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Petrochemical Companies Stock Price Volatility Affected by COVID-19 Pandemic: A Black Swan Event

Yassaman Khalili[1*], Keramatollah Heydari Rostami[2], and Vahid Omidi[3]

[1]Assistant Professor, Department of Accounting, Payame Noor University, Tehran, Iran
[2] Assistant Professor, Management Department, Faculty of Administrative Sciences and Economics, Arak University, Arak, Iran
[3]Assistant Professor, Department of Economics and Administrative Sciences, University of Qom, Qom, Iran

Highlights

- The COVID-19 pandemic is a black swan event.
- The COVID-19 pandemic affected the performance of stock markets in emerging and developed economies.
- The shock caused by the growth of the coronavirus initially caused a decrease in price volatility in Iranian petrochemical companies, but after two periods, the reaction of price volatility to the shock was positive. Finally, the shock effect disappeared after seven cycles.

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Abstract

One of the most important factors investors pay attention to in stock markets is stock price fluctuations, which is the basis for evaluating the performance of company managers. The performance of the company's stock includes the yield from the resources under the company's control and is considered a suitable criterion for reaching the set goals. In the meantime, one of the things that widely influenced the world financial markets is the outbreak of the COVID-19 epidemic. The COVID-19 pandemic is known as a black swan event since it was a rare, unexpected, unknown phenomenon with a high and universal impact. Therefore, the current research purpose is to investigate the fluctuations in the stock prices of petrochemical companies affected by the COVID-19 pandemic. For this purpose, 19 petrochemical companies on the Tehran Stock Exchange were studied between 2017 and 2022. The data were gathered daily and included 19 petrochemical companies in 220 working days for 5 years. The results showed that the shock caused by the growth of the coronavirus initially caused a decrease in price volatility in petrochemical companies, but the reaction of price volatility to the shock was positive after two periods. Finally, the shock effect disappeared after seven cycles.

Keywords: COVID-19 pandemic, Petrochemical industry, Stock price volatility

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1. Introduction

One of the challenging financial issues is stock price volatility, which has been the focus of capital market researchers in recent years (Sahebgharani and Sejellati, 2022). Vuong et al. (2024) stated that the reason for the growing focus of financial literature on the subject of stock price volatility is its effect

* Corresponding author:
Email: y_khalili@pnu.ac.ir

on the financial stability of companies. One of the reasons for paying attention to this issue is the relationship between price volatility and returns and its effect on the performance of the financial sector as well as on the entire economy. One of the other benefits of examining stock price volatility is that it can be considered a measure of risk by capital market participants and can also be used as a means to measure the vulnerability of the stock market (Sahebgharani and Sejellati, 2022). The stock price is not constant over time and always changes under the influence of various factors (Vuong et al., 2024). Sudden and severe shocks are among the factors causing stock price fluctuations, such as war and political instability or global crises (Lu et al., 2024). Further, stock prices fluctuate due to many factors such as demand, supply, economic policy, and company income (Naik and Mohan, 2021). Hence, investigating and studying the volatility of companies is an important issue because a sudden and significant increase in volatility may eventually lead to a financial crisis (Uddin et al., 2021).

One way to increase investment and risk diversification by investors is to trade in emerging stock markets, but these markets are more vulnerable to crises (Ncube et al., 2023). One of the latest and most important crises that threatened human life was the COVID-19 pandemic. In 2019, with the outbreak of the COVID-19 pandemic, the global financial markets underwent many changes and were affected by this disease. The outbreak of COVID-19 was first reported in China in December 2019, and after a short period, it spread all over the world; thus, the World Health Organization declared it a pandemic on March 11, 2020 (Haykır and Çetenak, 2022). Finally, this virus spread all over the world and impacted tremendously all countries' markets and economies.

The consequences of the COVID-19 pandemic can be seen in various dimensions of human life, such as socioeconomic and political dimensions. Economic and political analysts believe that the COVID-19 pandemic has exposed the world to extensive and long-term economic, political, and social changes (AbdelMaksoud et al., 2021). The coronavirus pandemic is not only a health crisis but also brings other crises. The financial markets and investors' decisions have also been affected. In a way, a few weeks after the spread of the COVID-19, the focus and attention on issues related to financial and investment decisions changed strangely. In the situation of the coronavirus epidemic, the stock markets constantly changed due to the possibility of negative effects on the financial sector. The decrease in the value of most stock markets indicated the belief of investors and financial analysts in the severe negative effect of the COVID-19 on the global economy (Saneifar et al., 2021).

Along with the first warning notices of the coronavirus pandemic, the oil industry was affected by this epidemic as well as other industries, and there was a big drop in the price of oil for various reasons. Among these reasons, we can mention the restrictions on transfers, quarantine the reduction in the amount of oil production, and the reduction in oil demand and oversupply. In continuation of this effect, oil price changes have significantly affected inflation, real production, and international interest rates as the most important factors of uncertainty in the stock value in the capital market. Undoubtedly, oil price shocks have played an effective role in stimulating financial markets since the start of the coronavirus epidemic (Reza Zadeh et al., 2022). Therefore, the purpose of this research is to investigate the stock price fluctuations of petrochemical companies affected by the COVID-19 pandemic.

1.1. Theoretical foundations of research

A black swan event refers to a very unusual event that is not predicted and can have catastrophic consequences (Talib, 2007). A black swan event comes as a natural disaster, war, financial crisis, or even a virus outbreak that affects the financial markets and negatively impacts economies and stock markets. This type of event even affects the type of traders' decisions and leads to herd behavior by investors. Therefore, the COVID-19 pandemic is considered a black swan event (Ncube et al., 2023) although the world has faced other related events and epidemics throughout history.

Stock markets are affected by various factors and crises, one of which is the spread of various diseases. In addition to that, companies always face various crises during their lifetime, which include a wide range of economic crises and unnatural events threatening the financial performance of companies (Pahsapour et al., 2019). One of the types of crises is diseases, especially epidemic diseases such as COVID-19, which has been studied in numerous researches.

Before the emergence of the coronavirus pandemic, the world also faced other diseases, and research showed that the emergence of these diseases affected the financial markets and stock prices (David et al., 2021). Even though we have not had a world pandemic after Spanish influenza of 1918–1919, different regions of the world have seen pandemics at some point during the last hundred years, for instance Asian Influenza (1957), the Hong Kong Influenza (1968), SARS (2002), MERS (2012), and Ebola (2016–2013) (Haykir and Çetenak, 2022), which had economic and financial consequences in addition to threatening human health (David et al., 2021). Among the research conducted in the field of the impact of diseases, we can mention the research of Chen et al. (2018) who studied the SARS disease effect on the financial markets of Asia and concluded that this disease caused the region's stock market fall. Another important disease that attracted the attention of researchers before the COVID-19 pandemic was Ebola. The research conducted on the effect of the Ebola disease on the performance of the stock markets led to the findings that the news about the outbreak of this disease caused an increase in sales in the stock markets and ultimately caused a decrease in prices of stock (Funck and Gutierrez, 2018; Ichev and Marinč, 2018). Further research showed that the effect of this disease was different in various industries, and this disease had a greater impact on small industries like airlines, food industries, and tourism. Another research conducted by Ichev and Marinč (2018) showed that the Ebola impact was more important in regions such as the United States, Europe, and West Africa, which was a factor of fear and anxiety instead of real economic factors that affected investment decisions. Finally, the most recent pandemic the world faced was COVID-19. With the coronavirus epidemic, the world underwent strange changes and the pandemic showed its effect on all aspects of human life. The coronavirus pandemic caused the death of thousands of people and had many consequences in their daily life of people, one of which was the fear of economic crisis and severe recession, which ultimately caused many losses and damage due to the adjustment and reduction of the labor force in various economic sectors (Nicola et al., 2020). The COVID-19 pandemic has directly affected the social and emotional behavior and the physical health of all workers and citizens (Lai et al., 2023). In addition, the effect of the COVID-19 pandemic on the economic and financial aspects is quite visible.

Many studies have examined the effect of the COVID-19 pandemic on stock market performance. Among these researches, Hsu and Liao (2022) investigated the effect of COVID-19 on stock price volatility and corporate governance and concluded that COVID-19 was related to stock price volatility. Haykir and Çetenak (2022), Yousefi et al. (2021), Alam et al. (2021), and Baker et al. (2020) also investigated the effect of this pandemic on stock markets of developed economies and concluded that the outbreak of the COVID-19 pandemic reduced the returns stock market. They found that the stock market performance decreased with the increase of cases and deaths caused by COVID-19. Further, Sivakumar and Sachdeva (2020) in an event study concluded that an increase in COVID-19 cases and deaths caused a sharp decline in stock market returns (Ncube et al., 2023). Another interesting topic that was considered in recent research was the pandemic effect of the coronavirus on developed and emerging economies.

For example, the performance of stock markets for developed and emerging economies was compared by Uddin et al. (2021) and Ledwani et al. (2021). They showed that the effect of the pandemic caused the stock markets to fall and decrease, and they showed that the news about the number of deaths due to COVID-19 led to increased volatility in developed markets more than in emerging markets. Haikir

(2020) showed that the increased volatility in stock markets because of this pandemic was due to the role of governments and their different actions (Haykir and Öztürk Çetenak, 2022). Although much research focused on the coronavirus pandemic and performance, most of the research conducted in the world on the coronavirus pandemic and the stock market performance focused on the performance of the entire stock market that is measured through changes in the value of an index. Even in developed markets, just very few studies have investigated the impact of COVID-19 on the performance of sectors or parts of the market (Ncube et al., 2023).

In a research, Alam et al. (2021) examined different sectors of the Australian Stock Exchange and concluded that at the time of the announcement of the COVID-19 epidemic, the effect of this disease on various parts of the economy was different. One of the important economic sectors exposed to the coronavirus pandemic is oil and petrochemical companies. According to the study of Kumpf et al. (2020), due to the effects of the economic recession caused by the coronavirus pandemic and the fall in oil prices in these oil and gas and chemical industries, the first quarter of 2020 was an important period for this industry. The coronavirus pandemic reduced the demand and price of oil; on the other hand, the emergence of this disease coincided with the decline of the petrochemical industry. In other words, the industry had already entered a downward cycle in 2019, after which the pandemic happened. The slowdown in demand growth, surplus growth, and stock depreciation were there before the pandemic and became more pronounced since the emergence of COVID-19. Adapting to normal conditions after the COVID-19 pandemic requires management planning that takes into account the events that occurred in the first half of 2020 (Malik et al., 2020). Finally, the research showed that COVID-19 forced petrochemical managers to reconsider the future of the industry (Malik et al., 2020). Therefore, according to the few works that have been done on the performance of a part of the markets, examining the COVID-19 effect on a part of the market can be an interesting topic to investigate.

In the following, several other internal and external works related to the subject of the current research are stated.

Lai et al. (2023) investigated the prevention and safety behaviors of COVID-19 in the workplace based on the employees' emotional domain in the petrochemical industry and concluded that regarding the prevention of petrochemical industry employees from COVID-19, safety attitudes and the emotional sphere have a positive reaction. Ncube et al. (2023) investigated the COVID-19 pandemic impact on the performance of stock in sub-Saharan African stock markets. These survey results showed that the performance of various sectors was different during the coronavirus pandemic period. Consumer goods, health care, and information technology companies, performed better during this pandemic, but industrial companies and real estate sectors performed poorly. Further, the consumer and financial sectors were the stablest sectors during the pandemic.

Golshan et al. (2022) investigated the impact of exchange rate shocks on the performance of active companies in the energy sector on the Tehran Stock Exchange: a case study of the petrochemical industry and the distribution of petroleum products. The results of this research showed that the effect of official exchange rate fluctuations was significant for both industries, and the relationship between the exchange rate and the performance index of the petrochemical and refining industry was positive. Mazur et al. (2021) studied the performance of the US stock market during the March 2020 crash caused by COVID-19. The results of this research showed that stocks of natural gas, food, health care, and software had a lot of positive returns, but the value of stocks of oil, real estate, and entertainment sectors decreased significantly. Nicola et al. (2020) investigated the socio-economic effects of COVID-19 on various aspects of the global economy. They reviewed the effect of COVID-19 on various sectors such as agriculture, oil and petrochemicals, production, education, health, real estate, and food.

Baky et al. (2020) investigated the outbreak impact of COVID-19 on the index's volatility of oil companies on the Tehran Stock Exchange. Their results showed that in the early stage of the spread of the coronavirus, despite the injection of new money into the market and the increase in the volume of market transactions, the efficiency of the prices of oil companies decreased. Malik et al. (2020) examined the effect of disruptions caused by the pandemic (decrease in demand and oil prices) on short-term, medium-term (second half of 2020 to 2023) and long-term (after 2023) perspectives.

Kumpf et al. (2020) studied the impact of the COVID-19 virus on the chemical industry. Fallah and Hosseinzadeh Lotfi (2020) in a work entitled "Evaluation of the Sustainability of Iranian Petrochemical Companies in the Stock Market: an Approach Based on Data Envelopment Analysis" showed that among the seven petrochemical companies examined, Maroon Petrochemical Company was efficient in terms of financial performance and sustainable development in all fields and years, and four companies were financially efficient during the period under review. Regarding the examination of the companies' performance, Marun, Jam, and Zagros petrochemical companies were ranked first to third. Using multi-criteria decision-making methods, Alinezhad Ssarokolaei and Alinia Esbokolaei (2020) in a work entitled "Ranking of Petrochemical, Pharmaceutical and Automotive Companies in the Iranian Capital Market" showed that Zamyad Company, in the automotive industry, Shazand Petrochemical Company, in the industry Petrochemical, and Alborz Darou Company, in the pharmaceutical industry, had the highest performance rating and were suitable for investment. Pahsapour et al. (2019) investigated the performance of a petrochemical plant in the event of a crisis as a case study. Their results reported that the most important economic reversibility factors with the greatest effect on improving the performance of a company during a crisis included preparation and planning, assets and resources, and alternative routes and redundancy. Maglad and Shaheen (2021) investigated the effect of going public on the financial performance of the petrochemical industry in Saudi Arabia. The results of this research showed that the financial performance of public companies during the economic recession was better than that of a private company. Therefore, they showed the positive effect of publicizing on the company's financial performance. Khalili Araghy et al. (2009) investigated the effect of environmental risks, company strategy, and capital structure on the performance of companies in the petrochemical industry. The results of this research showed that, among the environmental risks, the market risk had the greatest effect on the performance of petrochemical companies, and the environmental risk had an effect on the strategy; according to these effects, it has an effect on the capital structure and performance.

According to the review of previous research, it seems that no study has been done on the fluctuations of the stock prices of petrochemical companies as a part of the market, especially in an emerging economy like Iran during the coronavirus pandemic. Therefore, it can be stated that the innovation of the current research is the investigation of stock price fluctuations of petrochemical companies affected by the COVID-19 pandemic.

The research hypothesis is as follows:

The COVID-19 pandemic has had a significant impact on the stock price fluctuations of petrochemical companies.

2. Methodology

2.1. Research methodology

The statistical population of the research includes the companies of the petrochemical industry, and oil and chemical products of Iran, including 19 petrochemical companies accepted on the Tehran Stock Exchange during from 2017 to 2022. It should be noted that the data were checked daily herein.

Moreover, to collect the data required for the research, the library method was used, implying that the data were collected from website www.tsetmc.com and the Tehran Stock Exchange library. The data related to COVID-19 sufferers were collected from website https://covid19.who.int/data. Software Eveiws 12 was used to test the research hypotheses.

In this research, the panel-VAR model was used, and the variables were all growth, except for volatility. For this reason, it was developed to preserve data. The panel-VAR models were widely used in econometric literature to investigate various shocks to the economy and measure and criticize macroeconomic theories and growth accounting analysis and macro metric models. Using panel data is preferable to time series data because, in addition to increasing the degree of freedom, there is more confidence in the estimates (Nazemi et al., 2021).

2.2. Research model

Equation (1) presents the research model:

$$volality_{i,t} = \alpha_0 + a_1 cov19_{i,t} + a_2 VOLUMETRADE_{i,t} + a_3 VALUE_{i,t} + a_4 NUMBERTRADE_{i,t} + \varepsilon_{i,t} \quad (1)$$

where *volatility* is the dependent variable of the research, *cov*19 indicates the independent variable, and *VOLUMETRADE*, *VALUE*, *NUMBERTRADE* are the control variables of the research.

2.2.1. The dependent variable

In the current research, following the research of Hsu and Liao (2022), the volatility variable is calculated from the difference between the highest and lowest share prices on each day divided by the average of these two prices.

2.2.2. Independent variable

The independent variable of the research is the coronavirus. It is the number of people infected with COVID-19 every day, and its fluctuation is taken into account. The number of coronavirus infections today is subtracted from the number of coronavirus infections the day before, and the result is divided by the number of coronavirus infections on the previous day.

2.2.3. Control variable

The control variables of the research include the following:

VOLUMETRADE is the daily trading volume, and the data were taken from www.tsetmc.com. It is the number of stocks traded daily and considered volatility. That is, to measure this variable, we subtracted today's trading volume from yesterday's trading volume and divided it by yesterday's trading volume.

VALUE is the value of the day's transactions in Iranian Rials, which we consider a fluctuation; the today's transaction value is subtracted from yesterday's transaction value and divided by yesterday's transaction value.

NUMBERTRADE is the number of trades made on the day, considered a fluctuation; it is the number of today's trades subtracted from the number of yesterday's trades and divided by the number of yesterday's trades.

3. Results

The descriptive statistics of the research are described in Table 1.

Table 1

The descriptive statistics of the research

	VOLUMETRADE	*VOLATILITY*	*VALUE*	*NUMBERTRADE*	*COVID*
Mean	311.9443	0.085479	307.0000	64.17722	14.79657
Median	–3.146842	–0.058437	–2.951462	–2.987103	12.67606
Maximum	1082850.	18.98333	1083337.	29190.91	152.9412
Minimum	–99.95000	–98.36765	–99.98656	–99.81900	–100.0000
Std. Dev.	13461.24	3.804972	13435.45	619.8216	46.78962
Skewness	79.32067	–10.37750	79.84566	30.55735	–0.156963
Kurtosis	6374.197	227.1617	6434.652	1224.447	3.341298

To measure the variables, their daily fluctuations are used in the calculations. As mentioned in the explanations related to the operational definition, the result of any variable minus the same variable on the previous day divided by the same variable on the previous day indicates the amount of fluctuation of that variable, which is included in the calculations and operational definition. For example, in the case of the variable of COVID-19, the number of infected people on a particular day minus the number of infected people on the previous day, divided by the number of infected people on the previous day was calculated. In the case of COVID-19, an average of 14.79 was obtained, implying that the number of fluctuating COVID-19 increased by 14 people compared to the previous day. The number of transactions (*NUMBERTRADE*) grew by 64 during the days under review, and the value (*VALUE*) increased by 307 Iranian Rials. Regarding the volatility rate of stocks, because the volume fluctuation rate, the quantity fluctuation rate, and the price fluctuation rate together neutralize the total increase, the price volatility rate of *VOLATILITY* was about 0.08. The trading value (*VALUMETRADE*) was 311 Iranian Rials on average.

3.1. Research model test

Table 2

Determining the optimal lag

Lag2	LogL	LR	FPE	AIC	SC	HQ
0	–209529.5	NA	3.12e+23	68.28564	68.29112	68.28754
1	–209306.7	445.1075	2.92e+23	68.22119	68.25405	68.23259
2	–209263.8	85.76913	2.91e+23	68.21534	68.27558	68.23623
3	–209213.9	99.52758	2.88e+23	68.20722	68.29485	68.23762
4	–208946.8	532.3088	2.66e+23	68.12834	68.24335	68.16823
5	–204134.6	9583.636	5.60e+22	66.56822	66.71062	66.61762
6	–203900.8	465.1237	5.23e+22	66.50020	66.66997	66.55909
7	–203880.4	40.64437	5.24e+22	66.50168	66.69884	66.57007
8	–203781.1	197.3434	5.11e+22	66.47746	66.70200	66.55534
9	–203762.5	36.85659	5.12e+22	66.47955	66.73148	66.56694
10	–203197.5	1120.520	4.29e+22	66.30358	66.58290*	66.40047*

Table 2 shows that the optimal lag is 10, and this interval should be used in estimating the VAR model.

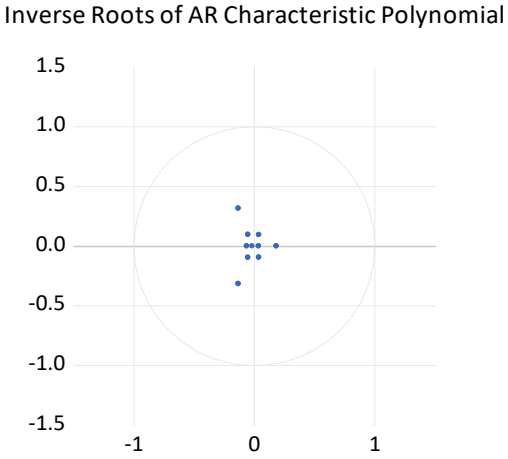

Figure 1

Inverse roots of AR characteristics polynomial

Figure 1 shows that all the points are placed inside a circle with a radius of one, indicating that the results of the VAR model are stable and therefore reliable, according to Lutkepohl (2005).

It should be noted that this research examined the data from 2017 to 2022; the panel data were used, and the quantile, i.e., the examined period, which was daily, was divided into 10 equal periods. The following examinations were presented in 10 quantile periods.

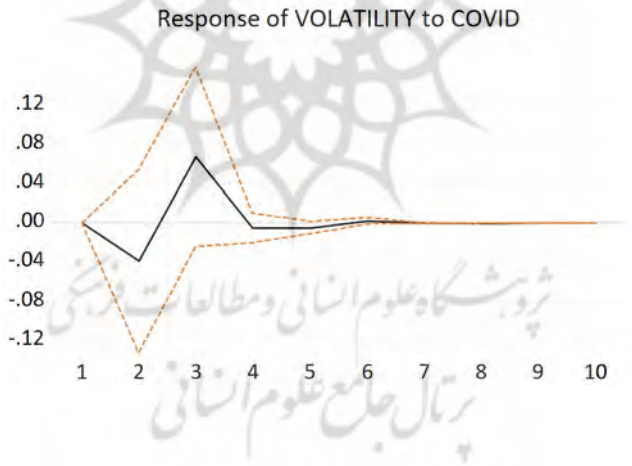

Figure 2

Response of *VOLATILITY* to *COVID*

Figure 2 depicts the reaction of the stock price volatility to a shock equivalent to one standard deviation to the growth of the number of cases of the coronavirus in Iran. The occurrence of a shock equal to one standard deviation to the growth of the coronavirus initially caused a decrease in the price volatility of the investigated petrochemical companies on the Tehran Stock Exchange, which could be caused by the insecurity of people and the lack of entering into transactions. However, after two periods, the reaction of the price fluctuation to the shock was positive. Finally, the shock effect disappeared after seven periods.

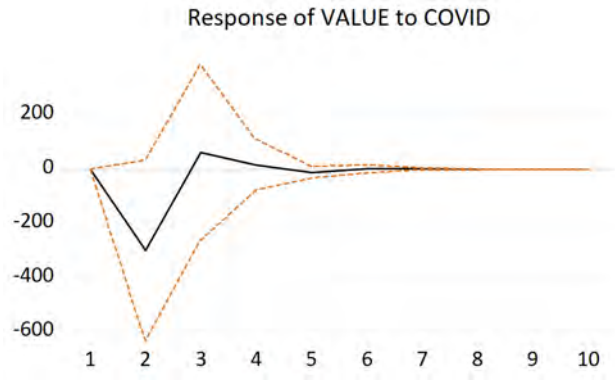

Figure 3

Response of *VALUE* to *COVID*

Figure 3 delineates the reaction of the value of daily transactions of companies to a shock equivalent to one standard deviation of the number of infected people. The reaction of the transaction value to the shock was initially negative, and after two and a half periods, it became positive; it finally became zero in seven periods. This result is completely consistent with the result obtained in Figure 2, confirming the harmony in the obtained results.

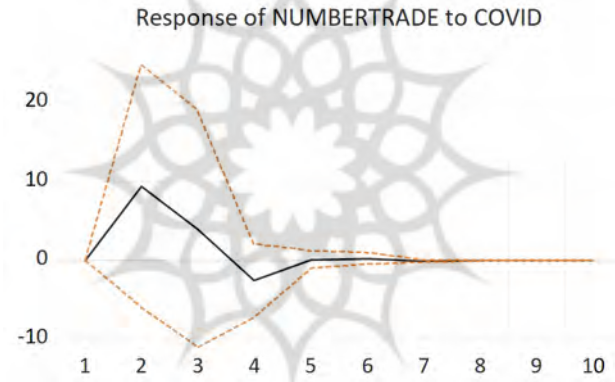

Figure 4

Response of *NUMBERTRADE* to *COVID*

Figure 4 shows the reaction of the number of transactions to the shock caused by the growth of the number of people infected with COVID-19. The number of transactions increased at first. However, after three periods of reaction, the number of transactions became negative, and in the seventh period, the shock effect disappeared. As seen in the first graph, the price fluctuation reaction was negative. Therefore, to reduce the price, an incentive was created to increase transactions. As a result, the reaction of this variable to the COVID-19 shock was positive.

Figure 5 draws the reaction of trading volume to a shock equivalent to one standard deviation to the growth of COVID-19 patients. The occurrence of the shock caused the volume of transactions on the Tehran Stock Exchange to decrease sharply. This shows that with the occurrence of the shock, the transactions were done in smaller volumes. Further, the effect of the COVID-19 shock on the volume of transactions disappeared after five periods.

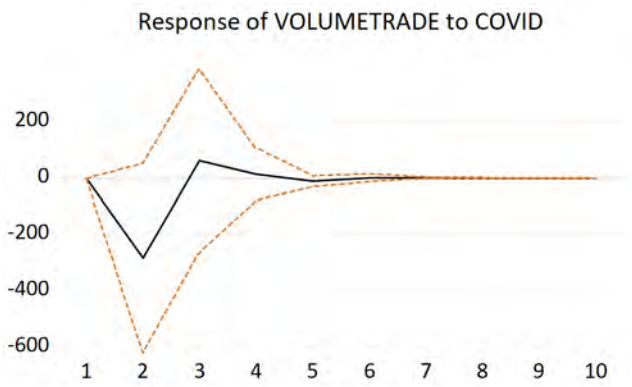

Figure 5

Response of *VOLUMETRADE* to *COVID*

4. Discussion and conclusions

The purpose of this research was to investigate the impact of COVID-19 on the stock price fluctuations of companies active in the petrochemical industry and oil products. For this purpose, 19 petrochemical companies on the Tehran Stock Exchange were studied between 2017 and 2022. The data were gathered daily and included 19 petrochemical companies in 220 working days for 5 years.

The obtained result showed that the occurrence of a shock equal to one standard deviation to the growth of the COVID-19 initially caused a decrease in price volatility, which could be caused by people's insecurity and lack of entry into transactions. However, after two periods, the reaction of the price fluctuation to the shock was positive. Finally, the shock effect disappeared after seven periods. Other results of the research indicated that the reaction of the value of daily transactions to the shock caused by the growth of coronavirus infection was initially negative, and after the passage of two and a half periods, it became positive; it finally became zero in seven periods. In addition, with the shock caused by the growth of COVID-19 patients, the number of transactions increased initially, but the reaction of the number of transactions became negative after three periods; in the seventh period, the shock effect disappeared. The shock caused by the growth of COVID-19 patients also caused the volume of transactions on the Tehran Stock Exchange to decrease sharply, indicating that transactions were done in smaller volumes with the occurrence of the shock. The effect of the COVID-19 shock on the volume of transactions disappeared after five periods.

The obtained results, agreeing with the works of Ncube et al. (2023), Ladwani (2021), and Uddin (2021), showed that the COVID-19 pandemic caused an increase in volatility in the markets. Hsu and Liau (2022) also reported a similar result. They found that the COVID-19 pandemic was correlated with stock price fluctuations. The result is also consistent with the works of Nicola et al. (2020) and Haykır and Çetenak (2022).

For future research, the following topics are suggested:

- Investigating the effect of the shock caused by the coronavirus on the stock returns of affected companies such as pharmaceutical and chemical companies
- Investigating the effect of the shock caused by the coronavirus on the variables of the micro and macroeconomics
- Investigating the effect of the shock caused by the coronavirus on research costs and development
- Investigating the effect of the shock caused by the coronavirus on the cost of transportation

- Investigating the effect of the shock caused by the coronavirus on the cost of production.

Furthermore, regarding the suggestions for future research, it can be mentioned that the current research has examined the companies active in the petrochemical industry and oil products, so it is suggested that research on this topic be carried out for other companies active in non-petroleum industries.

Nomenclature

AR	Autoregressive
VAR	Vector auto regression

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