



Investigating Wellness Benefit Adherence as an Input for Forecasting Future Healthcare Insurance Claims Costs

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Introduction

Project Objective: Explore the relationship between employee adherence to preventive wellness benefits and future healthcare claims costs for their employers.

Context: Provided by Brown & Brown Insurance, focusing on how preventive healthcare can predict future healthcare claims costs for clients.

Importance: Understanding this relationship can help in accurately forecasting healthcare costs which is crucial for serving clients as an insurance brokerage.

Methodology

Data Source: Data from Benefits Science Technologies website, focusing on 8 employer groups.

Data Preprocessing: Anonymized client names, standardized column names, validated data types, median imputation for missing values, and data smoothing using 6-month rolling averages.

Engineered Metric for Wellness Adherence: Preventive Claim Ratio (PCR) was engineered using the raw data based on the following formula:

$$PCR = \frac{\text{No. of Preventive Medical Claims}}{\text{Total Medical Claims}}$$

Where the *No. of Preventive Medical Claims* is calculated by counting the number of medical claims with an ICD-10 code starting with the letter “Z” in each month, and the *Total Medical Claims* is calculated by counting the total number of recorded medical claims for that month.

Models Used: K-Means for clustering clients; ARIMA and SARIMAX for forecasting future claims costs.

Clustering with K-Means

Number of Clusters: The Elbow Method was used to determine that the optimal number of clusters for our data is 4.

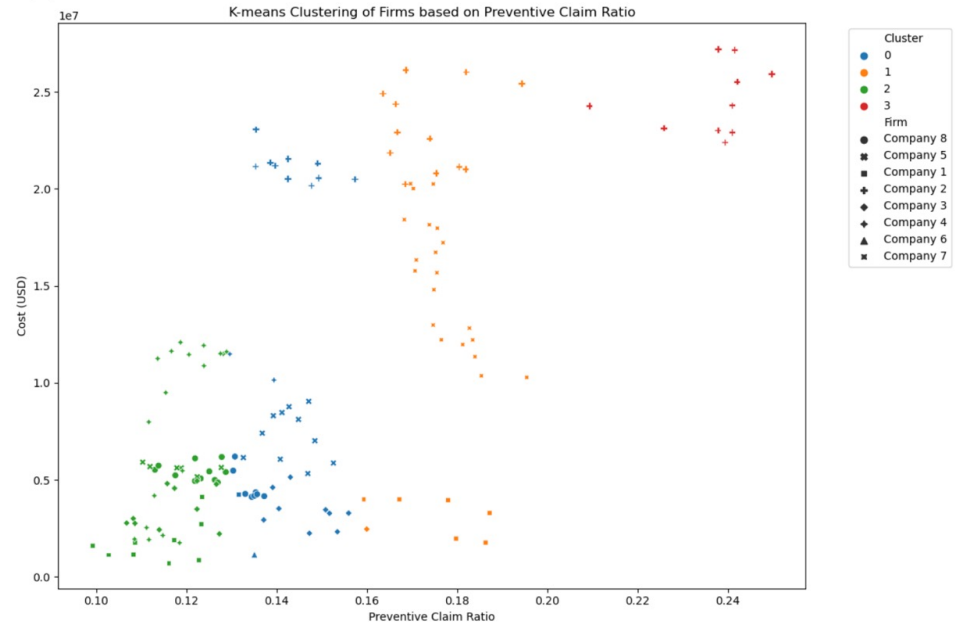
Result: The K-Means Algorithm achieves a Silhouette Score of 0.69.

Interpretation:

1. This is a relatively high score, considering that the scale ranges from -1 to +1.
2. This suggests that the clustering model has performed well for the given feature, and we can be confident in the distinction between the clusters found.
3. Except for Company 2, the clients seem to be neatly sorted into the different clusters.

Silhouette Score for k=4: 0.69

Cluster	0	1	2	3
Firm				
Company 1	6	6	9	0
Company 2	15	12	0	10
Company 3	14	1	10	0
Company 4	7	0	18	0
Company 5	16	0	6	0
Company 6	6	0	0	0
Company 7	5	20	0	0
Company 8	13	0	12	0



Time Series Forecasting

Overall: Both models underestimate the ground truth cost.

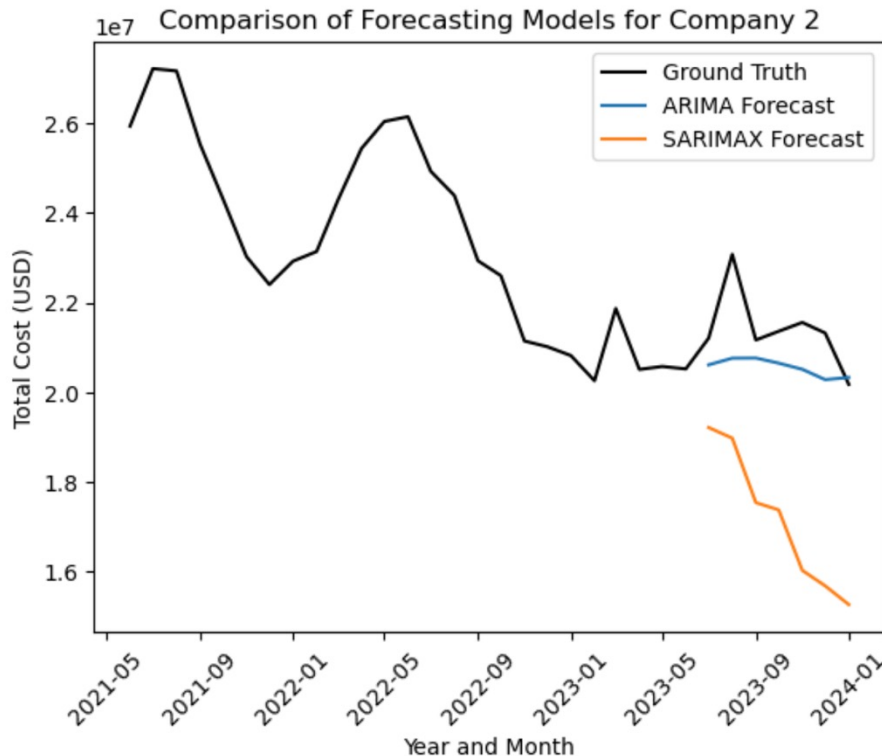
SARIMAX:

1. Captures the overall trend better.
2. Suffers from more extreme underestimation of the ground truth.
3. Yields a high relative RMSE of 0.21.

ARIMA:

1. Yields a low relative RMSE of 0.05.
2. Best model for forecasting future healthcare claims costs.
3. However, it is still desirable to have a lower relative RMSE for the purpose of financial forecasting in industry.

ARIMA RMSE: 1105941.98
SARIMAX RMSE: 4407349.95
ARIMA Relative RMSE: 0.05
SARIMAX Relative RMSE: 0.21



Conclusion & Next Steps

Implications: Demonstrated that Preventive Claim Ratio is a valuable predictor of future claims costs and feature for clustering client groups.

Business Impact: Provides Brown & Brown Insurance a tool to tailor insurance plans more effectively based on analytical and predictive insights.

Future Applications: Can enhance brokers' ability to serve clients with personalized, data-driven recommendations.

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Future Work:

1. Incorporate more detailed insurance plan data, such as plan type, deductible, copy, coinsurance, etc. as additional inputs to the models.
2. Experiment with other clustering and forecasting models to investigate if there are alternatives to K-Means and ARIMA that perform better.



THANK YOU!



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