



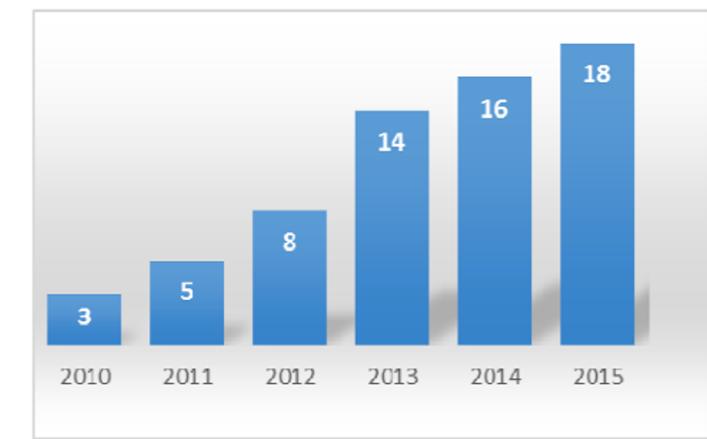
FACTORS AFFECTING HOSPITAL FINANCIAL STABILITY – PART II Developments and Challenges

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PROBLEM STATEMENT

- The COVID-19 pandemic has brought the importance of health services to the forefront of the national and global discussion
- **Rural hospitals are facing a crisis** as the number of hospitals closing is increasing every year since 2010. Total 136 rural hospitals closed since 2010
- **Legislative efforts** aimed at improving inpatient care are **having unintended consequences on hospital solvency**, especially rural hospitals
- **Financial overburden is the primary cause for rural hospital closings**
- Based on Medicare Cost Reports and Final Rule Data, the **median hospital lost \$82 for each discharge**

We intend to explore the factors that affect **cost-to-charge** ratio with the purpose of identifying how rural hospitals can reduce their risk of insolvency



Source: American Hospital Association

Figure 1: US rural hospital closures by year since 2010.

Data Source

The screenshot shows a web browser window with the URL data.cms.gov/resources/hospital-provider-cost-report-data-dictionary in the address bar. The page is titled "Data Dictionary" and features the CMS logo. It displays the title "Hospital Provider Cost Report Data Dictionary". A blue button labeled "Download" with a downward arrow is visible. To the right, it says "Last updated April 21, 2020".

← → C data.cms.gov/resources/hospital-provider-cost-report-data-dictionary

Data.CMS.gov
Centers for Medicare & Medicaid Services

Explore Data View Tools Browse by Category

Data Dictionary

Hospital Provider Cost Report Data Dictionary

Last updated
April 21, 2020

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Summary of Prior Literature

8 Publications cited with key takeaways including:

- Critical issue of hospital solvency in rural areas
- Importance of Type of Control on C2C ratio
- Impact of health IT – 27% of maintenance charges is for tech upgrades
- Hospital C2C ratio varies for inpatient and outpatient services
- Many issues with reimbursement
- Medicare accounts for 45% of rural hospital income
- Depth of understanding to identify which variables we should include
- Most used OLS models

Examination of each predictor variable in the data set (129)

- Understanding “TITLE” designation and relevance to our objective
- Understanding how Cost to Charge Ratio is calculated
- Understanding Financial variables & which ones to include individually and which to consider only aggregate
 - Ex. Individual: Hospital IT, Inpatient.Total.Charges, Outpatient.Total.Charges, Cash.on.Hand.and.in.Banks
 - Ex. Aggregate: Total.Current.Assets, Total.fixed.Assets, Total_Liabilities, Total.Income
- Identifying derived variables (Certain Totals, Cost to Charge Ratio, etc)

Predictor Table

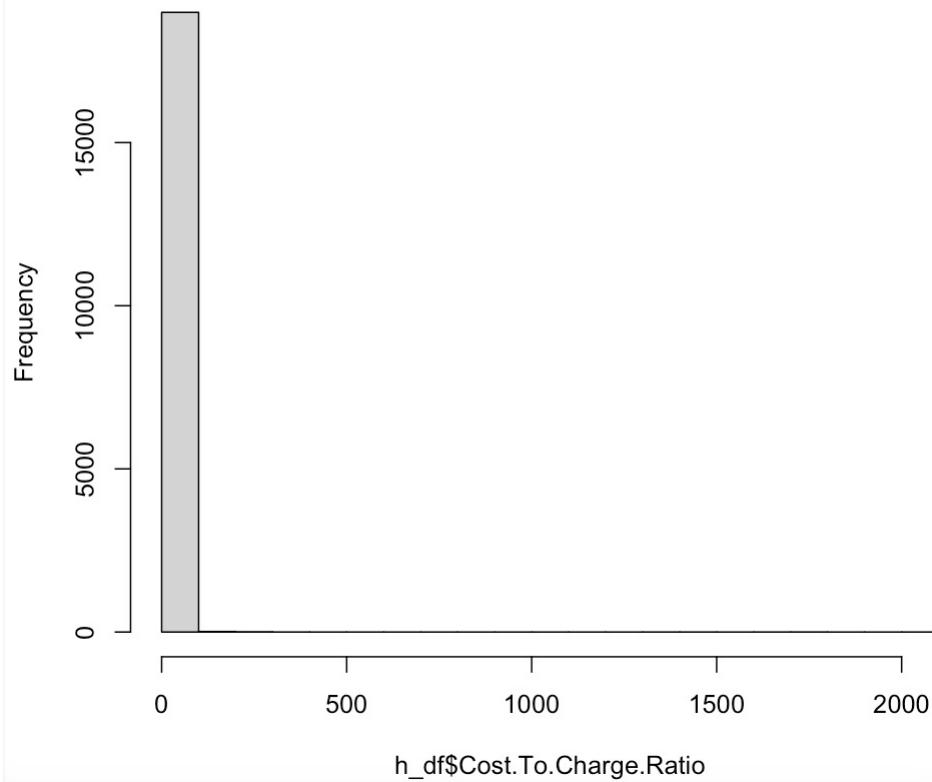
Variables	Effect Cost to Charge	Rationale
rpt_rec_num	none	The report number should not have any effect on cost to charge ratio
Hospital Name	none	Hospital Name should not have any effect on cost to charge ratio
State Code	+/-	Cost of services & Charges levied will likely vary by state
Rural versus Urban	+	Rural/Urban designation would affect cost to charge ratio
Provider Type	+/-	Types of service would have an effect on cost to charge ratio as certain services would
Type of Control	+/-	ToC would affect cost to charge ratio as certain hospitals would be operating for profit and
FTE - Employees on Payroll	+/-	More FTE employees increases cost, but may also facilitate higher revenue generation
Number of Beds	+/-	More number of beds increases cost, but may also facilitate higher revenue generation
Total Days for inpatient days		
Total Days for inpatient days	+/-	As total inpatient days increase, cost and revenue both would increase, but maybe in differing amounts
Total Days for inpatient days		
Total Discharges filed under		
Total Discharges filed under	+/-	Number of discharges can be used as a proxy for number of patients treated in inpatient class. Increased number of patients would increase both cost and revenue, but maybe in differing amounts
Total Discharges filed under		
Total Discharges not filed		
Cost of charity care	+	Increase in cost of charity care will likely increase cost to charge ratio
Total Bad Debt expense	+	Increase in Bad Debt Expense will likely increases cost to charge ratio
Total Unreimbursed and	+	Increase in cost unreimbursed and uncompensated care would increase cost to charge ratio
Overhead Non-Salary Costs	+	Increase in overhead costs would increase cost to charge ratio
Depreciation Cost	+	Increase in depreciation cost will increase cost to charge ratio
Inpatient Total Charges	-	Increase in Inpatient total charges will decrease cost to charge ratio
Outpatient Total Charges	-	Increase in Outpatient total charges will decrease cost to charge ratio
Wage-related Costs (core)	-	Increase in Wage-related costs will increase cost to charge ratio
Total Salaries (adjusted)	-	Increase in Salary expense would increase cost to charge ratio
Cash on hand and in banks	+/-	Amount of Cash on Hand may affect how the hospital sets charge rates and how much they prioritize spending which would have an effect on cost to charge ratio
Total Current Assets	+/-	Increase in Hospital's total fixed/current assets would affect cost to charge ratio. ex. having more fixed assets may facilitate hospitals to get loans, which would affect cost to charge ratio
Total fixed Assets	+/-	

Health Information Technology Designated Assets	+/-	Increasing value of Hospital IT Assets would correspond to an increased cost, but may also facilitate revenue generation
Total current liabilities	+	Increase in Current Liabilities could increase cost to charge ratio
Total long term liabilities	+	Long term Liabilities could increase cost to charge ratio
Inpatient Revenue	-	Increased inpatient revenue would decrease cost to charge ratio
Outpatient Revenue	-	Increased outpatient inpatient revenue would decrease cost to charge ratio
Total Operating Expense	+	Increased total operating expense would increase the cost to charge ratio
Total Income	-	Increased total income would decrease cost to charge ratio
Total Other Expenses	+	Increased total other expenses would increase cost to charge ratio
Net Revenue from Medicaid	-	Increased Total Net Revenue from Medicaid would decrease cost to charge ratio

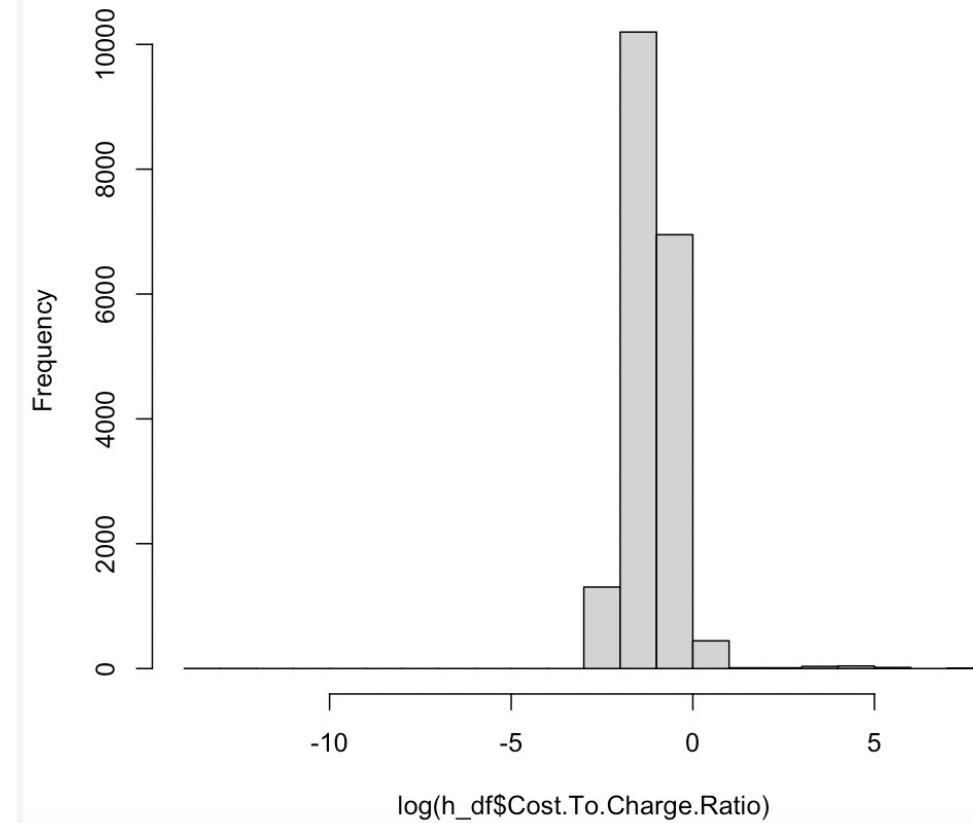
Descriptive Analytics

Target Variable Distribution is highly skewed

Histogram of `h_df$Cost.To.Charge.Ratio`

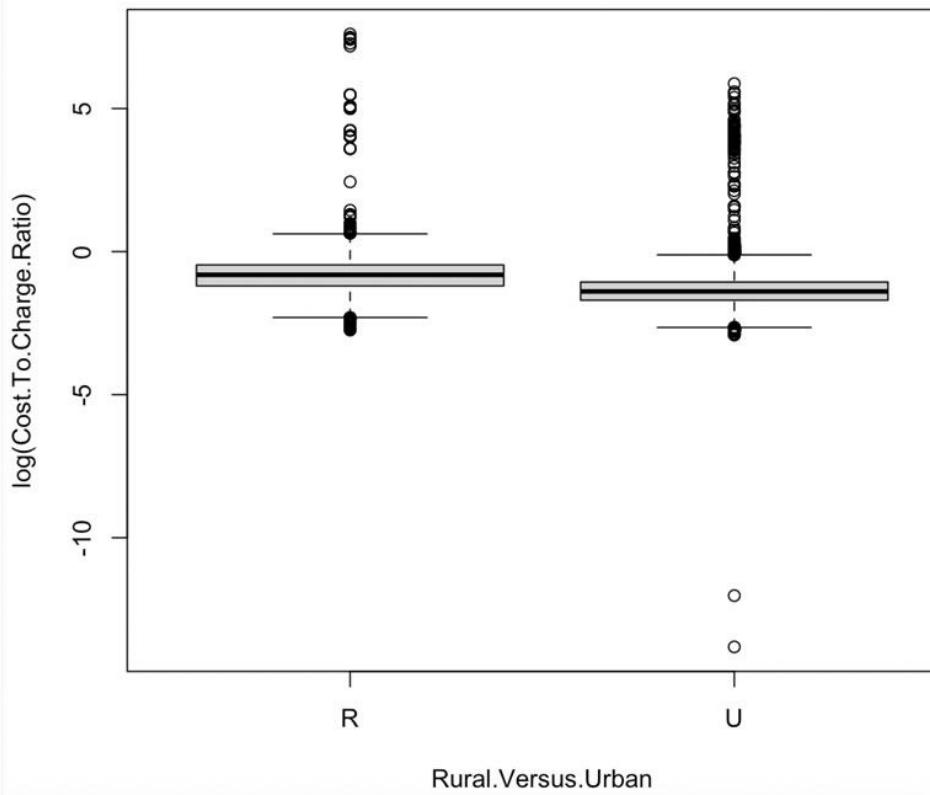


Histogram of $\log(h_df\$Cost.To.Charge.Ratio)$

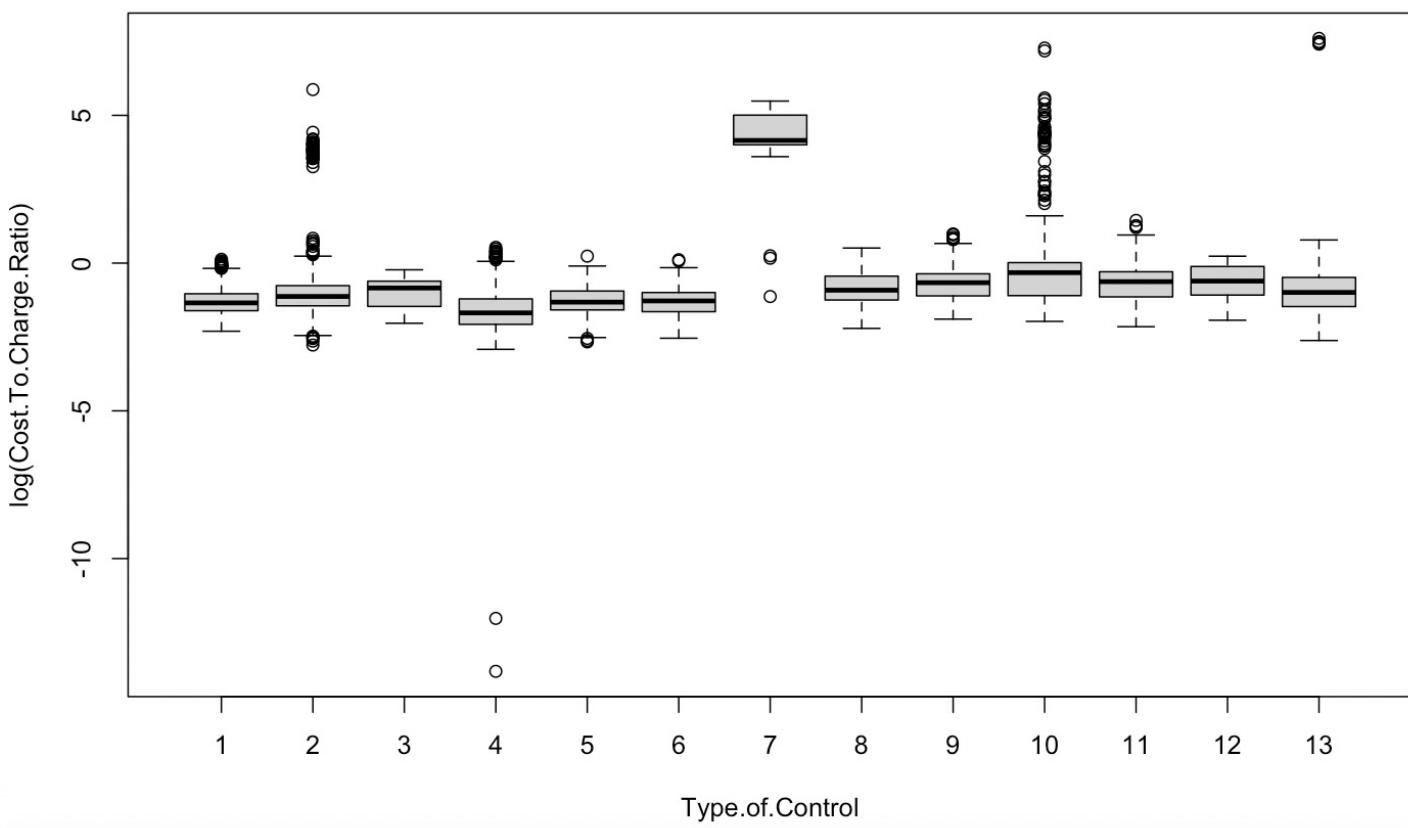


Descriptive Analysis

rural vs urban with log(cost to charge Ratio)



Type of Control with log(cost to charge Ratio)



Current Structure of Dataset

- 19,019 Observations of 46 Features

```
> str(h_df)
'data.frame': 19019 obs. of 46 variables:
 $ rpt_rec_num           : int 551267
 $ Hospital.Name          : chr "GOV. J
NTY" ...
 $ State.Code              : Factor w/ 55
 $ Rural.Versus.Urban      : Factor w/ 2
 $ Provider.Type            : int 1 1 1 1
 $ Type.of.Control          : int 13 11 1
 $ FTE...Employees.on.Payroll: num 603 149
 $ Total.Days.Title.V       : num 0 122 0
 $ Total.Days.Title.XVIII    : int 8793 31
 $ Total.Days.Title.XIX      : int 3760 32
 $ Total.Days..V...XVIII...XIX...Unknown.: int 21658 4
 $ Number.of.Beds             : int 112 25
 $ Total.Bed.Days.Available   : int 40880 9
 $ Total.Discharges.Title.V     : num 0 31 0
 $ Total.Discharges.Title.XVIII  : int 913 499
 $ Total.Discharges.Title.XIX    : int 687 74
 $ Total.Discharges..V...XVIII...XIX...Unknown.: int 2873 88
 $ Cost.of.Charity.Care        : num 1255664
 $ Total.Bad.Debt.Expense      : num 2914809
 $ Cost.of.Uncompensated.Care    : num 1795915
 $ Total.Unreimbursed.and.Uncompensated.Care: num 2616988
$ Overhead.Non.Salary.Costs      : num 3962956
$ Depreciation.Cost             : int 3200272
$ Total.Costs                   : num 7429805
$ Inpatient.Total.Charges       : num 8405750
$ Outpatient.Total.Charges      : num 4559479
$ Combined.Outpatient...Inpatient.Total.Charges: num 1296522
$ Wage.Related.Costs..Core.      : num NA NA N
$ Total.Salaries..adjusted.       : num NA NA N
$ Cash.on.Hand.and.in.Banks      : num 2534569
$ Total.Current.Assets          : num 7225840
$ Total.fixed.Assets            : num 3589132
$ Total.Current.Liabilities      : num 5258072
$ Total.Long.Term.Liabilities     : num 0 0 0 0
$ Inpatient.Revenue              : num 8374302
$ Outpatient.Revenue             : num 4590926
$ Less.Total.Operating.Expense    : num 7426325
$ Total.Income                   : num -484751
$ Cost.To.Charge.Ratio           : num 0.573 0
$ Net.Revenue.from.Medicaid       : num 4401878
$ year                           : Factor w/ 5
$ total_days_with_titles         : num 12553 3
$ total_days_unknown              : num 9105 79
$ total_discharges_with_titles     : num 1600 60
$ total_discharges_unknown        : num 1273 27
$ Total_Liabilities              : num 5258072
```

Correlation Matrices to identify Multicollinearity – 3 Iterations

	FTE_Employees.on.Payroll	Number.of.Beds	Total.Days.Title.XVIII	Total.Days.Title.XIX	Total.Beds.Available	Total_Discharge.Charges.Title.e.V	Total_Discharge.Charges.Title.e.XVIII	Total_Discharge.Charges.Title.e.XIX	Cost.of.Charity.Care	Total.Bad.Debt.Expense	Total.Unreimbursed.and.Uncompensated.D.Care	Overhead.Non.Salary.Costs	Depreciation.Cost	Inpatient.Total.Charges	Outpatient.Total.Charges	Total.Salaries.adjusted.	Cash.on.Hand.and.In.Banks	Total.Current.Assets	Total.fixed.Assets	Total_liabilities	Inpatient.Revenue	Outpatient.Revenue	Less.Total.Operating.Expense	Total.Income	Cost.To.Care.Ratio	Net.Revenue.from.Medicaid
FTE_Employees.on.Payroll	1	0.85	0.83	0.67	0.87	0.02	0.79	0.59	0.48	0.49	0.64	0.93	0.88	0.8	0.82	0.96	0.32	0.65	0.64	0.55	0.8	0.83	0.96	0.34	-0.04	0.78
Number.of.Beds	0.85	1	0.89	0.69	0.98	0.04	0.86	0.61	0.5	0.57	0.62	0.82	0.78	0.83	0.77	0.78	0.27	0.58	0.56	0.41	0.83	0.75	0.82	0.35	-0.18	0.7
Total.Days.Title.XVIII	0.83	0.89	1	0.61	0.91	0.03	0.98	0.54	0.37	0.47	0.5	0.8	0.77	0.79	0.73	0.77	0.26	0.57	0.56	0.41	0.78	0.72	0.8	0.35	-0.14	0.61
Total.Days.Title.XIX	0.67	0.69	0.61	1	0.71	0	0.57	0.88	0.53	0.53	0.63	0.64	0.57	0.58	0.54	0.62	0.2	0.45	0.42	0.35	0.59	0.53	0.64	0.26	-0.06	0.64
Total.Beds.Days.Available	0.87	0.98	0.91	0.71	1	0.04	0.88	0.63	0.51	0.58	0.63	0.84	0.79	0.84	0.78	0.8	0.28	0.58	0.57	0.42	0.84	0.76	0.84	0.36	-0.18	0.7
Total.Discharges.Title.V	0.02	0.04	0.03	0	0.04	1	0.04	0.02	0.01	0.03	0.02	0.04	0.07	0.02	0.05	0.07	0	0.01	0.04	0	0.02	0.03	0.02	0.03	-0.01	0.03
Total.Discharges.Title.XVII	0.79	0.86	0.98	0.57	0.88	0.04	1	0.52	0.35	0.45	0.46	0.75	0.74	0.74	0.72	0.72	0.25	0.54	0.54	0.38	0.74	0.7	0.75	0.35	-0.16	0.54
Total.Discharges.Title.XIX	0.59	0.61	0.54	0.88	0.63	0.02	0.52	1	0.49	0.49	0.56	0.55	0.5	0.47	0.47	0.53	0.16	0.37	0.36	0.28	0.48	0.45	0.55	0.22	-0.04	0.57
Cost.of.Charity.Care	0.48	0.5	0.37	0.53	0.51	0.01	0.35	0.49	1	0.65	0.78	0.44	0.42	0.44	0.44	0.42	0.16	0.3	0.31	0.21	0.45	0.43	0.44	0.14	-0.08	0.4
Total.Bad.Debt.Expense	0.49	0.57	0.47	0.53	0.58	0.03	0.45	0.49	0.65	1	0.63	0.46	0.43	0.48	0.48	0.43	0.16	0.32	0.31	0.24	0.48	0.47	0.45	0.18	-0.19	0.36
Total.Unreimbursed.and.Uncompensated.Care	0.64	0.62	0.5	0.63	0.63	0.02	0.46	0.56	0.78	0.63	1	0.64	0.57	0.57	0.56	0.63	0.23	0.46	0.44	0.41	0.59	0.56	0.64	0.16	-0.01	0.6
Overhead.Non.Salary.Costs	0.93	0.82	0.8	0.64	0.84	0.04	0.75	0.55	0.44	0.46	0.64	1	0.88	0.85	0.88	0.93	0.34	0.67	0.67	0.57	0.85	0.88	0.98	0.35	-0.07	0.79
Depreciation.Cost	0.88	0.78	0.77	0.57	0.79	0.07	0.74	0.5	0.42	0.43	0.57	0.88	1	0.76	0.79	0.87	0.28	0.6	0.68	0.52	0.76	0.79	0.89	0.33	0.06	0.7
Inpatient.Total.Charges	0.8	0.83	0.79	0.58	0.84	0.02	0.74	0.47	0.44	0.48	0.57	0.85	0.76	1	0.88	0.8	0.29	0.6	0.58	0.43	1	0.85	0.84	0.39	-0.29	0.69
Outpatient.Total.Charges	0.82	0.77	0.73	0.54	0.78	0.05	0.72	0.47	0.44	0.48	0.56	0.88	0.79	0.88	1	0.81	0.33	0.59	0.61	0.46	0.88	0.98	0.86	0.41	-0.28	0.63
Total.Salaries.adjusted.	0.96	0.78	0.77	0.62	0.8	0.07	0.72	0.53	0.42	0.43	0.63	0.93	0.87	0.8	0.81	1	0.32	0.67	0.65	0.58	0.81	0.83	0.97	0.32	-0.03	0.79
Cash.on.Hand.and.In.Banks	0.32	0.27	0.26	0.2	0.28	0	0.25	0.16	0.16	0.16	0.23	0.34	0.28	0.29	0.33	0.32	1	0.48	0.34	0.33	0.29	0.32	0.34	0.19	-0.01	0.24
Total.Current.Assets	0.65	0.58	0.57	0.45	0.58	0.01	0.54	0.37	0.3	0.32	0.46	0.67	0.6	0.6	0.59	0.67	0.48	1	0.7	0.71	0.6	0.59	0.68	0.3	-0.04	0.53
Total.fixed.Assets	0.64	0.56	0.56	0.42	0.57	0.04	0.54	0.36	0.31	0.31	0.44	0.67	0.68	0.58	0.61	0.65	0.34	0.7	1	0.79	0.58	0.61	0.67	0.27	-0.05	0.51
Total_liabilities	0.55	0.41	0.41	0.35	0.42	0	0.38	0.28	0.21	0.24	0.41	0.57	0.52	0.43	0.46	0.58	0.33	0.71	0.79	1	0.43	0.48	0.59	0.14	0.03	0.5
Inpatient.Revenue	0.8	0.83	0.78	0.59	0.84	0.02	0.74	0.48	0.45	0.48	0.59	0.85	0.76	1	0.88	0.81	0.29	0.6	0.58	0.43	1	0.85	0.84	0.4	-0.28	0.69
Outpatient.Revenue	0.83	0.75	0.72	0.53	0.76	0.03	0.7	0.45	0.43	0.47	0.56	0.88	0.79	0.85	0.98	0.83	0.32	0.59	0.61	0.48	0.85	1	0.88	0.41	-0.25	0.62
Less.Total.Operating.Expense	0.96	0.82	0.8	0.64	0.84	0.02	0.75	0.55	0.44	0.45	0.64	0.98	0.89	0.84	0.86	0.97	0.34	0.68	0.67	0.59	0.84	0.88	1	0.35	-0.05	0.8
Total.Income	0.34	0.35	0.35	0.26	0.36	0.03	0.35	0.22	0.14	0.18	0.16	0.35	0.33	0.39	0.41	0.32	0.19	0.3	0.27	0.14	0.4	0.41	0.35	1	-0.1	0.23
Cost.To.Care.Ratio	-0.04	-0.18	-0.14	-0.06	-0.18	-0.01	-0.16	-0.04	-0.08	-0.19	-0.01	-0.07	-0.06	-0.29	-0.28	-0.03	-0.01	-0.04	-0.05	0.03	-0.28	-0.25	-0.05	-0.1	1	0.02
Net.Revenue.from.Medicaid	0.78	0.7	0.61	0.64	0.7	0.03	0.54	0.57	0.4	0.36	0.6	0.79	0.7	0.69	0.63	0.79	0.24	0.53	0.51	0.5	0.69	0.62	0.8	0.23	0.02	1

Iteration 2

	FTE...Employees.on.Payroll	Number.of.Beds	Total.Days.Title.XVIII	Total.Days.Title.XIX	Total.Discharges.Title.V	Total.Discharges.Title.XVI	Total.Discharges.Title.XVII	Total.Discharges.Title.XIX	Cost.of.Charity.Care	Total.Bad.Debt.Expense	Total.Unreimbursed.and.Uncompensated.Care	Overhead.Non.Salary.Costs	Depreciation.Cost	Inpatient.Total.Charges	Outpatient.Total.Charges	Cash.on.Hand.and.in.Banks	Total.Current.Assets	Total.fixed.Assets	Total_liabilities	Total.Income	Net.Revenue.from.Medicaid
FTE...Employees.on.Payroll	1	0.85	0.83	0.67	0.02	0.79	0.59	0.48	0.49	0.64	0.93	0.88	0.8	0.82	0.32	0.65	0.64	0.55	0.34	0.78	
Number.of.Beds	0.85	1	0.89	0.69	0.04	0.86	0.61	0.5	0.57	0.62	0.82	0.78	0.83	0.77	0.27	0.58	0.56	0.41	0.35	0.7	
Total.Days.Title.XVIII	0.83	0.89	1	0.61	0.03	0.98	0.54	0.37	0.47	0.5	0.8	0.77	0.79	0.73	0.26	0.57	0.56	0.41	0.35	0.61	
Total.Days.Title.XIX	0.67	0.69	0.61	1	0	0.57	0.88	0.53	0.53	0.63	0.64	0.57	0.58	0.54	0.2	0.45	0.42	0.35	0.26	0.64	
Total.Discharges.Title.V	0.02	0.04	0.03	0	1	0.04	0.02	0.01	0.03	0.02	0.04	0.07	0.02	0.05	0	0.01	0.04	0	0.03	0.03	
Total.Discharges.Title.XVIII	0.79	0.86	0.98	0.57	0.04	1	0.52	0.35	0.45	0.46	0.75	0.74	0.74	0.72	0.25	0.54	0.54	0.38	0.35	0.54	
Total.Discharges.Title.XIX	0.59	0.61	0.54	0.88	0.02	0.52	1	0.49	0.49	0.56	0.55	0.5	0.47	0.47	0.16	0.37	0.36	0.28	0.22	0.57	
Cost.of.Charity.Care	0.48	0.5	0.37	0.53	0.01	0.35	0.49	1	0.65	0.78	0.44	0.42	0.44	0.44	0.16	0.3	0.31	0.21	0.14	0.4	
Total.Bad.Debt.Expense	0.49	0.57	0.47	0.53	0.03	0.45	0.49	0.65	1	0.63	0.46	0.43	0.48	0.48	0.16	0.32	0.31	0.24	0.18	0.36	
Total.Unreimbursed.and.Uncompensated.Care	0.64	0.62	0.5	0.63	0.02	0.46	0.56	0.78	0.63	1	0.64	0.57	0.57	0.56	0.23	0.46	0.44	0.41	0.16	0.6	
Overhead.Non.Salary.Costs	0.93	0.82	0.8	0.64	0.04	0.75	0.55	0.44	0.46	0.64	1	0.88	0.85	0.88	0.34	0.67	0.67	0.57	0.35	0.79	
Depreciation.Cost	0.88	0.78	0.77	0.57	0.07	0.74	0.5	0.42	0.43	0.57	0.88	1	0.76	0.79	0.28	0.6	0.68	0.52	0.33	0.7	
Inpatient.Total.Charges	0.8	0.83	0.79	0.58	0.02	0.74	0.47	0.44	0.48	0.57	0.85	0.76	1	0.88	0.29	0.6	0.58	0.43	0.39	0.69	
Outpatient.Total.Charges	0.82	0.77	0.73	0.54	0.05	0.72	0.47	0.44	0.48	0.56	0.88	0.79	0.88	1	0.33	0.59	0.61	0.46	0.41	0.63	
Cash.on.Hand.and.in.Banks	0.32	0.27	0.26	0.2	0	0.25	0.16	0.16	0.23	0.34	0.28	0.29	0.33	1	0.48	0.34	0.33	0.19	0.24		
Total.Current.Assets	0.65	0.58	0.57	0.45	0.01	0.54	0.37	0.3	0.32	0.46	0.67	0.6	0.6	0.59	0.48	1	0.7	0.71	0.3	0.53	
Total.fixed.Assets	0.64	0.56	0.56	0.42	0.04	0.54	0.36	0.31	0.44	0.67	0.68	0.58	0.61	0.34	0.7	1	0.79	0.27	0.51		
Total_liabilities	0.55	0.41	0.41	0.35	0	0.38	0.28	0.21	0.24	0.41	0.57	0.52	0.43	0.46	0.33	0.71	0.79	1	0.14	0.5	
Total.Income	0.34	0.35	0.35	0.26	0.03	0.35	0.22	0.14	0.18	0.16	0.35	0.33	0.39	0.41	0.19	0.3	0.27	0.14	1	0.23	
Net.Revenue.from.Medicaid	0.78	0.7	0.61	0.64	0.03	0.54	0.57	0.4	0.36	0.6	0.79	0.7	0.69	0.63	0.24	0.53	0.51	0.5	0.23	1	

Iteration 3

	FTE...Employees.on.Payroll	Total.Discharges.Title.V	Total.Discharges.Title.VIII	Total.Discharges.Title.X	Cost.of.Charity.Care	Total.Bad.Debt.Expense	Total.Uncompensated.Care	Overhead.Non.Salary.Costs	Depreciation.Cost	Inpatient.Total.Charges	Outpatient.Total.Charges	Cash.on.Hand.and.in.Banks	Total.Current.Assets	Total.fixed.Assets	Total.Liabilities	Total.Income	Net.Revenue.from.Medicaid	
FTE...Employees.on.Payroll	1	0.85	0.02	0.79	0.59	0.48	0.49	0.64	0.93	0.88	0.8	0.82	0.32	0.65	0.64	0.55	0.34	0.78
Number.of.Beds	0.85	1	0.04	0.86	0.61	0.5	0.57	0.62	0.82	0.78	0.83	0.77	0.27	0.58	0.56	0.41	0.35	0.7
Total.Discharges.Title.V	0.02	0.04	1	0.04	0.02	0.01	0.03	0.02	0.04	0.07	0.02	0.05	0	0.01	0.04	0	0.03	0.03
Total.Discharges.Title.XVIII	0.79	0.86	0.04	1	0.52	0.35	0.45	0.46	0.75	0.74	0.74	0.72	0.25	0.54	0.54	0.38	0.35	0.54
Total.Discharges.Title.XIX	0.59	0.61	0.02	0.52	1	0.49	0.49	0.56	0.55	0.5	0.47	0.47	0.16	0.37	0.36	0.28	0.22	0.57
Cost.of.Charity.Care	0.48	0.5	0.01	0.35	0.49	1	0.65	0.78	0.44	0.42	0.44	0.44	0.16	0.3	0.31	0.21	0.14	0.4
Total.Bad.Debt.Expense	0.49	0.57	0.03	0.45	0.49	0.65	1	0.63	0.46	0.43	0.48	0.48	0.16	0.32	0.31	0.24	0.18	0.36
Total.Unreimbursed.and.Uncompensated.Care	0.64	0.62	0.02	0.46	0.56	0.78	0.63	1	0.64	0.57	0.57	0.56	0.23	0.46	0.44	0.41	0.16	0.6
Overhead.Non.Salary.Costs	0.93	0.82	0.04	0.75	0.55	0.44	0.46	0.64	1	0.88	0.85	0.88	0.34	0.67	0.67	0.57	0.35	0.79
Depreciation.Cost	0.88	0.78	0.07	0.74	0.5	0.42	0.43	0.57	0.88	1	0.76	0.79	0.28	0.6	0.68	0.52	0.33	0.7
Inpatient.Total.Charges	0.8	0.83	0.02	0.74	0.47	0.44	0.48	0.57	0.85	0.76	1	0.88	0.29	0.6	0.58	0.43	0.39	0.69
Outpatient.Total.Charges	0.82	0.77	0.05	0.72	0.47	0.44	0.48	0.56	0.88	0.79	0.88	1	0.33	0.59	0.61	0.46	0.41	0.63
Cash.on.Hand.and.in.Banks	0.32	0.27	0	0.25	0.16	0.16	0.16	0.23	0.34	0.28	0.29	0.33	1	0.48	0.34	0.33	0.19	0.24
Total.Current.Assets	0.65	0.58	0.01	0.54	0.37	0.3	0.32	0.46	0.67	0.6	0.6	0.59	0.48	1	0.7	0.71	0.3	0.53
Total.fixed.Assets	0.64	0.56	0.04	0.54	0.36	0.31	0.31	0.44	0.67	0.68	0.58	0.61	0.34	0.7	1	0.79	0.27	0.51
Total.Liabilities	0.55	0.41	0	0.38	0.28	0.21	0.24	0.41	0.57	0.52	0.43	0.46	0.33	0.71	0.79	1	0.14	0.5
Total.Income	0.34	0.35	0.03	0.35	0.22	0.14	0.18	0.16	0.35	0.33	0.39	0.41	0.19	0.3	0.27	0.14	1	0.23
Net.Revenue.from.Medicaid	0.78	0.7	0.03	0.54	0.57	0.4	0.36	0.6	0.79	0.7	0.69	0.63	0.24	0.53	0.51	0.5	0.23	1

Important Feature engineering

Separating	Separating out Non SSA patient class data (Unknown)
Filtering	Filtering for 364 days report duration for consistency – 90% of data preserved
Handling	Handling NA values
Concatenating	Concatenating data of multiple years (5 years - 2014-18)

Model Building Logic + Example

- Logical preparation
 - Employ Fixed/Random Effects to control for-> State & Year
 - Using OLS as target variable is a decimal ratio
- ```
m3<-lmer(log(Cost.To.Charge.Ratio) ~ Rural.Versus.Urban + as.factor(Provider.Type) + as.factor(Type.of.Control) + FTE...Employees.on.Payroll + Number.of.Beds + Total.Discharges.Title.V + Total.Discharges.Title.XVIII + Total.Discharges.Title.XIX + Cost.of.Charity.Care + Total.Bad.Debt.Expense + Total.Unreimbursed.and.Uncompensated.Care + log(Overhead.Non.Salary.Costs) + Depreciation.Cost + log(Inpatient.Total.Charges) + log(Outpatient.Total.Charges) + Cash.on.Hand.and.in.Banks + Total.Current.Assets + Total.fixed.Assets + Total_Liabilities + Total.Income + Net.Revenue.from.Medicaid+ as.factor(year) +(1|State.Code), data=h_df, REML=FALSE
```

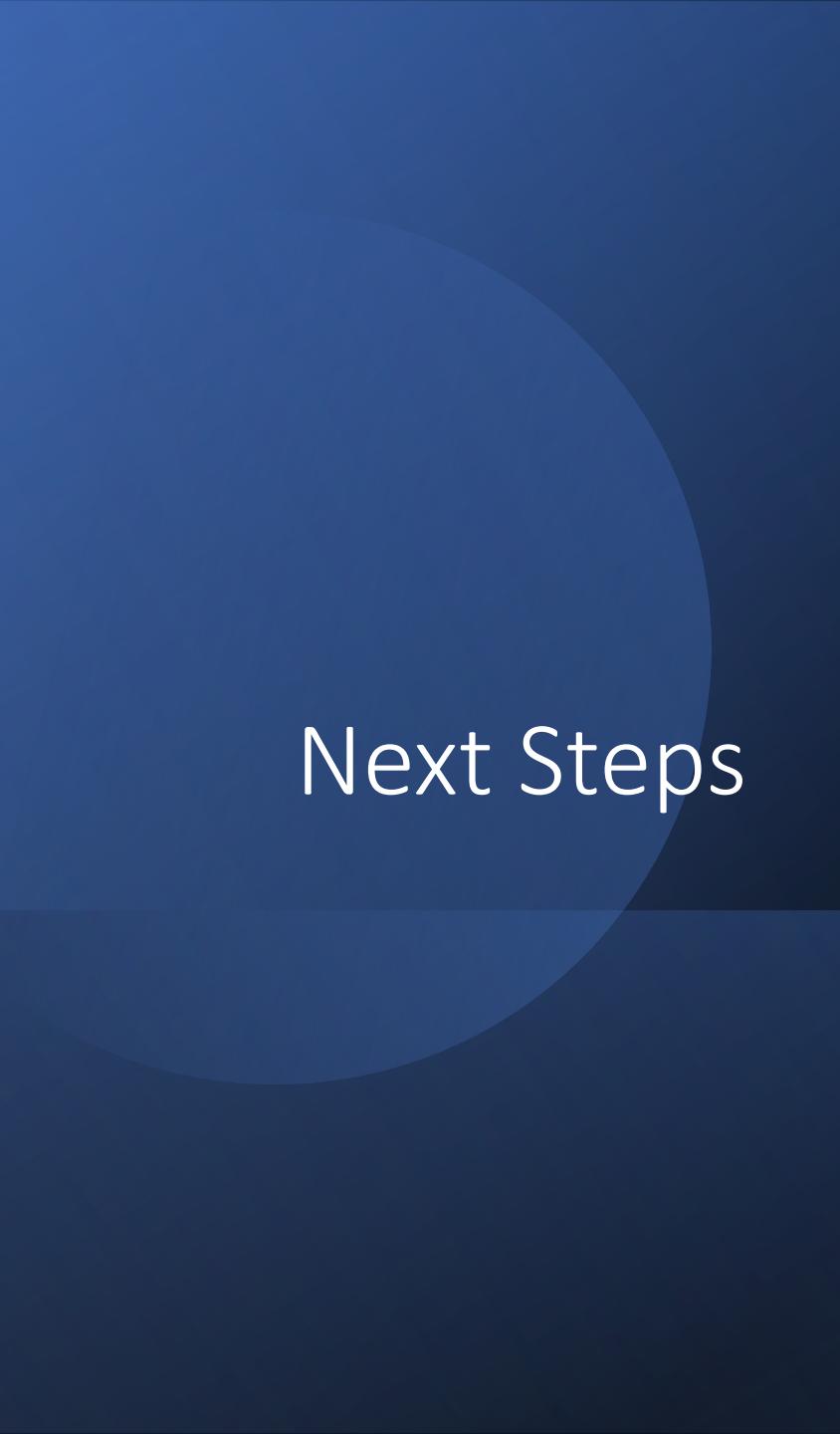
# Random Effects

Random effects:

| Groups                                                | Name        | Variance | Std.Dev. |
|-------------------------------------------------------|-------------|----------|----------|
| State.Code                                            | (Intercept) | 0.009464 | 0.09728  |
| year                                                  | (Intercept) | 0.000000 | 0.00000  |
|                                                       | Residual    | 0.024503 | 0.15653  |
| Number of obs: 10085, groups: State.Code, 52; year, 5 |             |          |          |

# Additional Models we intend to build

- (2) Inpatient vs Outpatient – Find out how inpatient/outpatient services affect C2C ratio
- (2) Medicare vs Medicaid Find out how Medicare/Medicaid services affect C2C ratio
- (1) Health IT – How does spending on health IT infrastructure affect C2C



## Next Steps

- Subsetting Data for particular investigations and building + analyzing corresponding models
- Verifying validity of interpretations
- Building report with findings regarding predictors with most significant effect on C2C ratio
- Analyzing limitations of current modeling
- List of recommendations to help improve C2C ratio