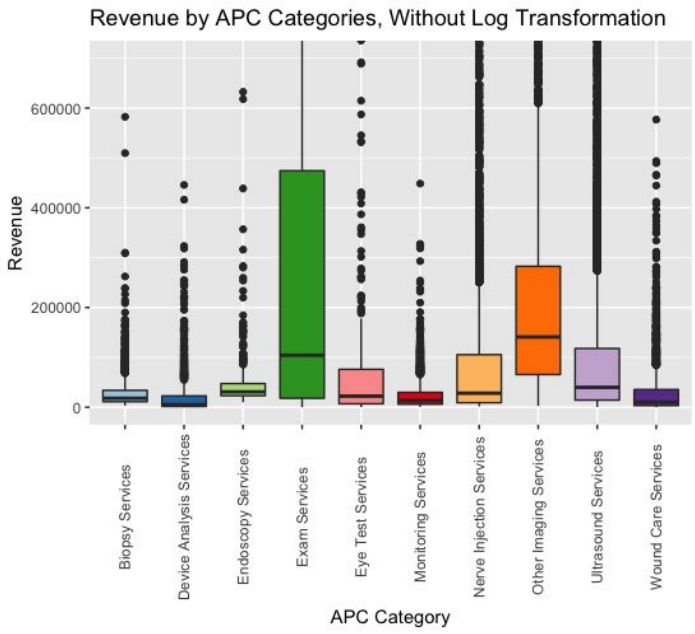
For the most part, the APC codes were simple to classify further as most of the codes are billed at several different levels. In some cases, we combined APC codes in other ways. For instance, under Ultrasounds Services, we combined both ultrasounds and echocardiograms, as the latter is a more specific kind of ultrasound of the heart. Additionally, we combined MRI services and Cardiac imaging services under Other Imaging Services, as both are intensive forms of imaging, with Cardiac Imaging studies including detailed studies such as Myocardial perfusion imaging.[1]

A brief summary regarding the 10 APC Categories from the 2015 data is in the table below:

[1] Source: https://www.asnc.org/files/Final%202015%20Payment%20Rates%20HOPPS(APC)%20Chart.pdf

	APC Category	Sum of Revenue	Sum of # of Services Billed	Avg. Submitted Charges	Avg. Payments Made
1	Biopsy Services	55120659	76457	4987.4335	712.98315
2	Device Analysis Services	27598272	710205	433.3199	60.74276
3	Endoscopy Services	24343686	15512	9540.0150	1699.28236
4	Exam Services	2345991122	24384505	283.5756	97.61443
5	Eye Test Services	38918955	151800	645.6081	203.67388
6	Monitoring Services	70989866	306497	1497.9020	236.67189
7	Nerve Injection Services	584885127	1193352	2858.5805	516.60933
8	Other Imaging Services	1087535977	1761487	5417.8257	743.48252
9	Ultrasound Services	1113554325	3939453	1795.6671	271.41882
10	Wound Care Services	95247234	733639	521.2158	117.57754

The category with highest sum of revenue was Exam Services, and the category with the highest payment received per service is Endoscopy Services. Visualizing the revenue that is obtained by hospitals in each APC category is shown below:



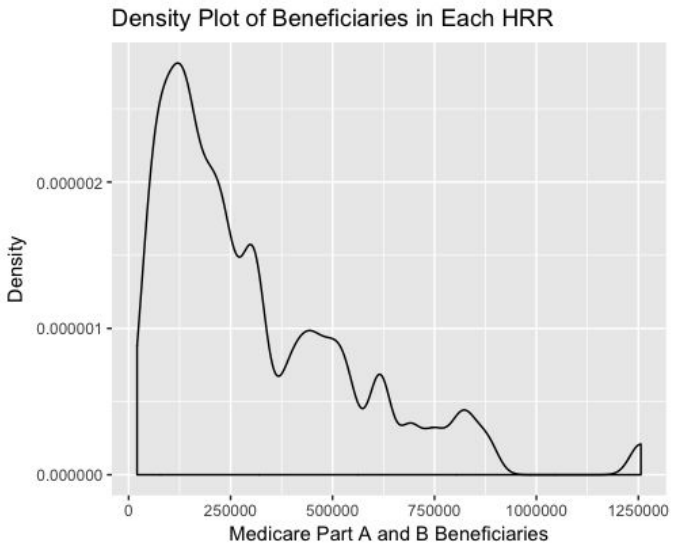
The median amount of revenue in each APC category ranges from a low of $5,349.73 (in Device Analysis Services) to a high of $140,940.20 (in Other Imaging Services). Additionally, the spread in Exam Services is by far the greatest, which has a mean of $719,188 and standard deviation of $1,944,934. These results suggest that Exam Services are the most variable source

of revenue from hospital to hospital. Endoscopy Services has the highest per-service revenue yet one of the lower mean revenues ($46,904.98) and median revenues ($30,811.49). This suggests that, though each service performed can be reimbursed at high dollar amounts, the number of services performed is not enough to make it one of the higher earning services.

Another variable we created to include in our linear models is what we define as the "reimbursement percentage." Medicare works where a hospital submits a charge for reimbursement from Medicare, and Medicare reimburses the hospital for those services at set rates The payment percentage is the ratio of the average submitted charges to the average payments made, multiplied by 100. Below is a table with summary statistics for payment percentages for each APC category:

	APC Category	Average %	Standard Deviation	Interquartile Range
1	Biopsy Services	25.78716	26.734140	17.938744
2	Device Analysis Services	23.75472	21.519487	19.574428
3	Endoscopy Services	30.81481	39.006624	16.994798
4	Exam Services	49.27065	33.708617	33.476791
5	Eye Test Services	47.68387	32.096819	36.418996
6	Monitoring Services	22.36973	14.471442	14.713641
7	Nerve Injection Services	25.39521	19.626849	18.702202
8	Other Imaging Services	15.33116	8.224807	9.586143
9	Ultrasound Services	19.27955	10.244333	11.707322
10	Wound Care Services	33.10308	24.090073	21.663435

When examining the effect that patient population size has on revenue, we looked at the variable that includes the total number of Medicare Part A and Part B beneficiaries located in each HRR. Among the 304 HRRs, the number of beneficiaries ranges from a minimum of 20,645 (in Minot, North Dakota) to 1,256,161 (in Los Angeles, California). The mean number of beneficiaries is approximately 309,204, and the median number of beneficiaries is 229,715. These numbers reflect a skew toward lower populations, which is depicted in this graph:



Lastly, in order to come up with our linear models, we also examined the number of outpatient services billed under each APC codes. There is a large range of outpatient services billed by hospitals, ranging from a minimum of 11 (which appears at many different hospitals across the country) to a maximum of 358,968. The skew of this variable is dramatically rightward. Additionally, there is a wide variation among different APC Categories, as is shown in the chart below:

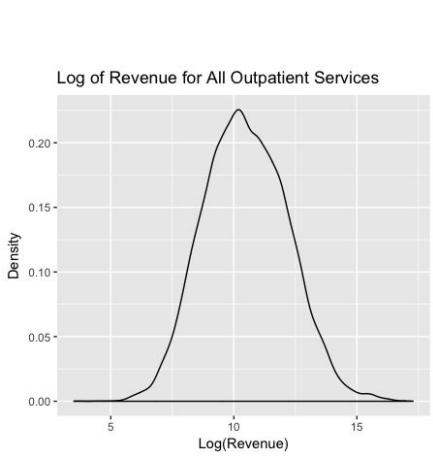
	APC Category	Average Outpatient Services Billed	Standard Deviation	Interquartile Range	Minimum	Maximum
1	Biopsy Services	39.55354	31.00	42.18665	11	705
2	Device Analysis Services	608.05223	473.25	1334.82352	11	13036
3	Endoscopy Services	29.88825	14.00	42.76730	11	519
4	Exam Services	7475.32342	4707.50	20018.39734	11	358968
5	Eye Test Services	484.98403	424.00	892.22412	11	6542
6	Monitoring Services	103.40655	104.00	130.64385	11	2013
7	Nerve Injection Services	222.76498	187.00	498.44226	11	16205
8	Other Imaging Services	399.52075	413.00	476.92946	11	5343
9	Ultrasound Services	410.48796	387.00	638.08393	11	12087
10	Wound Care Services	243.73389	248.00	406.74117	11	7464

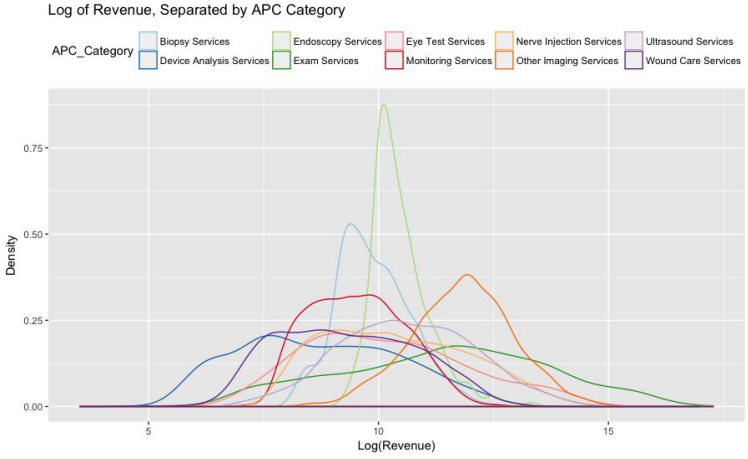
As can be seen, the maximum number of Endoscopy Services billed by a hospital is 519, which supports the conclusion (mentioned above) that Endoscopy Services earn higher revenue per service than any other category yet there is not a high enough volume of services for it to earn high revenue for hospitals. On the other hand, Exam Services has a maximum number of services billed at 358,968, supporting the conclusion that it is a key driver of revenue for hospitals around the country, at least in terms of revenue earned by Medicare patients.

Variable Transformations

As can be shown in the figures and tables above, all of the variables thus far (except for APC Category, a factor variable) are somewhat or heavily right-skewed. This poses a problem for statistical analysis, as many tests require that the variables that are being tested are normal or nearly normal. To solve this, we transformed variables by taking the natural log (log) of the values. We also tried to transform the variables by taking the square root of the values, but this proved to be not as effective as taking the log in transforming skewed variables.

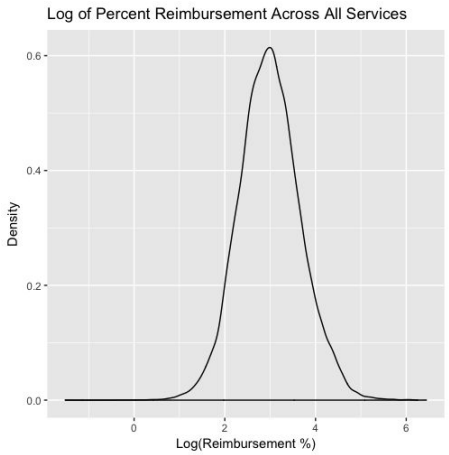
Below are graphs that show the distribution of Revenue, both overall across all data points and separated by APC Category:



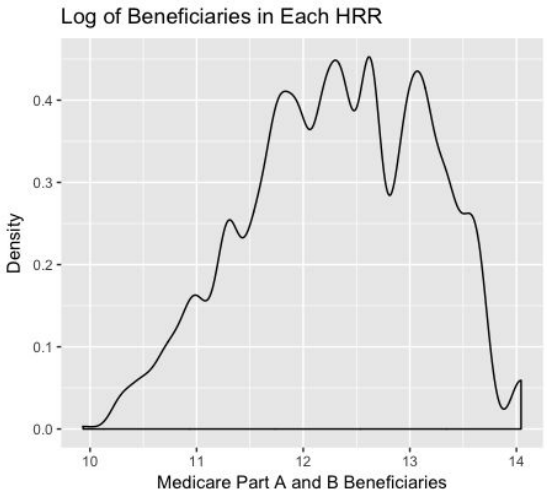


These graphs show that the log transformations work well to turn this variable into a normal distribution.

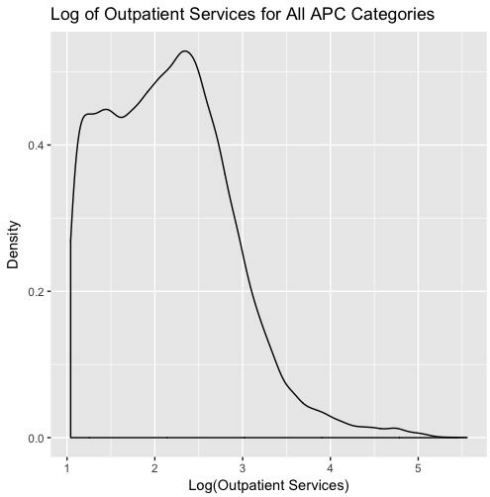
Using a log transformation also works well for the percent reimbursement variable:



This transformation also works for beneficiaries, but there is some leftward skew, likely due to the fact that there are not as many data points in this variable (304 total data points - one for each HRR):



The one variable where the log transformation does not work to create a normal distribution is the outpatient services variable:



This is due to the high degree of right skew in the untransformed variable. However, this transformation is still more normal than without the transformation, and the density graph of the untransformed variable (not shown) essentially looks like a straight line on the left of the graph.

Linear Models

As discussed above, due to the rightward skew of all the numeric variables (revenue, reimbursement percent, outpatient services, and beneficiary population size), we had to use a natural log transformation for all the linear models created. Additionally, when creating linear models, we found that, given the varying rates of revenue raised from different services, it was essential to include APC Category in all of our models. A linear model that predicts revenue using only APC Category produces an adjusted R-statistic of .2346.

Model 1 - Revenue Predicted by APC Category and Reimbursement %

For our first model, we included APC Category and payment percentage, and found that it resulted in an adjusted R-statistic of .255, an increase of .02 above a linear model predicting revenue using only APC Category:

```
Call:
lm(formula = log(Revenue) ~ APC_Category + log(payment_percent),
    data = Medicare_Dataset_Final)

Residuals:
    Min      1Q  Median      3Q     Max
-6.2095 -1.0041 -0.0221  0.9736  5.7221

Coefficients:
                                  Estimate Std. Error t value             Pr(>|t|)
(Intercept)                        8.70372    0.05189 167.741 < 0.0000000000000002 ***
APC_CategoryDevice Analysis Services -1.15778    0.05447 -21.255 < 0.0000000000000002 ***
APC_CategoryEndoscopy Services        0.51283    0.07269   7.055 0.000000000001757908 ***
APC_CategoryExam Services             1.20849    0.04350  27.778 < 0.0000000000000002 ***
APC_CategoryEye Test Services        -0.02089    0.09005  -0.232                0.817
APC_CategoryMonitoring Services      -0.35154    0.04296  -8.183 0.000000000000000286 ***
APC_CategoryNerve Injection Services  0.46652    0.03900  11.961 < 0.0000000000000002 ***
APC_CategoryOther Imaging Services    2.05756    0.04033  51.020 < 0.0000000000000002 ***
APC_CategoryUltrasound Services       0.77710    0.03666  21.198 < 0.0000000000000002 ***
APC_CategoryWound Care Services      -0.72735    0.04311 -16.871 < 0.0000000000000002 ***
log(payment_percent)                  0.40510    0.01353  29.947 < 0.0000000000000002 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.469 on 32521 degrees of freedom
Multiple R-squared:  0.2552,    Adjusted R-squared:  0.255
F-statistic:  1115 on 10 and 32521 DF,  p-value: < 0.00000000000000022
```

It should be noted that this model will not work for predicting revenue from Eye Test Services, as the p-value of the coefficient is above the threshold for statistical significance.

Model 2 - Revenue Predicted by APC Category and Beneficiary Population Size

In our second linear model, we used APC Category and beneficiary population size to predict revenue, and found that this model had an adjusted R-squared value of .2346:

```
Call:
lm(formula = log(Revenue) ~ APC_Category + log(Beneficiaries_with_Part_A_and_Part_B),
    data = Medicare_Dataset_Final)

Residuals:
    Min      1Q  Median      3Q     Max
-7.5449 -1.0089 -0.0387  0.9897  5.8439

Coefficients:
                                    Estimate Std. Error t value             Pr(>|t|)
(Intercept)                         9.568653   0.125890  76.008 < 0.0000000000000002 ***
APC_CategoryDevice Analysis Services -1.193133   0.055198 -21.616 < 0.0000000000000002 ***
APC_CategoryEndoscopy Services       0.586640   0.073633   7.967  0.000000000000000168 ***
APC_CategoryExam Services            1.527762   0.042750  35.737 < 0.0000000000000002 ***
APC_CategoryEye Test Services        0.268309   0.090747   2.957              0.00311 **
APC_CategoryMonitoring Services     -0.349668   0.043542  -8.031  0.000000000000000100 ***
APC_CategoryNerve Injection Services 0.497176   0.039518  12.581 < 0.0000000000000002 ***
APC_CategoryOther Imaging Services   1.924068   0.040629  47.357 < 0.0000000000000002 ***
APC_CategoryUltrasound Services      0.734847   0.037131  19.791 < 0.0000000000000002 ***
APC_CategoryWound Care Services     -0.579389   0.043411 -13.347 < 0.0000000000000002 ***
log(Beneficiaries_with_Part_A_and_Part_B)  0.026302   0.009852   2.670              0.00760 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.489 on 32521 degrees of freedom
Multiple R-squared:  0.2349,    Adjusted R-squared:  0.2346
F-statistic: 998.3 on 10 and 32521 DF,  p-value: < 0.00000000000000022
```

The R-squared value for Model 2 is lower than Model 1 and has the same adjusted R-squared value as a model with APC Category only, meaning that beneficiary population size has no effect when predicting revenue.

Model 3 - Revenue Predicted by APC Category, Reimbursement Percent, and Outpatient Service Number

For our third linear model, we added the number of outpatient services billed to the variables included in Model 1. As we have used the outpatient service variable as part of how we calculated revenue in the dataset, this model is limited by the assumptions within that calculation. As outpatient services were multiplied by average payment received by Medicare, this model will obviously have the highest adjusted R-squared value, which is .8885:

```
Call:
lm(formula = log(Revenue) ~ APC_Category + log(payment_percent) +
    log(Outpatient_Services), data = Medicare_Dataset_Final)

Residuals:
    Min      1Q  Median      3Q     Max
-3.5366 -0.3714  0.0174  0.4308  2.7177

Coefficients:
                                    Estimate Std. Error  t value            Pr(>|t|)
(Intercept)                         6.178909   0.020916  295.418 <0.0000000000000002 ***
APC_CategoryDevice Analysis Services -2.587628   0.021334 -121.290 <0.0000000000000002 ***
APC_CategoryEndoscopy Services        0.854336   0.028132   30.369 <0.0000000000000002 ***
APC_CategoryExam Services            -2.052707   0.018462 -111.186 <0.0000000000000002 ***
APC_CategoryEye Test Services        -1.459257   0.035000  -41.693 <0.0000000000000002 ***
APC_CategoryMonitoring Services      -1.059205   0.016701  -63.422 <0.0000000000000002 ***
APC_CategoryNerve Injection Services -0.484445   0.015250  -31.767 <0.0000000000000002 ***
APC_CategoryOther Imaging Services   -0.040732   0.016348   -2.492              0.0127 *
APC_CategoryUltrasound Services      -1.104768   0.014843  -74.431 <0.0000000000000002 ***
APC_CategoryWound Care Services      -1.844162   0.016880 -109.250 <0.0000000000000002 ***
log(payment_percent)                  0.135787   0.005271   25.762 <0.0000000000000002 ***
log(Outpatient_Services)              0.983579   0.002288  429.838 <0.0000000000000002 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.5685 on 32520 degrees of freedom
Multiple R-squared:  0.8885,    Adjusted R-squared:  0.8885
F-statistic: 2.357e+04 on 11 and 32520 DF,  p-value: < 0.00000000000000022
```

As true hospital revenue received from Medicare is likely to vary somewhat from how we calculated revenue for purposes of our analysis, the numbers predicted by this model should be seen as rough estimates and not exact predictions.

We can enter values for each of the variables included in the linear model and come up with a prediction of revenue earned. Take, for instance, the following two scenarios. In scenario one, a hospital bills 10,000 outpatient services under Exam Services with a 60% reimbursement rate and beneficiary population size of 300,000. Under this scenario, Model 1 predicts a revenue of $105,915; Model 2 predicts a revenue of $91,869; and Model 3 predicts a revenue of

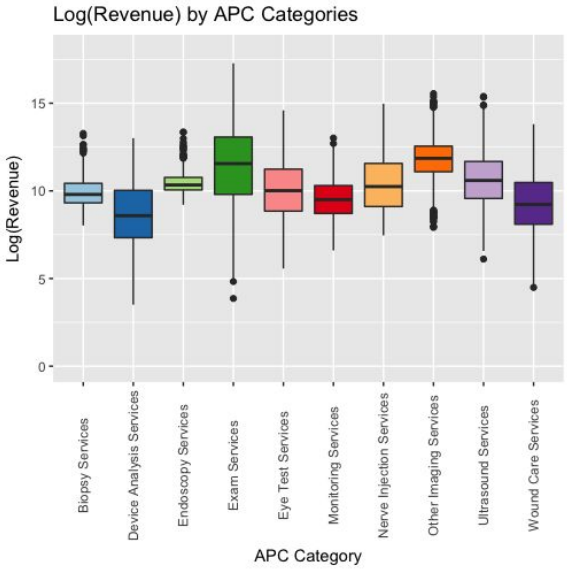
$928,439. For scenario two, a hospital bills 25 outpatient services under Endoscopy Services with a 30% reimbursement rate and beneficiary population size of 750,000. Model 1 predicts a revenue of $39,909; Model 2 predicts a revenue of $36,721, and Model 3 predicts a revenue of $42,663.

Hypothesis Testing

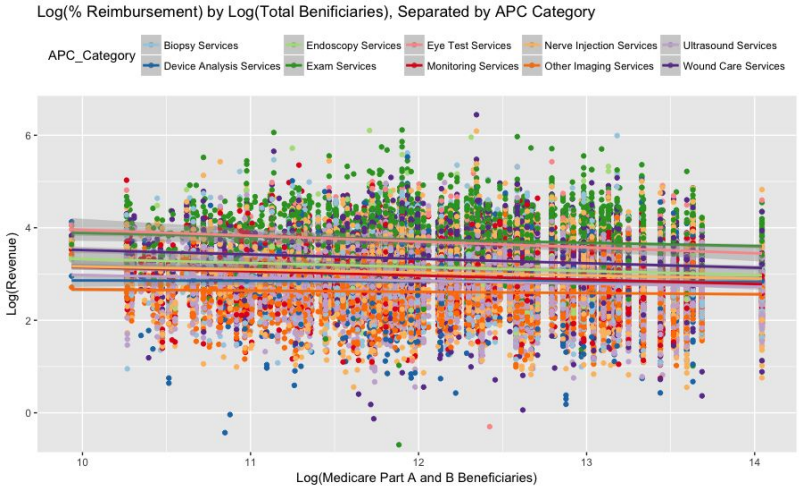
To test our hypothesis that certain APC codes will have a greater affect on Revenue than others, and specifically that Exam Services has a larger impact on revenue than any other service performed, we performed an ANOVA test followed by a Tukey test of the log of Revenue separated by APC Category. The results as they relate to Exam Services are below, and the complete results of the Tukey test are in Appendix A at the end of this report:

APC Categories	Differential	Lower Bound	Upper Bound	P-value (Adjusted)
Exam Services- Biopsy Services	1.52790268	1.39264323	1.66316214	0.0000000
Exam Services- Device Analysis Services	2.72190105	2.56121757	2.88258453	0.0000000
Exam Services- Endoscopy Services	0.93969986	0.71700487	1.16239485	0.0000000
Eye Test Services- Exam Services	-1.25749440	-1.53633541	-0.97865339	0.0000000
Monitoring Services- Exam Services	-1.87746298	-1.99704234	-1.75788361	0.0000000
Nerve Injection Services- Exam Services	-1.03010409	-1.13475871	-0.92544947	0.0000000
Other Imaging Services- Exam Services	0.39682542	0.28799589	0.50565494	0.0000000
Ultrasound Services- Exam Services	-0.79240617	-0.88791129	-0.69690106	0.0000000
Wound Care Services- Exam Services	-2.10744934	-2.22654901	-1.98834967	0.0000000

Our prediction is correct in all instances except when it comes to Other Imaging Services. Note that, for these particular services, the p value is very low, indicating a high degree of confidence that the reason for difference in revenue is due to differences in APC category classification, and thus the medical service that was provided. These results are shown in the boxplot below:



Next, we examined the hypothesis that, as patient population size increases, percent reimbursement will decrease and hospitals with lower patient population sizes will tend to get a slightly higher reimbursement rate. Plotted below is the log of the percent reimbursement by the log of Medicare beneficiary population size:



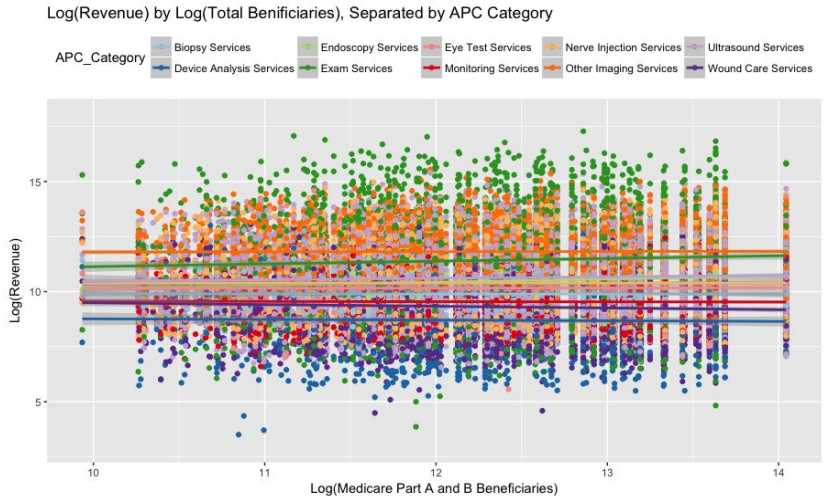
The lines of the linear model in the graph slope downward, indicating a weak negative correlation between reimbursement rate and beneficiary population size. To further test our hypothesis, we divided the dataset into two groups, one called “Low Beneficiaries” and another called “High Beneficiaries.” These two groups are separated at the median number of beneficiaries within an HRR, which is 229,715. We then performed a t-test on the means of the log of reimbursement percentage between the two groups. The results are below:

```
        Welch Two Sample t-test

data:  log(LowBeneficiaries$payment_percent) and log(HighBeneficiaries$payment_percent)
t = 12.784, df = 32512, p-value < 0.00000000000000022
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.08106678 0.11042647
sample estimates:
mean of x mean of y
 3.039905  2.944158
```

The results indicate that the difference in means between the two groups (20.90326% for Low Beneficiaries vs. 11.49118% for High Beneficiaries, calculated by taking the reverse natural log of the means for each group) are statistically significant to a high degree of confidence, supporting our hypothesis.

Additionally, we looked at the overall effect this may have on Revenue. First, we plotted revenue, separated by APC category, as a function of beneficiary population size:



The linear model fit lines have a weak positive correlation. To further investigate, we performed a second t-test on means of the log of revenue between the Low Beneficiary and High Beneficiary groups:

```
        Welch Two Sample t-test

data:  log(LowBeneficiaries$Revenue) and log(HighBeneficiaries$Revenue)
t = -1.648, df = 32522, p-value = 0.09936
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.068107526  0.005890402
sample estimates:
mean of x mean of y
 10.47344  10.50455
```

The p-value is greater than 0.05 and we cannot reject the null hypothesis that the difference in means is due to chance. These results indicate that there is no statistically significant difference between the means of the revenues of these two groups ($35,363.66 for Low Beneficiaries vs. $36,481.11 for High Beneficiaries).

Conclusion

From the Hypothesis and Tukey tests we can state that the APC category plays a significant role in the revenue that a hospital generates and also at the payment percent of the submitted charges that the hospital receives. Specifically, we found that Other Imaging Services produce more revenue than Exam Services, but Exam Services has the most variability from hospital to hospital in terms of services that bring outpatient revenue to Hospitals from Medicare.

Furthermore, there is a weak negative correlation between the number of Medicare beneficiaries and the reimbursement percent, which means that areas with a lower number of beneficiaries tend to have a higher reimbursement rate. Ultimately, however, this did affect revenue, as there was no statistically significant difference in the means of revenue earned in areas with a high beneficiary population compared to areas with a low beneficiary population.

Appendix A - Complete Results of Tukey Test Comparing Revenue Earned from Different APC Categories

```
  Tukey multiple comparisons of means
    95% family-wise confidence level

Fit: aov(formula = log(Revenue) ~ APC_Category, data = Medicare_Dataset_Final)

$APC_Category
                                                    diff        lwr        upr     p adj
Device Analysis Services-Biopsy Services          -1.19399837 -1.36863940 -1.01935733 0.0000000
Endoscopy Services-Biopsy Services                 0.58820282  0.35523636  0.82116928 0.0000000
Exam Services-Biopsy Services                      1.52790268  1.39264323  1.66316214 0.0000000
Eye Test Services-Biopsy Services                  0.27040828 -0.01670253  0.55751910 0.0850424
Monitoring Services-Biopsy Services               -0.34956030 -0.48732653 -0.21179406 0.0000000
Nerve Injection Services-Biopsy Services           0.49779859  0.37276699  0.62283019 0.0000000
Other Imaging Services-Biopsy Services             1.92472810  1.79618170  2.05327450 0.0000000
Ultrasound Services-Biopsy Services                0.73549651  0.61801656  0.85297646 0.0000000
Wound Care Services-Biopsy Services               -0.57954666 -0.71689673 -0.44219658 0.0000000
Endoscopy Services-Device Analysis Services        1.78220119  1.53361029  2.03079208 0.0000000
Exam Services-Device Analysis Services             2.72190105  2.56121757  2.88258453 0.0000000
Eye Test Services-Device Analysis Services         1.46440665  1.16447886  1.76433444 0.0000000
Monitoring Services-Device Analysis Services       0.84443807  0.68163882  1.00723732 0.0000000
Nerve Injection Services-Device Analysis Services  1.69179696  1.53962284  1.84397107 0.0000000
Other Imaging Services-Device Analysis Services    3.11872646  2.96365152  3.27380140 0.0000000
Ultrasound Services-Device Analysis Services       1.92949487  1.78346200  2.07552774 0.0000000
Wound Care Services-Device Analysis Services       0.61445171  0.45200447  0.77689894 0.0000000
Exam Services-Endoscopy Services                   0.93969986  0.71700487  1.16239485 0.0000000
Eye Test Services-Endoscopy Services              -0.31779454 -0.65503415  0.01944508 0.0846614
Monitoring Services-Endoscopy Services            -0.93776311 -1.16198951 -0.71353672 0.0000000
Nerve Injection Services-Endoscopy Services       -0.09040423 -0.30703949  0.12623104 0.9492858
Other Imaging Services-Endoscopy Services          1.33652528  1.11784260  1.55520796 0.0000000
Ultrasound Services-Endoscopy Services             0.14729369 -0.06507269  0.35966006 0.4606430
Wound Care Services-Endoscopy Services            -1.16774948 -1.39172042 -0.94377854 0.0000000
Eye Test Services-Exam Services                   -1.25749440 -1.53633541 -0.97865339 0.0000000
Monitoring Services-Exam Services                 -1.87746298 -1.99704234 -1.75788361 0.0000000
Nerve Injection Services-Exam Services            -1.03010409 -1.13475871 -0.92544947 0.0000000
Other Imaging Services-Exam Services               0.39682542  0.28799589  0.50565494 0.0000000
Ultrasound Services-Exam Services                 -0.79240617 -0.88791129 -0.69690106 0.0000000
Wound Care Services-Exam Services                 -2.10744934 -2.22654901 -1.98834967 0.0000000
Monitoring Services-Eye Test Services             -0.61996858 -0.90003415 -0.33990301 0.0000000
Nerve Injection Services-Eye Test Services         0.22739031 -0.04663540  0.50141602 0.2056249
Other Imaging Services-Eye Test Services           1.65431981  1.37867264  1.92996699 0.0000000
Ultrasound Services-Eye Test Services              0.46508823  0.19442473  0.73575172 0.0000024
Wound Care Services-Eye Test Services             -0.84995494 -1.12981603 -0.57009385 0.0000000
Nerve Injection Services-Monitoring Services       0.84735889  0.73948394  0.95523384 0.0000000
Other Imaging Services-Monitoring Services         2.27428839  2.16235859  2.38621820 0.0000000
Ultrasound Services-Monitoring Services            1.08505680  0.98603336  1.18408025 0.0000000
Wound Care Services-Monitoring Services           -0.22998636 -0.35192548 -0.10804725 0.0000001
Other Imaging Services-Nerve Injection Services    1.42692951  1.33110860  1.52275041 0.0000000
Ultrasound Services-Nerve Injection Services       0.23769792  0.15732997  0.31806587 0.0000000
Wound Care Services-Nerve Injection Services      -1.07734525 -1.18468821 -0.97000229 0.0000000
Ultrasound Services-Other Imaging Services        -1.18923159 -1.27496538 -1.10349780 0.0000000
Wound Care Services-Other Imaging Services        -2.50427476 -2.61569194 -2.39285758 0.0000000
Wound Care Services-Ultrasound Services           -1.31504317 -1.41348680 -1.21659953 0.0000000
```