

Electric Vehicle News' Impact on Stock

Performance: An Event Study

By

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Abstract

This paper explores the relationship between the release of news pertaining to firms' electric vehicle advancements and the stock performance of their respective companies. Using an event study approach, the objective of the research is to determine whether the mention of the electric vehicle related news has an impact on stock returns. If so, the secondary objective will be to determine what the impact of this news will be on the stock price by observing the magnitude of the shift. By aggregating data from S&P CapitalIQ amongst the largest nine automobile manufacturers in the world from October 2006 to March 2022, this design defines the news as firm transcripts from analyst calls, presentations, investor days, earnings calls, and essentially all official communication to the public that contains relevant terminology that indicates EV events. By creating event and observation windows, one can isolate these returns from the rest of the market fluctuations by running regression analyses against the corresponding volatility within the time frame. The weaker the correlation between market volatility and returns, the stronger the explanatory power that the EV related news possesses over the financial performance. The various permutations of the analyses determined that although each of the examined relationships resulted in a relatively weak correlation, certain types of EV related news, denoted by the key words they were selected by and the type of firm (legacy versus electric vehicle) it is received from, held various degrees of explanatory power.

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NYU Stern as a whole has provided me with the platform to fearlessly pursue knowledge by ensuring that every single step I take into the unknown, I have a community of genuine curiosity and intellect that I can rely on for help. Whether they have been various professors turned mentors or fellow classmates that inspire me to continue to improve myself, the members of our community here are a reflection of how commerce can be a catalyst for much needed change in this world.

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Introduction

Whether a chrome “T” for Tesla or a shiny three-pointed star for Mercedes-Benz adorns the hood of a vehicle, given the recent strides towards a future powered by fully electric vehicles, chances are that this vehicle will have ditched the gas pump for a charge port. With the rapid increase in global demand for low-carbon-emitting personal vehicles due to government incentives, various legacy manufacturers are often pledging themselves to fully electric fleets and disclosing more about their emissions as a result. Knowledge of how different types of news regarding vehicle manufacturers’ future or current electric fleets may help investors better position themselves for financial gain in an evolution of personal transportation.

The hyperfocus on the electric vehicle market can be felt from both the legacy manufacturers that have been at the forefront of the automobile industry for years as well as from the budding firms that created these cars from their genesis. However, the hype is not simply driven by hot air and empty promises. The Glasgow Declaration on Zero Emission Cars and Vans at COP26 acknowledges that these firms will commit to working “toward reaching 100 percent zero-emission new car and van sales in leading markets by 2035 or earlier” (convenience.org). Accompanying this watershed moment in automobile history was a plethora of announcements for new investment in infrastructure towards achieving these goals. For example, Ford’s announcement of an investment of \$11 billion towards a new assembly plant and three new battery factories are all attempts for these historical names to not lag behind as the world evolves. With innovation at the forefront of mitigating the lasting effects of a climate catastrophe, whether a believer in the ESG craze or not, the markets must reflect their opinion on this type of news.

With pressing concerns from government entities and the consumers alike, the EV market has grown dramatically in size, competing with its internal combustion counterparts. The Electric Vehicle market has a \$1.52 trillion market capitalization as of 2020, whereas the traditional vehicle market (those powered by an internal combustion engine and consumes fossil fuels) has a market capitalization of \$1.47 trillion. With such drastic shifts within the market driven by a combination of non-financial news (e.g., climate change concerns), the average consumer has some responsibility for the increase in such demand. However, they cannot be the sole reason for this market capitalization to completely shift, exhibiting a preference for the electric vehicle. Can investors make sense of how the hype revolving around the electric vehicle industry and its innovations impact an automaker's financial performance?

In order to analyze this relationship, this paper will control the domain of its research by solely observing the nine largest market capitalization automobile makers. This list consists of 7 legacy manufacturers that are beginning to take steps towards a fully electric fleet and 2 Electric Vehicle manufacturing companies that solely create electric powertrains. By controlling the largest market capitalization for these firms, the financial impact of the news around the electric vehicle industry should be most profound in order to exacerbate the impact on returns for the sake of observation.

Research Question

My research question is: how does the announcement of electric vehicle related news impact the daily stock performance of their vehicle manufacturers? Each of these vehicle manufacturers possess press release pages where they house critical information about their recent activity in order to maintain a direct communication with the public and shareholders. Within these Press Release pages are often some sort of ESG related filters (whether it be titled "ESG,"

“Sustainability,” or “Electric Vehicles”) that aggregate all of their announcements regarding their efforts in this space. Each of these announcements are released at particular times, which will allow one to then refer to the firm’s stock price at a given day.

Research Significance

With Greenwashing becoming a prominent element of any industry as a marketing tactic to engage an increasingly socially conscious consumer body, the vocabulary of ESG has been ingrained into every corporate document. From the Corporate Social Responsibility statements to the titles of the Chief Sustainability Officers, with carbon emissions remaining on the minds of all automobile manufacturers, the industry is undergoing a paradigm shift. With legacy manufacturers such as Mercedes-Benz announcing goals for an all electric fleet by 2030 or Toyota investing \$35 billion into new battery technology, it may be worth investigating patterns with these actions and their financial performance.

With the definition of the automobile evolving before the consumers’ eyes, investors should pay attention to such shifts in these promises. Thus, as these firms gear up for evolution, how does the conversation around these topics impact their stock performance?

Key Literature

In order to get an understanding of what researchers have explored about the industry and the potential relationship between the variables in this study, it is integral to do a deep dive into academic literature. Rather than blindly digging through the plethora of sources and journals, identifying key objectives to familiarize myself with in this field to guide my research was most effective. I aimed to understand the potential for emissions related phenomena or ESG performance to have a statistically significant impact on the financial performance of the firm. I also wanted to get a grasp on the forces that catalyze change within the electric vehicle market as

a whole. This would provide a solid foundation for comprehending the types of news to be released by these firms. This is not an extensive list, but rather the most pertinent to the research design of this study.

Omid Sabbaghi's "The Impact of news on volatility of ESG firms" was one of the watershed studies that provided an empirical argument linking ESG principles to financial market performance (Sabbaghi 2022 *Global Finance Journal*). It modeled asymmetric volatility by using market capitalization of ESG related firms. It provided a profound insight into how bad news' release impacts the volatility of the firm's stock price with a larger magnitude of change than good news' impact. What this suggested to the sustainable finance industry was that there existed empirical evidence to link the release of ESG related news and a firm's financial performance. The findings in Sabbaghi's study can be furthered to develop ESG-related investment strategies that weight various ESG style metrics across different industries.

Hélène Pasquini-Descomps and Jean-Michel Sahut published a working paper on "ESG Impact on Market Performance of Firms: International Evidence," providing a nuanced perspective to ESG metric on stock performance by adding a layer of consideration: nations where the firm is located (Descomps, Sahut 2015 *Management International*). Observing firms from the UK, Switzerland, and the US, this paper measured monthly stocks' excess returns in relation to their news-based rating in several ESG categories. What they found was that the ESG score and financial performance relied more so on industry and year rather than widely accepted by every nation. For example, the relationship between these two parameters is deemed neutral or even negative in certain instances within the United Kingdom, but positive within the United States and Switzerland. What this communicates is that not every financial market and sector has

realized the potential benefit of the improvement of ESG rating on their financial performance as certain markets may not reward such firms for their efforts.

François Derrien, Philipp Krueger, Augustin Landier, and Tianhao Yao published “How Do ESG Incidents Affect Firm Value?” in order to observe how the deliverance of negative ESG related news impacted the revisions of the earnings forecasts by analysts (Derrien, et. al., 2021 *SSRN Electronic Journal*). They noticed that there are significant downward trends regarding their earnings forecasts in the short term and even deeper dips in these forecasts in the long term, supporting the idea that ESG related metrics possess a long-term perspective on the firm. Overall, they suggest that the analysts that are most sensitive to this type of news will discount stock prices according to the negative ESG news and as a result will be more accurate in their forecasts as compared to the counterparts that did not take this information into account.

Sulin Ba, Ling Lei Lisic, Qindong Liu, and Jan Stallaert wrote the most relevant piece to my topic with “Stock Market Reaction to Green Vehicle Innovation” in 2013. This study observed how green vehicle innovation from 1996 to 2009 impacted firm stock price (Ba, Sulin, et al., 2013 *SSRN Electronic Journal*). It came to the conclusion that when automakers announce positive environmental news, their stock price will reflect this favorably. However, a major limitation to this study was that the electric vehicle space only accounted for less than 2% of the global automobile market at the time, as compared to the 7.2% of global market sales in the first half of 2021. This paper was also more concerned with the firm size and profitability rather than the type of news that was announced. At the time this was published, the Greenhouse Gas Protocol had yet to fully publicize and circulate the concept of varying scopes of emissions (where the emissions are categorized according to where they fall within the value chain). Thus, as this paper staged the space for the conversation about electric vehicle related news and

financial performance, it remained outdated. Many vehicle manufacturers have recently announced fully electric fleets and the data publicly available about their emissions have increased in volume as well.

Adrian Galvez's and Christiaan Kuiper's "The Effect of ESG on stock prices" was an event study on the S&P 500 and the Environmental Pillar, Social Pillar, Governance Pillar, ESG Controversies, ESG Score and ESG Combined Score (Adrian et. al., 2020). While limited to a single ESG weighted average, they simply observed the time period from 2015-2017. The limit to this study is that many ESG benefits seem to be longer term objectives. However, the research design will serve as an example of an effective event study design.

Brian Jacob's and Vinrod Singhal's "Shareholder Value Effects of the Volkswagen Emissions Scandal on the Automotive Ecosystem" provides an empirical perspective on one of the most infamous carbon emissions scandals in the industry: Volkswagen Dieselgate (Jacobs, Singhal 2020 *Production and Operations Management*). By observing not only the impact that the scandal had on Volkswagen itself, but their suppliers, competitors, and suppliers for other automobile manufacturers, they drew the conclusion that the impact was felt all throughout the value chain. For the 191 direct Volkswagen suppliers within their sample, the mean loss of shareholder value was 2.69% amounting to \$20.09 billion in a market loss value. The suppliers with greater dependence on the revenues derived from Volkswagen activities were subjected to greater losses as a result of the emissions scandal while indirect suppliers of materials did not see a significant impact on their stock performance. This single event exhibits the sheer impact that the carbon related news can have not only on the firm in which the story is about, but rather has network effects that can trickle up the value chain.

Juanhai Ma, Yaming Hou, Zongxian Wang, and Wenhui Yang discuss how carbon emission reduction policies such as electric vehicle consumer subsidies or combustion engine manufacturer tax penalties for excessive emissions in their paper “Pricing Strategy and Coordination of Automobile Manufacturers Based on Government Intervention and Carbon Emission Reduction” (Ma et. al., *Energy Policy* 2021). Thus, key determinants of financial success reflected in market performance amidst legislation in favor of an electric vehicle dominance rely heavily on consumer satisfaction as well as efficiency of the vehicles themselves. Thus, in the competitive landscape pushing the industry towards a fully electric future, this study found that the electric vehicle automakers possess a competitive advantage over their legacy counterparts as their infrastructure is already better equipped for the evolved outlook on the passenger car.

However, the question of whether the materiality of these Environmental, Social, Governance factors impact fluctuations within equity returns remains a debate until this day amongst proponents and naysayers. Costanza Consolandi, Robert Eccles, and Giampaolo Gabbi address this question within their paper “How material is a material issue? Stock returns and the financial relevance and financial intensity of ESG materiality.” While the material issues identified by the Sustainability Accounting Standards Board do not exclusively focus on the carbon emissions of the automobile maker firms, the matrix of materiality intensity was a tool they utilized to determine the financial relevance of these key issues within industries. Thus, the market rewarded firms who aligned themselves with ESG principles and manifested this in their actions through driving stock prices up according to the intensity of their sustainability commitment. While not designed as an event study on news related phenomena, this serves as an indicator that firm value may intrinsically be linked to ESG related strategy. As for the automobile

manufacturing industry, this paper intends to delve into where a particular segment of innovation (e.g. the evolution of the drivetrain from internal combustion to battery powered) could generate similar results). In fact, the SASB Materiality Intensity Index identified that the automobile industry tended

Methodology & Data

Data Collection

In order to evaluate the research question and the relationship between emissions related news and stock performance, an event study will serve to decrypt the puzzle regarding the impact of a triple bottom line. The sample size will be the largest nine public automobile makers by market capitalization as of 2022. Thus, to effectively assess the impact of emissions related news coming from the firm, a consistent source of this news will remain a key determinant of when this type of news has meaningful impact on what is released publicly. The proxy, as a result, will be the mention of a particular set of emissions related trigger words (e.g., “emission,” “carbon,” or “net zero”) in firm transcripts. These transcripts consist of earnings calls, special board meetings, conferences, analyst days, trading statements, that occur all throughout the year. As a result, a mention of any of these trigger words found in any of these key public communication transcripts should realize its impact, if any, into the stock performance accordingly.

Observations within this sample set of vehicle manufacturers date back from October 2006 to March 2022. While the legacy manufacturers have a rich history that the electric vehicle manufacturers may have not established yet, their advancements within the space accrue a denser set of events that contain the trigger words. Thus, the electric vehicle manufacturers may not have had the wealth of history that their legacy counterparts have, but they are rich in events related to carbon emissions.

By utilizing the S&P CapitalIQ database, one will have access to these transcripts and be able to filter out by when each trigger word was mentioned individually. After isolating a particular trigger word, say “emission,” the estimation window will occur fifteen days prior to the mention of this particular term and the post event window fifteen days after will allow for any effects of the potential impact to be realized. Thus, isolating individual terms and different permutations of the mention of one or more of these trigger words, will allow individuals to observe the magnitude of these shifts and whether a fitting model will serve a strong correlation between these phenomena.

Amongst the 3 trigger words selected as proxies for emissions related news, there were 450 observations that were sourced from the CapitalIQ transcript database. Of the 450 observations, 318 of these transcripts had the word “carbon,” 116 possessed the word “emission”, and 16 included the phrase “net zero.” The CapitalIQ database possessed the capability of determining various permutations of the trigger word in order to consider it as an observation. For example, being that the keyword searched for was “emission,” transcripts that possessed the word “emissions” would be extracted as an observation. This allowed the raw data collection to be less rigid and allowed for these proxies to reflect more of natural language in business communication.

To control for the volatility of the market that may be responsible for the fluctuation in stock price, a regression analysis performed on these shifts in stock prices against the CBOE Volatility Index. The CBOE Volatility Index (VIX) will serve as a real-time representation of investors’ sentiments towards risk and stress within the market throughout the following thirty days. With the forward-looking perspective on the market, the VIX serves as a key tool in the study. This

will help to indicate to what extent the shift of the stock prices has been general market trends or whether the mention of these trigger words correlate to these fluctuations.

Data Limitations

Despite the S&P CapitalIQ database being a useful aggregation tool, it lacks the ability of human discretion when it comes to determining when the trigger words are applied appropriately to the transcripts in the correct context. In the automobile industry, the word “carbon” is a key term with various different meanings depending on the context. For example, the woven graphite polymer known as “carbon fiber” possesses the trigger word, despite typically not being brought up in the same context as the firm’s greenhouse gas emissions. Therefore, a transcript of an announcement of the Ford Mustang GT500, a top-of-the-line sports vehicle, may potentially mention the carbon fiber elements of the car and be considered as one of the 318 “carbon” observations. In fact, the suitability of other key terms were brought into question. One may view the phrase “ESG” as another obvious key term to include into the list. However, there were several qualifications associated with this selection for the sake of this experiment. While the topic of electric vehicles obviously fits within the umbrella of ESG, the transcripts that this term filters for do not all isolate EV related news. Plenty of these transcripts veered far away from isolating EV’s and EV related news by incorporating plenty of unrelated topics (e.g. the social and governance concerns of the firms). Not only will this contaminate the sample with various significant yet unrelated observations, it did not add much to the statistical argument. Running preliminary regressions by using ESG as one of the key words, there were not enough relevant observations to even possess a significant argument that deviates from the final conclusions presented in this paper. Ironically, the same remains true for the phrase “Electric Vehicle.” There

simply were not enough observations that included this phrase in order to isolate a relationship with anything statistically significant.

Another consideration may be that emissions related news may not be a perfect proxy for electric vehicle related news. Especially for the legacy manufacturers within the sample size such as General Motors or Toyota, the word “emission” has been a part of their vocabulary since the 1970’s. During this era, the Environmental Protection Agency implemented legislation and standards to circumvent the production of heavily polluting vehicles. The word “emission,” while always concerned with the release of greenhouse gasses into the atmosphere, has not been placed in the same context as electric vehicle innovation until they have become more widely accepted as an alternative to combustion engines.

Additional concerns arise when observing the VIX as a tool to control for market fluctuation and volatility. In the research design, the 15 day intervals between the news events may not align with the dates in which the VIX has aggregated data. For instance, if the event occurs on the 16th of January, 2020, there is no guarantee that the VIX has both the 1st of January and the 31st of January readily accessible within its data set. In order to still determine if these stock prices Stock Price Dates may not be perfectly 15 day intervals, but may rely on the next market open date for data. While a simple solution, it is due to a limitation in the dataset that provided the access to daily VIX updates.

Another consideration may be the limitations of using the VIX, a U.S. based index, as a control for volatility amongst a global dataset. The VIX’s construction is a measure of the price changes within the S&P 500, which aggregates 500 large-cap companies traded on American stock exchanges. However, companies within the dataset such as Daimler AG may be traded on the Frankfurt Stock Exchange. Thus, as the VIX serves as a perfect volatility measure and

control for most of the sample size (e.g., Ford or GM), it may not be a perfectly fitting representation of the volatility of that market. However, as one of the most recognized measures of volatility amongst academics and media alike, its limitations may be a qualification for just a subset of the control regressions.

A final consideration to take into account is that the legacy manufacturers possess a lot more data than the newer EV firms. While an older firm such as Ford has a rich financial history dating back to its incorporation date in 1903, an EV manufacturer such as Tesla has 100 years less history being incorporated in 2003. This became apparent in the single-variate regressions against the control group. With firms such as Ford having 69 transcripts containing the word “emission,” Stellantis only had 25 transcripts with the same trigger. As a result, separate regressions, in addition to those including all firms, were run in order to distinguish between the younger EV firms and the legacy manufacturers to avoid a biased analysis.

Methodology

Gathering Data From S&P CapitalIQ

The transcript tab on the S&P Capital IQ database can be used to scrape throughout all instances of public communication to investors. Searching by keyword would be how one can determine which transcripts contain which trigger word (emission, carbon, and net zero). One will do this for each company and each word, totalling in 27 permutations total. Each instance of the trigger word can be downloaded into a list in order to compile a chronological order of events.

One may also acquire daily stock return data from CapitalIQ dating back to their Initial Public Offering. By downloading this data for each firm, one has acquired all of the raw data necessary for analysis.

Processing Data via Excel

Using simple Vlookup functions, one can determine the stock price of the day of the transcript as well as 15 days before and after the communication. By observing the percentage change from the estimation period (15 days before) and the observation period (15 days after), one will need to determine whether this change is due to the event or another control.

Thus, by downloading the Volatility Index from the Federal Reserve Economic Data site, one can conduct the same event study using the same range from each of the observations, including the percentage change. By running a single variate regression analysis on the VIX change and the stock price change, one can determine whether this change in stock price is due to volatility in the market or whether it possesses a correlation to the presence of emissions related news.

Results

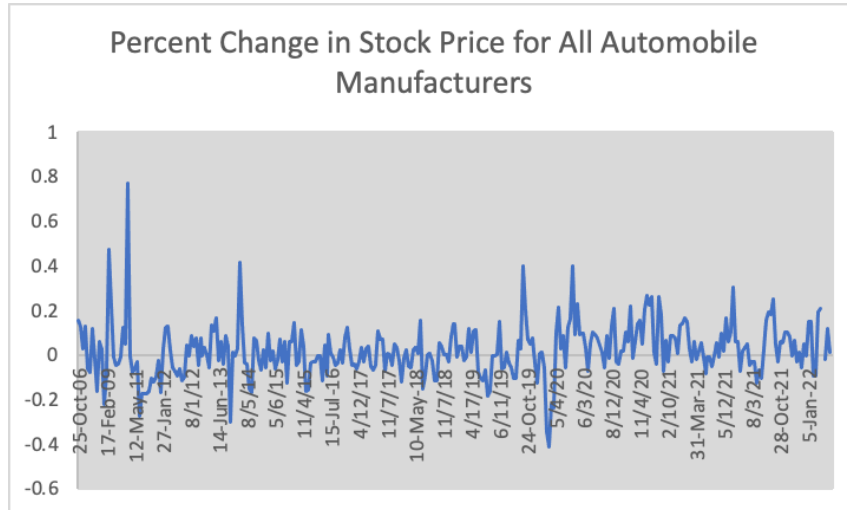
Regression Analysis & Discussion

The trigger words that may be found in the transcripts which may indicate emissions related developments in which the market will react are: emission(s), carbon (dioxide), and net zero. These terms are often plastered all over financial reports and mentioned more frequently in shareholder calls alike. Being that the automobile industry lies at the forefront of a watershed moment in the definition of personal vehicle transport, these terms have integrated themselves into the crucial vernacular of executives and investors.

i. All Automobile Manufacturers: Emission

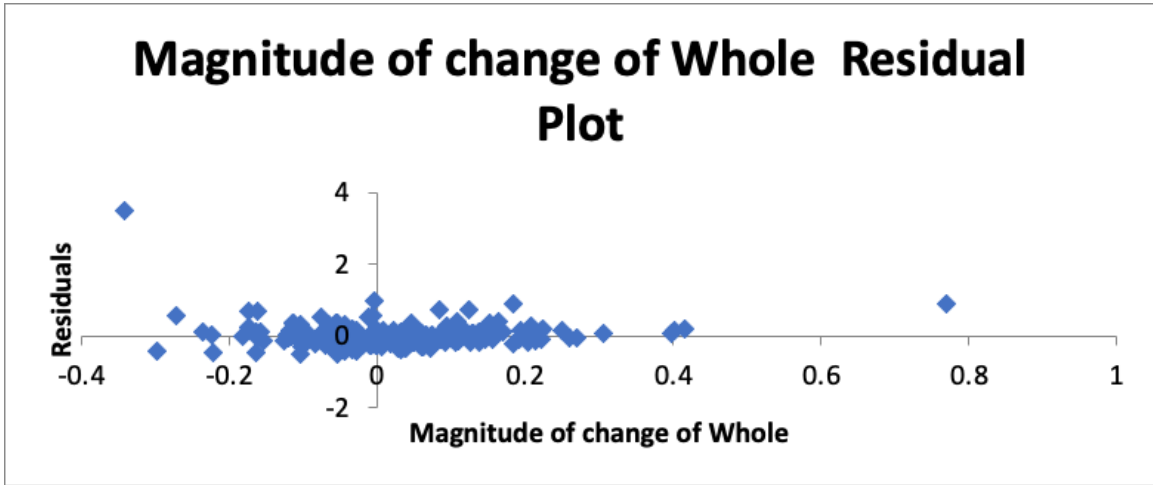
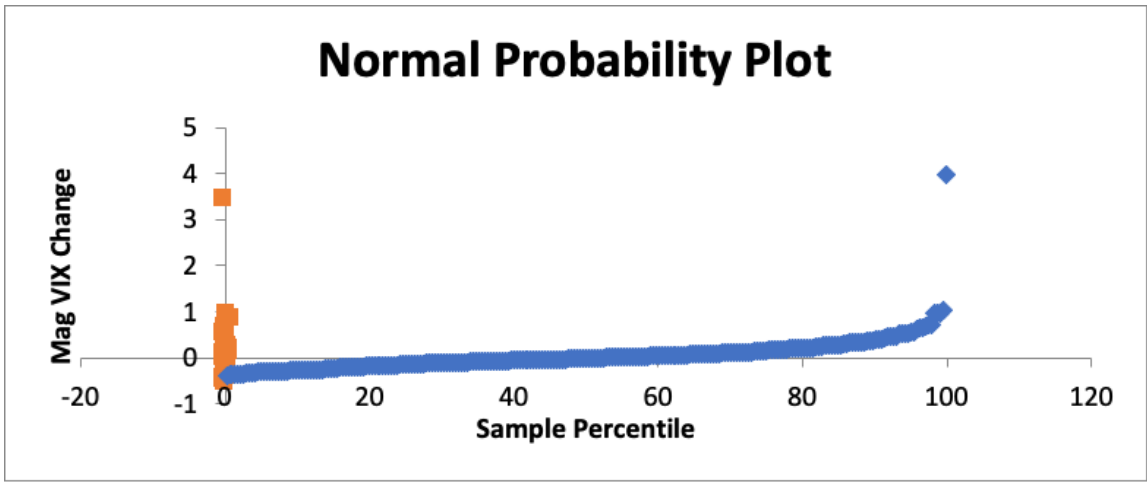
The automobile manufacturers being observed within the subset of the industry have been selected by market capitalization. The manufacturers with the largest market capitalization as of March 2021 are: Tesla, Toyota, Volkswagen, Mercedes-Benz (Daimler AG), Ford, General Motors, Bayerische Motoren Werke GmbH, Stellantis, and Honda.

Amongst these firms, as for the first trigger word “emission,” it was mentioned a total of 319 times over the course of their reported transcripts dating from October 25th, 2006 to October 7th 2021.



Mean	-0.020866119
Standard Deviation	0.120896046
Median	0.010105506

Interestingly, the mention of the word “emission” on average indicates about a -2.08 percent drop in daily stock price realized over the observation period. However, when accounting for the market volatility, one may perform a regression analysis on the magnitude of the shifts in the VIX during the same time periods as the estimation and post event windows of these trigger words. Thus, for all of the manufacturers, the regression appears as follows:



Regression Statistics

Multiple R	0.41901813
R Square	0.17557619
Adjusted R Square	0.17223844
Standard Error	0.32961439
Observations	249

ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	5.71510692	5.71510692	52.6031856	5.2441E-12
Residual	247	26.8354738	0.10864564		
Total	248	32.5505807			

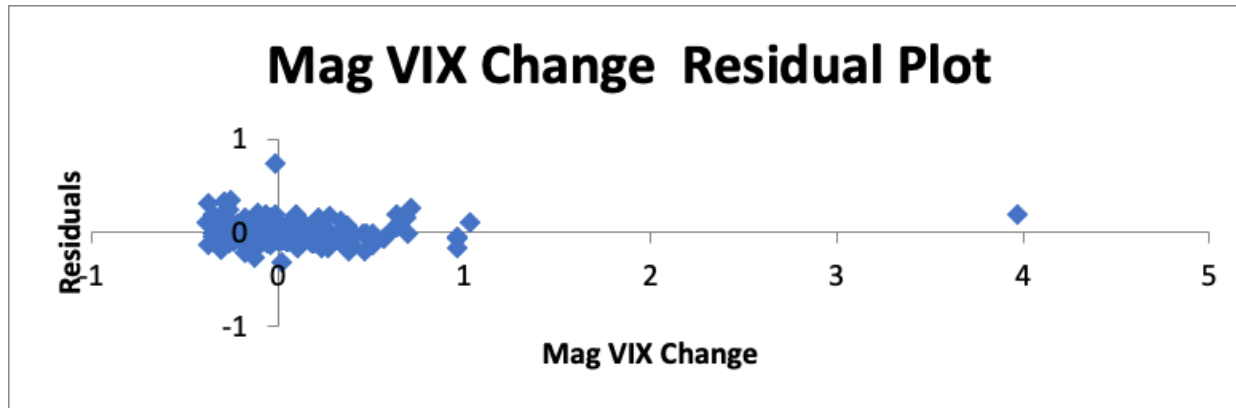
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	0.06997661	0.02117708	3.3043	0.00109	0.02826	0.1116	0.02826	0.111687
Magnitude of change of Whole	-1.2568109	0.17328617	-7.2528	5.2441E-12	-1.598117	-0.9155039	-1.5981179	-0.9155039

With poor R-Squared performance, the shift in stock price after the presence of the trigger word “emission” in the transcript does not seem to be correlated with the general market volatility proxied by the the VIX index. This reaffirms the possibility that the stock volatility observed by the event study may be strongly correlated with the mention of the word “emission” in the transcript.

However, the regression’s t-stats exhibit some explanatory power in of itself. Being that both the P-values are well under 0.05, this relationship, despite the poor R-squared value, has some redeeming qualities. For example, the magnitude of the stock shift every one percent increase of the VIX will drop the stock price 125.6 percent (as the t-stats are within the acceptable threshold). This indicates that there is a very serious consequence for the mention of emissions related news for all manufacturers. Thus, the word emission, as extrapolated from this relationship, typically indicates a phenomenon deeply punished by the market. In context, this may mean that emissions related news, for all manufacturers, typically denote a scandal or any other punishable events. However, placed in the context of reality, this outcome does not seem to be feasible whatsoever. This does indicate that the relationship between this trigger word and the stock price has a relationship that negatively impacts financial performance.

i. EV manufacturers: Emission

Segmenting the largest market capitalization automobile manufacturers into Electric Vehicle and Legacy firms may provide deeper insight as to whether a trend may be observed. Thus, by still observing the same trigger word of emission, the same analysis follows:



Regression Statistics

Multiple R	0.3811889
R Square	0.14530498
Adjusted R Square	0.09782192
Standard Error	0.17285622
Observations	20

ANOVA

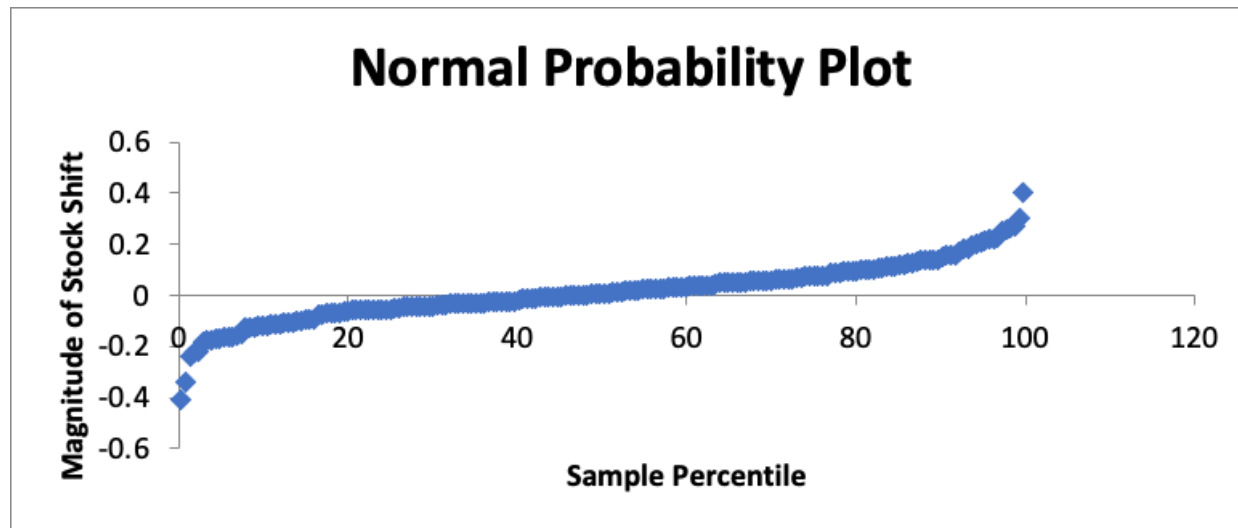
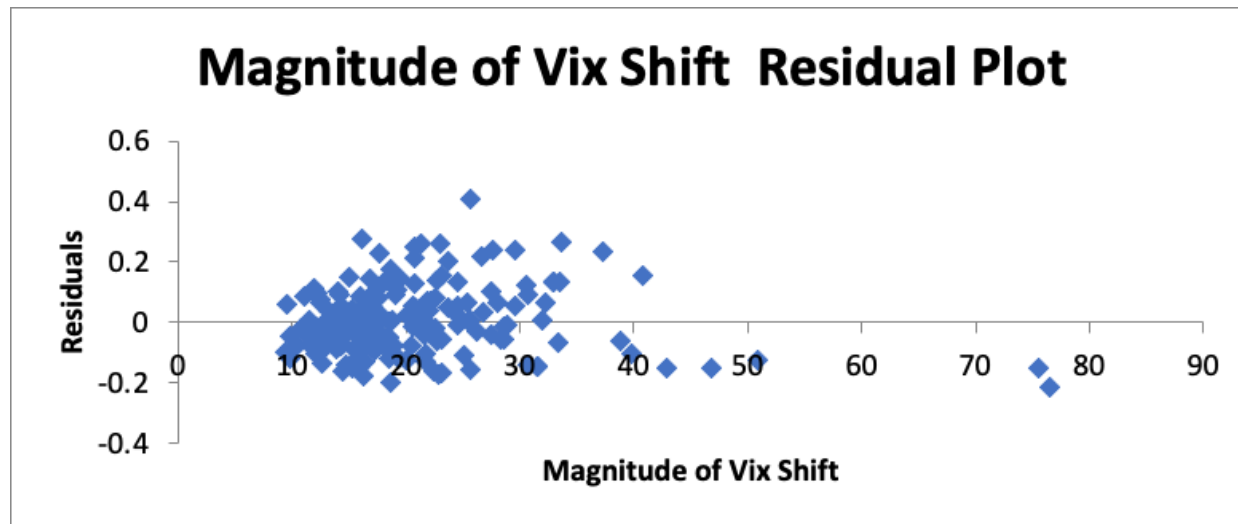
	df	SS	MS	F	Significance F
Regression	1	0.09143487	0.09143487	3.0601437	0.097264
Residual	18	0.53782689	0.02987927		
Total	19	0.62926176			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	0.02635277	0.0070172	3.75545165	0.00021584	0.01253158	0.04017395	0.01253158	0.04017395
Mag VIX Change	-0.1396998	0.01926148	-7.2528054	5.2441E-12	-0.1776375	-0.1017621	-0.1776375	-0.1017621

Also with a poor R-squared value, the shift in stock price after the presence of the trigger word “emission” in the transcript does not seem to be correlated with the general market volatility proxied by the the VIX index. This reaffirms the possibility that the stock volatility observed by the event study may be strongly correlated with the mention of the word “emission” in the transcript. Thus, the same conclusion may stand, albeit with concerns. Being that these EV companies, Tesla and Stellantis are very young firms, the number of times they mentioned the word emission, even before it had an explicit ESG implication, was substantially lower, creating a smaller subset of observations.

However, the regression’s t-stats exhibit some explanatory power in of itself. Being that both the P-values are well under 0.05, this relationship, despite the poor R-squared value, has some redeeming qualities (once again, the t-stats are within the acceptable range determining the coefficients to pose some validity). For example, the magnitude of the stock shift every one percent increase of the VIX will drop the stock price 13.9 percent. This indicates that there is a very serious consequence for the mention of emissions related news for all manufacturers. Thus, the word emission, as extrapolated from this relationship, typically indicates a phenomenon deeply punished by the market. In context, this may mean that emissions related news, for EV manufacturers, typically denote a scandal or any other punishable events. Interestingly, since this is within the electric vehicle subsector of the analysis, it seems to be as punished as the legacy manufacturers, despite having different intercept values

ii. Legacy Manufacturers: Emission



Regression Statistics

Multiple R	0.3002471
R Square	0.09014832
Adjusted R Square	0.08550622
Standard Error	0.10769541
Observations	198

ANOVA

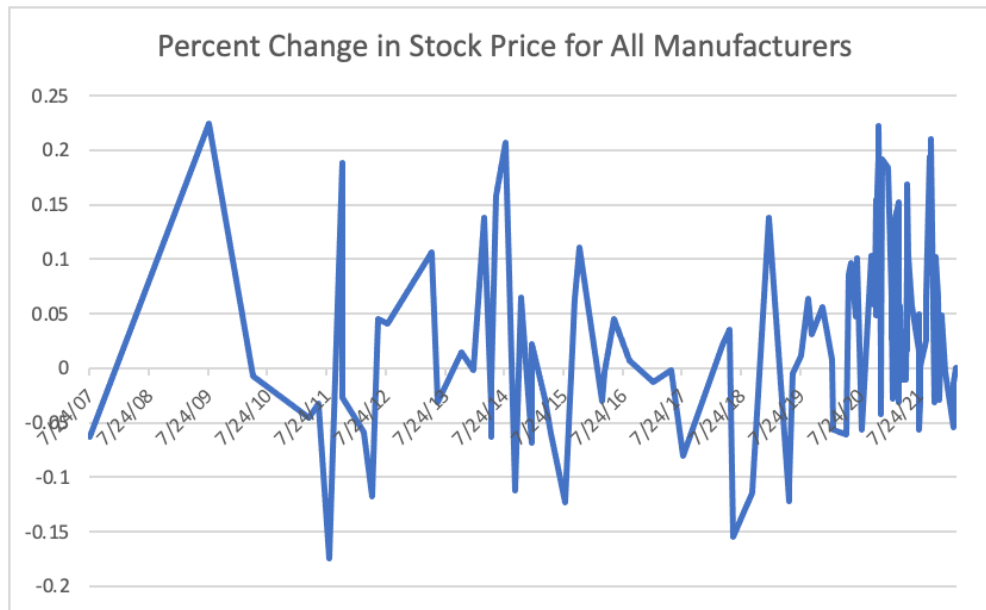
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	0.22523583	0.22523583	19.4197263	0.00001726
Residual	196	2.27326699	0.0115983		
Total	197	2.49850282			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	0.0867108	0.0185656	4.67050432	5.5696E-06	0.05009678	0.12332482	0.05009678	0.12332482
Magnitude of Vix Shift	-0.003684	0.000836	-4.4067819	0.00001726	-0.0053328	-0.0020353	-0.0053328	-0.0020353

With the R-Squared value of .09, the correlation between the VIX index and the percentage change of the stock price remains weak, similar to the other iterations of this regression. Ultimately, using the VIX as a control for this regression suggests that general market volatility cannot explain the shifts we are observing. However, the regression's t-stats exhibit some explanatory power in of itself. Being that both the P-values are well under 0.05, this relationship, despite the poor R-squared value, has some redeeming qualities. For example, the magnitude of the stock shift every one percent increase of the VIX will drop the stock price .003 percent. This indicates that there is a relatively significant consequence for the mention of emissions related news for legacy manufacturers. Thus, the word emission, as extrapolated from this relationship, typically indicates a phenomenon deeply punished by the market. In context, this may mean that emissions related news, for all manufacturers, typically denote a scandal or any other punishable events.

ii. All Automobile Manufacturers: Carbon

Amongst these firms, as for the first trigger word “carbon,” it was mentioned a total of 111 times over the course of their reported transcripts dating from July 24th, 2007 to March 9th 2022.



Mean	0.02943644
Standard Deviation	0.088339257
Median	0.017051386

On average, the mention of the key term “carbon” in the transcript may signify a 2.94 percent increase in daily stock price realized over the observation period. Similar to the regression performed on the data pertaining to the trigger word “emission,” the market volatility must be considered as a potential correlating factor to control for. Once again, one may perform a regression analysis on the

magnitude of the shifts in the VIX during the same time periods as the estimation and post event windows of the word “carbon” found in the transcripts. Thus, for all of the manufacturers, the regression appears as follows:

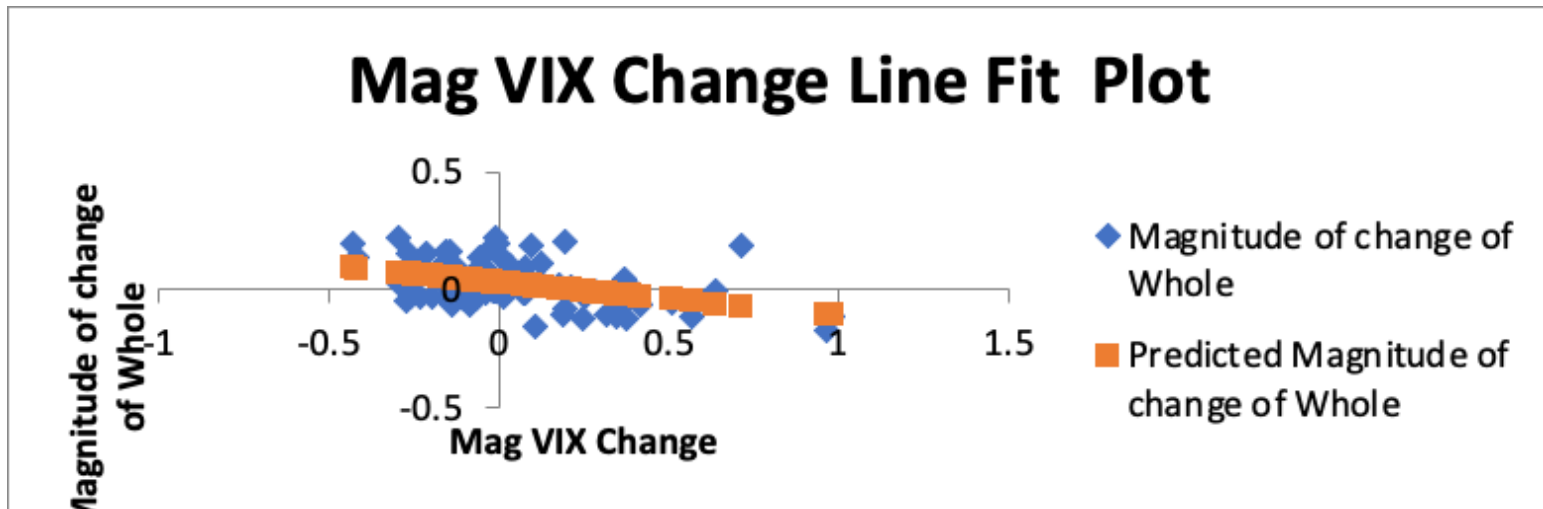
Regression Statistics

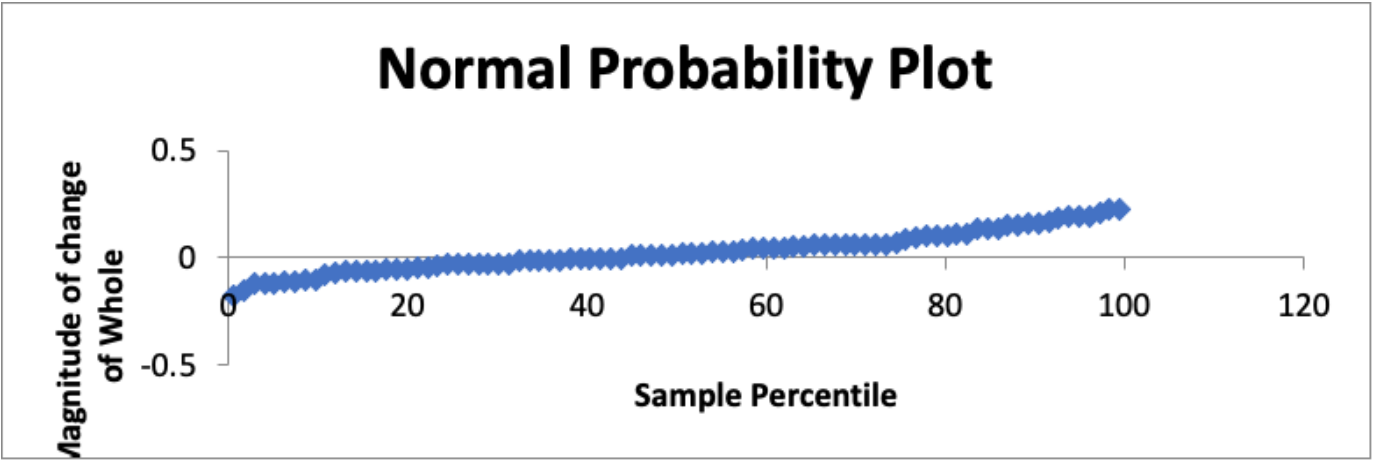
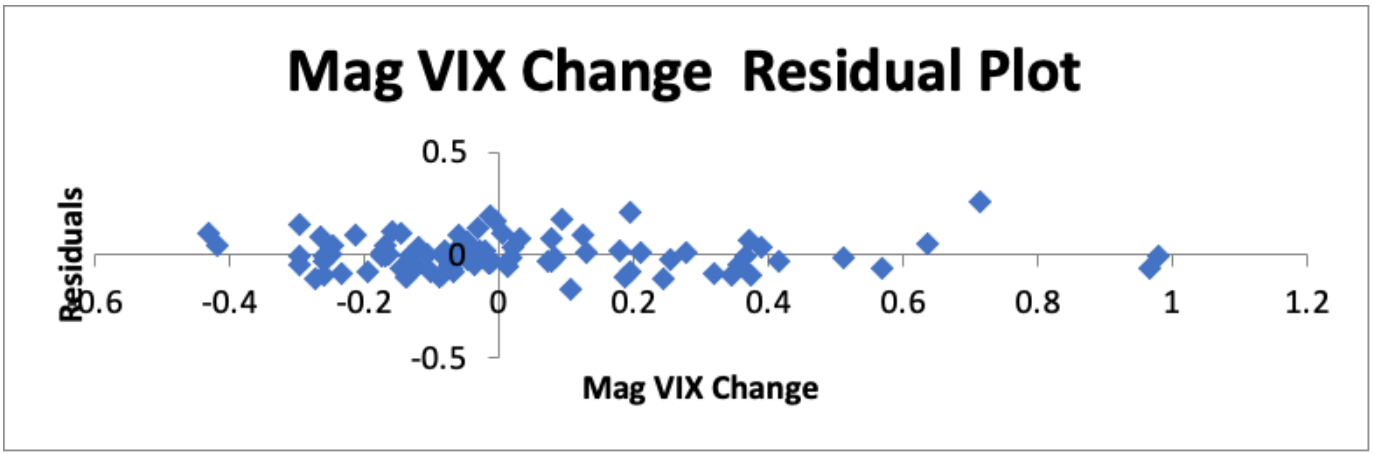
Multiple R	0.42482159
R Square	0.18047338
Adjusted R Square	0.17094401
Standard Error	0.08329927
Observations	88

ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	0.13141078	0.13141078	18.9386297	3.701E-05
Residual	86	0.59673413	0.00693877		
Total	87	0.72814491			

	Standard							
	Coefficients	Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.02998194	0.00892565	3.35907769	0.00116733	0.01223834	0.04772553	0.01223834	0.04772553
Mag VIX Change	-0.1421294	0.0326595	-4.3518536	3.701E-05	-0.2070543	-0.0772044	-0.2070543	-0.0772044





With poor R-Squared performance, the shift in stock price after the presence of the trigger word “carbon” in the transcript does not seem to be correlated with the general market volatility proxied by the the VIX index. This reaffirms the possibility that the stock volatility observed by the event study may be strongly correlated with the mention of the word “carbon” in the transcript. However, the regression’s t-stats exhibit some explanatory power in of itself. Being that both the P-values are well under 0.05, this relationship, despite the poor R-squared value, has some redeeming qualities. For example, the magnitude of the stock shift every one percent increase of the VIX will drop the stock price 14.2 percent. This indicates that there is a very serious consequence for the mention of carbon related news for all manufacturers. It may be that the mention of carbon will inject extra uncertainty into the firm’s plans to either reduce their carbon footprint or similar doubts of the sort.

iii. EV manufacturers: Carbon

Segmenting the largest market capitalization automobile manufacturers into Electric Vehicle and Legacy firms may provide deeper insight as to whether a trend may be observed. Thus, by still observing the same trigger word of “Carbon”, the same analysis follows:

Regression Statistics

Multiple R	0.55620888
R Square	0.30936832
Adjusted R Square	0.22303936
Standard Error	0.1103549
Observations	10

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	0.0436418	0.0436418	3.58359837	0.09498049
Residual	8	0.09742564	0.01217821		
Total	9	0.14106744			

	<i>Standard</i>							
	<i>Coefficients</i>	<i>Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	0.07205614	0.03502717	2.05715	0.07368546	-0.0087167	0.15282894	-0.0087167	0.15282894
Mag of VIX shift	-0.287869	0.1520671	-1.8930395	0.09498049	-0.6385364	0.06279834	-0.6385364	0.06279834

With a similar outcome to the electric vehicle subset regression, there were fewer observations that included the trigger word. Also with a poor R-squared value, the shift in stock price after the presence of the trigger word “carbon” in the transcript does not seem to be correlated with the general market volatility proxied by the the VIX index. This reaffirms the possibility that the stock volatility observed by the event study may be strongly correlated with the mention of the word “Carbon” in the transcript. However, the regression’s t-stats exhibit some explanatory power in of itself. Being that both the P-values are well under 0.05, this relationship, despite the poor R-squared value, has some redeeming qualities. For example, the magnitude of the stock shift every one percent increase of the VIX will drop the stock price 28.7 percent. Out of the rest of the observed relationships in this subsector, this appears to be the least impactful to the financial performance, since the t-statistic does not fall within the acceptable range. Since the EV firms are essentially conscious of their carbon footprint from the essence of their ethos, or at the very least they claim to be, it is possible that the market has already priced this into their stock price, thus resulting in a smaller shift in returns.

Legacy Manufacturers: Carbon

Regression Statistics

Multiple R	0.37604095
R Square	0.1414068
Adjusted R Square	0.13142316
Standard Error	0.07215035
Observations	88

ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	0.07373237	0.07373237	14.1638491	0.00030547
Residual	86	0.44768792	0.00520567		
Total	87	0.52142029			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	0.01591133	0.00775186	2.05258292	0.04315294	0.00050115	0.03132151	0.00050115	0.03132151
Magnitude of Vix Change	-0.1225577	0.03256492	-3.763489	0.00030547	-0.1872947	-0.0578208	-0.1872947	-0.0578208

With the R-Squared value of .14, the correlation between the VIX index and the percentage change of the stock price remains weak, similar to the other iterations of this regression. With both the intercept and the change of VIX having p-values $<.05$, we can say that we are certain that these results are replicable. Ultimately, using the VIX as a control for this regression suggests that general market volatility cannot explain the shifts we are observing. Once again, the t-stats are within the acceptable threshold of -2 to 2. Thus, considering the coefficients, the magnitude of the VIX change when the shift increases by one percent will drop the stock price by 12.3 percent.

iii. All Manufacturers: Net Zero

With only 16 observations for the trigger phrase “Net Zero,” the regressions conducted for the selected manufacturers possess limited useability and accuracy.

Regression Statistics

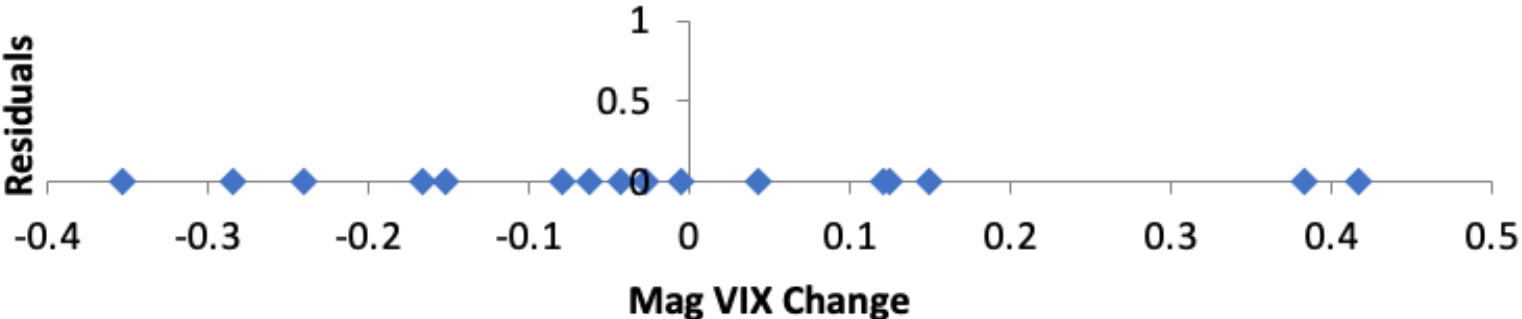
Multiple R	1
R Square	1
Adjusted R Square	1
Standard Error	0
Observations	16

ANOVA

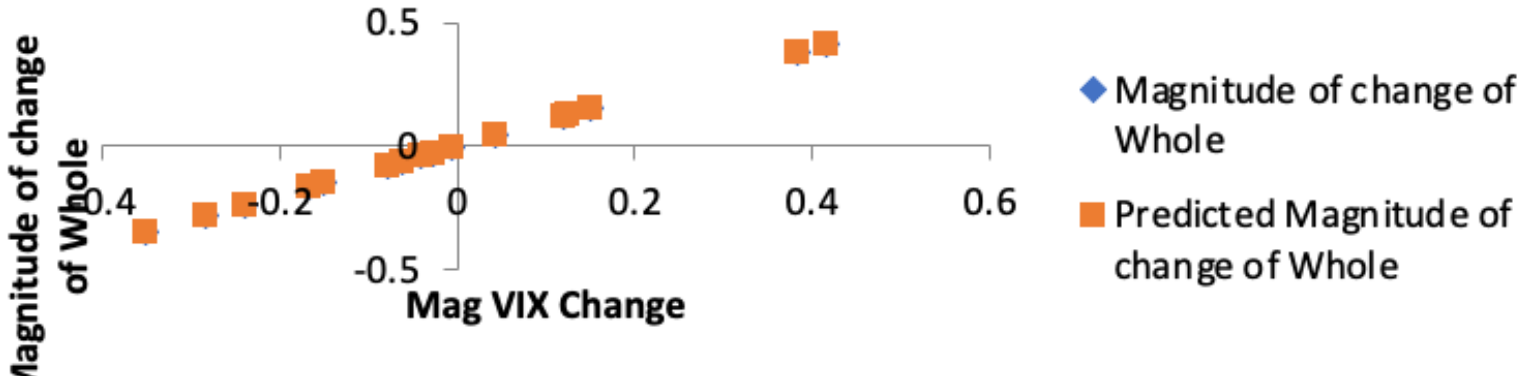
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	0.69945483	0.69945483	#NUM!	#NUM!
Residual	14	0	0		
Total	15	0.69945483			

		<i>Standard</i>			<i>Lower</i>	<i>Upper</i>	<i>Lower</i>	<i>Upper</i>
	<i>Coefficients</i>	<i>Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>95%</i>	<i>95%</i>	<i>95.0%</i>	<i>95.0%</i>
Intercept	0	0	65535	#NUM!	0	0	0	0
Mag VIX Change	1	0	65535	#NUM!	1	1	1	1

Mag VIX Change Residual Plot



Mag VIX Change Line Fit Plot



Thus, it may be inconclusive for this trigger word as a standalone determinant of stock performance with respect to stock movements as a result of the general volatility in the market.

The implications of this regression may be limited. Since the term “net zero” was recently coined in 2009 by a group of scientists that determined the presence of carbon dioxide in the atmosphere contributes to the global warming effect, its novelty shows in the sparse observations amongst the sample size.

iii. All Manufacturers: All Triggers

With various literature suggesting that the intensity of firms’ commitment to a sustainable future reflects favorably in stock price, to see if there is any correlation between the stock returns and the magnitude of the change in the VIX. Such an analysis can provide an insight into whether the emissions related communications are correlated with these returns aside from the market volatility. The regression statistics ran between the stock returns from the observation period and the VIX are as follows:

Regression Statistics

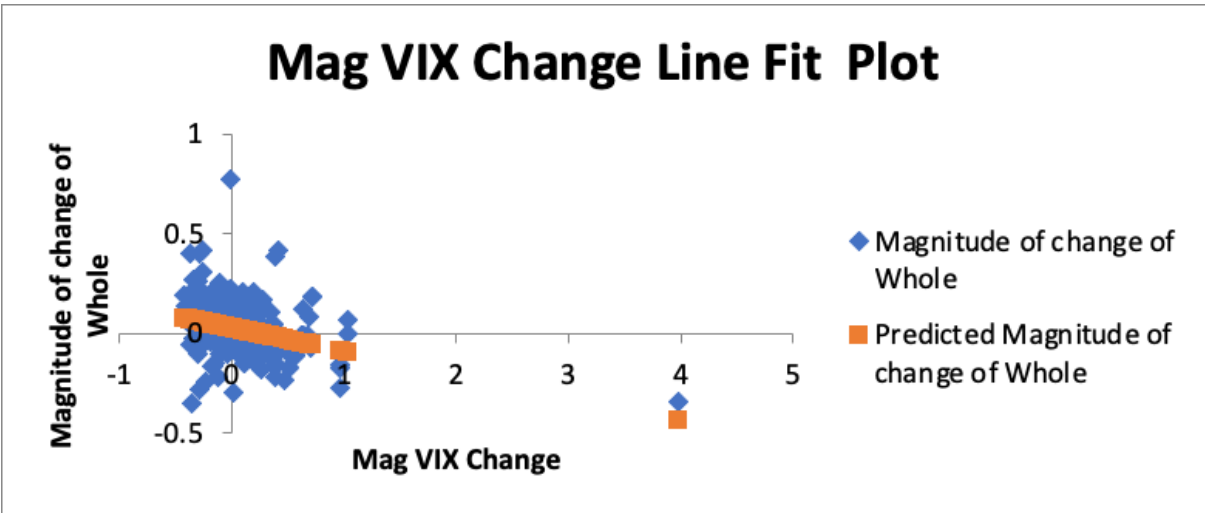
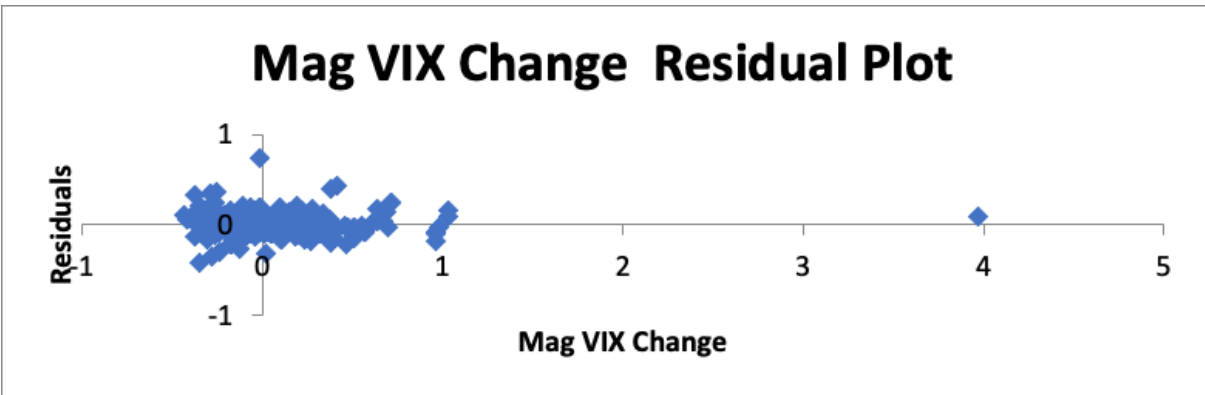
Multiple R	0.33086825
R Square	0.1094738
Adjusted R Square	0.10709271
Standard Error	0.11135733
Observations	376

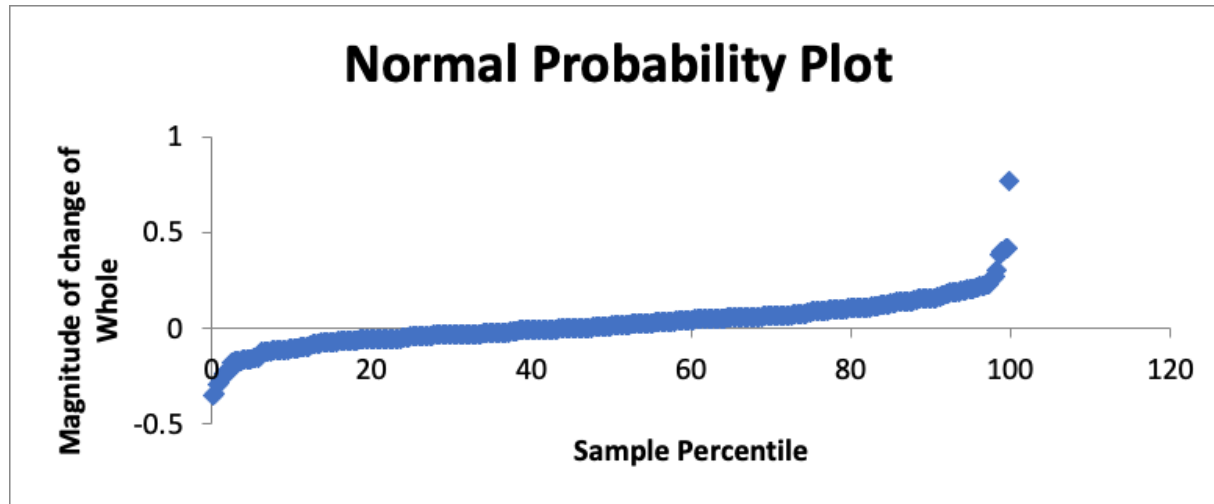
ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	0.57012846	0.57012846	45.9764132	4.6833E-11
Residual	374	4.63777032	0.01240046		
Total	375	5.20789878			

Standard

	<i>Coefficients</i>	<i>Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	0.02633931	0.0057861	4.55217091	7.1911E-06	0.01496194	0.03771667	0.01496194	0.03771667
Mag VIX Change	-0.1163477	0.01715894	-6.7805909	4.6833E-11	-0.1500878	-0.0826076	-0.1500878	-0.0826076





With an R-squared value of .109, an adjusted R-squared value of .107, and p values lower than .05, it may be assumed that a linear relationship between the stock returns amongst the events observed does not fit. Although this cannot prove that these emissions related news causes these fluctuations, the lack of a correlation between the presence of any of the key variables eliminates general market volatility as a primary influence for stock returns presented. However, the regression's t-stats exhibit some explanatory power in of itself. Being that both the P-values are well under 0.05, this relationship, despite the poor R-squared value, has some redeeming qualities. For example, the magnitude of the stock shift every one percent increase of the VIX will drop the stock price 11.6 percent. Since all of the firms were considered in this analysis as well as all of the trigger words, this can be utilized as a way to conclude the overall relationship observed between EV related news and financial performance. It appears that there is an additional 11.6 percent of unexplained volatility per percentage of change within the VIX. Thus, this can be observed as potentially having some sort of relationship with the independent variable being observed. The impact that this type of news may have on these firms' financial performance is great with a magnitude of 11.6 percent, thus indicating that this relationship is indeed something to take note of. It will be worth noting that additional controls may need to be added to isolate simply the marginal volatility caused by EV news, but for the sake of the study, the VIX isolates the firm's volatility, the market capitalization keeps size in control, and the subdivisions of this analysis keeps the types of firms constant.

Additional Considerations

According to the regression for Electric Vehicle firms that use the word "carbon," this had the strongest correlation to the returns of the VIX with an R-Squared value of 0.195 and a Multiple R value of .442. However, these values denote that the linear relationship between the variables

is still very weak. Thus, with all permutations of the trigger words and the selected firms (EV, Legacy, or both) it appears to be that general market volatility within the S&P 500 does not have a strong linear correlation with the returns from the news events. Thus, by controlling for market volatility in addition to screening firms for largest market capitalization, and subsectors, it may appear that these returns are poorly correlated with the control group. As a result, this subgroup of Electric Vehicle firms' news with the term carbon in their transcripts has the strongest correlation to the VIX, which may suggest that market volatility possesses relatively more explanatory power than with other scenarios. However, since the regression is weak altogether, it still does not serve as a great explanation for these changes in stock returns.

In contrast, the regression model that had the worst regression suggesting the more explanatory power that these news events had on stock returns was the legacy manufacturers with transcripts containing the word "emission." With an R-Squared Value of .09 and a Multiple-R squared of .3, this relationship proved to be the weakest in the study. Thus, emissions related news for legacy manufacturers serve as the strongest explanatory relationship than any other pairing in the study. This could be placed in context of the types of news that legacy firms release regarding their emissions. For example, July 2021, Mercedes-Benz was being sued for cheating their emissions measurements on their OM651 diesel engine, causing them to put 1.6 billion euros aside for potential claims (forbes). This type of news can certainly cause precipitous drops in stock prices as any type of scandal, whether emissions related or not, is not reflected favorably in the eyes of investors. However, speaking on average, July 2021 was a positive month for global equities with the S&P 500 (while not a global index can still deem itself as a proper proxy for this example) produced a total return of 2.38% (wstam). Thus, it appears that

the changes in the stock prices for legacy manufacturers when news regarding emissions is released tends to be unrelated to what the market sentiment appears to communicate to investors.

Developing a trading strategy solely on news may be unreliable and inaccurate. However, these results exhibit general trends that use news as general indicators as to the magnitude and direction of the stock price shifts. Especially referencing the regressions with the weakest correlations to the VIX, these may have the strongest explanatory reasoning as to why these stock prices move in the direction they do.

Limitations and Future Research

To broaden the lens of the event study, it may be worthwhile to observe if other trigger words are statistically significant explanatory variables for these fluctuations in stock prices. The words and phrases “emission,” “carbon,” and “net zero” are the most relevant indicators that the news was most likely about their carbon dioxide emissions. However, what if the study was to be expanded not only to automobile manufacturers' impact on their environment, but their social and governance impact as well (other elements of the SASB ESG materiality framework) (SASB.org)? Such a study could produce a valuable insight as to which element of a firm’s ESG proposition could deem itself most significant to the fluctuations in stock returns.

The design of this study allows one to explore the impact of time sensitive events on any element of a firm's financial performance. Therefore, instead of the emissions related news, one could substitute the independent variable for the release of various vehicle models (e.g., any of the new Mercedes electric fleet for example). This will hone in on specifically market sentiment towards the electric vehicles released rather than any emissions related news. A benefit of this could be that this will eliminate any noise that the data could produce by including adjacent

topics such as emissions scandals, but the lack of frequency of the release of these vehicles will serve as a limiting factor to sample size.

A flaw in the design of this study was embedded in the efforts to control for the market volatility and isolate the explanatory power in which the independent variable has over the outcome of the experiment. By running a regression of the returns against the VIX, it may be possible that some of this stock price change may be embedded in the volatility that was neutralized by the analysis. In other words, it is hard to determine where the marginal volatility begins and how to divorce that from the volatility of the market. Thus, this detracts from the accuracy of the analysis of the t-stats and R-squared values as it is unsure whether controlling for the VIX has eaten into some of the returns or not.

Overall, the use of simply nine manufacturers, while controlling for the largest market capitalization to get the largest impact on the market, provided a very small sample size skewed towards the legacy manufacturers. The electric vehicle market, as explored by this study, is a very new industry that is heavily concentrated in the few firms that have made the largest strides to progress the innovations. The dichotomy between the legacy firms and the electric vehicle firms is not a perfect comparison. Not only are their strategies, capital structure, and objectives different in regards to EV's, but also the sheer amount of data available for each of the firms differs as well. As exhibited not only by the R-squared and t-statistics of the regressions run for the electric vehicle market, but also by the simple number of observations in the EV space alone, the data is very sparse and limiting. The nature of the industry as it stands currently is novel in everything from its development to its nomenclature (evident by various firms using different terminology in their individual transcripts). This severely limits the extent in which simple linear

regression can capture some explanatory power in the relationship observed by a sheer lack of data that inhibits accuracy of conclusions.

Another expansion of this study could be adding additional control groups that could potentially possess an impact on the stock performance of these automobile makers. For example, another potential control could be to run regressions of these stock returns to see if within the observable period, oil prices correlate to any of these performance changes. By using WTI Spot prices, for example, one may be able to determine if the price of oil has an impact on whether these news stories truly have the influence on the financial performance of these firms.

If possible, developing a trading strategy by utilizing this type of analysis could be a useful tool in the future. Since news relating to emissions tends to be a hot topic, rather than simply using regressions to rule out the correlation of controlling variables, finding a predictive relationship could serve as a powerful tool to extrapolate the direction and magnitude of stock performance shifts.

Conclusion

From this study, the mention of electric vehicle related news seems to have some explanatory influence over stock price fluctuations. Legacy manufacturing firms' news releases containing the word "emission" possessed the weakest correlation with the general market volatility; it appears that this type of communications has the strongest impact on price performance. On the other hand, electric vehicle firms with the word "carbon" presented within their news statements had the strongest correlation relative to the other permutations of the regression. While not strong enough to declare that the general market volatility is correlated with these stock returns, it still suggests that this relationship has the weakest explanatory power. Depending on the type

of firm and the type of news being released to the public, the relationship between the control group and the experimental variable varied.

With the phrase “net zero” being a relatively new term being adopted into the vocabulary of all firms, there are the least observations collected amongst the largest 9 automobile manufacturers by market capitalization. Thus, as the discussion of “net zero” emissions becomes less promissory and more proactive, it will be safe to assume that this type of analysis may be revisited. This will especially be more relevant when these deadlines that the firms announced expire within the next decade.

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