BRIEF REPORT

How did the US and UK markets react to the COVID-19 vaccines' announcements? A preliminary assessment [version 1; peer review: awaiting peer review]

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Abstract

Background: The COVID-19 pandemic has caused major public health and economic disruption. At the same time, a pandemic allows researchers to assess market efficiency; namely, whether, to what extent, and how swiftly stock markets incorporated information related to COVID-19. Soon after the outbreak of the pandemic, research on this front was conducted, with a particular focus on the United States of America (US) market. However, new major events linked to the pandemic have unfolded: a number of vaccines were announced and authorized. The research available in relation to market efficiency relative to vaccine availability is scant. The aim of this study was to assess market efficiency hypotheses with regards to the US and United Kingdom (UK) markets, investigating the impact of the promising news of the vaccines' successful trials and, subsequently, their authorization.

Methods: This work considered data from the S&P500 for the US market and the FTSE100 for the UK market. The time interval considered ranged from the date positive results of vaccines' trials were first announced, 18 November 2020, until up to two months after the vaccines' authorization that happened later in December 2020. For both markets, we analyzed the daily returns, cumulative returns, standard deviation and average returns.

Results: In both the US and the UK, there was a positive effect of the vaccines' announcements in terms of increase in the daily returns. However, the standard deviation was not found to increase substantially, notwithstanding the increase in the COVID-19 cases worldwide and the potential lockdown in several countries, as well as the fear from new coronavirus strains that the new vaccines might not be protect against.

Conclusions: Whilst both markets displayed an increase in the average return following the vaccines' announcements, the UK market seemed to reflect vaccines' announcements faster than the US market.
Introduction
The coronavirus disease 2019 (COVID-19) pandemic has had devastating, manifold impacts across the world which rapidly triggered a quest for a vaccine. In April 2020, it was estimated that 115 candidate vaccines were in research and development (Le et al. 2020). Promising news for an upcoming vaccine, at first, came from the United States of America (US). On 18 November 2021, Pfizer and BioNTech reported the final results of their vaccine trials, stating an effectiveness rate of 95%. Subsequently, the US Food and Drug Authority (FDA) issued the first emergency authorization to use the Pfizer–BioNTech Vaccine on 11 December 2020. Shortly after, on 18 December 2020, an additional vaccine, in this instance developed by Moderna, received emergency authorization by the FDA. Later that month, on 31 December 2020, WHO authorized the use of the Pfizer vaccine. The United Kingdom (UK) also saw encouraging news of vaccine development. The University of Oxford, in collaboration with AstraZeneca, announced on 23 November 2020 the completion of the phase 3 trial with a 70.4% effectiveness rate; this vaccine was later approved for use in the UK on 30 December 2020 (Gallagher and Triggle 2020) and then subsequently by WHO on 15 February 2021.

These vaccines present remarkable differences in terms of cost and storage requirements. Governments around the world have secured different prices for the vaccines, but it appears the Oxford-AstraZeneca vaccine is the cheapest, followed by Pfizer and Moderna (Dyer 2021). With regards to the storage requirements, the Pfizer vaccine requires an extremely cold environment of −70°C. In contrast, the Moderna vaccine needs to be stored at −20°C. Finally, the Oxford-AstraZeneca vaccine requires the storage temperature to stay between 3–8°C, making its handling process easier as opposed to the other vaccines. However, all of these vaccines have been approved by the relevant health authorities indicating that they are considered helpful in the fight against COVID-19.

The announcement and authorization of COVID-19 vaccines has obvious health and economic implications. It is an example of positive economic shock that allows to assess the market efficiency hypothesis: do asset prices reflect all available information? The market efficiency hypothesis is classified in weak, semi-strong or strong, depending on how rapidly markets integrate new information. A weak market would reflect all data of past prices, a semi-strong market would reflect all publicly available information, while a strong market would reflect all public and private information (Fama 1970). During the COVID-19 pandemic, research was conducted to test the US market efficiency, with a focus on the market’s reaction following the outbreak of the pandemic. This research has shown that the US market did not react as swiftly as was expected, as it maintained positive returns and relatively low standard deviation until 21 February 2020. The news of the virus outbreak appear to have been reflected only from 24 February 2020 onwards (Vasileiou 2020).

We expect markets to be positively affected by the news of available vaccines, displaying higher average stock returns and higher standard deviation. Notably, the standard deviation is expected to be higher when new information is reported, regardless of whether it is considered to be positive or negative. We focused on the US and the UK stock market from the period of their successful vaccine trials announcements, until February 2021.

Methods
Ethical considerations
The Research Committee at Canadian University Dubai exempted this study from the requirement of ethical approval as it does not involve the use of human, animal or plant data.

Data
We analyzed the daily returns, cumulative returns, standard deviation and average returns across time intervals of interest related to the vaccines’ announcements. Time ranges are specified in the next section. The returns at a given time ‘t’ ($r_t$) are computed as a function of the current (Price$_t$) and previous day’s prices (Price$_{t-1}$), as follows:

$$r_t = \ln \frac{\text{Price}_t}{\text{Price}_{t-1}}$$  \hspace{1cm} (1)

whereas the cumulative returns (C$_t$) from period 1 to period T is given as follows:

$$C_T = \prod_{i=1}^{T} (1 + r_i) - 1$$  \hspace{1cm} (2)

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1Data was analyzed in Microsoft Office Excel online, which is available free of charge.
Finally, the standard deviation \((SD_r)\) is derived as shown below:

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SD_r = \sqrt{\frac{\sum_{i=1}^{T} (r_i - \mu_r)^2}{T-1}}
\]  

(3)

where \(\mu_r\) represents the average of returns for the time interval considered.

With regards to the US, we referred to the S&P500 Index during the period between 18 November 2020 to 19 February 2021. We retrieved the information relative to market prices using Yahoo Finance (Yahoo Finance 2021). The dates considered were motivated as follows: the first interval starts from 18 November 2020, when Pfizer announced their encouraging results about the vaccine. The second interval started on 11 December 2020, when the FDA authorized the Pfizer vaccine to be used in the US. The third interval started on 31 December 2020, when WHO authorized the use of the Pfizer vaccine.

Furthermore, for the US we considered the Dow Jones Industrial Average (DJIA), again accessed through Yahoo Finance, and looked at index movements around important events happening at the time of vaccine announcements. We further detailed our analysis by breaking our research period into 3 November 2020 to 9 November 2020, being the period of US Presidential elections; 10 November 2020 to 11 December 2020, corresponding to the first announcement by a pharmaceutical company to enter phase 3 of COVID-19 vaccine trials; finally, 12 December 2020 to 31 January 2021, corresponding to the announcement of the US FDA approval for emergency use of a COVID-19 vaccine, and post-announcement vaccine rollout.

When considering the UK, we inspected the FTSE 100 Index between 18 November to 19 February 2021. We retrieved the information relative to market prices from Yahoo Finance. The dates considered were motivated as follows. In a similar fashion as for the case of the US, the first interval started from 18 November, when Pfizer announced their encouraging results about their vaccine trials. The second interval starts on 24 November, when the Oxford-AstraZeneca news of successful vaccine trials was released.

### Results and discussion

#### US markets’ reaction

Results are presented in Table 1. Whilst the average of daily returns for the entire time period considered averaged 0.2%, it can be noticed that the cumulative returns definitely improved from 2.81% at the beginning of the period (18 November), up to 9.5% at the end of the period considered. Hence, it appears as the market took a few days to reflect the vaccine announcement dates.

It is important to notice that during the time period considered in this work, markets could have also been affected by the US election (Financial Times 2020). The presidential election took place on 3 November 2020, and on 14 December 2020, the winners were declared across the country. In Figure 1, we also present data relative to the DJIA, indicating key events around the US elections.

### Table 1. Analysis of S&P500.

|                      | 18/11/2020-10/12/2020 | 11/12/2020-31/12/2020 | 31/12/2020-29/01/2021 | 01/02/2021-19/02/2021 |
|----------------------|------------------------|-----------------------|-----------------------|-----------------------|
| Cumulative returns   | 2.81%                  | 5.28%                 | 4.10%                 | 9.50%                 |
| Standard deviation of returns | 0.64%                  | 0.50%                 | 1.03%                 | 0.60%                 |
| Maximum              | 1.60%                  | 1.30%                 | 1.50%                 | 1.60%                 |
| When the maximum was observed | 24/11/2020             | 15/12/2020            | 7/1/2021              | 1/2/2021              |
| Average daily returns| 0.20%                  | 0.20%                 | -0.02%                | 0.40%                 |
By assessing specific time intervals, the following should be noticed:

1) 3 November 2020 to 9 November 2020: The 2020 US Presidential elections were concluded with a change in evident administration. This was altogether seen as a positive development (The New York Times 20202). However, there was growing uncertainty of the validity of the election results, which provided a lot of counter-arguments stating that the markets were volatile during the period (Chicago News 20213).

2) 10 November 2020 to 11 December 2020: The Pfizer-BioNTech COVID-19 vaccine was announced to have completed phase 3 trials with a 95% efficacy in COVID-19 disease prevention. A surge of investment in the US stock markets could have been expected, particularly in the stocks of major pharmaceutical companies. However, only an increase of 3.05% and a standard deviation of 0.82% were observed, indicating that the market participants, though optimistic about the upcoming vaccine introduction, were pessimistic about the conclusion of the US Presidential power transfer.

3) 12 December 2020 to 31 January 2021: the Pfizer vaccine obtained emergency use authorization and began rolling out for the general public. However, there were several events that might have contributed, at least partially, in the negative returns for the period, which are as follows:

   i) On 6 January 2021: riots occurred at the US Capitol which resulted in the deaths of four civilians and one law enforcement personnel;

   ii) On 20 January 2021: the US President Joe Biden was inaugurated and sworn in as the 46th President of the United States. He pledged a USD 1.9 trillion package to fight the COVID-19 pandemic and to revive the US economy. Furthermore, there was growing uncertainty around the impeachment trial of former US President Trump for encouraging the US Capital riots.

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2https://www.nytimes.com/2020/11/13/business/stock-market-record.html
3https://news.uchicago.edu/story/lasting-impact-trumps-attempts-challenge-2020-election-results
UK markets’ reaction
Results are presented in Table 2. It can be noticed that the cumulative returns improved significantly from negative 0.80% at the beginning of the period, compared to 3.74% at the end of the period considered. The average value of the daily returns, taking into consideration the entire period, is 0.03%. It appears that the market reacted swiftly to the news of successful trials, as average returns increased from −0.3% to 0.2%, and the standard deviation increased from 0.44 to 0.87.

Conclusions
Both the US and the UK appear to have reacted to the encouraging news of the vaccines’ availability. This can be seen from the increase of the average daily returns. It can be noted that the UK market seems to have reflected the announcements faster as opposed to the US market: the FTSE100 took one day to reflect the vaccine’s announcements, while the S&P500 took several days. It is important to highlight that when vaccines were announced, COVID-19 case numbers were still increasing, with new lockdowns being put in place: this might have counter-balanced, to some degree, the impact of the vaccines’ announcements.

Data availability
Underlying data
Zenodo: ‘How did the US and UK markets react to the COVID-19 vaccines’ announcements? A preliminary assessment’ https://doi.org/10.5281/zenodo.5733141 (Contu 2021).

The project contains the following underlying data:

- Data 2021. xlsx (The file contains data from S&P 500, DJIA, FTSE100 employed in this research)

Data are available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).

Table 2. Analysis of FTSE100 data.

|                          | 18/11/2020-23/11/2020 | 18/11/2020-24/11/2020 | 24/11/2020-31/12/2021 | 01/02/2021-19/02/2021 |
|--------------------------|------------------------|------------------------|------------------------|------------------------|
| Cumulative returns       | -0.8%                  | 0.74%                  | 0.35%                  | 3.74%                  |
| Standard deviation of returns | 0.44%                  | 0.87%                  | 1.13%                  | 0.85%                  |
| Maximum                  | 0.3%                   | 1.6%                   | 3.5%                   | 2.4%                   |
| When the maximum was observed | 20/11/2020             | 24/11/2020             | 6/1/2021               | 16/2/2021              |
| Average daily returns    | -0.3%                  | 0.2%                   | -0.03%                 | 0.2%                   |

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