Analyzing The Impact Of News Sentiment on Airline Stock Returns

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Abstract

This paper investigates the relationship between the stock return price of commercial airline companies and news sentiment of the economy. The regression is based on the CAPM model and the parameters are estimated using OLS (Ordinary Least Squares). All variables consist of data collected daily from May 4, 2007 to April 5, 2021. American Airlines, Alaska Airlines, Delta Airlines, Southwest Airlines, and United Airlines make up the five companies used in the regression. The results of the regression are inconclusive at best, there is no clear relationship discovered between the firms. None of the regressions result in any meaningful statistical significance, which is likely due to limitations of the model and variables used.

Introduction

The efficient market hypothesis claims that the prices of traded assets such as stocks reflect all known information available. Whenever new information becomes available it is immediately implemented into the price. This assumes that on average, the information is done so correctly. However, human beings are often susceptible to bias. The paper “Mood and the Market: Can Press Reports of Investors' Mood Predict Stock Prices?” by Cohen-Charash et al. concluded that “both valence and activation levels of collective mood are important in predicting trend continuation in stock prices”. (Cohen-Charash et al. 1). Similar logic can be applied to specific industries, such as the airline industry. When market sentiment is high, people would be more willing to spend on luxuries such as flights to go on vacation. If market sentiment is low, people may be less likely to purchase airline tickets. They are generally expensive and would be one of the first expenses cut if trying to save money. As a result, stock returns of airline companies would decrease.

One way market sentiment can be measured is through news outlets. This paper investigates the relationship between stock returns of airline companies and news sentiment. To represent airline companies, the daily stock returns are compiled from the five of the biggest American airline companies. The news sentiment variable comes from the paper “Measuring News Sentiment” by Shapiro, Sudhof, and Wilson. Each day was assigned a score from -1 to 1 based on how news outlets were talking about the economy. The closer to -1, the more negative and the closer to 1, the more positive. The paper builds the regression on the CAPM model. The dependent variable is the stock return prices of the airlines, and the two independent variables are news sentiment and stock returns of the S&P 500. For each variable, the data was collected daily from May 4, 2007 to April 5, 2021. Coefficient estimates are derived using OLS as well.

The results of the paper indicate no relationship between news sentiment and the stock returns of airline companies. The p-values were high for all five companies, the highest being Delta Airlines with 0.975 and the lowest being Alaska Airlines with 0.163. Furthermore, three of the coefficients were positive and two were negative and all were close to 0. In an attempt to discover why the results were so inconclusive, a Breush-Pagan test was run. Since the coefficients were estimated using OLS, it is likely the model violated the assumption of homoskedasticity. The test proved this theory true, for every regression there was evidence of heteroskedasticity. To compensate, the model was then run again using heteroskedastic-robust standard errors. The results were largely the same, however the standard errors and p-values for the news sentiment coefficients all increased. The same two companies had the highest and lowest p-values, but Delta's increased to 0.981 and Alaska's to 0.335. Given the results, it is fair to conclude that there is no statistically significant evidence of a relationship between news sentiment and the stock returns of airline companies.

Data

All the stock data used for the regression model was collected from Yahoo Finance. Data of stock prices from five of the biggest American airline companies is used to represent how the airline industry responds to the dependent variable, news sentiment. The five selected companies are Delta Airlines (DAL), Southwest Airlines (LUV), United Airlines (UAL), American Airlines (AAL) and Alaska Airlines (ALK). Their adjusted close stock prices are then transformed into their stock returns using the formula in Figure 1. In the formula, r(t) represents the stock return, p_t represents the adjusted close stock price during time period t, and p_{t-1} represents the stock price at time period t - 1. Figure 2 shows the summary statistics of each airline from May 3, 2007 to

April 5, 2021. This time range was selected because it is the only one all variables cover. The stock returns for each company were calculated daily. See Appendix 1 for time series graphs for each company.

$$r(t) = \frac{p_t - p_{t-1}}{p_{t-1}} * 100$$

Figure 1: Stock Return Formula

Stock	Mean	Median	Standard Deviation	Min	Max	Range	Skew	Kurtosis
AAL	0.09	0.00	4.48	-30.36	58.74	89.10	1.20	16.35
ALK	0.11	0.11	2.99	-23.24	31.28	54.52	0.50	12.71
DAL	0.09	0.08	3.43	-25.99	26.55	52.54	0.28	8.85
LUV	0.07	0.07	2.28	-18.45	17.06	35.51	-0.15	6.27
UAL	0.11	0.03	4.39	-36.77	68.54	105.31	1.34	27.89

Figure 2: Summary statistics of daily stock returns of selected companies (May 3, 2007 - April 5, 2021)

For the dependent variable news sentiment, the data comes from the paper "Measuring News Sentiment" by Shapiro, Sudhof, and Wilson. They calculated the sentiment of news articles from a variety of sources daily and standardized their results to a scale from -1 to 1. -1 is the most negative while 1 is the most positive. By sentiment, the paper means the emotion and tone of the article itself rather than the economic condition. Figure 3 below shows a time series plot of the data.

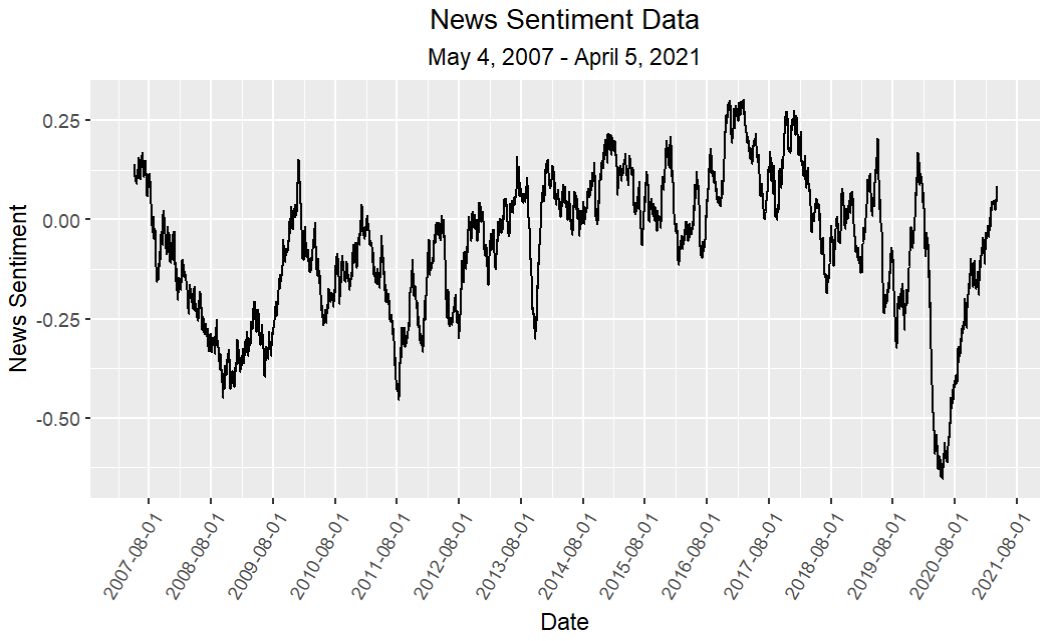

Figure 3: Daily Time Series Data of News Sentiment

Data from the S&P 500 was collected from the Wall Street Journal and follows the same time range as the rest of the variables. Figure 4 visualizes the data, showing daily returns during the specified time range which were calculated using the same formula in Figure 1.

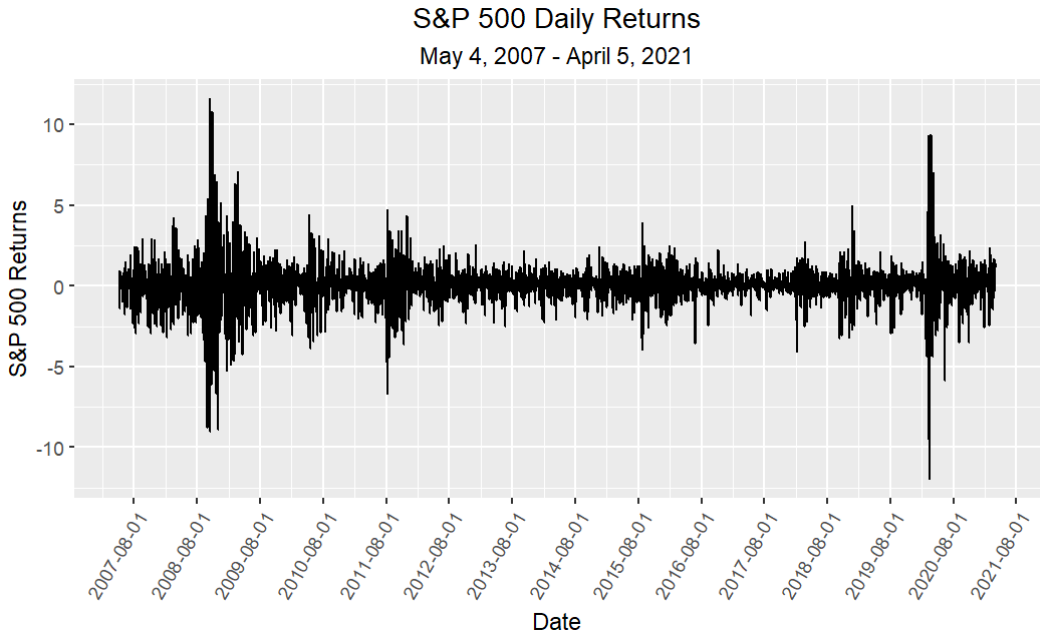

Figure 4: Daily S&P 500 returns

Regression

The regression to predict the stock returns of the selected companies uses a linear model where the parameters are estimated with Ordinary Least Squares (OLS). OLS calculates the parameters by minimizing the sum of squared residuals. The model is based on the Capital Asset Pricing Model (CAPM), which is often used in practice to determine whether the risk of an investment is worth it or not. Figure 1 below shows the model in its entirety.

$$Returns_t^i = \alpha^i + \beta_1^i Returns_t^{S\&P\ 500} + \beta_2^i News_t + \varepsilon_t$$

Figure 5: Regression model

The dependent variable $Returns_t^i$ represents the stock return of firm i at time period t. The companies include the five mentioned in the Data section. Time period t can be any day from May 3, 2007 to April 5, 2021. α^i represents the intercept and ε_t is the error term. The parameters β_1 and β_2 estimate the rate of change of $Returns_t^i$ given a one unit change in daily returns of the S&P 500 ($Returns_t^{S\&P\ 500}$) and daily news sentiment ($News_t$) respectively.

The purpose of this regression is to determine whether news sentiment has any influence on the stock returns of airline companies. A possible explanation is that many view flying as a luxury good, so are less likely to do so if they believe the economy is not doing well. In times of perceived economic hardship many prefer to save their money for more important items. As a result, the variables would have a positive relationship. As news sentiment is higher, so are the stock returns for the selected companies. However, this model has limitations. It is assumed the variables have a linear relationship, which may not be the case and would lead to model misspecification. The model also relies on OLS assumptions, such as the error terms being normally distributed and no multicollinearity. Any violation of these assumptions could cause the estimates of β_1 and β_2 to be biased.

Results

The results of the regression can be seen in Figure 6 below. It contains all the parameter estimates for each company. Below each estimate is its standard error and p-value. The adjusted R-squared was also calculated to account for there being multiple independent variables in the model.

Company	α	β_1	β_2	R^2	Adjusted R^2
AAL (Standard Error) (P-value)	0.0119 0.0711 0.8670	1.6171 0.0506 0.0001	-0.2460 0.3759 0.5130	0.2264	0.2259
ALK (Standard Error) (P-value)	0.0439 0.0454 0.3340	1.2293 0.0323 0.0001	-0.3347 0.2399 0.1630	0.2937	0.2932
DAL (Standard Error) (P-value)	0.0387 0.0533 0.4690	1.3168 0.0380 0.0001	0.0088 0.2824 0.9750	0.2557	0.2553
LUV (Standard Error) (P-value)	0.0492 0.0341 0.1490	0.9762 0.0242 0.0001	0.2321 0.1801 0.1980	0.3171	0.3167
UAL (Standard Error) (P-value)	0.0470 0.0704 0.5040	1.5360 0.0501 0.0001	-0.1096 0.3722 0.768	0.2121	0.2116

Figure 6: Results of the regression

The results of the regression make it difficult to draw any definite conclusions. AAL, ALK, and UAL indicate a negative relationship between their stock returns and news sentiment, whereas DAL and LUV show the opposite. The size of each standard error further raises the uncertainty. A 95% confidence interval for each company would include both positive and negative values. UAL displays the largest amount of uncertainty, having the largest 95% confidence interval and the lowest R^2 value of 0.2121. The variation among the p-values is striking as well. Although none are statistically significant at even 90% confidence, there is a

wide gap between the lowest and highest p-values. DAL has a p-value of 0.975 while ALK is only 0.163.

A possible explanation for why the data is so uncertain could be a violation of one of the OLS assumptions. This would result in a biased estimator and reduce the credibility of our results. When creating scatter plots of news sentiment against each of the stock returns (see Appendix 2), there seems to be heteroskedasticity. For each company, the variance of the errors is not the same across the independent variable. As news sentiment increases, the variance of the errors decreases. Using the Breusch-Pagan test would confirm whether heteroskedasticity exists in the data. If the p-value of the test is less than 0.05, we can reject the null and conclude there is evidence of heteroskedasticity.

Company	Breusch-Pagan Test Statistic	P-value
AAL	133.45	0.0001
ALK	125.12	0.0001
DAL	231.27	0.0001
LUV	116.44	0.0001
UAL	89.408	0.0001

Figure 7: Breusch-Pagan test results for each regression

As Figure 7 clearly indicates, each regression displays evidence of heteroskedasticity. All had p-values close to 0 which is well below 0.05. For the model to achieve more meaningful results, it can be modified by using heteroskedastic-robust standard errors instead. This adjusts for the violation of the homoskedasticity assumption of OLS. The results are below in Figure 8.

Company	α	β_1	β_2	R^2	Adjusted R^2
AAL (Standard Error) (P-value)	0.0119 0.0507 0.8143	1.6171 0.1023 0.0001	-0.2460 0.5299 0.6426	0.2264	0.2259
ALK (Standard Error) (P-value)	0.0439 0.0349 0.2086	1.2293 0.0607 0.0001	-0.3347 0.3473 0.3352	0.2937	0.2932
DAL (Standard Error) (P-value)	0.0387 0.0391 0.3229	1.3168 0.0698 0.0001	0.0088 0.3788 0.9814	0.2557	0.2553
LUV (Standard Error) (P-value)	0.0492 0.0288 0.0881	0.9762 0.0388 0.0001	0.2321 0.2569 0.3664	0.3171	0.3167
UAL (Standard Error) (P-value)	0.0470 0.0491 0.3383	1.5360 0.0903 0.0001	-0.1096 0.5272 0.8353	0.2121	0.2116

Figure 8: Results of the regression with heteroskedastic-robust standard errors

All companies saw the same changes in their regression models. The standard errors for α all decreased but increased for β_1 and β_2. The p-values for α also saw a decrease while for β_2 they saw an increase. These results are expected, as heteroskedastic-robust standard errors tend to be larger. They still run into the same issues as the original regression, so concluding there to be any linear relationship between news sentiment and the stock returns cannot be done with any significant level of confidence.

Another potential limitation from utilizing OLS is assuming the variables have a linear relationship. As seen in Appendix 1, that does not seem accurate when graphing the relationship between stock returns and news sentiment. As news sentiment decreases, the less linear the relationship becomes. Given the time range of the data, a lot of this uncertainty likely arises from the two economic crises that took place. Both the 2008 recession and the COVID-19 pandemic had significant impacts on the US economy, with the pandemic in particular hurting airline companies. To capture this effect, two new variables were added to the regression. Recession_t is

a dummy variable that equals 1 if the time period is between December 1, 2007 and June 1, 2009 and 0 otherwise. Similarly $Pandemic_t$ equals 1 if the time period is between February 1, 2020 and April 5, 2021. Figure 9 shows the updated model and Figure 10 shows the results.

$$Returns_t^i = \alpha^i + \beta_1^i Returns_t^{S\&P\,500} + \beta_2^i News_t + \beta_3^i Recession_t + \beta_4^i Pandemic_t + \varepsilon_t^i$$

Figure 9: Updated regression model accounting for 2008 recession and 2020 COVID-19 pandemic

Company	α	β_1	β_2	β_3	β_4	**R^2**	**Adjusted R^2**
AAL (Standard Error) (P-value)	0.0267 0.0504 0.5965	1.6163 0.1027 0.0000	-0.4147 0.4734 0.3811	-0.1497 0.3181 0.6379	-0.1247 0.4156 0.7642	0.2265	0.2256
ALK (Standard Error) (P-value)	0.0516 0.0337 0.1257	1.2294 0.0610 0.0000	-0.4250 0.3031 0.1609	-0.1407 0.2156 0.5140	-0.0175 0.2522 0.9446	0.2938	0.2930
DAL (Standard Error) (P-value)	0.0446 0.0379 0.2392	1.3170 0.0701 0.0000	-0.0600 0.3275 0.8554	-0.1097 0.2236 0.6236	-0.019 0.3251 0.9733	0.2558	0.2549
LUV (Standard Error) (P-value)	0.0488 0.0289 0.0914	0.9756 0.0388 0.0000	0.2374 0.2455 0.3335	0.0366 0.1680 0.8278	-0.0219 0.1588 0.8905	0.3171	0.3163
UAL (Standard Error) (P-value)	0.0618 0.0463 0.1821	1.5354 0.0905 0.0000	-0.2794 0.4410 0.5264	-0.1774 0.2948 0.5473	-0.1038 0.4428 0.8147	0.2122	0.2113

Figure 10: Results of regression when dummy variables are added

All the added coefficients were negative except for β_3 for LUV. This would indicate that economic recessions lead to a decrease in daily stock returns for airline companies. However, each of the values are close to zero, with none having a larger value than 0.15. This model suffers the same fate as the others, the standard errors are so large that 0 would be included in the confidence interval. The R^2 values are all close to the same, any improvements being marginal.

All β_2 values besides for LUV deviated farther away from 0, showing a stronger effect on the dependent variable. Another positive impact of the added variables was the reduction of the p-values for β_2. While none are still statistically significant, they are much closer than they were prior.

The final version of the model demonstrated improvement compared to the initial model. There was a clearer sense of direction among the coefficients as well as less uncertainty. The standard errors and p-values decreased, but the R^2 values were nearly identical and the coefficient estimates were all close to 0. This is likely due to the nature of the airline industry. It may not be one whose performance is dependent on news sentiment. The efficient market hypothesis could also play a role in the results. As new information becomes available, it is immediately implemented into the stock prices. An example would be the COVID-19 pandemic. It was detrimental to the airline industry, as multiple travel bans were put in place and the number of available flights plummeted. Investors knew it would hurt airline companies, causing their stock prices to fall. As the pandemic continued, that information remained a part of the price. Each would remain low until travel bans started to be lifted.

Conclusion

The results of the regression signal that news sentiment does not have a significant effect on the stock returns of airline companies. The direction of the estimates was mixed, some positive and some negative, and none were close to being statistically significant at a level of 95%. The range of coefficient estimates for β_2 were all close to 0, indicating its lack of impact. However, there was great range in the p-values of these estimates. Alaska Airlines (ALK) had the lowest p-value of 0.163, while Southwest Airlines (LUV) had a p-value as high as 0.975.

Even when taking into account heteroskedasticity, the results were just as inconclusive. The standard errors and p-values increased for all estimates of β_2. Creating dummy variables for the 2008 recession and COVID-19 pandemic yielded slightly better results. The standard errors and p-value for the coefficients decreased, giving the estimates more stability.

In the future, accounting for other variables would make the analysis more accurate. Including other variables that indicate consumer perception would be beneficial. Examples could include consumer spending or surveys that measure confidence. These would do a better job of capturing how the general public perceives the economy instead of just relying on news outlets. Another way to improve the regression would be to expand the range of data that was collected. Having more data points would give a more accurate representation of the relationship between the dependent and independent variables. Including more than five airlines would also provide more data points for the model. However, as discussed prior, it may be that news sentiment does not influence the airline industry. The perception of the economy of the general public may not always align with how the news portrays it.

References

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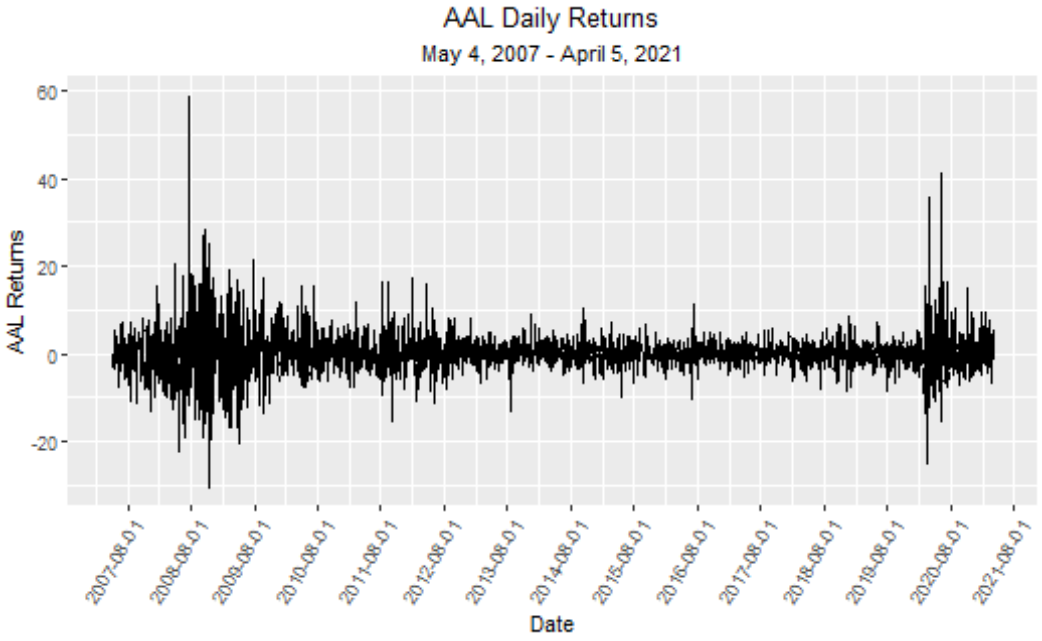
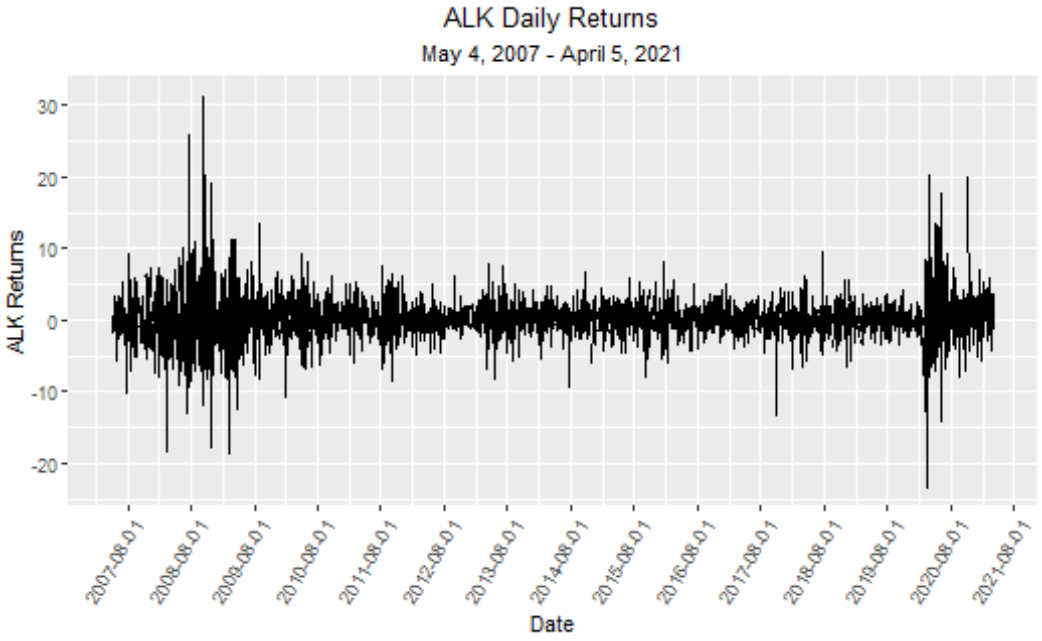
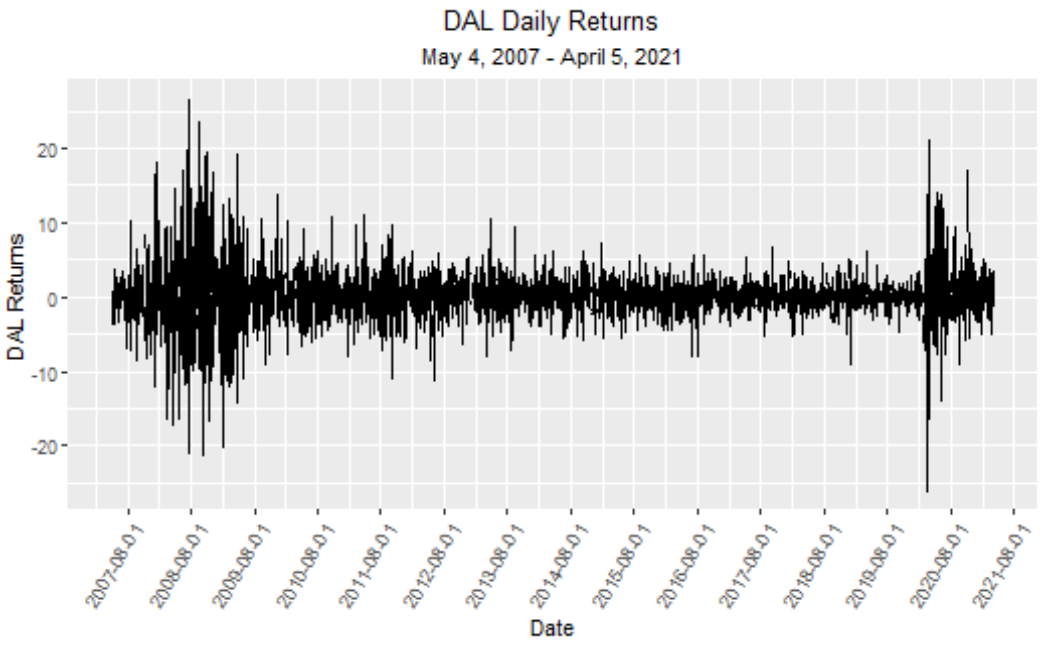
Appendix

Appendix 1: Time series charts of daily stock returns for selected companies






DAL Daily Returns
May 4, 2007 - April 5, 2021
DAL Returns
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10
0
-10
-20
2007-08-01
2008-08-01
2009-08-01
2010-08-01
2011-08-01
2012-08-01
2013-08-01
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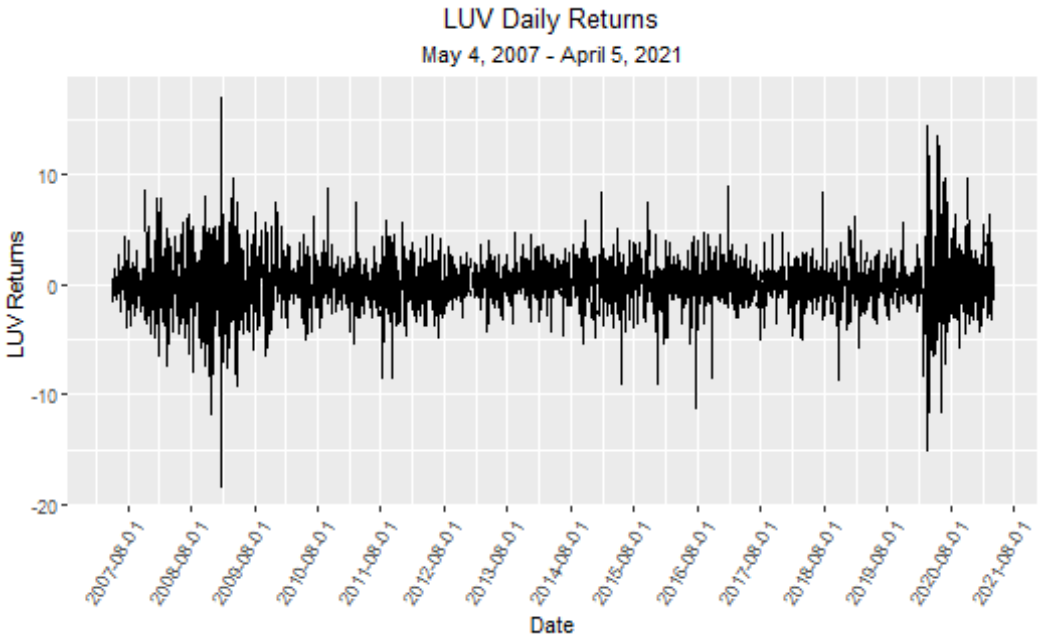
2021-08-01
Date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LUV Returns
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0
-10
-20
2007-08-01
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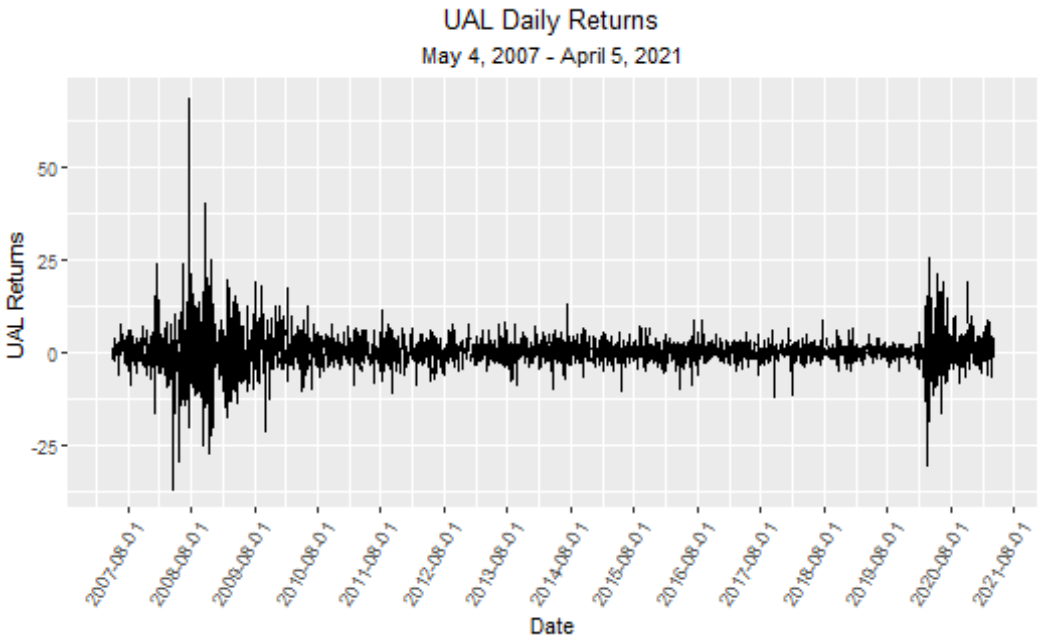
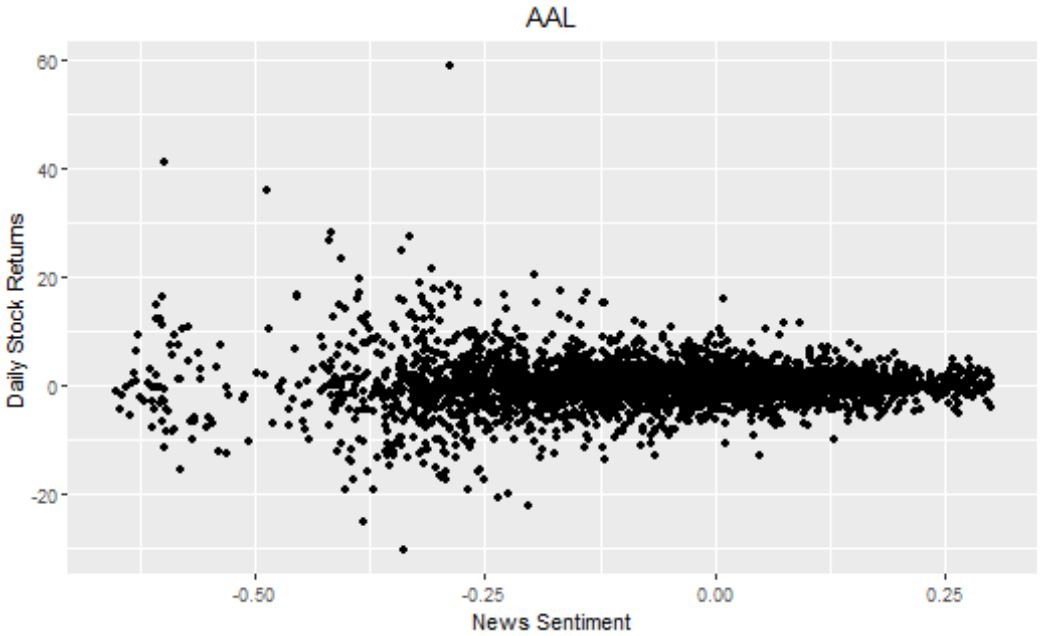
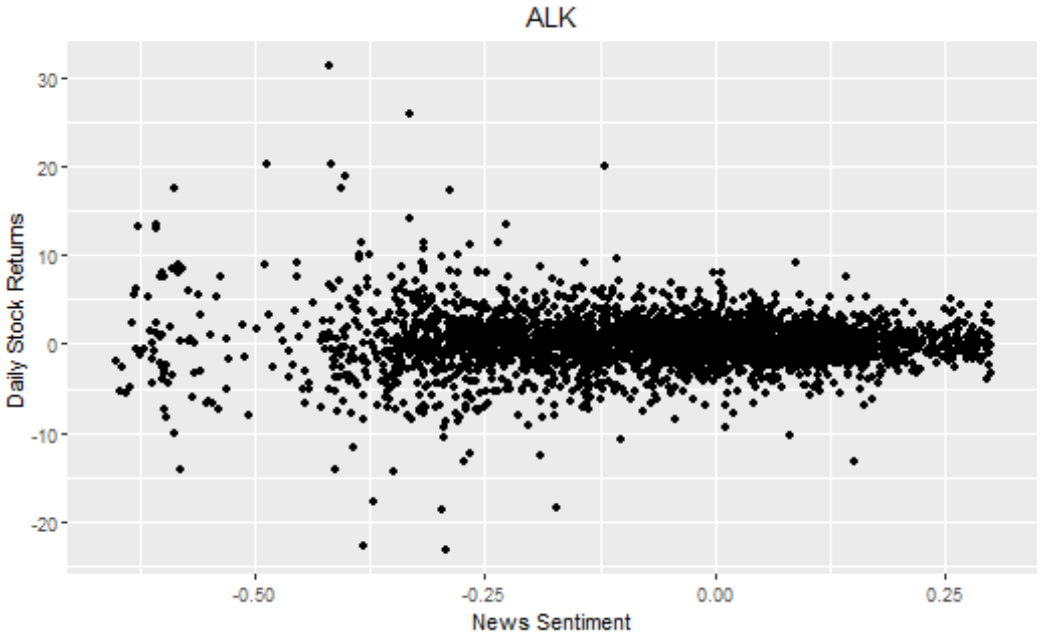
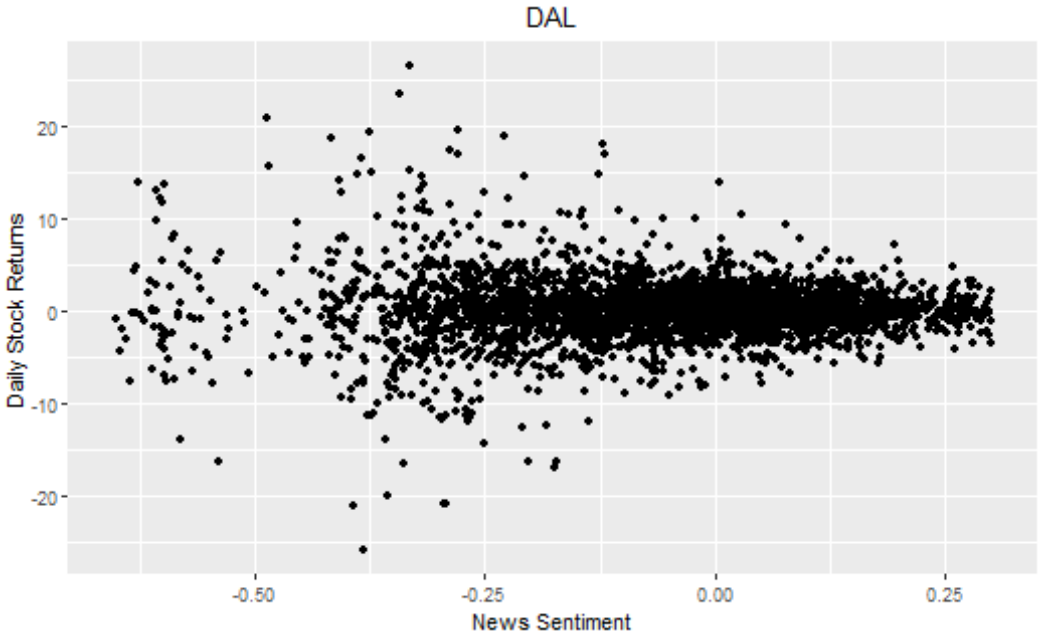


Appendix 2: Scatter plots displaying news sentiment against the daily stock returns of selected companies




ALK
Daily Stock Returns
30
20
10
0
-10
-20
-0.50
-0.25
0.00
0.25
News Sentiment


DAL
Daily Stock Returns
20
10
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-10
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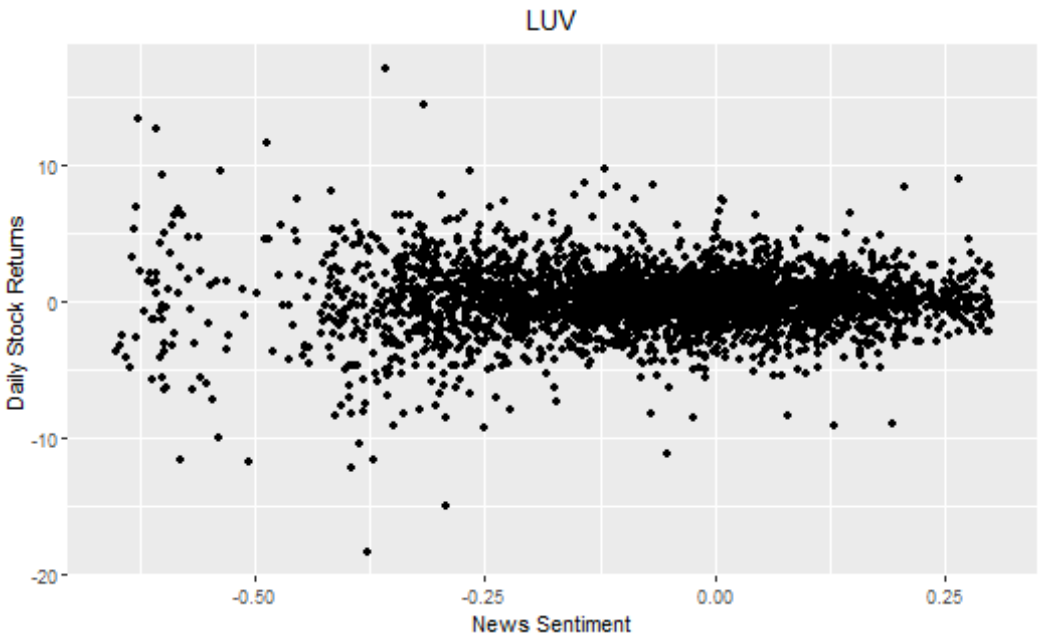
-0.50
-0.25
0.00
0.25
News Sentiment


LUV
Daily Stock Returns
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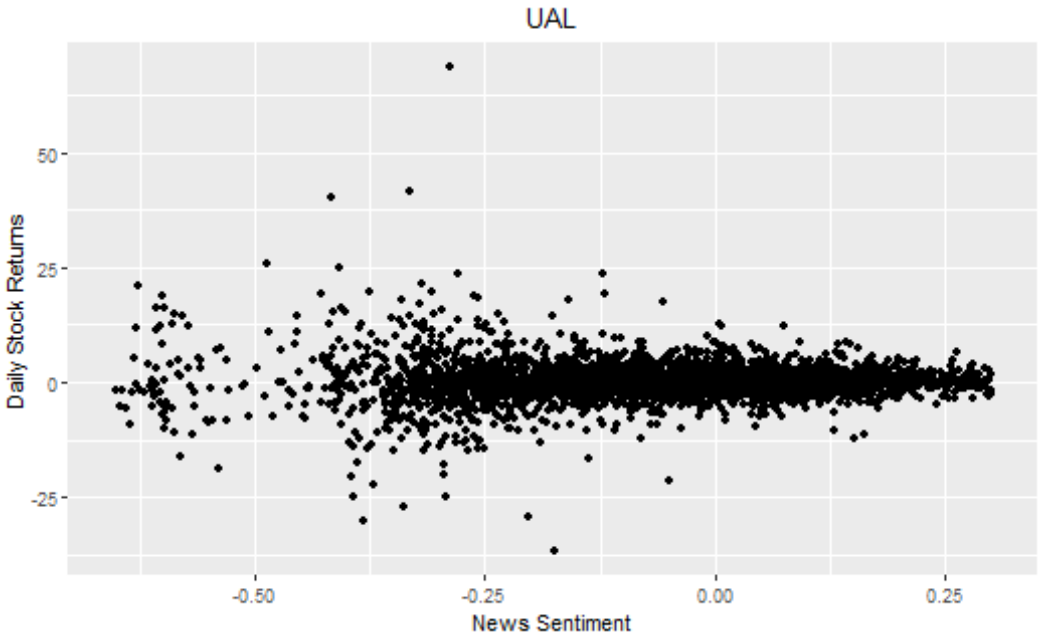
0
-10
-20
-0.50
-0.25
0.00
0.25
News Sentiment


UAL
Daily Stock Returns
50
25
0
-25
-0.50
-0.25
0.00
0.25
News Sentiment