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A-share Stock Reactions to the Approval of COVID-19 Vaccine Clinical Trial: An Event Study Model of Listed Pharmaceutical Firms' Returns

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***Abstract*—There is a growing body of literature that conducts empirical analysis based on COVID-19 pandemic. This paper is to investigate the influences of approval of clinical trial of COVID- 2019 vaccine developed by China National Biotec Group on pharmaceutical enterprises' return in the A-share market. Daily stock returns of 218 pharmaceutical firms were selected to conduct the study with the market model of event study. The announcement of the world's first inactivated COVID-2019 vaccine clinical trial is found to have a positive impact on the stock market where the maximum abnormal return as well as cumulative abnormal return both reaches the top on the 2 days after the event day. It indicates that shareholders reacted to the event rapidly and actively. The findings confirm that during the pandemic, people are sensitive to the news about R&D of vaccine, mapping to the strong actions to the stock exchanges. This serves governments and investors as a proof to respond to the economic market more effectively.**

Keywords—COVID-19 vaccine; Economic Model; Event study; Pharmaceutical enterprises; A-share stock returns

I. INTRODUCTION

As the latest life-threatening in the globe, the COVID-19 pandemic has caused disruptive impacts on business operations in all industries [1]. At the same time, COVID-19 vaccination programs have received considerable critical attention that relevant researches have embarked on since the ending of January this year when there was an outbreak in China.

Since the global disaster, researches investigating the impacts on industries and the stock market associated with COVID-19 have been focusing on negative aspects. Previous research of [2] has established that the stock markets had a negative response to the increase in confirmed cases as well as the response to the increase of toll is weak where 64 countries were selected and the overall window was from January 22 to April 17 this year. But countries have different observations, which lead to a loose of controlling variables. Beyond that, his study failed to consider that some countries' confirmed cases may also have impacts on a specific one.

Due to the lack of adequate data and high-end techniques to support decisions of reducing risks of manufacturing of COVID-19 vaccines [3], there are only a few technological enterprises with universities working on R&D of the vaccines. Studies over recent months have provided important information of impacts of COVID-2019 on the stock market.

Data of 75 countries' stock market indices from a study [4] suggests that the pandemic damages the global stock market significantly. In addition, a research based on data of 24 countries' stock market has shown a negative and statistically significant impact of the coronavirus on emerging stock markets [5]. The study defines three vital announcements about the pandemic, and the event window is from 5 days before and after each event, which is an improvement of Ashraf's study. Researchers conclude that countries react to the events at different degrees but all three announcements mentioned above have negative effects on the stock market. One criticism of the literature is that governments' policies such as restricted navigation may also interact with the stockreturn.

Preliminary work on the effects of epidemic disease outbreaks on restaurant industry was undertaken by Kim et al. (2020), including 9 events on 4 diseases from 2004-2016 that confirms the negative impacts on the industry. However, a much more systematic approach would consider various kinds of menu items, for different diseases influence food supplies to diverse degrees. At the same time, some samples are selected in just one state, which cannot represent a whole industry due to the geographical limitation.

However, insufficient attention has been paid to the positive effects from COVID-19 on the stock market. In the pages that follow, it will be argued that whether the stock market responds actively and positively to the R&D of COVID-19 vaccines. Specifically, this paper focus on the event that the inactivated COVID-19 vaccine invented by China National Biotec Group (CNBG), which is a large healthcare group directly under the State- owned Assets Supervision and Administration Commission (SASAC) of the State Council, was first approved to conduct clinical trial in the world [8, 9] on April 12. This paper will analyze whether this event has impacts on the pharmaceutical A-s hare market or not and how.

II. METHODOLOGY

A. *Sample source*

CSMAR database is a large-scale, accurate and

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comprehensive economic and financial research database in China. Considering the objects in Chinese A-share market, ST (Special Treatment) stocks, in which listed companies with abnormal financial situation or other anomalous conditions named by Shanghai & Shenzhen Stock Exchange in 1998 was rejected. Finally, 218 firms were sampled from the database to conduct a series of analyses ultimately. They were from 30 provinces in China that can represent the whole industry in geographical aspect basically as shown in the Figure 1. It can be seen that the top three enterprises are from Zhejiang, Guangdong and Beijing while the last three are from Liaoning, Xinjiang and Qinghai.

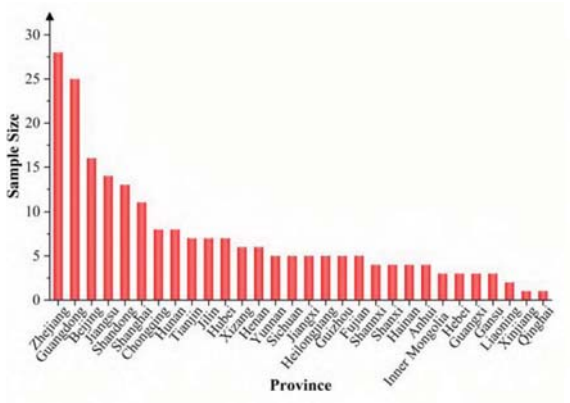

Figure 1 Geographical distribution of samples Based on the information from the official website of CNBG

Beijing Biological Products Institute Co., Ltd. attached to CNBG was approved to carry out the COVID-19 vaccine clinical trial on April 27 [9], windows were defined before that day. So in this study, the closing prices were used to calculate the daily stock return covering 135 trading days for analysis [10].

B. Model

Event study, the methodology suggested by Fama et al. (1969) was the way mainly employed [1] in this paper. When economic and financial activities are affected, the returns on financial assets do not remain insulated. Their risk and return profile also change. The purpose is to evaluate the effect of an "event of interest" or "importance" on stock.

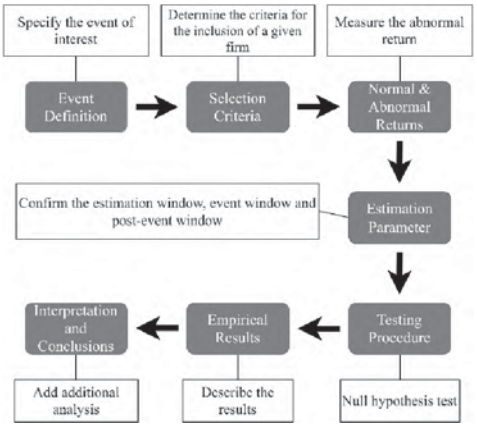

Figure 2 Outline of an event study

While there was no unique framework, the event-study analysis can be seen as having seven steps in Figure 2 [12].

The event date and the sample of companies to be examined needed to be identified, and sample selection criteria, such as types and the size of firms, were used to conduct an event study. The main purpose of an event study is to examine or quantify the effect of an event of interest on the return of the equity return. Such events are expected to generate additional positive or negative returns over and above of the normal or expected returns, depending on whether the event is good or bad. These additional positive or negative returns are called abnormal returns. An abnormal return is in excess of the normal return of the asset in question. Then measuring expected normal return of asset or equity as if the event never happened was necessary before comparing the actual realized return during the event window (on the event day or over the event week) with the expected normal return. This allows us to derive the abnormal return as the difference between the realized return on the event window minus the expected normal return. And the time line could be shown as follows [12]:

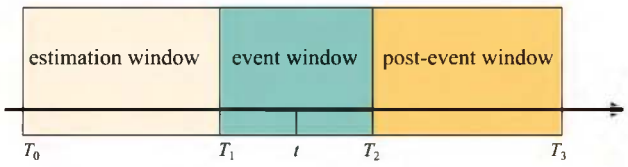

Figure 3 Time line for an event study

In the above illustrated time line, t=0 as the event date was defined. Let $T_1 - T_0$, $T_2 - T_1$ and $T_3 - T_2$ be the length of the estimation (or pre-event sample), event window and post-event window [12].

For the purpose of analysis, while a variety of methods of defining the abnormal return have been suggested, market model was selected to obtain the abnormal return as following:

$$R_{it} = \alpha + \beta R_{mt} + \varepsilon_{it} \tag{1}$$

Where R_{it} and R_{mt} are the individual stock return and market return, respectively; α and β are the parameters of the market model; ε_{it} is the zero mean error term; note:

$$E[R_{it}] = \alpha + \beta R_{mt} \tag{2}$$

Proxies to the market returns in this study are Shanghai Comprehensive Index and Shenzhen Component Index. Under this model, the abnormal return is defined as:

$$A_{it} = R_{it} - \alpha + \beta R_{mt} = \varepsilon_{it} \tag{3}$$

This model controls for the return of the i th company with respect to the variation in market return.

Now, we generate the cumulative abnormal returns (CAR) donated by $\widehat{CAR_i}$ and the CAR was calculated as:

$$\widehat{CAR_i} = A_{it} + \widehat{CAR_{t-1}} \tag{4}$$

This step aims to improve the capability of identifying

abnormal return [13]. The significance of CAR can be tested by using t-ratio under the assumption that abnormal returns are normally distributed.

Finally, we can proceed to test significance of CAR. In a panel framework we need to calculate the mean CAR of each individual company:

$$\overline{CAR_{(T_1,T_2)}} = \frac{1}{N}\sum_{i=1}^{N}\overline{CAR_{i(T_1,T_2)}} \tag{5}$$

Where each records on the right can be calculated as

$$\overline{CAR_{i(T_1,T_2)}} = \frac{1}{T_2 - T_1}\sum_{t=T_1}^{T_2} CAR_t$$

To conduct a t-test for my panel of firms to see if they experienced a significant rise or fall in their abnormal return by conducting the test shown in the following equation:

$$S\left(\overline{CAR}\right) = \sqrt{\frac{1}{N^2}\sum_{i=1}^{N}\sigma_i^2(T_1,T_2)} \tag{6}$$

$$t-ratio = \frac{\overline{CAR_{(T_1,T_2)}}}{S\left(\overline{CAR}\right)} \tag{7}$$

Where $\sigma_i^2(T_1,T_2)$ is the variance of CAR of individual companies during the event window (T_1,T_2) that can be shown as the following:

$$\sigma_i^2(T_1,T_2) = \frac{\sum_{t=T_1}^{T_2}\left(CAR_t - \overline{CAR_t}\right)^2}{T_2 - T_1 - 1}$$

And then the t-test appears as equation (7).

C. Hypothesis

Based on the research topic, testable hypothesis in the following is formulated.

H_0 : Approval of clinical trial of COVID-19 vaccine made by

CNBG does not affect the pharmaceutical companies' stock return in the A-share market;

H_1 : Approval of clinical trial of COVID-19 vaccine made by

CNBG affects the pharmaceutical companies' stock return in the A-share market

If $|T_S| > |T_C|$, the null hypothesis will be rejected; if $|T_s| < |T_c|$ the null hypothesis will be remained, and whether the effect is positive or not we can pay attention to the value of CAR and AR.

III. RESULTS

A. Event study results

At a glance of Table 1, it is shown that the p-value of AR with t-test of only 2 of 15 days during the event window are insignificant, which means, on an industry-wide basis, the abnormal returns can be seen as the same as normal ones in the current period that the approval of clinical trial of COVID-19 vaccine does not affect the pharmaceutical return on the one day before and after April 12. The p-value of cumulative abnormal return each day during the event window that is all significant at a 1% confidence level leads to a strong evidence against the null hypothesis [14]. And the maximum of AR and CAR are 0.0216 and 0.0601 respectively which are both significant at a 1% confidence level, which leads to the conclusion that shareholders responded to the studied event strongly when they bought in relevant stocks or increase their holdings in terms of the good news.

Table 1 AR, CAR and their significance

Event window	AR	t	p	CAR	t	p
-7	-0.0145	-8.9769	0.0000***	-0.0145	-8.9769	0.0000***
-6	-0.0055	-5.2197	0.0000***	-0.0200	-10.3869	0.0000***
-5	0.0126	7.4916	0.0000***	-0.0075	-2.9359	0.0037***
-4	0.0167	10.1353	0.0000***	0.0092	2.9821	0.0032***
-3	0.0084	4.6959	0.0000***	0.0177	4.7254	0.0000***
-2	0.0114	6.7818	0.0000***	0.0290	7.4797	0.0000***
-1	-0.0020	-0.9139	0.3618	0.0270	5.7050	0.0000***
0	0.0142	7.6913	0.0000***	0.0412	7.5708	0.0000***
1	-0.0028	-1.6210	0.1065	0.0384	7.0278	0.0000***
2	0.0217	9.4374	0.0000***	0.0601	9.8824	0.0000***
3	-0.0046	-2.1655	0.0314**	0.0555	8.4077	0.0000***
4	-0.0200	-11.1043	0.0000***	0.0355	5.3693	0.0000***
5	0.0114	6.1870	0.0000***	0.0469	6.6754	0.0000***
6	-0.0045	-2.6831	0.0079***	0.0423	6.0113	0.0000***
7	-0.0034	-2.2422	0.0260**	0.0390	5.5026	0.0000***

The visualized results of the AR and CAR are depicted in Figure 3. It is clear that until 3 days before the event day t, the cumulative abnormal return gets positive and keeps elevating generally for about 6 days, including 2 days after the event day, which reaches the maximum as the blue dashed line shows. After that, the CAR curve tapers in whole with a small increase during the days, and then CAR and AR have the almost same trend. As would be expected, the CAR still maintains positive most of the time during the even window while negative impact (drop of AR return) is minimal [1].

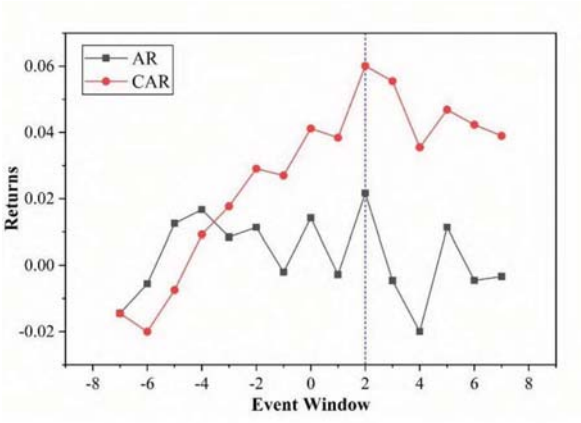

Figure 4 AR and CAR of the event window

IV. CONCLUSION AND DISCUSSION

A. Conclusion

This paper examines the effect of the Chinese first approval of inactivated COVID-19 vaccine in the globe on the value of 2018 pharmaceutical firms in the Chinese A-shares. With 135-day stock returns of 218 listed firms at hand, the marketing model was used in event study theory to detect the impacts.

The results of the analysis can be summarized as follows. The biggest effect, with regard to the highest abnormal return and cumulative abnormal return [15], occurs on 2 days after the event day t that are significant at a 1% confidence level. In respect of the whole period of the event window, there is a significant positive effect among these large companies, which is in accordance with general rules and our expectations [16] that as R&D of COVID-19 vaccine make a vital progress, pharmaceutical and biotech enterprises may obtain more shocks of the same time in the previous ordinary years. Although there are some drops during the stage, it is insensitive. As the vaccinations advance, related stocks of the industry chains will rise strongly and face greater volatility perhaps. Shareholders may also react strongly and sensitively, even overreact to the vaccination section of the stock market if there is big news of clinical trials of COVID-19 vaccine and remarkable progress in the R&D of it. And investors can buy in on the day when the approval of clinical trial for the COVID-19 vaccine is announced and the highest return may be reached after 2 days of the event day.

B. Limitation

It is unfortunate that, instead of analyzing or enterprises including the small and medium-sized ones in China, the study only includes the big-size listed firms in the A-share market so that this event was not overwhelming enough to influence the pharmaceutical industry across all kinds of enterprises (Kim et al., 2020). Another important limitation lies in the fact that on April 27, CNBG announced that it was approved to conduct another clinical trial that there may be an overlap of these two event windows. In other words, the event on April 27 may also affect the stock return which this study focuses on. Moreover, there is the paucity of identification of pharmaceutical enterprises that some have no business for R&D of vaccine, but healthy products, traditional Chinese medicine, and external medicine, etc., who may react to the event weakly. Considerably more work will need to be done to classify the firms into vaccine manufacturers and against it. In spite of these limitations, the study certainly increases the level of our convince that approval of COVID-19 vaccine clinical trial does have positive effects on pharmaceutical enterprises on the whole that can help investors and governments make wiser decisions.

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