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THE EFFECT OF TECHNOLOGICAL ADVANCEMENTS IN ARTIFICIAL  
INTELLIGENCE AND AUTOMATION IN STOCK VALUES

AFONSO VICENTE DA CRUZ  
CAMACHO

Work project carried out under the supervision of:

Giorgio Ottonello

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## Abstract

With Artificial Intelligence (AI) becoming ever more relevant in today's world, it becomes pertinent to study and understand the relationship between advancements in this field and the stock value of companies that are, in some way or another, invested or investing into it. I discovered that AI advancements influence stock returns, and the most telling sector in which this occurs is the Energy industry. Software and Utilities show a lesser influence from this matter. In the end we conclude that AI advancements are relative but influence Software and Energy the most and tentatively influence Utilities.

## Keywords (minimum of four)

- AI (Artificial Intelligence)
- GenAI (Generative Artificial Intelligence)
- AI announcement
- Event Study
- Stock Prices
- Technological Advancements
- CAR (Cumulative Abnormal Result)

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## **1 Introduction**

Investment into Artificial Intelligence and Automation and its usage has been growing at an incredible pace. It is estimated that Generative AI is boosting sales from segments within the technology industry (such as software, hardware and gaming) by a compounded annual growth rate of 43%. Generative AI is also expected to create \$1.3 trillion in revenue by 2032 and amount to 10-12% of total tech spending, which is a substantial increase from its value of less than 1% as of 5<sup>th</sup> of March 2024. (Singh, Rana, 2024). Due to the attention that AI is getting and its current importance in several industries, the most affected of which being the Tech industry, I thought relevant to study the impact of technological advancements in Artificial Intelligence and Automation on the stock value of companies which take advantage of this technology. This study will be mostly focused on industries that heavily invest into Artificial Intelligence, as I believe the results will be more reliable. Nevertheless, I will also be comparing this effect to the effect that these advancements have on industries not so invested into AI, so as to understand if these companies would also benefit from increased usage/spending on Artificial Intelligence. Throughout this thesis, I will be following a predetermined empirical methodology in order to infer on my initial question. However, there currently is an issue with information regarding investment on AI, that is, the lack of it. Therefore, this thesis will be based on event studies, such as the launch of ChatGPT in 2023, using these advancements as a proxy for AI firm investment. In this regression, I evaluate the impact of these events on company stock returns using the Fama-French three-factor model. This model incorporates additional risk factors beyond the market, specifically size (SMB) and value (HML), to provide a more comprehensive analysis of expected returns. As a next step, this model will be estimated and tested (e.g., using the Z-test). The thesis will also include an

analysis of the estimated coefficients and their statistical significance, as well as the socio-economic implications of the findings. These implications include moral considerations surrounding the usage of artificial intelligence. To conclude, I will summarize my findings and discuss the potential limitations of this research.

## **2 Literature Review**

By now we have already established that AI has been gaining more and more attention, and it is predicted that, by 2032, Generative AI spending will account for 10-12% of all tech spending. This is an impressive feat. However, as previously stated, the impact of AI spending/usage on firm value is rarely discussed. Nevertheless, it has been observed that AI investment announcements come with a negative impact on firm market value. Furthermore, it has been shown that AI investment provides significant positive abnormal returns in most companies. However, negative abnormal returns are observed for companies with weak IT capability, financial healthiness or that are present in non-manufacturing industries (Lui, Lee, & Ngai, 2022). There are a few lacks within this publication, mainly being that this study only accounts for U.S. publicly listed firms. My paper will go a step further and account for firms outside the U.S. diversifying possible country-specific risks, providing a broader assessment of AI investment impact on firm market value. In this sense, advancements in the field of AI will be used as a proxy to AI investment, meaning that this study assumes the target companies, in this case operating in industries which heavily invest or rely on AI, are investing in/working with AI. In addition, using this as a proxy allows the study of the market value variation for companies in other industries, which are not so dependent on AI. Moreover, instead of firm specific announcements, this paper will focus on market wide AI advancements. This means that, all the while still being an event study, and despite there being the negative aspect that the study won't be as accurate, the paper will be able to take into consideration more firms, diversifying away firm specific factors.

Other studies have also concluded the usage or investment in AI, such as the hiring of AI trained workers (Babina, Fedyk, He and Hodson, 2024), to bring positive growth for the company. Regardless, this thesis aims to measure the actual market value return of the usage of AI (as a company using AI, they would need to previously invest in AI), by using major AI advancements as a proxy to actual investment data and analyzing the impact on several different companies within AI heavy industries. The hypothesis here is that advancements in the field of AI will indeed bring positive returns for companies in AI heavy industries. Comparing, these abnormal returns should deteriorate, possibly even going into negative numbers, for companies in not-so AI reliant industries, which would imply these companies should further invest in Generative Artificial Intelligence (GenAI) and automation.

### **3 Empirical Methodology**

In order to infer on the impact of technological advancements in AI and automation on tech stocks and other industries, doing event studies on major advancements within this field, I first needed to choose which events would be more relevant for this study. I chose a relevant time-period for AI, in this case, the last 6 years, as prior to that there is not sufficient data for the events to have a meaningful impact within this study, as many companies have only started adopting AI in recent years. Afterwards, I chose events that were more relevant for stock performance study, rather than political discussions (such as discussions regarding ethical implications of AI usage surging with the emergence of deepfakes). As one would expect, the last 3 years have had significantly more events than later years, as these were the years that showed the largest breakthroughs for AI and automation. This study will consider four different events, the first being the release of GPT-1 in 2018, then AlphaFold's victory in 2020, the launch of GPT-3.5 in 2022 and finally the launch of GPT-4 in 2023. Moreover, I chose 3 different industries to analyze in this study. The first industry is in the top 2 leading industries in AI investment as % of Revenue, which is the software industry. Afterwards, I

chose 1 industry who ranks in the middle of this ranking, Energy, and finally, 1 industry that ranks at the bottom, Utilities (Shah, Moss, Samadhiya, Israel, 2023). Additionally, the chosen companies not only differ in industries, but also vary in size, geographical location and overall performance. This sample of companies and industries ensures a more robust analysis, by analyzing and comparing performances from companies with vastly different characteristics.

The next step was to clean and process all the data, which meant getting rid of missing data or data with inaccurate values and structure it by industry. This data was obtained using Compustat from WRDS. In addition, I obtained data from yahoo finance (using Stata's getsymbols function) for the market indexes that best explained each industry's stock performance. Following, I outlined the dependent variable (stock return, which will be the abnormal return during an event study), and the independent variables, which include event dummies, that is, variables which return a value of 1 for an event period, and 0 otherwise.

Then, I defined how long the period for the estimating and the event windows should be (100 observations for the estimation window and 5 observations for the event window. I'm using observations rather than days due to missing dates caused by the closing of markets. Whenever I say 100 days, keep in mind the meaning is 100 observations, due to the prior reasons).

Moving onto the calculations, to assess the impact that such events have on firm stock returns, I employed the Fama-French three-factor model. The Fama-French model is an adjustment over CAPM (capital asset pricing model) which considers market risk and two other factors—size (SMB, small minus big) and value (HML, high minus low)—thus making it a more accurate estimator of any stock's expected return. Thus, the first step here was to generate abnormal returns, or the expected return of any stock in a bubble, without consideration of the expected shocks from the forthcoming happening or announcement. These abnormal returns are what the stock should be doing without any significant artificial intelligence (AI) achievement or scandal during the relevant event windows. The equation to

determine normal returns via the Fama-French model is:  $ER_{it} = \alpha_i + \beta_{MKT,i} * RM_t + \beta_{SMB,i} * SMB_t + \beta_{HML,i} * HML_t$ . In this case, I will describe in this next paragraph what each of the used variables are:

$ER_{it}$  = expected return of stock i at time t (i.e. the normal returns);

$RM_t$  = return of the market portfolio at time t, calculated through the relative indexes of each sector;

$SMB_t$  = size factor at time t, meaning the return spread between small stock portfolios and large stock portfolios.

$HML_t$  is the HML factor at time t, representing the return differential of value vs. growth stocks.

$\alpha_i$  is the alpha term signifying the return to the stock regardless of the model's factors.  $\beta_{MKT,i}$ ,  $\beta_{SMB,i}$  and  $\beta_{HML,i}$  are the factor loadings (betas) of stock i to the market, size and value factor, respectively. Using these more accurate assessments relative to each industry increases the chances that the model reflects the accurate socioeconomic realm of each sector. Estimation of the parameters  $\alpha_i$ ,  $\beta_{MKT,i}$ ,  $\beta_{SMB,i}$ , and  $\beta_{HML,i}$  occurs with a 100-day estimation window per firm, which is standard for this type of event study, and occurs over all trading days prior to the event window to eschew any influence felt from the merger at hand. 100 days is a sufficient sample that is not so far removed in the past that any subsequent historical assessment would render these findings irrelevant. Once I projected normal returns, I then sought to calculate abnormal returns (AR) throughout the event window. Abnormal returns are calculated by taking the in-event return and subtracting the return that would have been the prediction from the Fama-French model:  $AR_{it} = R_{it} - E_{rit}$ , Where:

$R_{it}$  is the return of stock i at time t.

ER<sub>it</sub> is the expected return of stock *i* at time *t* as generated by the Fama-French model.

The event window spans five trading days: two days before the event (*t*-2), the day of the event (*t*=0), and two days after the event (*t*+2). This creates a neutral situation of all expected benefits/losses anticipated beforehand from previous news and afterwards, as trading in response to AI news events should be corrected as soon as possible. Then I assessed the Cumulative Abnormal Returns (CARs) to determine the significance of each event over the five-day event window: Because the CAR is the sum of the abnormal returns in the event window, it's a comprehensive measure of stock performance influence. Therefore, by assessing CARs at the firm and industry levels, I could assess the ranking of which industries were most affected by AI advancements and then determine if firms within those industries were differentially impacted as well. To determine if CARs were statistically significant, a Z-test was employed. The Z-test establishes whether a firm's CAR is significantly different than zero by assessing the standard deviation of the abnormal returns during the estimation window:

$CAR_i = \alpha_i + \beta_i R_{RM} + \epsilon_i$ ; where:

$\epsilon_i = CAR_i - \beta_i R_{RM}$ .

$AR_i = CAR_i * (\text{realized return} - \text{expected return})$  where:

expected return =  $CAR_i - AR_i$ .

A two-tailed T-test was performed at the 5% level of significance ( $|t| > 1.96$ ). CARs are deemed statistically significant if this is the case, meaning that the AI-event did affect pricing. Thus, positive significant CARs reflect a positive aggregate sentiment about the news, which means that AI advancements are generally seen by investors as something positive for the company, leading to an increase in the stock price of the company, while negative significant CARs reflect a negative aggregate sentiment, which means that AI advancements are generally seen by investors as something negative for the company, leading to a decrease in the stock

price of said company. Ultimately, I assessed the results on an industry level. I aggregated the CARs of Industries (Software, Energy, and Utilities) to see if any particular industries were more or less affected by the AI news. I also assessed the average CAR per industry per year as a way to showcase the overall industry effects of the AI advancements. Furthermore, I also constructed a table of the percentage of statistically significant CARs by Industry and the average CAR by Industry to understand how different Industries responded to the news of AI and whether there would be a generally positive or negative sentiment for future expectations. This method creates a strong framework on which to evaluate the connection between subsequent developments about the company and the industry, stock price movements, and subsequent advancements in AI and vice versa.

#### **4. Findings Discussion**

In this first part of my findings' discussion section, I will be discussing the actual impact of events on industry returns. The results of this research indicate that AI events' CARs depend on the industry. For the most part, each industry goes in a different direction as an inverse reaction to the AI event, finding that AI is a strong manipulator of stock market activity in the Software, Energy, and Utilities Industries. This section details the comparative propensity of each industry to be affected by such AI events, including the CARs' associated level of significance and other generalizable conclusions from such investor and market behavior.

For this section of my discussion of this thesis' findings, I will be talking about the significance of the events. More specifically, I will further elaborate on the level of significance of the CARs by industry. In the end, the findings of the study support an industry response to AI advancements, as supported by the levels of significance of CARs, as seen in the table below.

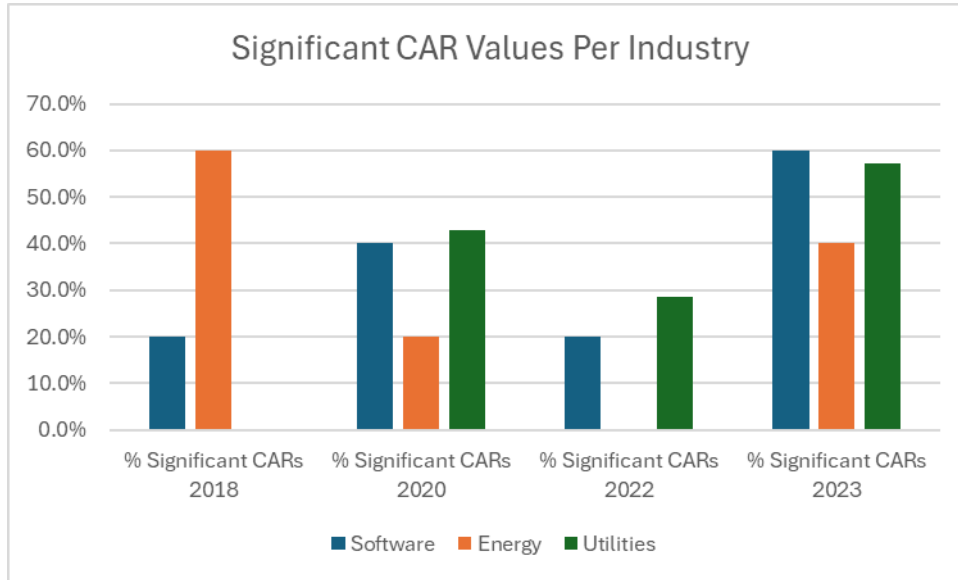


Figure 1 - Percentage of Significant CAR values Per Industry Per Event

Overall, the Energy industry responds more to these advancements, that is, this industry's CARs are more frequently significant, than the Software and Utilities industries. This makes sense since the Energy industry, as previously stated, is somewhat invested into AI, all the while not being on the cutting edge of Artificial Intelligence developments compared to the majority of other industries, which provided, along the years of this analysis, a higher movement in stock price. However, the comparison across each event of the levels of significance relative to CARs per event per industry, over time, proves to be somewhat different. In a generalized way, over time, that is, as events go by, there are more and more statistically significant CARs. This could suggest a higher adoption of AI from several companies across the time period of this analysis. Moreover, this holds true in an almost overwhelmingly way for the Software Industry. An example of this is the fact that the Software sector's significant values showed an increase during the analyzed time period. In addition to this, there is a notable difference in CARs gaining significance based on industries. The significance of the CAR for Software rises to a significance greater than that of the Energy or

Utilities sectors. Nevertheless, I alert that, despite the truthfulness of my previous comment, it is also true that the Energy sector kept high significance levels, all the while remaining at a higher stock price increase (the Software sector showed many negative significant CAR values, and the significant positive values were lower than those of the Energy industry). Taking a look into the average CAR per industry per event, we can see that the Energy sector actually has the highest average CAR spanning across all the events, whether the average is positive or negative, the Energy sector always has the highest average CAR. However, this is not accounting for the significance of the CARs. The industry that shows the highest significance, in general, is the Software industry. Adding to this, this industry also shows a relatively strong performance when it comes to the average CAR value for the companies evaluated, as seen in the tables below.

	Average CAR 2018	% Significant CARs 2018	Average CAR 2020	% Significant CARs 2020	Average CAR 2022	% Significant CARs 2022	Average CAR 2023	% Significant CARs 2023
Software	-0.3%	20.0%	-1.8%	40.0%	1.6%	20.0%	1.0%	60.0%
Energy	1.1%	60.0%	-0.7%	20.0%	3.3%	0.0%	3.1%	40.0%
Utilities	-0.3%	0.0%	-0.9%	42.9%	1.4%	28.6%	0.5%	57.1%

Table 1 - Average CAR Value and Percentage of Significant CAR Values Per Industry Per Event

	2018	2020	2022	2023
Software - Positive	0.00%	0.00%	4.09%	4.22%
Software - Negative	-3.23%	-2.23%	0.00%	-2.65%
Energy - Positive	6.46%	0.00%	6.89%	6.70%
Energy - Negative	-4.15%	-3.89%	0.00%	0.00%
Utilities - Positive	0.00%	0.00%	0.00%	5.10%
Utilities - Negative	0.00%	-2.88%	0.00%	-3.98%

Table 2 - Average Significant Positive CAR Value vs Average Significant Negative CAR Value Per Industry Per Event

Furthermore, during this research I also examined the directionality of CARs across sectors and events in order to perform a sentiment analysis. A positive (and significant) CAR value indicates that an advancement within the field of AI is positively viewed by investors and will

hence lead to an improvement within the company in question, which ultimately means that the company is now valued above the value pre-advancement, leading to additional investment by the market, hence an increase in price for the company's stock. This reaction will be reversed in case the CAR value is negative. As one would expect, there are positive CARs and there are negative CARs. For the Software industry, the significant highs are not so high as to doubt their veracity, and the lows are not so low as to believe there is something else going on. Furthermore, realistically, given the high amount of investment in AI within this sector, it makes sense that this is the sector with the most positive CARs by events (in percentage terms, that is, positive CARs across the number of companies analyzed, and taking into account the significance of CAR values), which would indicate that, over time, investors had continuously felt more positive about AI's potential to change this sector for the better, which would follow my initial supposition that the Software industry would show a positive relation towards AI advancements, as this is an industry known for heavily investing in and taking advantage of advanced technologies, such as the case of AI. However, we see that the Energy sector shows the highest positive significant values, and the highest number (in percentage terms) of positive significant CAR values. Given the small sample size, this is **not enough** to conclude that, overall, the Energy sector **will** have more positive returns on their stocks whenever there is a worldwide positive advancement in the field of AI. Regardless, a possible reason behind this is the fact that, by Energy companies being invested into AI, yet not nearly enough as to incorporate into their stock prices the value added of AI technology, their valuation would increase **more** than that of the Software industry, which would already have the AI value added incorporated into their stock prices. **Table 2** illustrates the results discussed in the previous paragraph.

Furthermore, where investors feel less positive (keeping in mind the significance of the CAR values) is with the Utilities sector, signifying a more cautious stance towards companies operating in these industries. On the other hand, where investors feel positively, it's with discrete AI events that could upgrade efficiencies within the sectors (as is the case for the Software industry); however, when AI is announced with an overarching theme, CARs are negative or not statistically significant. In addition, the findings measure whether CARs are positive or negative by industry and by event to determine whether investors are bullish or bearish. Bullish investors are confident in positive CARs. Bearish investors are concerned with negative CARs. For example, by events, the Energy industry experiences predominantly positive CARs, meaning investor sentiment is confident in AI's promise to change the world, in almost all cases. However, Software and Utilities experience more mixed, positive and negative CARs, which indicates a bearish sentiment. Only in certain events where AI can boost productivity for these industries do positive CARs arise, as seen in **Figure 1** and in **Table 3**.

The generation of CARs from the AI-related events was not consistent across the board by industry, that is, each industry responded differently and thus was differently impacted on stock prices from such events. Each cumulative abnormal return (CAR) by sector by event is an important (or unimportant) reaction to the implementation of AI across the four events analyzed. For example, the higher the CAR, the more positive short-term investor reaction. Moving onto a deeper analysis of the industry findings, in this case for the Software industry: AI is Acknowledged in this Industry more than any other and is predicted to yield the most potential. The software industry has positive reactions to announcements of any AI development prediction. The CARs are assessed over all the firms in this industry, and the vast majority of them experience high CARs with statistically significant findings in at least one of the events. This is necessary over the period of the event occurrence, suggesting that an

opportunity to develop with AI is a welcomed approach by the company. Digging deeper into the findings shows that the greatest fluctuations in AI—for example, new AI models or new AI applications—take place within the Software sector and create significant positive CARs. Now moving onto the Energy sector, where AI events have a surprising reaction. The Energy sector has experienced a number of significant CARs, meaning announcements regarding AI do have an effect on these companies—however, because this sector is relatively less active with the undertaking compared to the Software sector, none of the high CARs are as promising here. Thus, this idea supports generally lower CARs across the board. However, in the Utilities sector, the CAR analysis suggests a more nonchalant response to AIs since fewer large CARs exist and peaks and valleys are more evenly spread. In addition, the level of significance of the CARs tends to be relatively low, which suggests that investors do not see AIs as something that will impact their immediate operations but rather as something that could facilitate better operations in the future. Thus, the average CARs of the other events being mixed suggest that the market has yet to be fully adjusted to the efficiencies that AI could bring to the industry—it's only being adopted by a small percentage for the time being. The next portion of my findings' discussion is to make a Cross-Event and Cross-Industry Comparison. This analysis intends to find out how events impact the various industries in my analysis in the short term and, overall, over time, based on investor sentiment and AI's evolving nature across industries. Thus, through a CAR comparison by event and industry, this section presents findings and comparisons that relate to the relaying of market expectations and the subsequent relative response of each industry to AI. Further discussing the comparison of Events by industry, this study helps understand that specific levels of significance can be ascertained by CARs trending by industry. For instance, the CAR over time in the Software industry illustrates that this sector increasingly feels AI is becoming essential for business, which corresponds to the hypothesis

that it's increasingly being used for routine strategic applications. This is evidenced by the gradual increase in average CAR values over time, as seen in **Table 1**.

The comparison of the CARs across industries in relation to one another makes sense of how investors feel about this progress based on the sector. For example, in the Software Industry, CARs are generally statistically significant. Investors feel that progressive steps with AI pertain to this sector. The fact that CARs are so high and statistically significant suggests that investors feel like AI is a technology that needs to catch up to its advancements. AI increases productivity, better personalizes integration opportunities, and sets the stage for future software products and services to be dependent upon AI usage. Moving forward onto the comparison of Events Over Time, or more specifically, the Events' Impacts Over Time - Events are compared through CARs across a time series and the findings clearly indicate that equity investor sentiment relative to AI is positively increasing over time. During the early years of my analysis, the connections to AI in 2018 and 2020 suggest that across industry investors provide a more subdued reaction. The mere fact that so many CARs do not achieve statistical significance during these most formative years suggests that the investing public was not exactly clear on what AI would bring about for their marketplace, or whether it would be something potentially available to all of them for decades. Interestingly, the CARs from those connected to Software and Energy increase marginally over time; however, the Utilities sector receives almost no meaningful reaction, as seen in **Table 1, Figure 1** and in the table below.

	2018	2020	2022	2023
Software	3	2	4	3
Energy	2	2	5	4
Utilities	3	1	7	5

*Table 3 – Number of Positive CAR Values Per Industry Per Event*

Moving forward, I will be discussing the comprehension of the CARs for Early Innovations. It's as if the CAR for these early advancements into AI is so low because it was somewhat unclear what AI would one day become at such an early juncture. Investors likely assumed this was a no for high growth potential down the line because there were clear scaling, operating, and regulatory concerns moving forward; likewise, companies were likely testing the waters with use cases at this time, meaning investors were conservative to see how AI developments would progress; therefore, the relative CAR insignificance was low across the board.

Nevertheless, discussing more recent events, such as 2023's GPT-4 launch, the story is different. 2023 was a year of new everything, that is — new research in the Software and Energy Sectors, too, with CARs much higher in the aggregation, including many more instances of significantly positive CARs in total and within these two sectors. This shows investor sentiment has changed relative to AI (likely for the better due to more actual application of AI in recent day-to-day business and structures). The fact that CARs within the Software Sector are so high, to begin with, shows that investors feel that developments within AI are needed to sustain the Sector's growth and competitiveness. This research's findings regarding what I would refer to as the heightened sensitivity to 2023, indicate that AI is not a theoretical thing anymore and not a theory pushed to the back for now but a concept brought to

life that companies need to be able to operate down the line. It seems as if investors felt that the 2023 advancements were more applicable and actionable, creating an even greater sensation—especially for these industries that could create operational efficiencies through task redundancies or more streamlined engagement with consumers. Further detailing the meaning behind High and significant CARs, specifically for the software industry, the implication of CARs being higher here is that investors feel that AI is an addition to this market. Investors think of AI as an auxiliary resource that enhances productivity, allows for more substantial scaling due to its extensive data reach, and rapid entrepreneurial innovation and adaptation. In addition, the software market is continuously expanding with much intrapreneurial technological integration and buy-in. Thus, it would support the notion that within this space, AI would be the differentiator. Thus, the high, stable CARs would indicate that not only do investors think there is a continuous additive value to integrating AI, but they also think this market would integrate AI best for its purposes. Nevertheless, there still needs to be discussed the possible concerns regarding overvaluation. The high CARs indicate what investors think of the technology at present but also the possibility of overvaluation should these expected metrics fail to materialize down the line. In other words, CARs project what the value in the market should be. If for some reason, however, AI fails to effectively improve company performance over time and in the future, a market response should occur, as seen in **Table 1**, **Figure 1** and in **Table 3**.

Moving onto the energy sector - Compared to the rest, the Energy sector boasts lower CARs and less statistically significant response to the events. Perhaps this implies apathy—too hard to do, too many regulatory problems—which is sad because AI could generate several efficiencies and increased sustainability for this industry. Grasping investor sentiment for low CARs, the non-significance or lesser significance implies that investors feel AI is not a quick

solution—like with energy. For example, the energy sector AI (or AI related to energy) is often associated with predictive maintenance, predicting needs, and efficiencies—none of which can happen overnight and requires substantial investment into revamped systems. In addition, investors understand that a multitude of regulations acts as a confounding variable for more rapid implementation of AI in energy—which leads the markets to be less responsive to developments in AI in the energy space. Decreased CARs suggest increased investor caution, perceiving expensive capital and highly regulated spaces as barriers to rapid AI investment. This is furthered by the highly regulated spaces energy companies operate in—legal restrictions make it more challenging to adjust on a whim to using AI—rendering it less likely that rapid wins will be a thing, as seen in **Table 1**, **Figure 1** and in **Table 3**.

Lastly, within this section of industry analysis, I will be discussing the utilities sector. The Utilities sector presents average CARs but even less significance compared to Software. The reduced response here indicates that investors perceive AI-fueled developments as less groundbreaking and more incremental—at least with this sector that’s naturally more internal efficiencies. Interpreting the Moderate CARs within this sector lets us understand that cost savings and reliability improvements are boons for this slow-growth, naturally occurring sector (with regulatory growth on future developments). Thus, the meaning of the moderate CARs indicates a more stable investment down the line; AI won't apocalyptically generate growth patterns, but it can generate meaningful ones, incrementally, over time. In addition, the less exuberant response to the AI events across the board could be relative to how capital intensive and infrastructure reliant Utilities truly are. The conservative CARs within this sector demonstrate that although AI is perceived as this new form of technology for the sector to expand productivity, investors do not believe a lot of money is going to be made in the near

future—possibly because of the sector's more operational focus and the follow-up need for regulatory approvals, which goes to show how conservative the anticipations from people investing in this sector actually are, as seen in **Table 1**, **Figure 1** and in **Table 3**.

Moving onto another section of this portion of the research, I will be discussing the Statistical Validations and Hypothesis Testing of my analysis, or, further specifying, Z-Tests of CAR Significance. Serving as statistical validations, I implemented Z-Tests of CAR significance, another empirical method of determining whether the AI events were, in fact, significant to stock returns by sector. The Z-Test relies upon the CAR produced and the standard deviation of abnormal returns from the estimation window to determine whether or not CARs are statistically different from what would have happened but for generalized market movement.

For the Software Sector: Several of the CARs for the Software sector are statistically significant at the .05 level via Z-Test. This indicates that the AI events are statistically relevant in this sector. With this, comes the following interpretation: The statistical significance of CARs within this industry further supports the finding that AI drives investor sentiment in Software. Investors seem to believe that Software with AI is more efficient, offers competitive edges, and fulfills growth expectations more rapidly, which merited positive CARs that average out to beyond statistical significance. Moving onto the two industries which, as previously mentioned, are not so invested in AI, the Energy and Utilities Industries: The Z-test results of these sectors show less significant CARs, which denote that the stock price impact is not as noteworthy within these industries. Why does Less Significance still matter? This less significance matters because it shows that within these industries, AI is more of a supportive factor than a game changer. For example, AI can help support increases in efficiencies and reliability over time—but stock price value is adjusted over time, not instantly—which is why less CARs are significant, as seen in **Figure 1**.

In addition to the Z-test, I also performed a Sign Test for the Direction of CARs. While the Z-test assesses the significance of CARs by industries, the sign test assesses the directionality of CARs (i.e., positive or negative) to assess further whether the market believes AI events to be more positive or negative, giving those CARs that are statistically significant even more value. Firstly discussing the Positive Bias from Energy Industry CARs: The directional nature of the sign test resulting in a conclusive majority of positive CARs from the Energy industry suggests that investors consistently respond favorably to any news concerning AI advancements. This directional nature suggests that developmental predictions about AI and its destined functionality in this arena support investor belief that such announcements are value adding. The question pertaining this subject is why do we presume positivity? This expectation of value adding comes from the position that AI is going to change Energy in a good way. Essentially, investors believe that in the future, Energy companies will be more efficient, more state of the art, and more scalable because of AI, as seen in **Table 1** and the figure below.

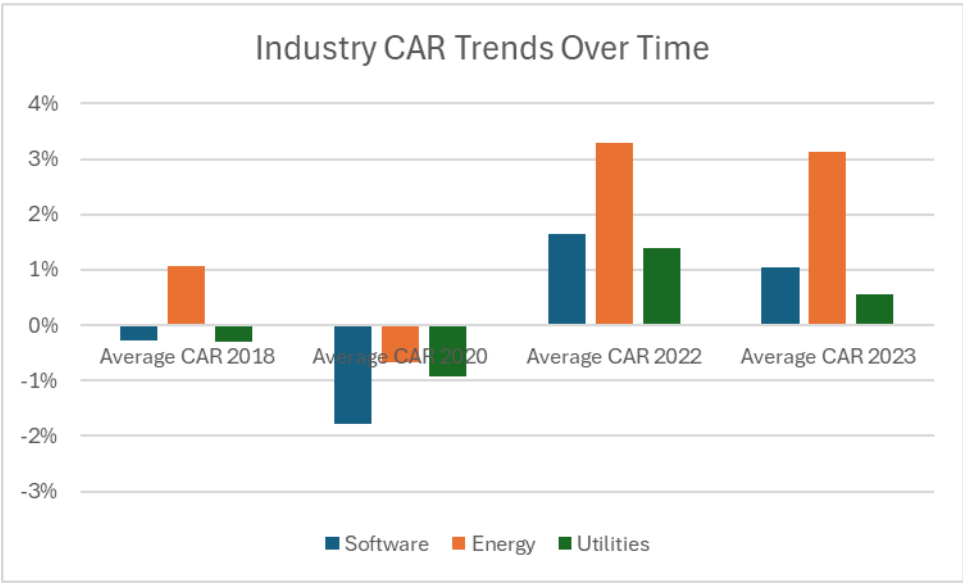


Figure 2 – Average CAR Value Per Industry Per Event Trends Over Time

Moving onto other industries, with regards to Energy and Utilities, CARs are more balanced, and expectations are more conservative. The sign test for Software and Utilities shows results with a higher balance between positive and negative CARs, meaning a more nuanced response. The interpretation of this split response is the following- The notion that Utilities generate this balance between positive and negative CARs suggests that investors enjoy the promise of AI within such capitalistic, regulatory-heavy environments—but are also aware of possible failings. For example, improved efficient day-to-day operations is a positive; the potential of associating AI satellites to just-overwhelming, short-term projects with long-term implementation possibilities and uncertain ROIs has investors not impressed. The variable response comes from industries where AI is possible—but might take longer to materialize due to regulations and operational hurdles, as seen in **Table 1** and **Figure 1**.

Lastly on this section of the discussion of the findings of my analysis, I will be referring to possible Implications for Future AI Development and Investor Expectations. Analyzing the aforementioned AI advancements sheds considerable light on present-day application of AI in the securities market and what it means for future applications. Moreover, with respect to the Application/Creation of AI and Resultant Estimated Business Expansions, the findings show that the Software sector is the most non-diverse in thinking that AI-generated growth will be a strategy for competitive business and innovative expansion. The significance of the CARs in this instance suggests that these investors feel AI will be the wave of the future that increases productivity, boosts efficiency, and generates entirely new revenue streams. Thus, this sector should seek expansion to a more extensive customer base through AI-based software/add-ons, yet be cautious of overestimations and faulty expectations of stock value. Nevertheless, we should always consider the significance of Investor Reaction There's a reason investor

sentiment was so high on this question. For example, Energy and Utilities were the least excited by the notion that those industries understand the difficulties of implementing AI in capital-intensive, heavily regulated environments. Thus, these firms should deliberately blend any AI achievements with anticipated long-term operating solutions and present a strategy to do so. Yet, relative over time, investors' expectations have changed positively for the innovations with large, statistically significant CARs for the events. This makes sense for AI, as it's much older and in the development stage; investors expect value generation to occur quickly over widespread applicability. Yet, the industry breakdown shows that it's more applicable for certain industries over others. Thus, investors need to be careful with the industry it's created for, and then considerations of regulation, size, and ease of implementation to assess the value of any advancement within the field of AI. In addition to this, we can also argue for the relevancy of AI towards Policymakers and Regulators. The lower CARs from the Energy and Utilities sectors—more established, more regulated—suggest that shareholder enthusiasm is dampened by uncertainty with regulatory (or governmental) intervention. Therefore, regulators should aim to set more definitive, certain standards for AI technology application so that regulations not only assist in the materiality of the potential social benefits that arise from AI, but also, from a company standpoint, foster investment.

## **4.1 Summary of Key Findings**

With regards to events and temporal Findings, we can say that Artificial Intelligence events become more frequently positively regarded as the sample window progresses, due to investor sentiment and technological advancement. 2023 shows the strongest reactions from the market, especially within the Energy sector, meaning that the window period transitioned from doubtful to believing. Moreover, the Energy Sector had the greatest CAR value for all events overall, taking into account the fact that this industry's positive CARs are the most statistically

significant amongst the industries studied, which means it's the sector that best understands AI potential. Software and Utilities were more mixed and, to an extent, both had an overall reaction that shows investors feel AI will be an enhancement—not a groundbreaking transformation—for these sectors. With regards to the z-test, CARs from Software and Energy were somewhat significant, suggesting that investors feel there are changes with substantial impact once AI is integrated. Directional testing found a strong directional bias for Software and Energy CARs, while Utilities had, once more, mixed results. For investors, the findings of this analysis implicate that the Energy industry was more so at the forefront of believing AI would create significant change, however, less so for industries with ambiguous past performance and for industries with increased regulatory issues.

## **4.2 Limitations and Future Research**

Despite the comprehensive nature of this project, there are limitations here. For example, the sample population of the data for this study was relatively low. There weren't that many trades associated with AI, nor was there that much participation across industries. However, this corresponds to a more targeted assessment of the industries involved—Software, Energy, and Utilities. Future studies should take a much larger international and industrial scope to truly assess the economic impact of AI. Second, the research is based upon the notion of the Fama-French three-factor model. Therefore, what is taken into consideration is an efficient market, a relative balance across assessed risk factors: equity, size, value, and any occurrence of AI in the market will always have the same level of response by investors. However, while the Fama-French model is an enhancement over generalized focus models (like CAPM), this does not mean that these results hold valid anywhere and anytime. For instance, AI in banking may trigger a positive response in investors in India, but a negative response in the United States—despite the same study occurring in both areas—which would complicate the assessment of

abnormal returns. Third, this is a quantitative study, in comparison to assessing qualitative aspects that would be vital to stock market response. This study does not take into account the quality of the AI developed, the intra-industry rivalry between industries, and the practicality of trading after developments of AI—which all would be important contextual factors that would influence stock price gains and losses. In addition, I used AI advancements as a way to assess the impact of AI investment on company stock returns, due to the inexistence of AI investment data. In the future, these values will possibly be available and hence lead to a more comprehensive and conclusive research. Future potential research could rectify these limitations in various ways. First, a larger population could be involved from other multi-factor models that use other risk factors based upon sector or location that either better adjusts or enhances any given anticipated return. Second, an examination of investor sentiment—via natural language processing to assess sentiment from news or social media—would provide a better idea of how the market feels about developments peripheral to AI. Finally, research that seeks to determine whether AI-related announcements about fundamentals are effective in the long run—as opposed to this research which seeks to determine whether CARs are statistically significant in the short run—will provide meaningful insight into intentions and goals of companies after choosing to adopt AI or announce developments thereof. Should these shortcomings be addressed in subsequent research, future studies could build off the findings here and present a clearer view of the financial and strategic advantage of such AI advancements across sectors and international markets.

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