Research Article

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Law and Economics of Language Model Development: Empirical Examination of Corporate Strategies and Vaporware Claims

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Abstract: This research investigates the application of corporate strategies in developing Large Language Models (LLMs) like ChatGPT, with a focus on law and economic aspects. Improved LLM performance is largely credited to expanded dataset size, leading to developments of similar models in non-English languages. This study questions whether such announcements, particularly in the Japanese market, could be classified as 'vaporware' posing potential antitrust issues. Using a stock event approach, the research scrutinizes the possibility of vaporware characteristics in these announcements by examining any resultant cumulative abnormal returns (CARs). The empirical evidence suggests an absence of significant upsurges in CARs in response to these announcements, implying a lack of vaporware characteristics and a stable market response. Consequently, in a market displaying reasonable efficiency towards investment in LLM development, these findings underscore the necessity for meticulous contemplation of competition policy regulation and the implementation of industrial policy promotion measures.

Keywords: cumulative abnormal return; Japan; large-scale language models; stock event analysis; vaporware

1 Introduction

Large-scale language models (LLMs), including ChatGPT, have the potential to instigate significant transformations within the economy and society, presenting numerous considerations from the vantage point of law and economics (Note 1). In light of these applications, the paper significantly contributes to the writing process, particularly in structuring and aiding the articulation of ideas (Note 2). However, this

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paper delves into characterizing corporate strategies surrounding ChatGPT and LLMs through the lens of 'vaporware', an existing concept in law enforcement. It is crucial to note, as this paper intends to elucidate, that while certain behaviors indicative of vaporware were observed, they do not conclusively fit the classification. Subsequently, we analyze the stock market as a monopolistically competitive arena, conducting an event study on stock prices for firms announcing the initiation of LLM development, including ChatGPT. This analysis aims to ascertain whether there is an increase in cumulative abnormal return (CAR). The findings on CAR are then scrutinized to determine their trajectory. The overarching aim of this study is to unravel the vaporware characteristics in the development of LLMs, including ChatGPT, and to assess the necessity for regulatory measures.

LLM are a type of computer program used in the field of natural language processing (NLP). It is designed to perform tasks related to the understanding and production of human language. LLM are trained using large amounts of textual data as training data. Training data includes text collected from a variety of sources, including documents on the Web, blogs, news articles, books, and Wikipedia. The evolution of this LLM has improved performance on a variety of NLP tasks, including machine translation, automatic summarization, sentence generation, and question answering. LLM are being used in many application areas, including information retrieval, customer support, and automated sentence generation.

In deep learning, the phenomenon of generalization error decreasing as the number of parameters is increased is known as the inverse of overlearning (overfitting). Overlearning is a state in which the model overfits the training data and the generalization performance for new data decreases. While increasing the number of parameters improves the expressive power of the model, and models with more parameters can learn more complex functions, there is also an increased risk of overlearning, which is high performance on training data but poor performance on unknown data. However, with a sufficient amount of additional training data, the model is now able to learn more complex patterns by increasing the number of parameters. With this particularly large data set, models with more parameters capture more patterns and features, potentially resulting in better generalization performance, and indeed, ChatGPT based on this has been very successful.

However, it has been pointed out that these LLM are in principle developed and operated in English, and that their accuracy in other languages is not as high as in English (https://ja.stateofaiguides.com/20200817-nlp-beyond-english/). This has resulted in strategic actions by companies trying to address this gap. Specifically, a series of announcements by large Japanese companies regarding the establishment and operation of LLM in Japanese have arisen (It is organized later in Table 1).

Table 1: Announcement of each company's LLM initiatives.

	Company name	Date of announcement of LLM initiatives announcement	URL
1	CyberAgent, Inc.	May 11, 2023	https://www.cyberagent.co.jp/news/detail/id=28797
2	Fujitsu, Ltd.	May 22, 2023	https://pr.fujitsu.com/jp/news/2023/05/22.html
3	Hitachi, Ltd.	May 15, 2023	https://www.hitachi.co.jp/New/cnews/month/2023/05/0515.html
4	Nippon Telegraph and Telephone Corporation	May 31, 2023	https://www.ntt-at.co.jp/news/2023/detail/release230531.html

Even among high-tech firms, including R&D-oriented firms, such announcements that they have begun development are of a somewhat unusual kind. Usually, announcements of R&D results are made to stimulate demand or lead to further investment. This is partly because such announcements of research results at an early stage, when they have not yet been commercialized, are sometimes called vaporware and have been viewed with suspicion.

Vaporware refers to computer hardware or software that was announced to the public in the computer industry but was delayed or never actually manufactured or officially cancelled. Historically, the U.S. Department of Justice was notably accused of doing this by IBM in 1969 in United States v. IBM. There, IBM announced the release of the System/360 Model 91 after an IBM competitor, Control Data Corporation (CDC), released a computer. This announcement resulted in a significant drop in sales of CDC products. However, because the System/360 Model 91 was not released until two years later, the U.S. Department of Justice accused IBM of doing this intentionally. (Note 3, Note 4) Similar lawsuits have been filed against Kodak, AT&T, and Xerox. (Note 5) Also, U.S. District Court Judge Spokin vociferously opposed the practice during the 1994 settlement hearing in United States v. Microsoft Corp. "Vaporware is, on its face, a deceptive practice, and everyone in the business community knows it." said Spokin. (Note 6)

In the United States, it is illegal under Section 2 of the Sherman Antitrust Act of 1890 to announce a product that does not exist in order to gain a competitive advantage, but in practice, few hardware or software developers have ever been convicted for this type of conduct. False or misleading announcements intended to influence stock prices are also illegal under the Securities Fraud Act in the U.S. and the Financial Securities Exchange Law in Japan. Several companies have been

charged in court with knowingly making false announcements to gain an advantage in the market.

It is not easy to directly observe and evaluate whether a Japanese company's announcement of its efforts to build LLM in Japanese constitutes vaporware or a misstatement in its securities report, since there are a wide variety of factors to consider, including the perceptions of the people involved and objective technical standards. Therefore, we would like to examine the vaporware nature (misstatement character) of this announcement by understanding consumer perceptions of such an announcement, as well as the impact of this LLM initiative on the economy as a whole.

In order for vaporware to be established, it is assumed that a certain degree of market dominance exists (Note 7). However, with regard to LLM technologies such as ChatGPT, it is extremely difficult to even consider the possibility of a strong business, especially since it is a software and web service in a high-tech market, and its usage is still being explored around the world, and it is also extremely difficult to investigate how consumers perceive it. It is also extremely difficult to investigate how consumers perceive the software.

In response to this situation, we consider stock market trading of the shares of each company, in which each company is differentiated from the others and, while recognizing the trends of other companies, the company is the sole provider and consumer interest in it is demonstrated. The stock of each company is considered to be a market in which market dominance exists (Note 8), a place for trading in monopolistic competition, where the company is the sole provider but competition is taking place and no excess profits are being generated. In this market, we attempt to verify whether each company's LLM activities are indicative of vaporware-like trends.

In this case, we consider each firm's press release as a shock that reveals information that was not previously available in the market, and examine how the shock is reflected in the stock market by examining the change in CAR through a stock price event analysis.

The efficient market hypothesis is a hypothesis that all available information is fully reflected in market prices. In other words, in the stock market, since all available information is reflected in prices, asset prices follow a random walk, and since it is not possible to predict future price changes using currently available information, investors cannot earn more than their expected returns. Stock price event analysis is the idea that there is a possibility that an event, say the announcement of certain information, could have an impact on price formation.

The conclusion of this study was that LLM development announcements were not perceived as vaporware at all by the companies, and that their announcements were received calmly by the market. This is a robust result, as it is the same even

when the event window is changed or when the control group is taken into account. Therefore, it is highly likely that LLM development will be constrained by market mechanisms, and it is difficult to see a clear rationale for the immediate introduction of competition and industrial policy regulations.

This paper is organized as follows. Section 2 reviews prior studies, particularly the recent consideration of the economic impact of LLMs, particularly ChatGPT. It then summarizes the Vaperware study, which was a major discussion in law and economics at the time of the Microsoft litigation. Section 3 summarizes the methodology and data in this paper. It also discusses descriptive statistics and summarizes the methodology for the stock price event analysis. Section 4 summarizes the results. In addition, the robustness of the data is examined based on several methods. Section 5 is the conclusion.

2 Previous Study

Regarding the impact of LLMs around ChatGPT in recent years, the following are some of the most prominent discussions of artificial intelligence (AI) and skills, starting with Autor as a particularly prominent discussion here from an economics perspective. The study offers a unified analysis of the growth of low-skill service occupations between 1980 and 2005 and the concurrent polarization of US employment and wages. The study hypothesizes that polarization stems from the interaction between consumer preferences, which favor variety over specialization, and the falling cost of automating routine, codifiable job tasks. Applying a spatial equilibrium model, the study corroborates four implications of this hypothesis. Local labor markets that specialized in routine tasks differentially adopted information technology, reallocated low-skill labor into service occupations (employment polarization), experienced earnings growth at the tails of the distribution (wage polarization), and received inflows of skilled labor (Autor and Dorn 2013). In light of this, therein,the study discusses how recent AI advancements, largely fueled by machine learning's predictive abilities, affect jobs. It highlights the importance of understanding the distinction between prediction and decision-making roles. The paper illustrates how AI's influence on labor can differ when automation is used for decision-making versus when it aids human decision-making (Agrawal, Gans, and Goldfarb 2019). This has been shown, among other things, recently by the study that explores the potential impact of LLMs like GPTs on the U.S. labor market, emphasizing the amplified capabilities of LLM-powered software. Using a unique method, the study evaluates jobs based on their alignment with LLM capabilities. The results show that roughly 80 % of U.S. workers could see at least 10 % of their tasks affected by LLMs, with around 19 % possibly having 50 %

of their tasks impacted. These effects could touch all wage brackets, with higher-income jobs at higher risk. Importally, these effects are not limited to high-growth industries. With LLMs, about 15 % of all tasks could be done significantly quicker without quality loss. This rises to between 47 % and 56 % when considering LLM-powered software, implying substantial economic effects. The study concludes that LLMs, like GPTs, show characteristics of general-purpose technologies with wide-ranging potential implications (Eloundou et al. 2023).

In addition to this, the direct impact of LLMs such as ChatGPT is discussed: The study presents a method that utilizes online job ad data to evaluate the likelihood of emerging technologies becoming General Purpose Technologies (GPTs) – rare innovations with substantial economic impact. This technique helps identify which technologies might have a broad economic influence versus those that will be beneficial but remain narrow enabling technologies. This method, with at least five years predictive power, is distinct from traditional patent-based approaches. Applied to 21 emerging technologies, it indicates that machine learning and related data science technologies are quite likely to become GPTs (Goldfarb, Taska, and Teodoridis 2023). The other study observes that early uses of artificial intelligence technologies (AITs) were narrow yet highly profitable, and their widespread application could lead to an economic boom. Firms replicating these early applications could gain strategically, a pattern seen in previous information and communication technology rounds. For AITs to become a general-purpose technology across sectors, new innovations are necessary. The paper explores potential innovation paths for this outcome, those that have stalled, those currently in progress, and future possibilities. Interestingly, early AIT usage, in both commercial and technical sectors, succeeded without needing Digital Transformation. However, all potential innovation paths identified necessitate Digital Transformation as crucial steps (Bresnahan 2023). In addition, the following more specific verifications have been made. The study examines the impact of an AI-based conversational assistant on 5179 customer support agents. The tool enhances productivity by an average of 14 %, particularly benefiting novice and low-skilled workers, with little impact on experienced or high-skilled workers. The AI model appears to share the tacit knowledge of more skilled workers, aiding less experienced workers. The study also shows that the AI tool improves customer sentiment, lessens the need for managerial intervention, and boosts employee retention (Brynjolfsson et al. 2023).

This present study does not examine these aggregate effects on labor or the direct effects of technology from the events here; the study examines how LLM is used where it is one of the business strategies, and the actual effects when it may cause harm, and the law to regulate it based on these effects in terms of law and economics to advance the discussion.

Furthermore, this research extends its scope to include traditional marketing strategies, highlighting the exigency of law enforcement and regulatory measures in this domain. A critical aspect of this study is the exploration of the legal and economic implications of vaporware, a practice characterized by premature product announcements that lack substantiation at the time of disclosure. This practice's potential harm and the need for regulatory oversight are scrutinized, drawing attention to the 1995 Microsoft antitrust case. In this landmark case, Judge Stanley Sporkin's initial rejection of a consent decree brought to the fore the contentious nature of vaporware. While the judge's ruling was subsequently overturned, it catalyzed robust discussion surrounding the potential antitrust ramifications of vaporware strategies (Note 9).

The notion of fraudulent vaporware marketing, which is classified as predatory under the Sherman Act, threatens to impede fair competition. Nevertheless, vaporware announcements that are innocently made with strategic intent ought not to be construed as antitrust violations, given their prospective efficiency benefits (Prentice and Langmore 1994). Furthermore, vaporware, defined specifically within the context of software that is announced but not subsequently delivered as expected, has ignited contentious debate over its potential anticompetitive effects. However, given the deleterious impact on a firm's reputation, the probability of firms deliberately issuing false product pre-announcements appears minimal. As such, vaporware may not pose a significant concern for antitrust authorities (Levy 1997). From an economic standpoint, vaporware – a strategy whereby a firm inaccurately announces a new product, often to deter potential competitors – warrants analysis. The argument proposed is that vaporware operates as an equilibrium strategy within a signaling game and can exert adverse effects on consumers. Despite this, the overall welfare implications of vaporware remain equivocal, and the need for further research is thus underscored (Haan 2003). Similarly, the widespread practice of "vaporware," where firms pre-announce products prior to their market availability, is a notable trend within the computer industry. Another study develops a model suggesting that such announcements, despite constituting "cheap talk," may yet convey valuable consumer information. That study interrogates the welfare implications of this practice, the potential network effects, and its prospective influence on firms' innovation strategies, thereby advocating for further research concerning the nexus between product pre-announcements and R&D incentives (Choi, Kristiansen, and Nahm 2010).

This study is intended to examine the vaporware nature of the company's LLM efforts and its response. We advance our understanding of the possibility and reality of how new technologies are used in old marketing strategies.

3 Methodology and Data

3.1 Methodology

This study uses the stock price event study methodology, using the start of LLM development as the event, to infer the vaporware nature of that announcement from the CAR trend and how consumers perceived it. As we have seen in previous studies, vaporware characteristics are one of the keys to understanding how consumers perceive a business's announcement, and therefore, this study captures the reality of the vaporware characteristics.

Stock price event analysis, also known as event study analysis, is a method used to evaluate the impact of a specific event on the stock price of a listed company. Its purpose is to determine whether an event caused an abnormal price movement and to quantify the magnitude of that price movement. This analysis is used by investors, analysts, and researchers to understand the market reaction to a particular event and to assess its impact (Fama et al. 1969). Since the efficient market hypothesis states that the stock price may include all factors related to the stock price, not just investor reaction, it also includes consumer reaction to the product or service (which may affect the stock price increase through, for example, increased sales and profits). Particularly in relation to mergers, this study examines the reaction of stock prices to mergers and acquisitions. It shows that shareholders of the target firm usually experience a positive stock price reaction, while shareholders of the acquirer usually experience a negative stock price reaction (Jensen and Ruback 1983). In addition to this, numerous event studies have been conducted and a lot of information has been analyzed, including companies' responses to various announcements, mergers, and incidents (MacKinlay 1997; Page and Connell 2020).

The standard method of stock event study analysis is as follows:

(i) Identify the event. The first step is to identify the event that you want to study. This could be a corporate announcement, such as a merger or acquisition, or a regulatory event, such as a change in interest rates.
(ii) Define the event window. Once you have identified the event, you need to define the event window. This is the period of time around the event that you will use to measure the stock's reaction. The event window typically includes the day of the event and the days before and after the event.
(iii) Choose a benchmark. You also need to choose a benchmark. This is a stock that is similar to the stock that you are studying, but that was not affected by the event. The benchmark will be used to compare the stock's reaction to the event.
(iv) Calculate the abnormal returns. Once you have defined the event window and chosen a benchmark, you can calculate the abnormal returns. This is done by subtracting the benchmark's returns from the stock's returns.

(v) Test for statistical significance. Finally, you need to test for statistical significance. This is done by using a statistical test, such as the t-test or the z-test, to see if the abnormal returns are statistically significant.

The standard method of stock event study analysis is a simple and effective way to measure the reaction of a stock to an event. However, it is important to note that this method has some limitations. For example, the method assumes that the benchmark is a perfect proxy for the stock that is being studied. This is not always the case, and this can lead to errors in the results. Additionally, the method does not take into account any other factors that may have affected the stock's price during the event window.

With respect to the impact of new product development on financial markets, including stock prices, that we seek to examine in this study, studies that attempt to estimate new product performance from stock prices (e.g., that stock returns associated with new product announcements are not appropriate forward-looking indicators of future product performance; Talay, Akdeniz, and Kirca 2016), as well as international differences in the market impact of new product announcements (Talay et al. 2019), the impact of new product development announcements (differing between individual and institutional investors Bhattacharya and Sardashti 2022), and other studies. This study examines the specifics of the impact of new product development announcements on the market for a confirmatory view that they are not vaporware in the context of high-tech antitrust, and such prior studies are also instructive, albeit in a somewhat different context than the various impacts of new product development announcements.

This study applies standard stock price event analysis to the announcement date of a company's LLM development. The expected outcome is a stock price increase due to investor optimism about the potential of LLM technology. However, actual reactions may vary based on factors like the company's track record, competition, and market sentiment. A stock event study would collect data and use statistical methods to test for abnormal returns. Possible outcomes include increased, unchanged, or decreased stock prices. Comparing multiple studies can provide insights into investor perceptions, influencing factors, and market sentiment towards LLM technology. Such analysis can help companies make investment decisions and understand the need for regulation regarding LLM disclosures.

In general, daily stock price event analysis often looks at a short period of time, several days after the event date. In particular, positive news such as new product announcements and changes in corporate strategy are often reflected in the stock price in the time from the announcement. Since the announcement of Japanese LLM development in this study may require some time to determine the impact, the author also tested the CAR calculation up to two weeks later, as well as up to four days later. In order to analyze the beta from this perspective, the study took 2 months as about 4 times 2 weeks.

3.2 Data

In this analysis, the daily closing prices of the Nikkei Stock Average, CyberAgent, Inc., Fujitsu Limited, Hitachi, Ltd. and Nippon Telegraph and Telephone Corporation are all used. In addition, the following list (Table1) shows the announcement of each company's LLM initiatives.

4 Results

4.1 Estimation Formula and Results

In this section, the estimation formula is as follows (equation (1)).

$$\mathrm{SP}_{\mathrm{i,t}} = \alpha_{\mathrm{i}} + \beta_{\mathrm{i}} \times \mathrm{NIKKEI}_{\mathrm{t}} + \varepsilon_{\mathrm{i,t}} \tag{1}$$

where i be a subscript for each company (i = CyberAgent, Fujitsu, Hitachi, and Nippon Telegraph and Telephone), SP be the stock price of each company, and NIKKEI be the Nikkei average, and β_i for each company is calculated from data for the two months before the announcement date. The subscript t indicates time and is taken daily. The CAR is then obtained by subtracting the actual stock price from the assumed stock price using β_i from the day following the announcement date. This is done until one week after the announcement date, and the values are compared. α and β are the coefficients to be obtained. e is the error term. Here, instead of using stock price returns and market returns, the CAR equivalent is estimated by calculating the estimated stock price and estimating and accumulating the stock price returns from it.

The α and β for each company are as follows Table 2:

Table 2: The α and β for each company.

		α (S.E.)	β (S.E.)	Adjusted R2
1	CyberAgent, Inc.	262.685 (157.263)	0.031 (0.006)	0.427
2	Fujitsu, Ltd.	10619.070 (1386.118)	0.256 (0.048)	0.403
3	Hitachi, Ltd.	−5336.157 (639.894)	0.451 (0.023)	0.911
4	Nippon Telegraph and Telephone Corporation	2803.168 (316.748)	0.043 (0.011)	0.273

Here, we consider the announcement date as the event window and the CAR up to two weeks later. There have been some indications regarding stock price volatility due to information leaks prior to an event (e.g., Talay, Akdeniz, and Kirca 2016). For example, CyberAgent made similar announcements in January and

Table 3: Relationship between stock price movements of each company and control group before and after the announcement date and the announcement date dummy variable

Dependent variable:	**Press release Dummy**	
Method: least square	***n* = 21**	***n* = 21**
	Coefficient (S.E.)	Coefficient (S.E.)
C	−10.737	−17.828
	(5.7750)	(12.7109)
CyberAgent, Inc.	0.001	0.018
	(0.0113)	(0.0152)
Fujitsu, Ltd.	0.127[a]	0.069
	(0.0316)	(0.0557)
NTT	−0.063	−0.039
	(0.0456)	(0.0614)
Gree, Inc.		−0.029
		(0.0420)
NEC Corporation		0.063
		(0.0412)
Toshiba Corporation		0.123
		(0.1763)
KDDI		−0.014
		(0.0659)
R-squared	0.907	0.929
Adjusted R-squared	0.884	0.882
Akaike info criterion	−0.453	−0.342

[a]Indicates 1 % significance.

March 2023, and the possibility that such information is reflected in stock prices cannot be denied. However, in this study, we only consider the elimination of uncertainty in the announcement of official views as one event, and therefore, in principle, we consider the announcement date of each company's official announcement as the event date. Based on this, we then examine the event date and the cumulative abnormal return after the event date for each company. However, one limitation of this study is that the possibility of stock price fluctuations due to such information leaks cannot be completely ruled out.

Based on this, the CAR for each company were calculated as the difference between the estimated and realized values, and their two-week trends are shown in the following chart (Figure 1).

The above chart shows the cumulative ratio (%) of the CAR to the stock price by day, starting from the day after the LLM development announcement date, which is 0. According to this chart, although Fujitsu's ratio is slightly positive on the first day,

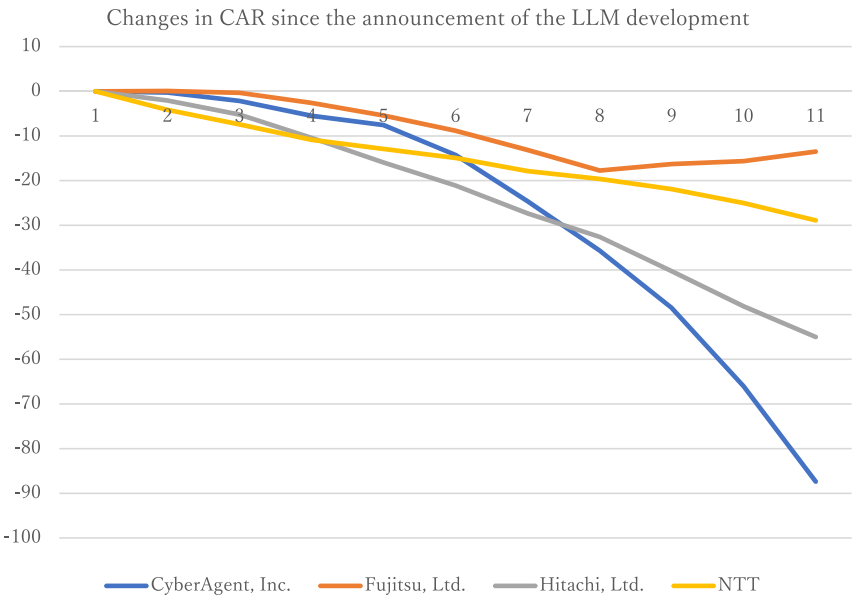

Figure 1: Changes in CAR.

all other ratios are negative, indicating that consumers and investors do not positively evaluate each company's announcement of LLM development efforts.

For CyberAgent's CAR, a t-test based on results up to day 4 yields a t-value of approximately −3.152 and a p-value of approximately 0.9901, and a t-test based on results up to 2 weeks later yields a t-value of approximately −5.127 and a p-value of approximately 0.99997. Both of these results indicate that there is insufficient evidence to support the null hypothesis that the CAR is positive. In other words, the conclusion is that it is not statistically significantly greater.

Similarly, for NTT's CAR, a t-test based on the results up to day 4 yields a t-value of approximately −4.092 and a p-value of approximately 0.9968. A t-test based on the results up to 2 weeks later showed a t-value of approximately −7.462 and a p-value of approximately 1.0000. For the Hitachi CAR, a t-test based on the results up to day 4 yielded a t-value of approximately −5.770 and a p-value of approximately 0.9994. A t-test based on the results up to 2 weeks later yielded a t-value of approximately −10.972 and a p-value of approximately 1.0000. Furthermore, a t-test based on the results up to day 4 for Fujitsu's CAR yielded a t-value of approximately −1.938 and a p-value of approximately 0.9497. A t-test based on the results up to two weeks later yielded a t-value of approximately −0.997 and a p-value of approximately 0.8346. All of these company results indicate that there is insufficient evidence to support the

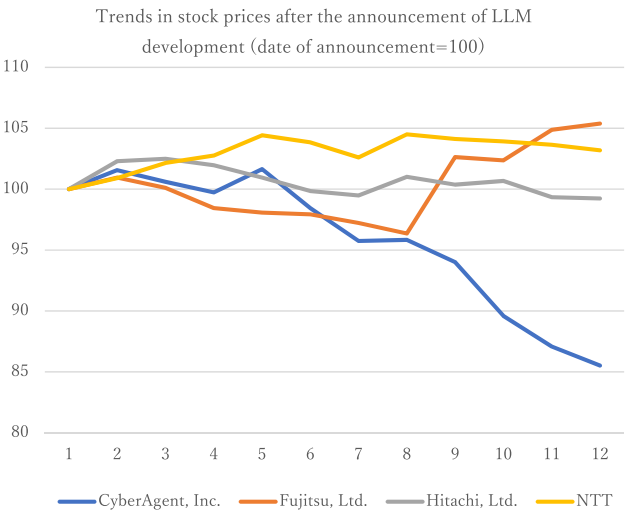

Figure 2: Trends in stock prices.

null hypothesis that the CAR is positive. In other words, the conclusion is that it is not statistically significantly greater.

The following chart (Figure 2) illustrates the stock price trends of each company after the date of their LLM development announcements.

The graph shows that no company's stock price has increased significantly since the announcement of the LLM development.

Therefore, the announcement of LLM development was not perceived as vaporware by the companies, and the announcement was received calmly by the market. It is highly likely that the actual launch of the service and its market acceptance is recognized as something to come. If the announcement by high-tech companies that they will develop products incorporating innovative technologies has any effect on rivals, for example, it is likely to be perceived by the market as an increase in the number of competitors of the same type competing in technological innovation and that there will be even fiercer competition in the future.

4.2 Robustness Check

The robustness of this estimation is examined from the following two points. The robustness of this estimation is examined from the following two points: changes in the event window and the use of control groups.

As for the change in the event window, the next figure plots the CAR from the fourth day after three days have passed (Figure 3), instead of looking at the cumulative abnormal earnings from the day after the LLM development announcement date.

The same trend can be seen in this figure. In other words, CAR are negative for all firms, suggesting that the market is not receiving the firms' announcements positively.

Next, as a control group, we would like to look at the stock price trends of Japanese competitors during the same period compared to the stock price trends of each company. The companies that are comparable to each of the firms are as follows

(i) GREE, Inc.: Like CyberAgent, Inc., GREE is active in the fields of Internet advertising and social games. GREE develops and operates mobile social games and operates a digital advertising business.

(ii) NEC Corporation (NEC): Like Fujitsu Limited, NEC is a world-renowned company in the fields of information and communications technology, computer products, and telecommunications infrastructure; NEC provides computers, network equipment, security solutions, and cloud services.

(iii) Toshiba Corporation: Like Hitachi, Ltd., Toshiba Corporation is a company with a wide range of businesses in the fields of electrical equipment, information and telecommunications equipment, and energy. Toshiba offers products and services such as home appliances, information systems, and infrastructure systems.

(iv) KDDI Corporation: Like Nippon Telegraph and Telephone Corporation, KDDI Corporation is a company that operates in the fields of telecommunications services, Internet access, and mobile communications. KDDI provides cell phone services, fixed-line telecommunications services, data center services, and cloud computing services.

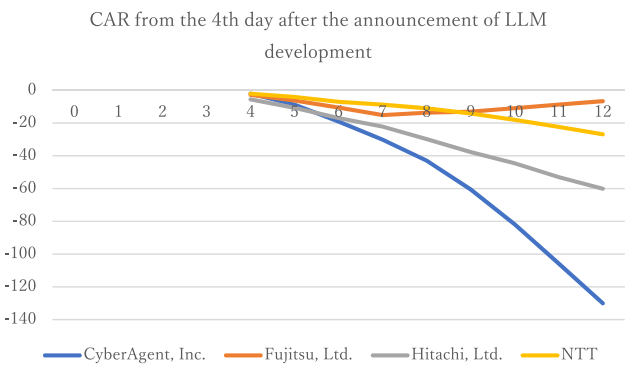

Figure 3: CAR from the 4th day.

The following graph compares these companies with CyberAgent, Fujitsu, Hitachi, and Nippon Telegraph and Telephone, discussed here, by picking up 10 days before and after the date of LLM development announcement, along with the change in the Nikkei Stock Average. The graph shows the Nikkei Stock Average for each of the 10 days before and 10 days after the LLM development announcement (Figure 4).

As can be seen from these graphs, there is no clear difference between the companies considered here after the announcement of LLM development and the control companies, with the exception of Fujitsu. Incidentally, when we looked at the relationship between the indexed stock price and the stock price in the 10 days before and after the announcement using a dummy variable that takes 0 before the announcement date and 1 after the announcement date, no company (except Fujitsu when no control is used) was significant at 5 %.

$$PR_t = \alpha + \beta_i \times Company_{i,t}\left(+ \gamma_j \times Company_{j,t}\right) + \varepsilon_{i,t} \quad (2)$$

In equation (2), the subscript t represents time, i represents each firm, j represents each dummy firm, PR is the announcement date dummy variable, and Company represents the stock price of each company. α, β_i, and β_j are the coefficients to be obtained, and ε is the error term (Figures 5–7).

From the robustness of the results, it can be assumed that the announcement of each company was received calmly by the market, and no vaporware-like effects were found.

There are various possible reasons why the announcement of the LLM development did not lead to an increase in the company's valuation. In the following, for example, the limited impact of a company's announcement about developing an LLM can be condensed into three main reasons:

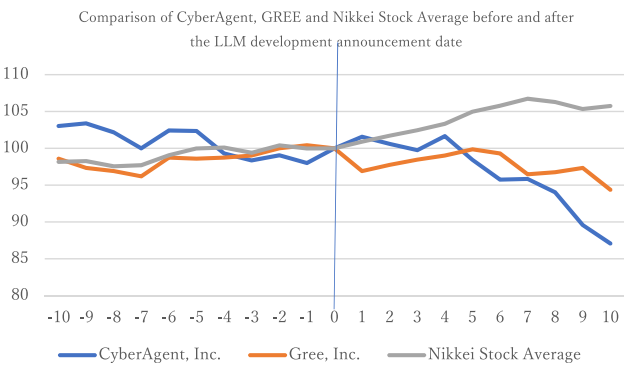

Figure 4: CyberAgent, GREE, and Nikkei Stock Averate.

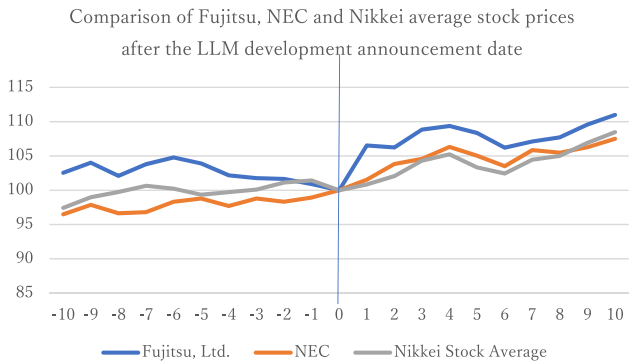

Figure 5: Fujitsu, NEC, and Nikkei Stock Average.

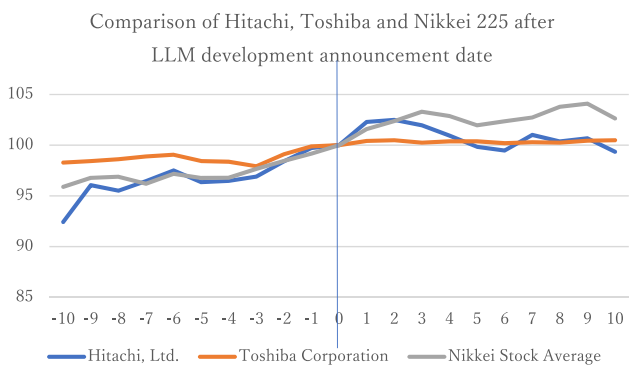

Figure 6: Hitachi, Toshiba, and Nikkei Stock Average.

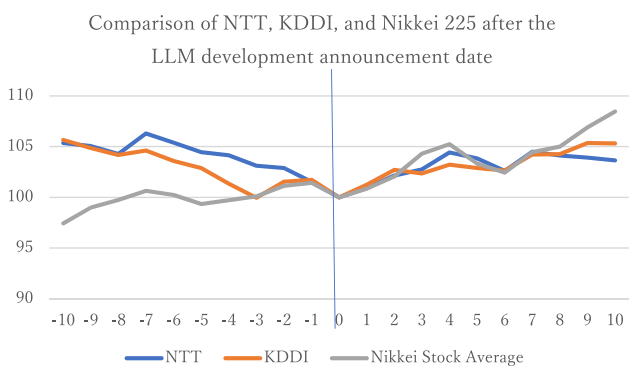

Figure 7: NTT, KDDI, and Nikkei Stock Average.

(i) Communication and Relevance Issues: Ineffective communication of the project's benefits and relevance, coupled with a failure to align the development with the company's core business and strategic goals.
(ii) Market and Competitive Factors: The announcement's lack of distinction in a competitive market and the technical complexity of the LLM, making it hard for non-experts to grasp its importance.
(iii) Company Reputation and Timing: Skepticism arising from the company's past performance and credibility, exacerbated by inopportune timing of the announcement amidst more pressing market issues or negative news.

However, it is reasonable to assume that one or more of such reasons could not have been at work and that market efficiency was demonstrated and legitimate valuation did not result in an increase in valuation.

In addition, in one episode, in March 2023, Baidu announced the Ernie bot, the Chinese version of ChatGPT, to the market's disappointment and a 10 % drop in its stock price. In fact, even financially strong companies like Baidu lag behind some U.S. companies in the generative AI space. It is conceivable that the market's lack of appreciation for the development of generative AI by Japanese companies may be due to their perceived lack of strength to challenge the monopoly of certain companies. If this antitrust issue is to be discussed in the area of generative AI, it may be better to address the issue of monopoly by a few companies rather than unfounded concerns about vaporware (NOTE 10).

4.3 Summary of this Section and Discussion

There are many concerns about the development of LLM models such as ChatGPT (Note 11). However, the market is calmly evaluating this development, and if the efficient market hypothesis is valid in some aspects, and if a certain evaluation is being made based on the market's judgment of various information, then it is appropriate from the perspective of law and economics to wait and see how the LLM model development progresses for the time being.

As we saw in Section 4.1, the announcement of the LLM development was not viewed vaporware-like at all by the companies, and the companies' announcements were received calmly by the market. As we saw in Section 4.2, this is a robust result, as it is the same whether we change the event window or consider a control group. In light of these results, it is difficult to believe that there is a clear basis for the argument that LLM development is likely to be constrained by market mechanisms and that some form of competition or industrial policy regulation should be introduced because LLMs such as ChatGPT may have a significant impact on future

economic growth. Consequently, given that this is a unanimous view in a reasonably efficient market, the need for competition policy regulation and the justification for industrial policy promotion measures are issues that should be more carefully considered.

On the other hand, it should be noted that this study only examines the market response to the announcement and does not consider other potential factors or long-term impacts. Drawing broad policy conclusions based on a single analysis of market response may oversimplify the complex dynamics involved in regulating and fostering innovation in the LLM sector. Therefore, it is necessary to go beyond the appropriateness of regulation from competition policy for vaporware and to promote a further understanding of the actual conditions of the technology's applicability and the business strategies of firms that include it.

5 Conclusions

This study empirically analyzes the presentation of corporate strategies for LLM development, such as ChatGPT, from a law and economics perspective. LLM derived its performance by increasing the size of the data set to a gigantic size. Therefore, in principle, it is possible to produce innovations that show similar performance in languages other than English. For this reason, several Japanese companies have announced the development of ChatGPT and similar models in Japanese. In this study, we examine whether these firms' announcements can be positioned as vaporware, which has once been an issue in the antitrust debate. Specifically, we conducted a stock-event analysis using the date of the announcement as the event with regard to the fact that the announcement regarding the development of LLM, including the Japanese version of ChatGPT, did not have the vaporware nature that is likely to be a problem for antitrust in the high-tech sector. That is, a survey was conducted to verify that the firm's announcement regarding LLM development was not vaporware and that the firm's CAR was not elevated. The results showed that there was no increase in CAR with respect to these announcements, no vaporware element was observed, and the market reaction was confirmed to be quite calm in a robust manner. This may indicate that market mechanisms are calm regarding LLM development investments, making it difficult to justify current restrictions in competition policy and promotional measures in industrial policy (Note 12).

The implication of this study is that this study raises important questions about the validity of existing industrial and competition policies that might unduly restrict or impede such technological advancements. It suggests the need for a more nuanced understanding of the market dynamics surrounding the development and adoption of advanced artificial intelligence technologies. Future studies may build upon these

findings to further investigate the role of market dynamics in shaping AI development strategies, and how regulatory frameworks might adapt to support beneficial competition and innovation.

The limitation of this study is that it primarily focuses on the reaction of financial markets to the announcement of LLM development, CAR as an indicator of whether the announcement was perceived as vaporware. Therefore, it does not account for the actual follow-through and execution of these projects, which is crucial for understanding whether these initiatives yield the promised results and benefits. Another limitation is the lack of analysis of the impact on the stock market of the leakage of information about the start of development. Furthermore, it primarily concentrates on Japanese companies, which may limit the generalizability of the findings to other cultural or economic contexts. It is also limited in its ability to address potential long-term effects of these technologies on market competition, consumer welfare, or broader societal implications. Future research may aim to address these gaps by investigating the post-announcement performance of companies, broadening the scope to include a more diverse set of global firms, and examining the specific details and impacts of different competition policies.

Note

(Note 1)

For example, when we ask ChapGPT about analyzing the impact of LLMs in terms of law and economics in Asia, we get the following response:

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User:

What is the analysis of the impact of large-scale language models, including ChatGPT, from the perspective of Asian “law and economics”?

ChatGPT:

Analyzing the impact of large-scale language models (LLMs) like ChatGPT from an Asian “Law and Economics” perspective would involve looking at various factors. Law and Economics, as a discipline, applies economic theory (mainly microeconomic theory) to the analysis of law to provide an economic understanding of law and the legal system. Here are a few potential areas of impact:

Economic Efficiency: From an economic perspective, the implementation of LLMs can drive efficiency in legal services. In the Asian context, this can mean making legal advice more affordable and accessible, especially in countries where access to such services is limited. With LLMs, businesses, governments, and individuals could quickly access basic legal information without needing to consult with a legal professional directly.

Legal Market Disruption: Large-scale language models could potentially disrupt the legal market by automating some tasks traditionally done by humans. For instance, LLMs could help with document review, due diligence, contract analysis, and even basic legal research. This could impact employment in the legal sector and potentially devalue certain legal skills while elevating others, such as tech skills or advanced legal judgment.

Legal Framework and Regulations: On the law side, regulations might need to evolve to accommodate the growing use of AI technologies like LLMs. For instance, issues related to data privacy, intellectual property rights, liability for misinformation or errors, etc., would need to be addressed. Asian countries may face challenges given the heterogeneity in legal systems and regulations across the region. There might also be unique cultural and societal norms that need to be taken into account when formulating these laws.

Cross-Border Legal Services: (Omitted.)

Inclusion and Bias: (Omitted.)

Economic Impact: (Omitted.)

Digital Divide: (Omitted.)

It's important to note that these points are based on an interpretation of Law and Economics principles and current knowledge of AI technologies as of 2023, and actual impacts could vary based on how these technologies develop and are adopted in different countries.

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(Note 2) This is actually strongly felt in the writing of this paper, and it is assumed that there will probably be several papers in this special issue that will be written in a similar manner.

(Note 3) In explaining this vaporware, I referred to the description in the "vaporware" section of wikipedia: https://en.wikipedia.org/wiki/Vaporware (2023/06/25 accessed)

See also https://web.archive.org/web/20100408174629/, and

http://www.hagley.lib.de.us/library/collections/manuscripts/findingaids/ibmantitrustpart2.ACC1980.htm.

(Note 4) See Gerlach (2004).

(Note 5) See Stern (1995).

(Note 6) See Bayus, Jain, and Rao (2001).

(Note 7) For an examination of the antitrust perspective, see Prentice and Langmore (1994) and Levy (1997). For an examination of the economics, see Haan (2003) and Choi, Kristiansen, and Nahm (2010).

(Note 8)

Although it is highly possible that there is no completely differentiated and independent trading of each company's shares based on modern portfolio

theory, for the purpose of applying the vaporware argument here, we consider the stock market as a trading venue where monopolistic competition is taking place for convenience.

(Note 9) One of the accusations made during the Microsoft trial was that Microsoft had illegally used the initial announcement. The claim in the trial came to light when three anonymous companies protested the settlement, claiming that the government had failed to thoroughly investigate Microsoft's use of this practice. Specifically, they alleged that Microsoft had released the Quick Basic 3 program to delay the sale of competitor Borland's recently released Turbo Basic program. As it turns out, this was not admitted.

(Note 10) This part is the referee's suggestion. The author thanks the referee for pointing out this episode.

(Note 11) The United States and the European Union are taking different approaches to regulating generative AI. The EU has already passed a landmark regulation on AI, the AI Act, which is set to come into force in 2024. The AI Act classifies AI systems into four risk categories, and applies different regulatory requirements to each category. For example, high-risk AI systems, such as those used in facial recognition or social scoring, will be subject to strict requirements for transparency, accountability, and fairness.

The US government has not yet passed any comprehensive legislation on AI regulation. However, the White House has issued an executive order on AI, which sets out a number of principles for the responsible development and use of AI. The order also directs federal agencies to develop regulations for specific AI applications, such as facial recognition.

The US Congress is currently considering a number of bills on AI regulation. One bill, the Algorithmic Accountability Act, would require large companies to disclose how they use algorithms to make decisions that affect people. Another bill, the AI Ethics Act, would establish a national commission on AI ethics.

It is still too early to say what the final form of US AI regulation will be. However, it is clear that the US government is taking the issue of AI regulation seriously. The EU has already set a precedent with the AI Act, and the US government is likely to follow suit in the near future.

This is a table summarizing the status of AI regulation in the US and the EU:

Country	Regulatory body	Status
United States	Congress	Considering a number of bills on AI regulation
United States	White House	Issued an executive order on AI
European Union	European Commission	Adopted the AI Act
European Union	European Parliament	Approved the AI Act

(Based on information available through July 23, 2023)

(Note 12) SoftBank Corp. announced that it has received certification from the Ministry of Economy, Trade and Industry on July 7, 2023 for its plan to secure the supply of the "Cloud Program," a specified critical commodity under the Law for the Promotion of Economic Security (https://www.softbank.jp/corp/news/press/sbkk/2023/20230707_01/). As a result, SoftBank will be able to build a computing environment with high data processing capacity by utilizing NVIDIA DGX SuperPOD™ and other technologies to develop its own SoftBank plans to use this computing environment with high data processing power to develop its own generative AI and other AI-related businesses, as well as to provide it to universities, research institutes, companies, and other entities to meet various needs centered on generative AI. According to the announcement, the company expects to invest approximately 20 billion yen in the construction of this computational environment, of which 5.3 billion yen will be subsidized.

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