Skilled Nursing Facilities Performance Analysis

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Analytical Questions

01 Evaluate the overall financial performance of nursing homes

02 Are there specific types of facilities that are more profitable?

03 Is there a relationship between facility profitability and Overall Rating?

04 Is there a relationship between facility profitability and penalties?

05 Was there an impact on profitability for skilled nursing facilities before/during COVID-19?

AQ1: Evaluate the overall financial performance of nursing homes

Utilized Cost Report's **Net Income** variable to get a general idea of the profitability across all providers from 2015–2021.

Key Takeaways:

- Decrease in Net Income in 2018
- Significant increase in Net Income in 2020
- 2020 and 2021 had the highest average Net Income

We hypothesize that the significant fluctuation in net income throughout 2019–2021 may be attributed to the COVID–19 pandemic.

Total Net Income by Year
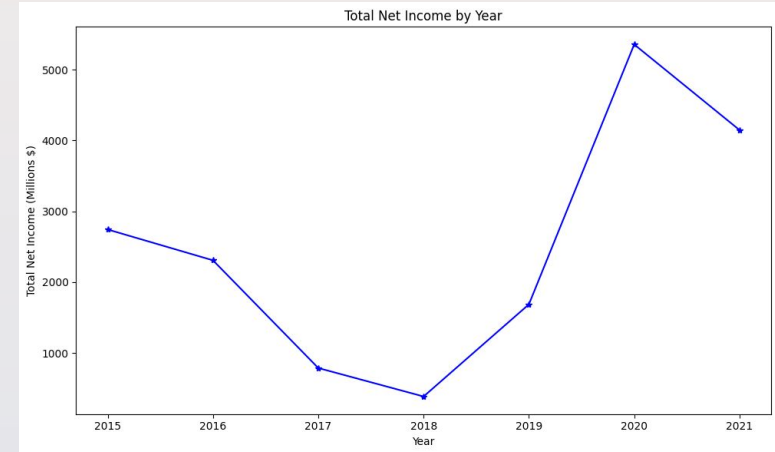
Summary Stats for Cost Reports by Year	Count	%	Mean
2015	15,402	14.49%	$178,122
2016	15,104	14.21%	$152,804
2017	15,433	14.52%	$51,010
2018	15,142	14.25%	$25,449
2019	15,182	14.29%	$111,074
2020	14,949	14.07%	$358,325
2021	15,057	14.17%	$275,506

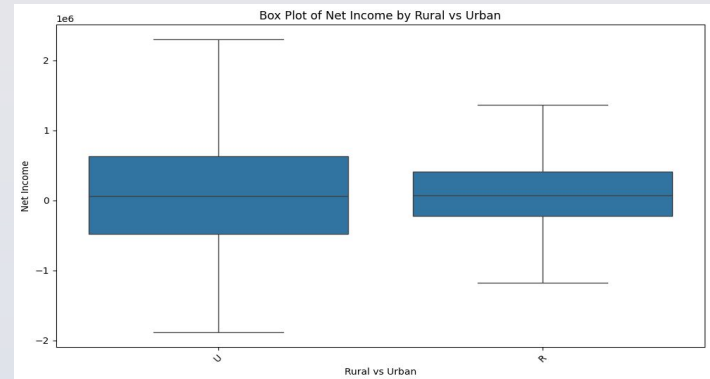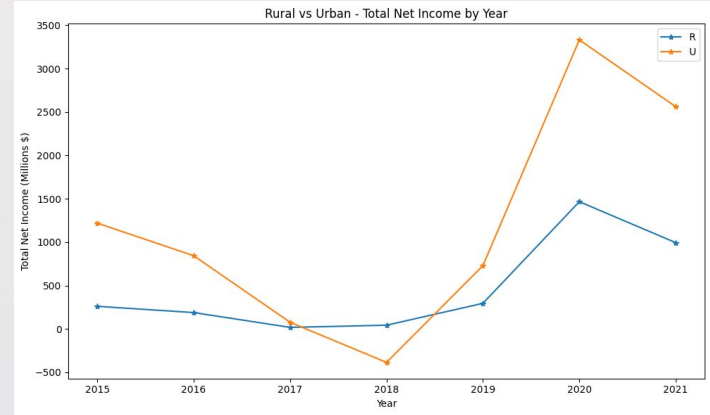# AQ2: Are there specific types of facilities that are more profitable?
Rural vs. Urban Nursing Facilities

Key Takeaways:

- The data set is primarily comprised of facilities in Urban areas (73%).
- Financial paths between the two types diverged in 2017.
- Despite a slight decline of Net Income in 2018 and 2021, Urban facilities have a relatively higher Net Income when compared to Rural facilities.

One Way t-test Results (low p-value) indicate a significant difference in Net Income between the two types.

Rural vs Urban t-test	Results
T-statistic	–3.867
P-value	0.00011

AQ2: Are there specific types of facilities that are more profitable?
Type of Ownership

When first analyzing Type of Ownership, we noted 13 different ownership types in the data set.
- 50% of the cost report data was attributed to 'For Profit – Corporation' facilities.
- Gov't State and Non–Profit – Other had the highest and lowest average net income, respectively.
  - Note: These types only covered <3% of the data
- To make more fair comparisons, we grouped states into regions.

Key Takeaways:

- Non–Profit facilities were main drivers behind decrease in Net Income in 2018.
- For Profit facilities saw a significant increase in 2020
  - Hypothesis: For Profit facilities are more easily accessible. As the pandemic hit, there was an urgent demand for accommodations, thus increasing residency at these facilities.

ANOVA test Results (low p-value) indicate a significant difference in Net Income between the ownership types.

Total Net Income by Ownership Type

ANOVA Test – Ownership Types								
	Overall	2015	2016	2017	2018	2019	2020	2021
ANOVA F–Statistic	31.053	2.673	5.208	8.446	18.599	1.341	27.049	74.825
P–Value	3.323^{-14}	0.0691	0.0055	0.0002	8.761^{-09}	0.2617	1.975^{-12}	6.695^{-33}
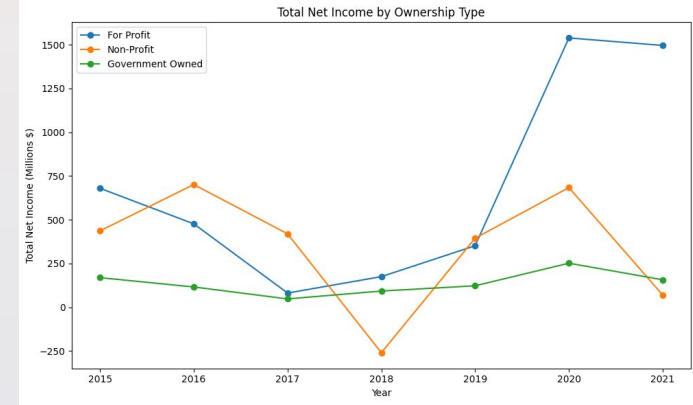
Ownership Type	Count	%	Mean
For Profit – Corporation	53,861	50.72%	$169,008
For Profit – Individual	5,966	5.62%	$189,996
For Profit – Limited Liability	13,541	12.75%	$161,990
For Profit – Partnership	5,416	5.10%	$276,688
Government – City	512	0.48%	$68,535
Government – City/County	414	0.39%	$146,740
Government – County	2,334	2.20%	$116,848
Government – Federal	86	0.08%	$349,183
Government – Hospital district	1,306	1.23%	$186,492
Government – State	729	0.69%	$450,847
Non–Profit – Church Related	2,577	2.43%	$114,102
Non–Profit – Corporation	17,164	16.16%	$126,345
Non–Profit – Other	2,295	2.16%	–$7,885

AQ2: Are there specific types of facilities that are more profitable?
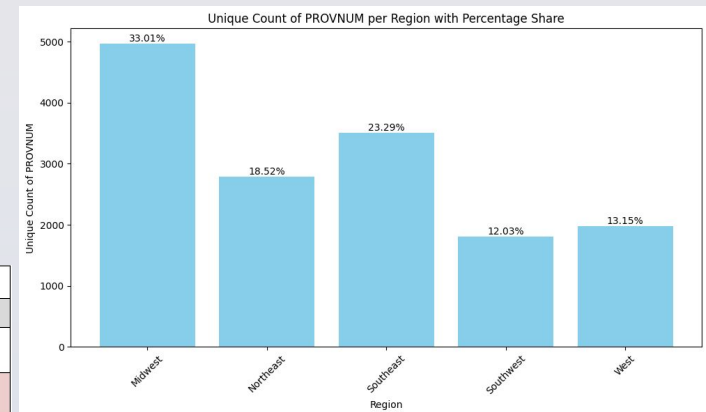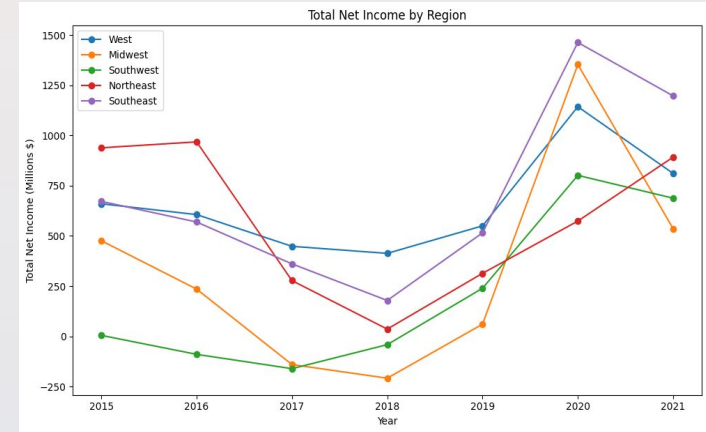# Geographic Location (Regions)

When first analyzing Geographical Location, we ultimately decided to group the states into regions for a more comparable analysis.

Key Takeaways:

- Western and Southeastern regions typically had a higher net income than other regions from 2017 – 2021.
- Midwestern regions (33% of dataset) had the lowest net income from 2015–2019.
  - Facilities in this region saw a significant increase in net income in 2020 and a sharp decrease in 2021
- Hypothesis: People in Midwestern regions contracted COVID at a faster rate than other regions, explaining the spike in Net Income. These regions may not typically follow COVID regulations and may have received an influx of penalties therefore leading to the decrease in net income in 2021.

ANOVA test Results (low p-value) indicate an overall significant difference in Net Income between the facility regions. (With the exception of 2021 performance.)

ANOVA Test – State Regions								
	Overall	2015	2016	2017	2018	2019	2020	2021
ANOVA F-Statistic	187.065	51.462	56.464	29.552	20.591	11.128	39.956	2.068
P-Value	4.550^{-160}	5.245^{-33}	3.442^{-36}	5.177^{-19}	2.689^{-13}	2.744^{-07}	1.168^{-25}	0.102

Total Net Income by Region

Unique Count of PROVNUM per Region with Percentage Share

AQ3: Is there a relationship between facility profitability and Overall Rating?
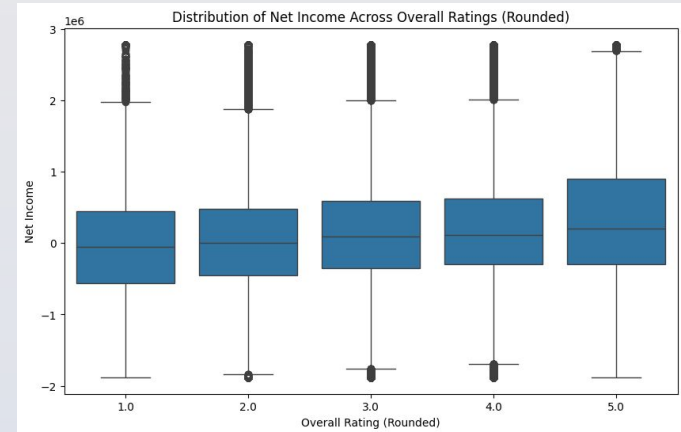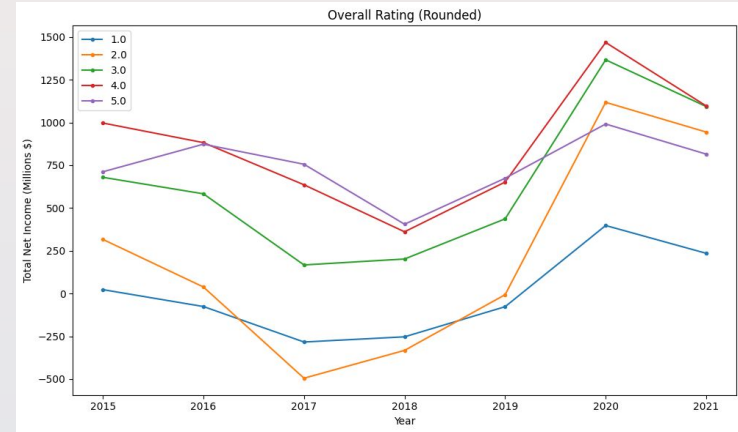
Key Takeaways:

- 4.0 and 5.0 rating nursing facilities typically have a higher Net Income specifically in 2018–2021
- Lower Overall Rating scores showcased a lower net income across the years.
- There was an overall increase for all facilities during 2020 and 2021 likely because of the pandemic.

From the boxplot we can identify the general trend in facilities with higher overall rating score having a higher median net income.

- 5.0 overall rated facilities have a larger range compared to those with lower scores

ANOVA test Results (low p-value) indicate an overall significant difference in Net Income between the facility Overall Rating scores.

Overall Rating (Rounded)

Distribution of Net Income Across Overall Ratings (Rounded)

| Ratings ANOVA test	Overall
ANOVA F-Statistic	6.015
P-value	0.0011

AQ4: Is there a relationship between facility profitability and penalties?

Key Takeaways:

- As the amount of fines increased, the overall average net income for nursing facilities decreased.
    - These two variables are inversely related.
- Fine has a significantly higher frequency compared to payment denials over the years
- In 2021, the amount of fines increased significantly, this is most likely due to the pandemic.

ANOVA test Results (low p-value) indicate an overall significant difference in Net Income between the penalty type.

Penalty ANOVA test	Overall
ANOVA F-Statistic	59.993
P-value	9.535^{-15}
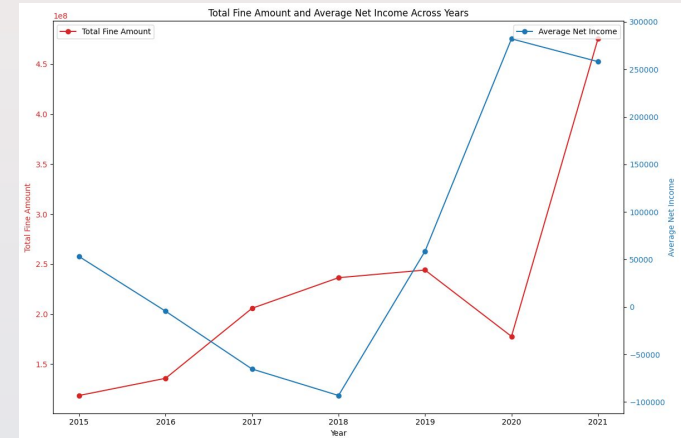
AQ5: Was there an impact on profitability for nursing facilities during COVID?
# COVID - Region

Key Takeaways:

- Southeastern and Southwestern regions have lower average percentages of vaccinated residents/staff.
- Midwestern regions have the lowest average percentage of vaccinated staff (for primary)

Suggestion: Continue to monitor correlation between regions with lower average vaccination rates and overall net income.

ANOVA test Results (low p-value) indicate an overall significant difference in average percentage of vaccinated staff/residents between the two facility types.

Average Percentage of Vaccinated Residents and Staff by Region
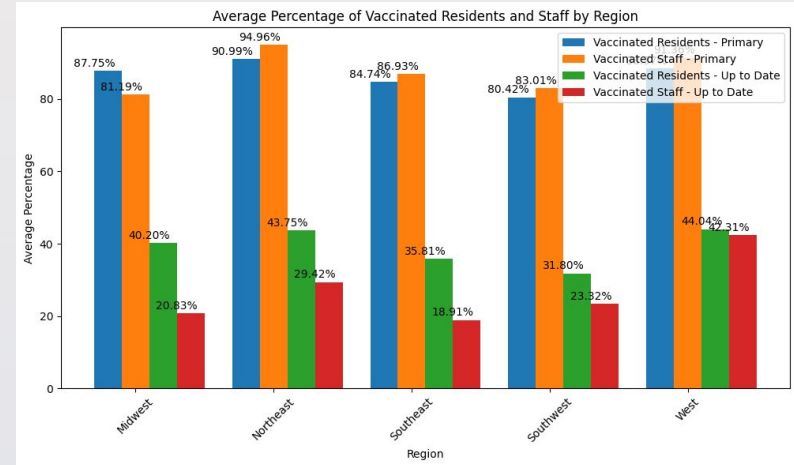
Region (Vaccination Rate) ANOVA test	Residents Primary	Staff Primary	Residents Up To Date	Staff Up to Date
ANOVA F-Statistic	266.651	609.186	52.859	271.094
P-value	4.589^{-221}	0.0	2.882^{-44}	1.230^{-224}

Random Forest Model

After testing several models of linear regression, and decision tree, our final approach was to use a Random Forest Model.
We included the following variables:

- State, Year, Penalty Type, Fine Amount, and Rural vs. Urban

In comparison to other models we tried, the random forest model had the most positive results.

- We were able to get the R-Square closer to 1
- MSE and R-Square as still not idea levels, however we can take this as an indication that the random forest model is a better predictor for this project

Model Evaluation Method	Result
Mean Squared Error	774,285,438,634
R-Squared	0.263824

Recommendations & Conclusion

Key Analysis Highlights:

- Urban Facilities have showcased an increase in net income more than Rural Facilities.
- For-Profit Ownership Types have maintained a significantly higher net income when compared to Nonprofit and Government facility types.
  - This type of facility also saw the greatest increase in net income from 2019 – 2020.
- Facilities in Western and Southeastern regions typically had a higher net income over the years.
- Overall Rating of nursing facilities often had a positive correlation with net income
  - A higher rating (4.0 – 5.0) typically indicates a higher net income
  - Facilities with lower ratings (2.0 or lower) often had a negative net income (indicating they often operated at a loss and were not profitable)

Client Recommendation:
From our analysis, we can ultimately recommend to invest in nursing facilities that possess the positive attributes highlighted above.

Additional Research Recommendation:
Further investigate target resident demographics for nursing facilities as well as facility marketing efforts. Both variables could provide additional context that would potentially help to further inform a predictive model.