Empirical Analysis of the Impacts of ChatGPT on Fine Arts, Information Technology, and Semiconductor Stock Markets

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Abstract

This empirical research was conducted to illustrate the relationship between the release of ChatGPT, an artificial intelligence language model, and the stock markets in fine arts, information technology, and semiconductor sectors. Near the end of 2022, ChatGPT was released to the public who for the first time experienced human-like conversations with a computer model. The linear regression model was used to calculate stock returns and set up the null hypothesis. In this way, it allows the research to focus and analyze the degree of impact that ChatGPT had on various industries by checking the curves of cumulative abnormal return. First analyzing the Fine Arts sector, then the Information Technology industry, and last the semiconductor industry, the findings indicated an increasingly strong and positive effect of ChatGPT on the stocks of representative firms within each sector. Meanwhile, results from companies in the information and technology fields are also contributed by the release of another following event, the release of GPT-4. The findings explain possible reasons for both moderate and positive market reactions through current events as well as social factors.

Key words: Artificial Intelligence, ChatGPT, Fine Arts, Information Technology, Semiconductors, Event Analysis, Linear Regression, Abnormal Return.

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1 Introduction

In today's digital age, artificial intelligence (AI) has become the focus of the social, business, and technology fields. The rapid development of AI has led to a extensive discussion of its impact, especially in the financial sector. Between Jun 2022 and Mar 2023, the traffic volume of "AI" has tripled, making it one of the most concerning and interesting topics of the year, as shown in Figure 1 [1].

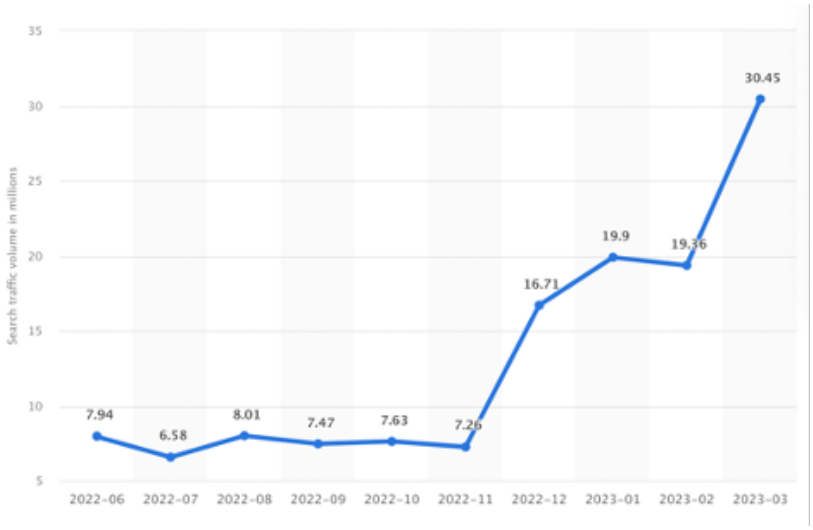

Figure 1

Here is the question, why is everyone so obsessed with AI? First, it could be due to the abruptness. It is worth noting that for many, Artificial Intelligence is still a word related to the far future or a sci-fi movie. However, the development of artificial intelligence models was not just built in a day. Powered by the exponential growth of data generated by the Internet, the AI models received a large amount of data for training to improve the accuracy of responses [2]. Moreover, the increase in computational processing power also boosts AI efficiency since it would require fewer computations to get equal results [3]. Surprisingly, Covid serves as a catalyst for the development of AI technology. The pandemic ramped up the digital-driven initiatives, compressing year-round plans into months, which would require investment in automation to expedite remote working effectiveness. This series of changes in company management leads to better customer satisfaction and a great reduction in costs, which increases the demand for AI algorithms. A study by PwC shows that 52% accelerated AI automation processes and 86% believe AI will become a "mainstream

technology". Here is a quote from the Chief growth officer at Frito-Lay Michael Lindsey: "The pandemic inspired our teams to move faster than we would have dreamed possible." [4]

With the increasing demand for AI models due to the pandemic and the complex algorithms trained in years, on November 30, 2022, OpenAI released ChatGPT, a natural language processing technology developed by OpenAI. The reason to pick OpenAI for case analysis is that it has achieved one million users in just five days after its release. A comparison between OpenAI and other product's user growth is the following [5]:

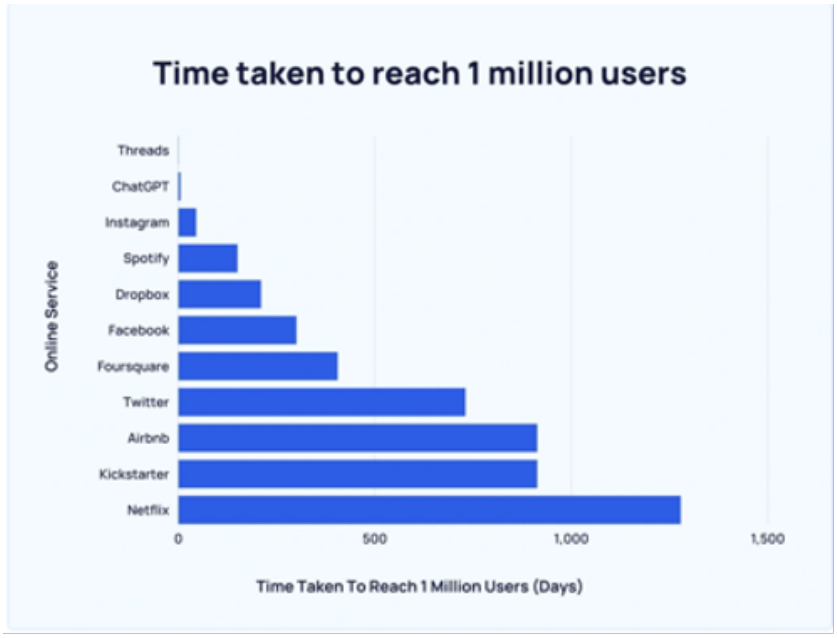

Figure 2

OpenAI's growth rate is unprecedentedly high, compared with 2.5 months for Instagram (note: thread is released after ChatGPT, which means ChatGPT has the highest user growth after its release). This outbreaking data has made the release of ChatGPT the most appealing event to conduct an empirical analysis on. Therefore, this paper will take the release of ChatGPT as a striking case to analyze this impact in detail in the finance sector. By analyzing the release of ChatGPT, we will explore its impact on the art industry, information technology industry, and chip industry and possible future trends. In this age of information emergence, it is necessary to understand how AI affects the stock market from various perspectives and how it might shape the future.

This paper picks and analyzes the most representative companies within each industry: Electronic Arts in the Fine Arts industry, Baidu, Google, and Microsoft in the Information Technology industry; and Intel, AMD, and Nvidia in the Semiconductor industry. It will also bring up a secondary event to help with the analysis of Artificial Intelligence's impacts on certain companies. The background understanding of each industry will be explained in addition to elaborating on the motives for choosing specific firms. Clear visuals of initial and processed data will be demonstrated, providing the basis for all possible interpretations of the event.

2 Literature Review

According to Pietrzak (2023) [6] who employs event study analysis, the public reaction to 6-K and 8-K current reports on ChatGPT demonstrates that merely a few have significant implications. The information technology sector shows an overall positive abnormal return, regardless of the report's nature. Starting from Feb 6th, 2023, Chegg's stock price began to decrease, though a report noted that Chegg had been using similar tools to ChatGPT for a relatively long time. The same year on May 1st, Chegg's stock price went down by 50%. The firm presented a warning report stating that the growth of ChatGPT has seriously affected its user growth rate and business model, showing that the public reaction to AI tools is fierce and has a strong influence as reflected in stock price.

In addition, C3.AI (2023) [7], a software company specializing in the development of Artificial Intelligence, saw its share price rise 28% for its announcement of the integration of its suite of AI tools with ChatGPT. Although C3.AI does not have a share of OpenAI, a contract with Microsoft has made the partnership possible between two AI tech firms, leading to the booming of its share prices.

Utilizing the synthetic difference-in-difference, Saggu and Ante (2023) [8] discovered a significant ChatGPT correlation with returns of AI-related crypto assets: average returns between 10.7% and 15.6% one month into ChatGPT's launch and a range from 35.5% to 41.3% two months after the release. They also found that it is the Google search volume that could play a vital role as price indicators for AI-related cryptos. Ultimately, they conclude that investors valued AI assets, such

as cryptos, as heightened potential that results in higher expectations and valuations.

Though the development of science brings numerous changes, it is hard to judge the degree of influence on various markets and industries. Lee and Connolly (2010) [9] have discussed the impact of IT news on hospitality firm value using the values of cumulative abnormal returns, and the results suggest no significant effects from IT news, which supported the IT paradox theory. AI, another main force in driving productivity in the future, also encouraged an investigation into the influence upon the financial stock markets.

A. Shaji George and A. S. Hovan George (2023) [10] analyzed the impact of ChatGPT and concluded that ChatGPT is an innovation that completely changes the world by boosting work efficiency in many sectors, such as education, entertainment, health, and news. The event analysis would require a striking case to build the event window, and the release of ChatGPT3.5 would be an ideal target.

3 Methodology

This empirical research utilizes the event analysis strategy.

Event analysis is a measurement method used to study the short-term impact of major events on company-level variables. This method is mainly applied in the financial field, and it is mainly used to measure the impact of a particular event on the company's stock price.

The mechanism of event analysis is that assuming the market is rational, then when something happens, the impact is quickly reflected in the stock price. Therefore, the impact degree of the event can be judged by observing the stock price changes in a short period of time.

The analysis steps of the event analysis method are as follows:

1. To define an influential event, in the study, we selected the launch of ChatGPT as the landmark event.

2. Select the daily stock market data of each company as the sample data and calculate the daily stock returns with the given formula: P_T^C is the closed stock price at some time T

$$R_t = \frac{P_T^c - P_{(T-1)}^c}{P_{(T-1)}^c}$$

3. Select the estimation window and the event window, and the coefficient alpha and beta of the regression equation are calculated from the data of the estimation window. With this coefficient and event window calculated the error term, ε_{it}, from the estimate window, and the abnormal yield AR(ε_{it})and cumulative abnormal yield CAR from the event window. Note: R_{it} is the company's return; $R_{MKT,t}$ is the market's return.

$$R_{it} = \alpha + \beta R_{\mathrm{MKT},t} + \varepsilon_{it}$$

4. Test the significance of the calculation results with the upper and lower confidence bands to judge whether to reject the null hypothesis, that is, the event has no impact on the earnings of individual stocks.

$$\text{Upper Confidence Bound} = 1.96\sqrt{T\sigma^2}$$

$$\text{Lower Confidence Bound} = -1.96\sqrt{T\sigma^2}$$

$\sigma^2$is the variance of all epsilons obtained from the estimate window.

Note: the large difference in variance data in this paper is due to the inclusion of percentage, for instance writing in 0.01 instead of 1%.

4 Data Analysis

A Industry Selection

Artificial Intelligence has various applications. It ultimately comes down to using computer power to mimic human behaviors or form their unique cognitive abilities. Thus, the fields it can reach, and impact are almost anything related to neural networks, language processing, and machine learning [11].

From here, it has become clear that merely analyzing one individual sector would be an underestimate of the consequences of the release of potentially the most powerful AI language model, ChatGPT.

In a conversation with the Chatbot, the chatting AI, users can input their questions and receive a response of hundreds of words within just a few seconds. By providing new ideas and offering different perspectives, this language model has proved its astounding creativity for innovations. Meanwhile, a few months prior to the release of ChatGPT, Stability AI announced a powerful AI painting platform. Like how Chatbot interacts with users, Stable Diffusion generates a picture in minutes based on the user input, which leads people to speculate the relationship between these two AI models: ChatGPT generates creative prompts and ideas, and Stable Diffusion brings meals to the table. As a result, this paper intends to investigate how this massive increase in painting efficiency can influence stock markets in the Fine Arts Industry.

In addition to its creativity, ChatGPT is also used for solving questions and overcoming challenges for its users. With the extensive amount of data, this model was trained on 570 gigabytes of text & 175 billion parameters from Twitter, Wikipedia, Reddit, etc. [12] and is able to quickly extract the right information in its data set and present it in human-readable forms. Unlike the Google search engine where users would need to scroll through countless websites and papers to find a favorable answer, the Chatbot customizes all the related information that is most relevant to the given question. To simply put it in a metaphor, the Chabot is a personal Google assistant. Hence, knowing how ChatGPT has made access to information more effective, this paper will also look at this event's impacts on the Information Technology sector.

To ensure the accuracy of AI models, such as ChatGPT, the developer trains it with an increasing amount of large data samples. Noted by Singh (2023) [13], this process will require a more powerful computational tool as the sample size rises, and this is where semiconductors that enable processing, sensing, and moving data come into place. The training of AI models utilizes many of these semiconductors (chips) such as memory and logic chips for storing and processing data. While early AI models used central processing units (CPU), the newest development takes advantage of graphic processing units (GPU). Though the GPU was originally designed for graphic and visual rendering, its parallel processing of information is much more effective than the CPU's serial processing since the latter only allows one

object to be processed at a time, whereas parallel processing allows multiple. Therefore, realizing the development of AI models would increase the demand for semiconductors, this paper will include the aspect from the semiconductor sectors which specifically specialize in making GPUs.

B Fine Arts Industry

The target for the fine arts industry is Electronic Arts Incorporated (EA), a global leader in the industry. With nearly 600 million active players, EA developed some of the most popular games in history, such as the FIFA series, It Takes Two (2021 Game of the Year), Battlefield Series, and Apex Legends (2019 Best Game for Multiplayers). With each of the above games having over 10 million units sold, it has become more appealing to use this company as a representative of the entire industry to see whether the release of ChatGPT can have potential effects on the Fine Arts sector [14].

From data collected through the Nasdaq Index [15] and the stock price of EA [16], the equation obtained is the following:

$$y = 0.4358x + 0.0212$$

Estimate Window	Event Window	α	β	R^2	Var
514	[13,15]	0.0212	0.04358	0.178	2.25382

Table 1: Summary Statistics of Variables

Note: for all data tables in this paper, the event window is noted as [number of days before event, number of days after].

The R^2 indicates there's only a small proportion of variance can be explained via the past data and less than 20% of the data fit the regression model. This further demonstrates that the Fine Arts market stock return is not a strong predictor for the company stock return in this model.

Nevertheless, the low R^2 does not necessarily mean that there's no relationship between the two variables, rather it could potentially be other contributing factors that are yet to be discovered. Figure 3.0 is a visualization of the linear equation.

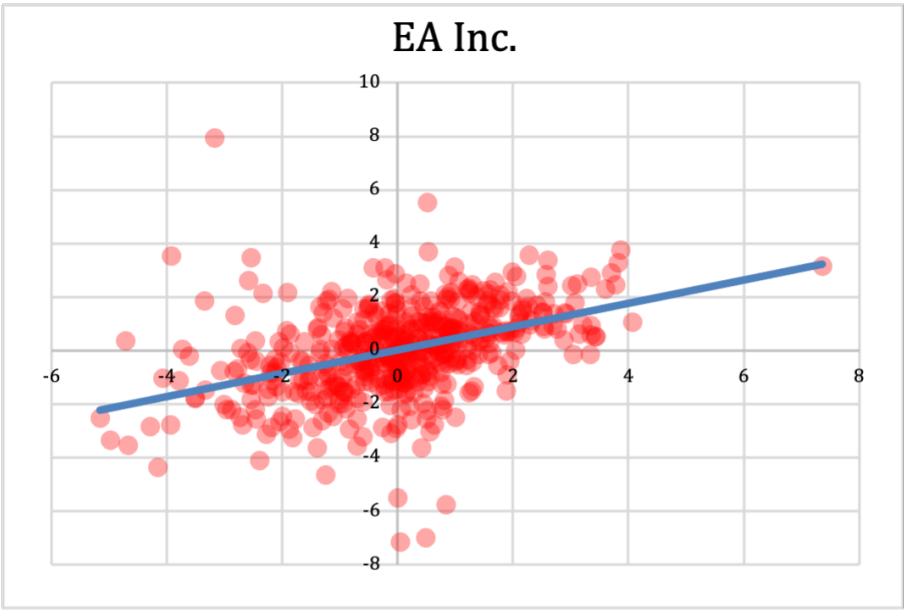

Figure 3.0

Then, the relationship of cumulative abnormal returns during the event window and upper/lower boundary obtained by the variance produced the following:

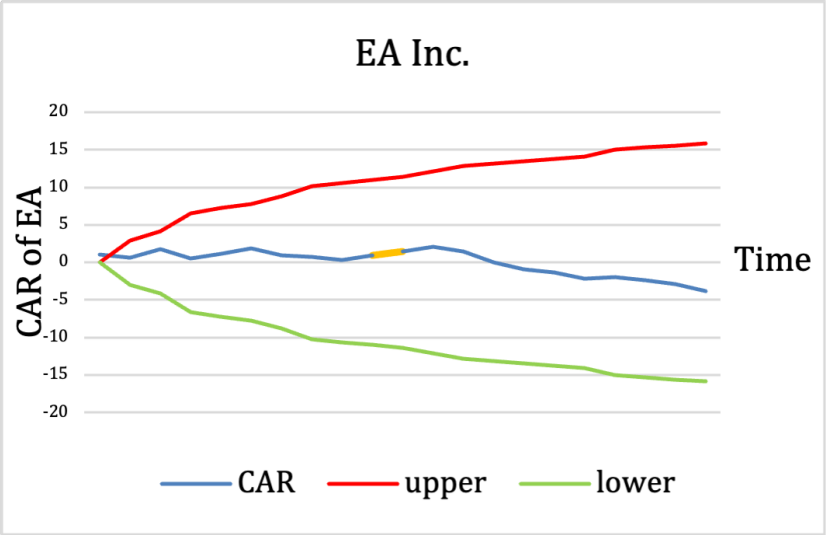

Figure 3.1

The yellow dash indicates the date when ChatGPT was released. Throughout Figure 3.1, the cumulative abnormal return is relatively moderate. For both before and after the

event, EA's stock closely follows the market's performances due to its low deviation in abnormal returns. Since the cumulative abnormal return crosses neither of the boundaries, it can be concluded that EA's stocks behave in an expected manner during the event. However, since the coefficient of determination is substantially low, other social factors are necessary to consider.

As mentioned in section IV.A, Stability AI released its AI painting model four months prior to the event. The time between these two events could simply be too short for users from different platforms or areas of study (AI engineering and arts) to build up the slightest connections. In addition, artists at the time were quite indifferent about the potential consequences of the AI painting model. The majority believes that the model is merely a play tool due to its lack of human touch, originality, qualities, and traditional artistic genres. The existence of these elements could yet challenge the careers of professional artists, and because of this, the AI painting model fails to win the favor of the public. Though, in theory, ChatGPT could greatly boost the efficiency of artworks, these connections were highly in doubt and treated as only assumptions [17].

C Information and Technology Industry

The subjects chosen in the information and technology industry are Baidu, Google, and Microsoft, all of which are without question the most successful internet software and service providers in the country. In China, Baidu holds the largest share in terms of all platforms (60.87%), with 35.93% in PC and 79.45% in mobile [18]. Meanwhile, across the Pacific, Google dominates the search engine market by having a 91.58% share in the past year around the globe. Though Microsoft's search engine Bing only holds 3.01% of the market, Microsoft may benefit most from this event as it owns 49% of OpenAI, which can lead to many possibilities considering the potential impact of AI searching on the current industry, data collected by PYMNTS (2023) [19].

Baidu, Inc:

The empirical analysis used the Hang Seng Index [20] and Hong Kong stock prices of Baidu [21], covering 2021/3/23 to 2023/2/22.

With the data between 2021/3/23 and 2022/11/3, the Stock Market Line of Baidu is estimated under CAPM. The estimation is shown below:

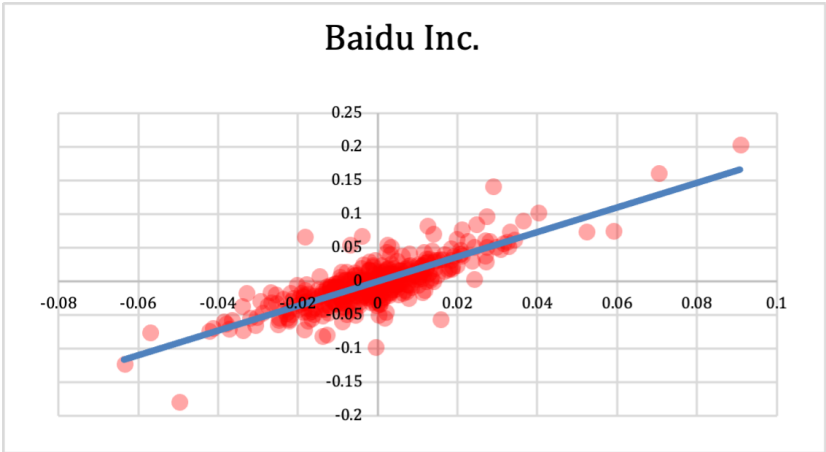

Figure 4.0

$$y = 1.8274x + 0.0003$$

Estimate Window	Event Window	α	β	R^2	Var
400	[6,26]	0.0003	1.825	0.663	4.61323×10^{-4}

Table 2: Summary Statistics of Variables

As R^2 is larger than 0.6, it is partly reliable to build the boundary for CAR analysis.

Selected from 2022/11/30, the date of the release of ChatGPT3.5, as the mid-point of the event window, the first test based on a 32-day event window from 2022/11/28 to 2023/1/13 was done but failed to reject the null hypothesis.

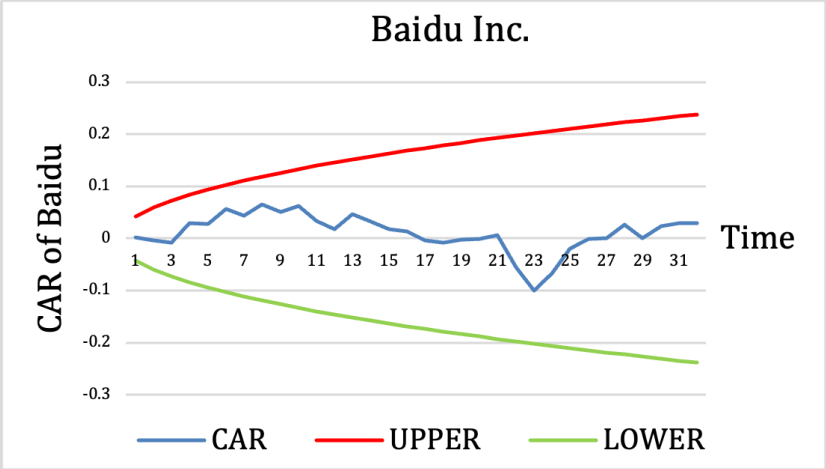

Figure 4.1

To further verify the impact of ChatGPT's release on Baidu, the second test was extended: from 32 days to 61 days, ending its window at 2023/02/22. In Figure 4.2, the CAR curve has distinct ups and downs when compared to Figure 4.1, however, it still failed to reject the null hypothesis.

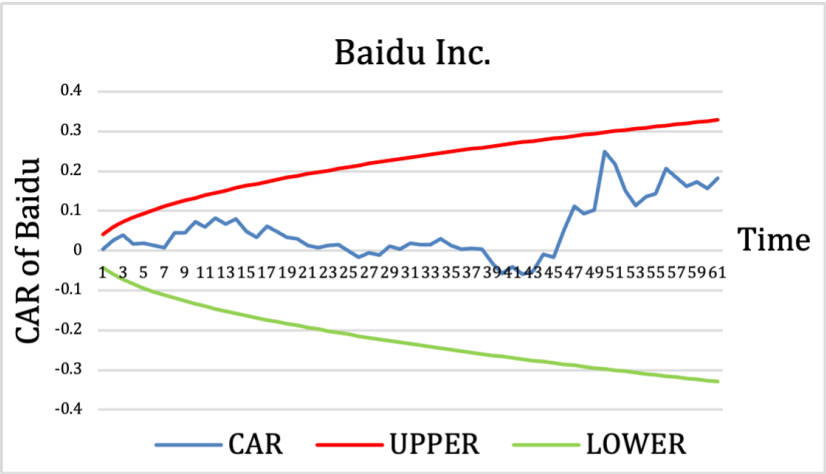

Figure 4.2

As can be seen from Figure 4.2, the abnormal return of Baidu's shares is not significant, and the issuance of ChatGPT has not had a significant impact on the return rate of Baidu's shares listed in Hong Kong. Here are possible explanations: First (business correlation),

ChatGPT is a natural language processing model developed by OpenAI, which is not directly related to Baidu's core business (such as search engines, online advertising, etc.). Therefore, it will not have a direct impact on Baidu's main source of revenue in the short term. Secondly (market factors), stock prices are affected by various factors such as market supply and demand, investor sentiment, and overall economic conditions. The publication of a technical model is usually insufficient to significantly alter these factors. Lastly (long-term impact), if the application of ChatGPT is related to Baidu's strategy or products, then it may have an impact on the company's competitiveness and business growth in the long term. However, this effect will take time to emerge and is not immediately reflected in the stock price.

Google LLC:

With an estimated window of 511 days before the event, the Nasdaq index, and the stock price of GOOG [22], a linear equation that represents the connection between the market and Google is the following:

$$y = 1.0168x + 0.0338$$

Estimate Window	Event Window	α	β	R^2	Var
511	[13,61]	0.0338	1.017	0.673	1.29047

Table 3: Summary Statistics of Variables

In this case, the coefficient is very close to 0.7, indicating the market stock generally obeys the trends of the market.

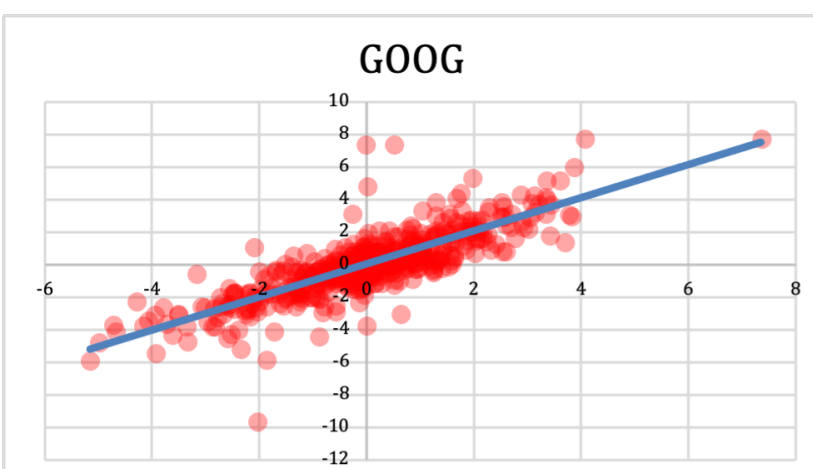

Figure 5.0

Then, with the alpha and beta obtained from above, the error term as well as daily abnormal return are calculated and presented in Figure 5.1. It is worthwhile to note that the event window for this analysis is 13 days before the event and two months after. The long period of this event window assumes that it would take time for the public to accept and learn how to properly utilize ChatGPT in searching for any relevant information. Here is a visual look at the cumulative abnormal return across more than 70 days.

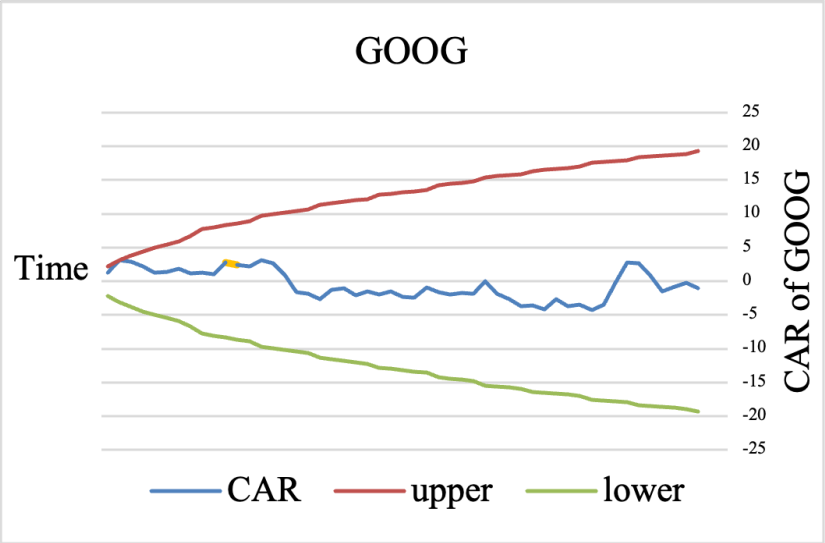

Figure 5.1

The yellow dash again represents the date of the event. From Figure 5.1, the cumulative abnormal return did not exceed any boundary, and as a matter of fact, it stayed relatively consistent for the entire event window. This behavior did not reject the null hypothesis so the release of ChatGPT has near-zero effects on Google. The result from the analysis has left serious doubt on the initial expectations of ChatGPT. Despite extending the event window, there's no clear sign that the Chatbot can affect the place of Google. One possible reason could be that as the majority of the world has used Google for a significant amount of time, it would be challenging for this large group of people to completely switch gears. Habits have been formed so that access to information through AI technology seems only a bonus,

not a replacement. Overall, it would be wiser to look into ChatGPT's effects on Microsoft's stock before making ultimate conclusions.

Microsoft Corp

As the biggest investor in OpenAI, Microsoft Corp invested more than three billion dollars in the continuing development of AI models. After the release of ChatGPT, Microsoft announced to the extension of the partnership along with a 10-billion-dollar investment. This post-event news had already reflected the degree of success of ChatGPT. Hopefully, the regression model could also reflect the success of stock markets [23].

The estimated window is 512 days. The event window for Microsoft is set to be 28 days before and 47 days after considering Microsoft's involvement in this event. Selection of the Nasdaq Index return rate and stock price return of Microsoft (MSFT) [24] in the past two years yields the following equation:

$$y = 0.963x + 0.0296$$

Estimate Window	Event Window	α	β	R^2	Var
512	[28,47]	0.0296	0.963	0.732	0.83245

Table 4: Summary Statistics of Variables

R^2 here illustrates a strong relationship between Microsoft's stocks and the market.

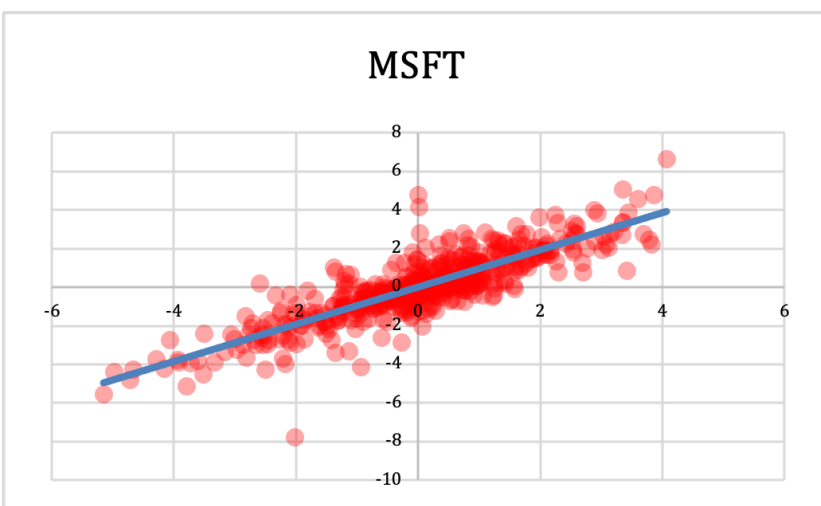

Figure 6.0

Utilizing the alpha and beta from the equation above yields the variance 0.832454 and the cumulative abnormal return across the event window, presented in Figure 6.1.

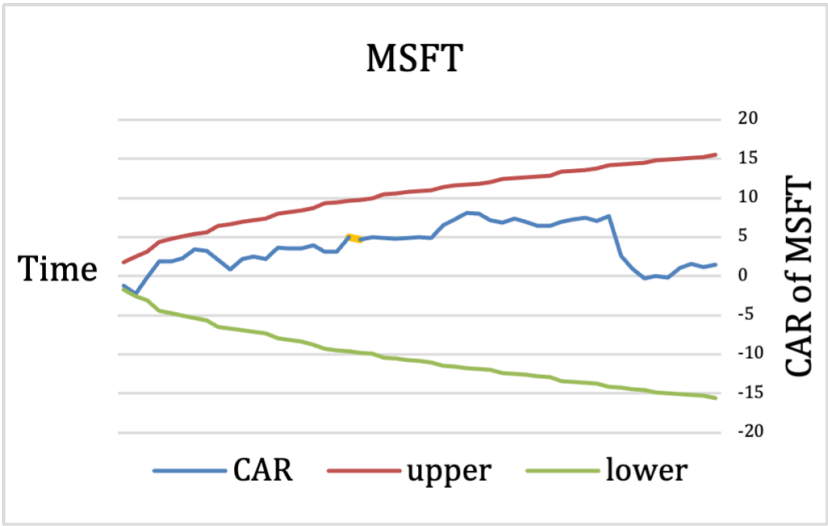

Figure 6.1

Compared with all previous analyses, although the cumulative abnormal return did not exceed the boundaries and thus the null hypothesis is not rejected, there's an obvious deviation with positive abnormal returns before and after the event. Figure 6.1 demonstrates a positive market reaction towards the event, despite of the fact that the deviation may not be significant enough to be distinguished from normal fluctuations.

GPT-4:

For all companies analyzed so far, none of the cumulative abnormal return curves has exceeded the boundaries. Some companies may show some deviations and positive abnormal returns, but since the boundaries were never reached, these positive or negative fluctuations are not favorable to prove that the release of ChatGPT has significant impacts on the stock markets.

In theory, this event unravels numerous possibilities for the public. As previously mentioned, AI helps people generate creative ideas and gain easier access to information. How-

ever, another particular concern may lead to the public's "indifference" to the advancement of Artificial Intelligence, as reflected in the four analyses done above.

According to the Pew Research Center (2023) [25], 52% of Americans state that they have more concerns over excitement with the increasing usage of Artificial Intelligence, while only 10% say they are more excited and the rest 36% feel an equal mix. Concerns include but are not limited to personal information private, finding accurate information online. By the same institution (2023) [25], a survey conducted from July 31to Aug 6, 2023, shows that 53% of US adults believe in the area of information AI hurts more than it helps; 27% of US adults view AI as not so effective in the area of acquisition of information online while 33% see the opposite with another 40% still not sure about how AI can improve access to information.

Considering this survey was done eight months after the event, a large portion of people who stayed in the grey area are still unsure about the effectiveness of AI. In particular, regarding privacy and overall impressions of AI, more than half of US citizens expressed negativity towards the introduction of AI to daily lives. In general, this set of data reflects the public reaction and helps explain the reason for the stock markets of all these multi-billion-dollar companies to have remained relatively "ease" for this big event.

In addition to the public's post-event attitudes towards the uses of Artificial Intelligence, let's go back to square one and investigate another alternate reason that might explain or even reveal ChatGPT's impacts on the stock markets.

On Nov 30th, 2022, OpenAI released the most powerful AI language model, ChatGPT, also known as GPT-3.5, based on the architecture of the GPT-3 model with 175 billion parameters. A few months later, on Mar 14, 2023, GPT 4 was released and integrated with Microsoft search engine Bing. This brand-new version of GPT has 1.76 trillion parameters, ten times as much as the previous version [26].

To abbreviate, GPT-4 is more creative and reliable. Here is a more direct comparison of exam results between the performances by GPT-4 and GPT-3.5:

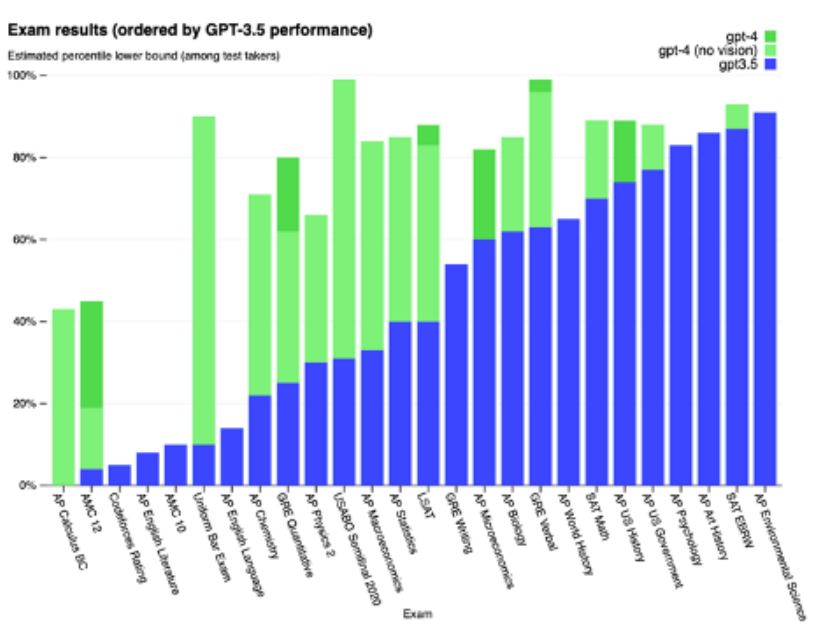

Figure 7[27]

With the substantial improvements from GPT-3 to GPT-4 and more time for the market to accept the era of Artificial Intelligence, it is expected that the release of GPT-4, the second event, would have a much more direct influence on the stock market.

Revised EA Inc:

Utilizing the same linear regression models and pushing the event date from Nov 30th, 2022, to Mar 14th, 2023, the revision of the event analysis is the following.For Electronic Arts Inc., after the adjustment of time, the new linear equation is formed:

$$y = 0.4268x - 0.0086$$

Estimate Window	Event Window	α	β	R^2	Var
583	[13,36]	-0.0086	0.4268	0.1709	2.23303

Table 5: Summary Statistics of Variables

Still, the coefficient of determination is just as low as before, about 0.1709.

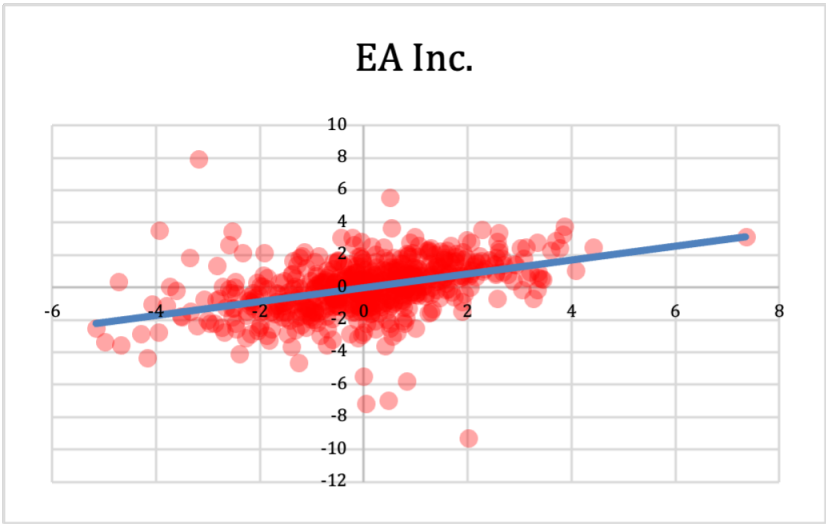

Figure 8.0

The corresponding abnormal returns and upper/lower boundaries yield the following:

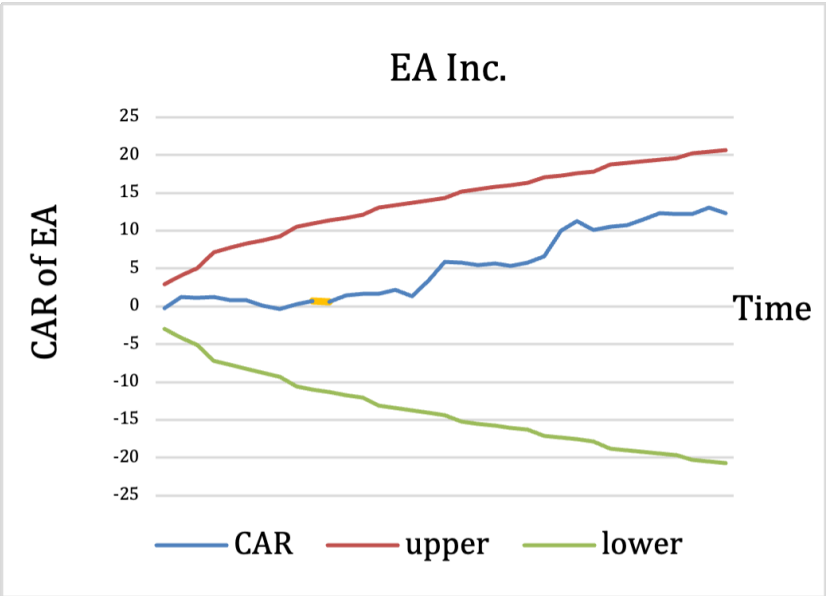

Figure 8.1

Unlike the curve generated based on the first event (GPT-3.5), the cumulative abnormal return is gradually increasing at several rates after Mar 14th (the yellow dash). The positive abnormal return after the event indicates a positive market reaction to the new event.

However, since the R^2 is not high enough to indicate the correlation between the market and the company's stock return as well as the fact that the cumulative abnormal return, despite increasing, never exceeds the upper boundary, it is only suspected that the new event has a slight impact on the Fine Arts industry.

Revised Google LLC.:

The new yielded linear equation based on past market returns and GOOG returns is reflected by the following:

$$y = 1.0491x - 0.0173$$

Estimate Window	Event Window	α	β	R^2	Var
573	[13,36]	0.0173	1.0491	0.6672	1.38725

Table 6: Summary Statistics of Variables

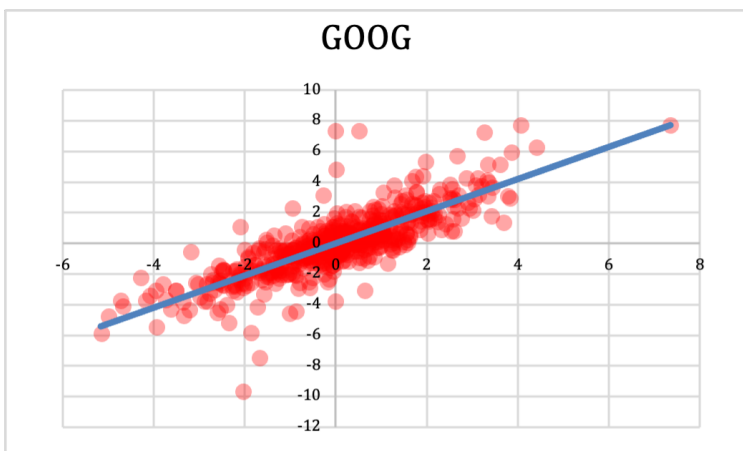

Figure 9.0 visualizes the table data.

After adjusting the new abnormal return and variance with the new parameters, the cumulative abnormal return exceeds the upper boundary only four days after the event as illustrated here:

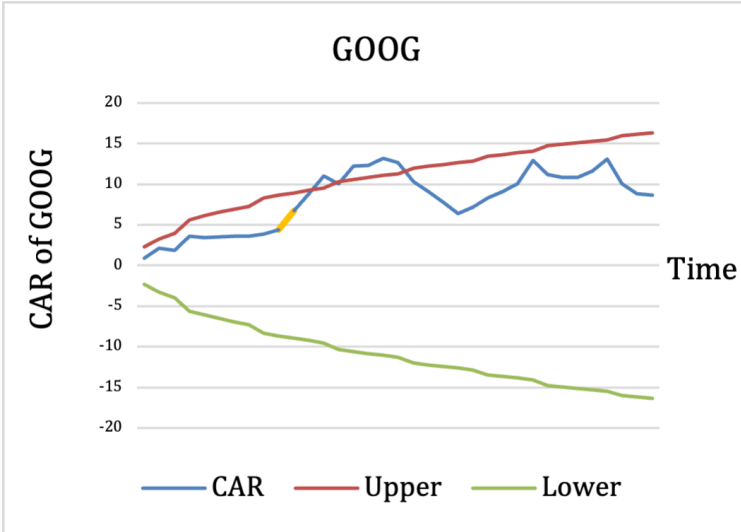

Figure 9.1

At last, the null hypothesis is rejected, proving that the new event has a significant impact on Google LLC. However, the CAR curve is going in a direction that is opposite to the expectation. As one of the largest firms in the information technology sector, Google LLC is also the strongest competitor against Microsoft Corp. As seen by Figure 9.1, the impacts of GPT-4 are no longer negligible, proving the success of the event. Nevertheless, the increasing trend of GOOG's cumulative abnormal returns reflect the opposite as the curve implies a generally positive market reaction to GOOG stocks.

Revised Microsoft Corp:

Based on past market returns, a new linear equation that shows the connection between the market and Microsoft is the following:

$$y = 0.9902x + 0.0326$$

Estimate Window	Event Window	α	β	R^2	Var
585	[11,34]	0.0326	0.9902	0.7401	2.23303

Table 7: Summary Statistics of Variables

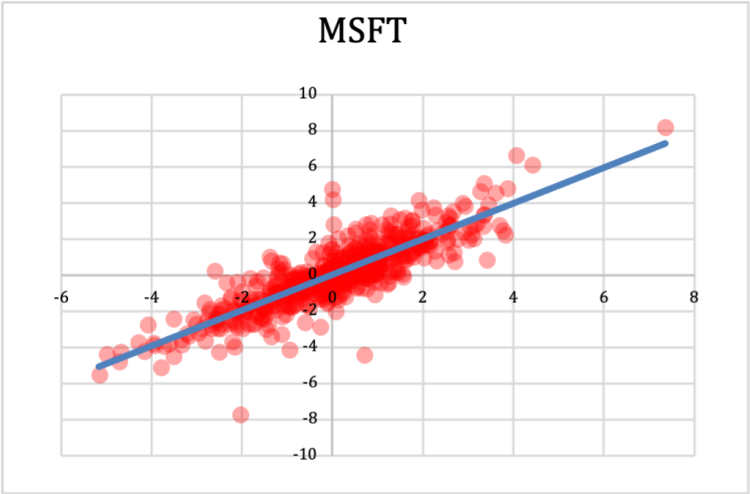

Figure 10.0

The new linear graph Figure 10.0 helps yield the following cumulative abnormal return curve:

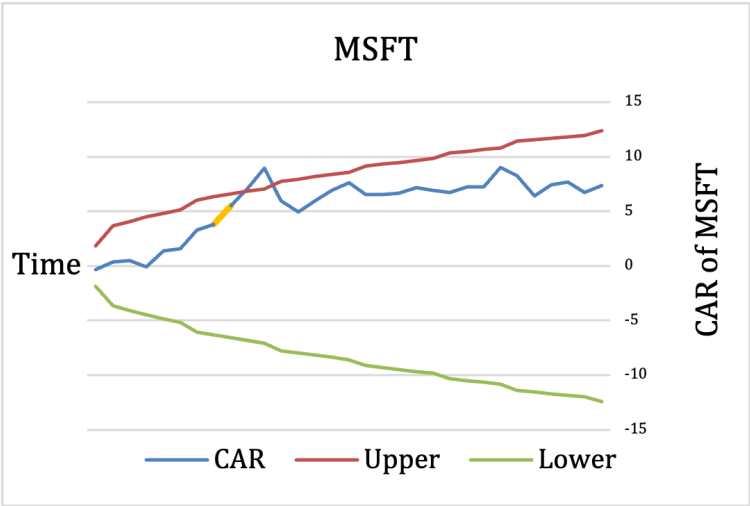

Figure 10.1

Two days after the event (indicated by a yellow dash) shows that the cumulative abnormal return exceeds the upper boundary. Not only that, but the overall abnormal return is also positive, which demonstrates the market's positive reaction and proves the success of Microsoft's investment in OpenAI. In addition, Microsoft integrated this incredible GPT-4

language model with its own search engine Bing, a huge upgrade to Bing's searching ability. In the past, Google had a much larger user base, taking over 90% of the entire search industry because of its large data size with hundreds of billions of web pages, while Bing's index size is estimated to be eight to 14 billion, data collected by Wilkinson (2023) [28]. The AI innovation in searching algorithm can lead to more efficient usages of existing data size, which means Bing (integrated with GPT-4 language model) can best understand the user's request and deliver the most desired answer supported by online sources instead of only giving a list of webpages like Google. Still, it would take time for the public to fully realize the potential and benefits of utilizing AI for access to information. The exceeds in the upper boundary demonstrates that the market has a positive expectation of Microsoft, but never ascertained that Microsoft or Bing could revolutionize the industry due to this single event.

E Semiconductor industry

To understand why the release of ChatGPT could make such an impact on the company that this article focuses on, an overview of the Semiconductor industry is necessary.

The semiconductor industry is a huge industry that contains thousands of companies and reaches many other fields. Semiconductor companies are at the center of technology innovation, finance, geopolitics, and human ingenuity, touching virtually every aspect of business and people's lives [29].

Semiconductors (chips) are very diversified. Chips with difference purposes - such as memory, logic, mixed-signal, power semis, etc. - are manufactured for different end markets. Each variant of chip would require different wafer sizes, process technologies, materials, facilities, and much more. Simons and Kulik (2023) [30] claimed that the two dominant models are the fabless /foundry/ OSAT (outsourced semiconductor assembly and test) ecosystem, and the integrated device manufacturing model (IDM). For instance, Intel and Samsung both implement the IDM, and NVIDIA and AMD implement the Fabless model which outsources their manufacturing process to OSAT company TSMC.

Semiconductor Use in AI Models

In AI training, GPUs are more suitable for which they enable the parallel processing of

information. Singh from Congressional Research Service (2023) [13] claimed that for better-utilizing chips, many chip design firms are offering custom logic chips designed for specific applications, including AI training, called application-specific integrated circuits (ASIC) or accelerators. Logic chips used for AI applications are also referred to generally as AI chips.

Both GPUs and ASIC can be used for AI training, but ASIC is more widely used as a customized computing circuit, for example, as a dedicated on-board chip or mining machine chip or as a mining machine chip. No chip can capture all the applications at once.

As mentioned above this paper will include the aspect from the semiconductor sectors which specifically specialize in making GPUs, the next part is about GPUs.

GPUs were originally designed to accelerate the rendering of 3D graphics. Over time, they became more flexible and programmable, enhancing their capabilities. This allowed graphics programmers to create more interesting visual effects and realistic scenes with advanced lighting and shadowing techniques. Other developers also began to tap the power of GPUs to dramatically accelerate additional workloads in high-performance computing (HPC), deep learning, and more [31].

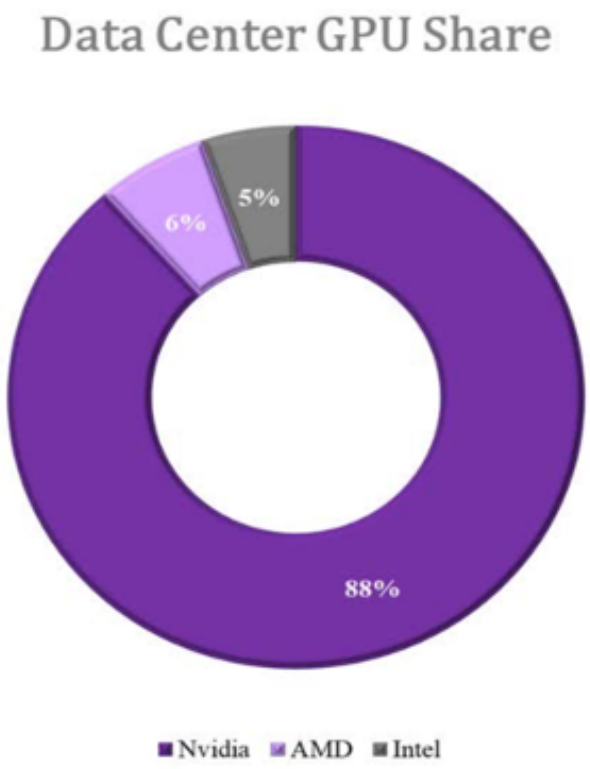

Figure 11

As seen above, Nvidia's market share is the highest in data center GPU at 88% followed by AMD at 6% and Intel at 5%, a dominating rival against AMD and Intel (2023) [32].

Intel Corp:

Data in this analysis uses the NASAQ index and the stock price of Intel (INTC) [33] from 2021/01/06 to 2023/10/06. With the data from 2022/03/29 to 2022/10/19, the Stock Market Line of Intel is estimated under CAPM, shown below:

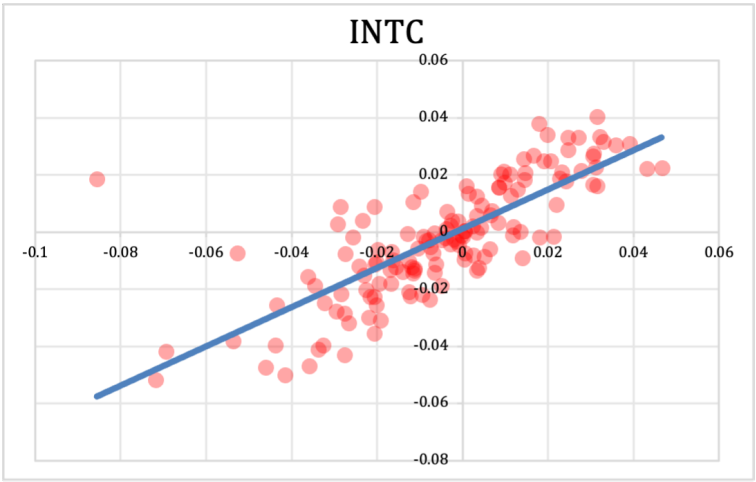

Figure 12.0

$$y = 0.6856x + 0.0012$$

Estimate Window	Event Window	α	β	R^2	Var
479	[2,41]	0.0012	0.6856	0.6067	0.00028013

Table 8: Summary Statistics of Variables

Though 0.6067 is a little lower than 0.7, it is still a relatively useful set of data. Selected from 2 days before (2022/11/28) the release of ChatGPT to 41 days after (2023/01/11) as the event window, CAR of Intel is the following:

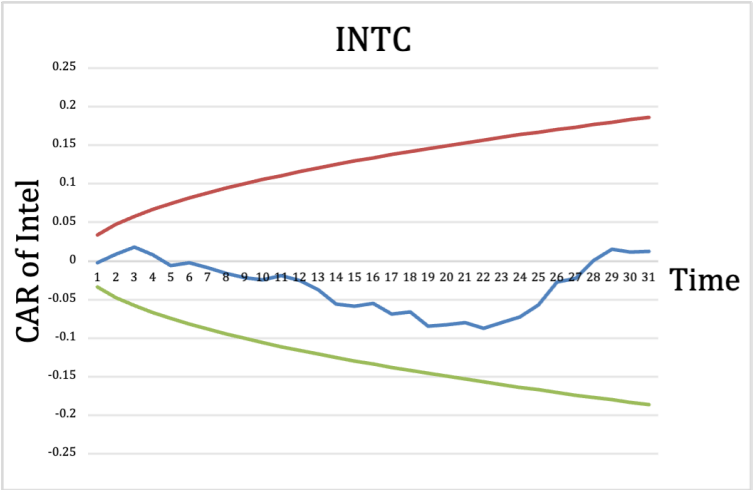

Figure 12.1

As is shown in Figure 12.1 the Cumulative Abnormal Returns fail to reject the null hypothesis and hardly see a clear connection between the main event and the company's stocks.

However, a couple of speculations may justify this situation. As is mentioned above in the introduction part, most AI natural language models training is based on GPUs instead of CPUs whose biggest supplier is Intel, and there are almost only two major suppliers in the GPU market, thus the release of ChatGPT won't have a strong impact on Intel. Meanwhile, a slight decreasing trend of the cumulative abnormal return can be observed, showing that the market's reaction to ChatGPT does not seem to favor Intel considering Intel's little share in the competition for GPU.

Advanced Micro Devices Inc. (AMD):

Data in this analysis collected the NASDAQ index and the stock price of AMD [34] from 2021/01/06 to 2023/10/06. With the data from 2021/08/06 to 2022/11/25, the Stock Market Line of AMD is estimated under CAPM. The estimation is shown below:

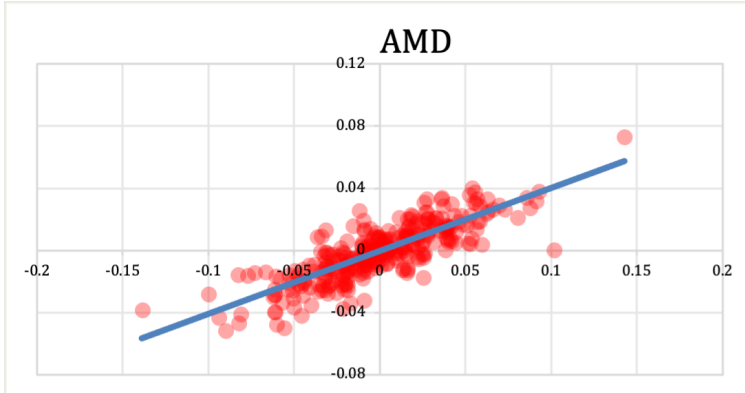

Figure 13.0

$$y = 0.4058x - 0.0005$$

Estimate Window	Event Window	α	β	R^2	Var
331	[2,28]	-0.0005	0.4058	0.6767	0.000939237

Table 9: Summary Statistics of Variables

Since 0.6767 is close to 0.7, it is still reliable enough to build the boundary for CAR analysis.

This analysis selected the day when ChatGPT was released in 2022-11-30 as the start of the whole event and selected from 2 days before (2022/11/28) to 41 days after (2023/01/11) as the event window (31trading days in total).

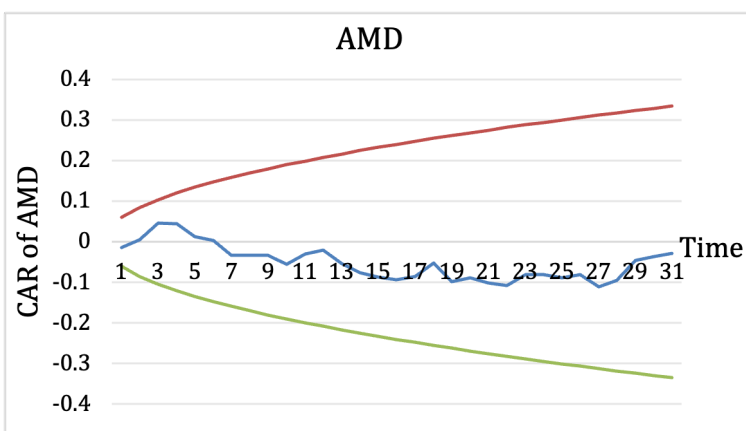

Figure 13.1

As is shown in Figure 13.1, the Cumulative Abnormal Returns fail to reject the null hypothesis and hardly see a clear trend. However, from a long-term perspective, if the CAR event was extended, an upward trend in AMD's CAR can be observed, as shown in Figure 13.2.

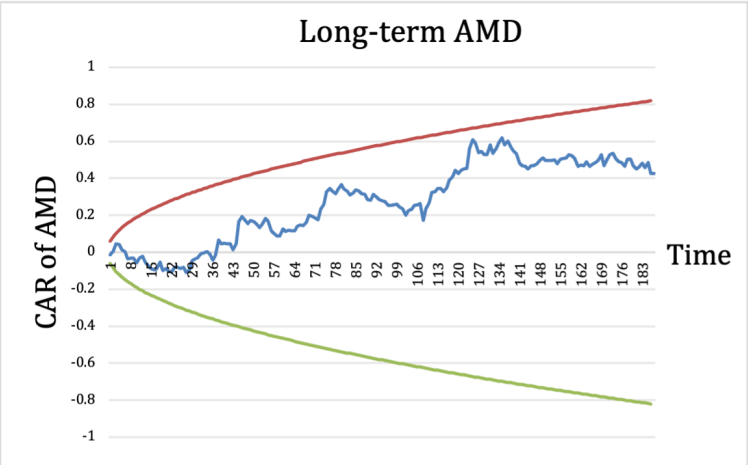

Figure 13.2

According to Deloitte (2023) [30], the top 10 global chip companies' combined market cap is down 34% from $2.9 trillion in November 2021 to $1.9 trillion in November 2022. At one point in October 2022, the Philadelphia Semiconductor index has dropped to 45% since January and ended the year with 37%. With the entire market suffering heavy losses and AMD's small share of the GPU market, the increasing CAR, conversely, illustrated a positive market reaction. This result is indeed surprising, but it is yet too early to determine the degree of benefits that AMD might have received from ChatGPT. In addition to the public's adaptation to AI, it is necessary to consider the model is often limited to consider the short-term impact of an event. The long-term increasing trend in CAR should only be viewed as a measure of last resort of analysis.

Nvidia

This part of the analysis used the Nasdaq index and stock prices of Nvidia (NVDA) [35] and covered from 2021/01/06 to 2023/10/06. With the data between 2020/01/06 and

2022/10/14, the Stock Market Line of Nvidia is estimated under CAPM. The estimation is shown below:

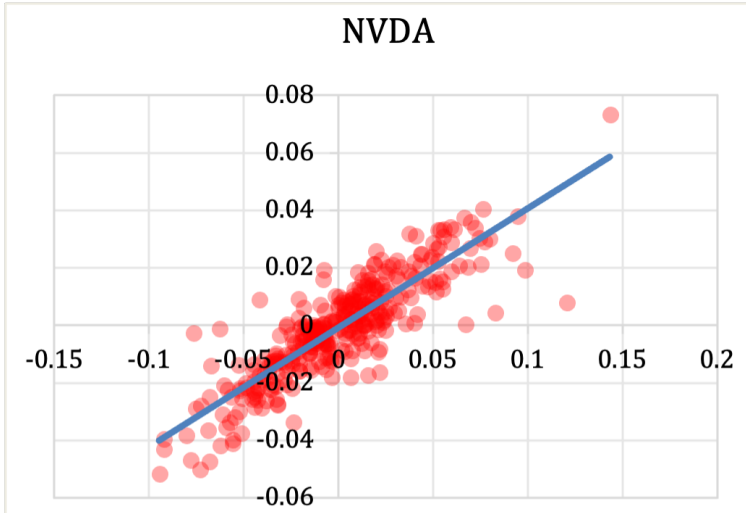

Figure 14.0

$$y = 0.414x - 0.0007$$

Estimate Window	Event Window	α	β	R^2	Var
347	[7,27]	-0.0007	0.414	0.7504	0.000939237

Table 10: Summary Statistics of Variables

As the R^2 is larger than 0.7, it is reliable enough to build the boundary for CAR analysis.

Selecting 2022/11/30, as the mid-point of the event window, the first test is based on a 34-day event window from 2022/11/22 to 2022/12/27 but failed to reject the null hypothesis (Figure 14.1).

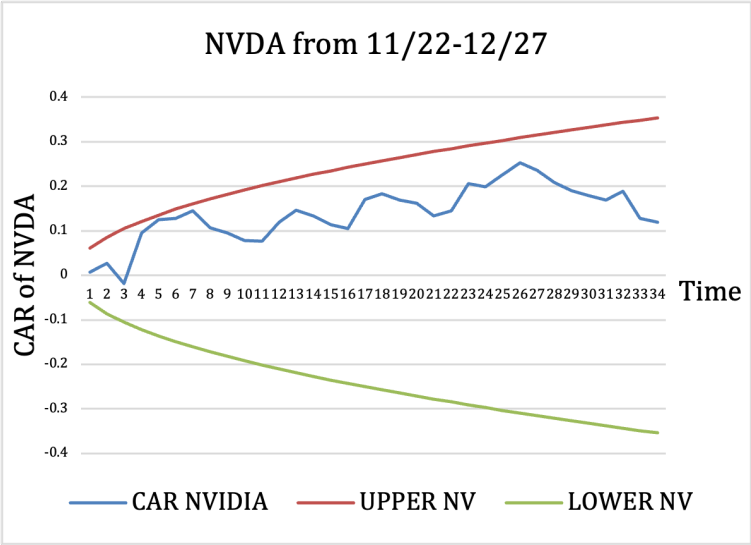

Figure 14.1

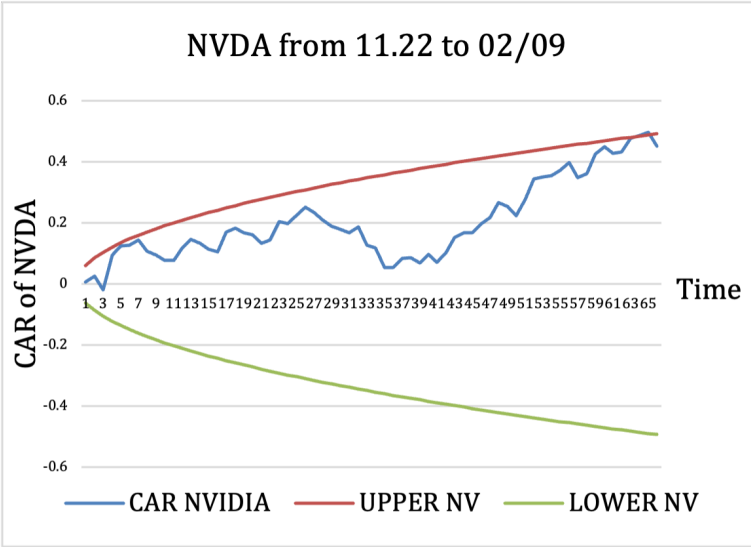

Figure 14.2

The second test motivated by the strong relationship between AI and Semiconductor extended its event window from 34 days to 66 days and ended its window on 2023/02/09. The breakthrough in the upper boundary happened at the 64th,and 65th days. (Figure 14.2) This phenomenon switched the focus to the period around 2023/02/08, the date of the 65th point.

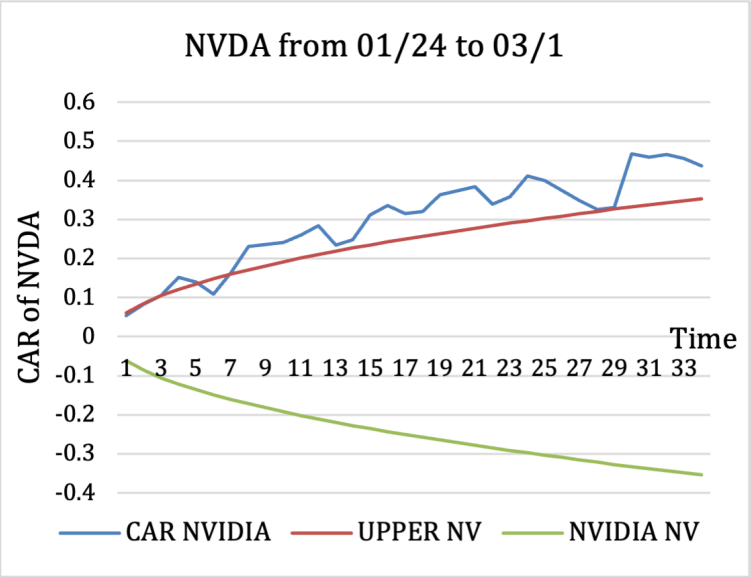

Figure 14.3

Selecting 2022/02/08 as the mid-point of the event window, the third test with a 34-day event window, from 2023/01/24 to 2023/03/01, showed an obvious result that the null hypothesis is rejected and a strong correlation between the AI language model and the semiconductor industry. (Figure 14.3)

Searching through the news about Nvidia between 2022/11 and 2023/2, there are two that are most influential to Nvidia. One is the release of ChatGPT3.5, while the other is the 2023 Consumer Electronics Show in January (CES). Over the past ten years, Nvidia has become a dominant force in producing chips dedicated to performing complex AI tasks such as image and text recognition, as shown in the previous figure of GPU market share. The success of ChatGPT has further increased the demand for these chips, allowing Nvidia to become the biggest winner in the trend of AI development, also reflected in the increasing CAR in the third test [36]. In the second news report, Mercedes-Benz announced that it is using the NVIDIA AI Omniverse platform to design and plan manufacturing and assembly facilities, further digitalizing the production process. Benz has been collaborating with NVIDIA to develop software-defined cars. Its upcoming vehicles will be based on NVIDIA DRIVE Orin centralized computing. They will be tested and validated for intelligent driving capabilities on the NVIDIA DRIVE Sim platform built through Omniverse. NVIDIA

Omniverse is a 3D development platform that enables businesses and institutions in various industries to establish and execute digital twins for industrial and scientific use cases. This platform adopts Universal Scenario Description (USD), which allows enterprises and developers to establish customized 3D processes, view, summarize, and interact with simulation results from a single source of facts. Both news are about AI development and application [37].

Therefore, a possible explanation for the result from the third test is that the investors had delayed reactions to the potential and value of AI. Besides the prospect of the public 'indifference' to AI, another reason for the delay is that the public has not built up connections with AI and investors would never have expected the overwhelming uses of the new launch of ChatGPT. The concept of AI has been known among many investors, so there must be some motives that prevent investors from believing the "worthiness" of AI investment – the failure of previous AI technology for not bringing obvious changes to general productivity. Not any AI before ChatGPT3.5 was widely used by the public. Back then, it would take long-term training or professional skills to excel and utilize AI in a specific task. This experience can most likely lead investors to cast doubt on the launch of ChatGPT3.5, but the reality proves the opposite ChatGPT brought everyone a chance to engage with AI on a daily basis.

5 conclusion

To summarize, this empirical analysis has investigated the degree of impact that the newly released ChatGPT has on sectors of Fine Arts, Information Technology, and Semiconductors. Though the version of GPT 3.5 does not have a significant effect on the first two industries, its upgraded version of GPT4 clearly illustrates a positive impact on the two industries, especially in the case of Google LLC and Microsoft Corp for both CAR curves have exceeded the upper confidence band only a few days after the event. All three companies in the semiconductors have not shown any clear signs of the impacts of ChatGPT in the short term. However, once the event window is extended, AMD demonstrates a positive abnormal return while Nvidia's CAR curve has

exceeded the upper band by a large portion. The study demonstrates the release of ChatGPT has successfully influenced multiple industries' stock markets.

Despite the clear effects, there are a few places that are worth future investigations. Known as the biggest competitor of Microsoft, Google rejected the null hypothesis by yielding a positive CAR, which implies a positive market reaction on Google. There is no doubt that Microsoft is the winner in taking the lead in AI development, and because of this, the expectation for Google's CAR is to exceed the lower confidence band, which is opposite to the result conducted in this paper. This may be due to BARD, Google's own research AI model, or the performance of Google's other services, such as Google Cloud. Yet, the real reason behind this is clouded. Secondly, it is nice to see that both AMD and Nvidia show a positive CAR curve. With the global semiconductor companies' capital shrinking, CAR manages to have a steady increase in CAR in the long term. There must be other reasons backing up AMD's performance. Lastly and back to square one, as the AI painting technology gets more and more data on training, the outcomes of AI-generated arts would only be increasingly realistic and potentially replace many artists' careers. In the Book an Artist 2023 AI survey, 54.6% expressed concern and even fears regarding AI's impacts on artists' income. As the AI painting becomes more mature, this percentage would likely rise. By then, the stock markets of the entire industry will be a whole new chapter [38].

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