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The Impact of COVID-19 on Power Generation Companies in the Tehran Stock Exchange

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ABSTRACT

The COVID-19 pandemic has emerged as one of the most significant public health crises in recent decades, exerting far-reaching effects not only on human health but also on global economies and financial markets. Its disruptive nature created unprecedented uncertainty, making it essential to understand sector-specific impacts. This study examines the consequences of the pandemic for the performance of power generation companies listed on the Tehran Stock Exchange during the period from April 2020 to July 2023. To achieve this, a Structural Vector Autoregression (SVAR) model was employed, incorporating several key variables such as COVID-19 mortality and infection rates per million people, international oil prices, global gold prices, and foreign exchange rates. The empirical results indicate that higher COVID-19 mortality and infection rates exerted a significant negative effect on the performance of power generation companies, reflecting the sensitivity of this sector to public health shocks. Conversely, increases in oil prices and exchange rates were associated with improved company performance, while rising gold prices had adverse effects. These findings highlight the importance of strategic policymaking to mitigate economic vulnerabilities during pandemics and strengthen market resilience in the face of future crises.

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1. Introduction

One of the key pillars of the international economy that is gradually evolving is the capital markets. By establishing an appropriate mechanism for optimal resource allocation, capital markets provide a strong foundation for economic progress and growth (Mehr et al., 2021). Through investment and participation in capital markets, individuals can generate income, accumulate wealth, and preserve the monetary value of their assets against inflation. This plays a crucial role in making sound financial decisions to achieve long-term financial goals (Baker & Wurgler, 2006). One solution for financing industries and promoting economic growth is the stock market, which serves as an essential economic tool for governments to fund companies and address budget deficits. Governments, as the main planners of economic strategies and the primary shareholders of key industries, generate revenue and secure financial resources through the sale of state-owned shares, transaction fees, and trading taxes. However, various events, such as crises, sanctions, and economic uncertainties, can significantly impact the stock performance of listed companies and influence economic decision-making (Cheshmi & Osmani, 2021). Several factors affect individuals' small assets and their investment planning in stock markets, including economic imbalances. If these issues are not addressed, they can disrupt macroeconomic stability. However, global events occurring at different times do not have uniform effects on all economies and financial markets. The extent of their impact depends on a country's economic strength. The energy industry plays a crucial role in a nation's Gross Domestic Product (GDP) and is among the most important industries in energy-producing countries (Razavi et al., 2022). Energy price fluctuations, particularly those of oil, impact the profitability and performance of energy-sector companies listed on stock markets. These fluctuations also influence investment planning, financial flows, trade, and economic conditions in energy-exporting countries.

The petrochemical industry, recognized for its high market value, is regarded as a strategic downstream sector that links petroleum products with

end consumers. This growing investor interest in the industry continues to increase (Baki Haskoui et al., 2020). The highest volume of international trade is in oil. As a result, the refining sector is another major industry in the energy domain, heavily dependent on oil prices. The sustainability or closure of oil-related industries depends on how oil price fluctuations impact financial markets, economies, and economic variables (Gharib et al., 2020). Power plant industries are among the most critical sectors in the energy economy. Other significant industries, such as food, cement, and metal industries, establish specialized power plants to meet their energy needs. Power plants are typically categorized into four types: thermal, hydro, wind, and solar. Since thermal power plants account for over 84% of total power plant capacity, all energy supplies for Iranian power plants on the stock market come from thermal sources. The publicly listed power companies on the stock market include those that provide electricity, gas, steam, and hot water (Enigma Website, 2022). A significant issue that can impact economic systems and decision-makers is the occurrence of external shocks that harm public health and well-being. These shocks not only create limitations on economic resources and production technology but also disrupt financial stability. On March 11, 2020, the World Health Organization (WHO) declared the COVID-19 pandemic a global health emergency. The virus spread rapidly worldwide, including in Iran (World Health Organization, 2020). Since World War II, the COVID-19 pandemic has been recognized as the second-largest international crisis. Unlike other localized health crises, COVID-19 has affected all economic, social, and financial sectors worldwide. The pandemic led to a decline in stock offerings in certain industries, financial shortages in budget allocation, and increased risk exposure. The banking and insurance sectors were among those that experienced significant financial and economic impacts from COVID-19 (Goodell & Hain, 2020; Atri et al., 2021).

The COVID-19 pandemic had varying effects on the Iranian stock market, which is a significant source of financial capital in the economy (Alijani et al., 2021). For example, the positive and upward trends were mostly associated

with stocks of companies in the pharmaceutical, healthcare, and food industries. In contrast, the negative and downward trends were predominantly related to the stocks of transportation and tourism companies listed on the Tehran Stock Exchange (Ehterami et al., 2024). Energy prices were not exempt from this trend, as global oil prices declined during the pandemic due to the rapid spread of the virus. This event impacted the performance and profitability of energy-related companies, resulting in a downward trend in earnings and revenue for energy sector stocks on the stock market (Baki Haskoei et al., 2020). The COVID-19 pandemic also impacted macroeconomic variables. For instance, the price of crude oil lost half its value in global markets, creating unfavorable consequences for energy-producing countries (Herjoto et al., 2021). Similarly, the global gold price initially decreased with the outbreak of the pandemic. However, due to gold being considered a safe-haven asset, investor demand increased after stock markets declined, leading to a subsequent rise in gold prices. While some countries continued to struggle with the challenges of the pandemic, others successfully mitigated its adverse effects by adhering to proper health and safety protocols (Duppati et al., 2025). A global epidemic influences key economic variables, including exchange rate fluctuations, oil price volatility, and gold prices, all of which impact stock market returns and the profitability of power industry stocks on the Tehran Stock Exchange. These fluctuations create challenges for both retail and institutional investors in making investment decisions. For example, when the COVID-19 pandemic began spreading in Iran at the end of 2019, the Tehran Stock Exchange's overall index, which reflects the performance of listed companies, experienced a 187.1% growth compared to late 2018 when COVID-19 had not yet emerged. However, as the virus spread globally and affected international markets, the stock index in Iran recorded a 155% increase in 2020, followed by a 4.6% rise in 2021 and a 43.4% increase in 2022. After the official announcement of the pandemic’s end on July 25, 2023, the stock index recorded a modest growth of 2.1% compared to the end of 2022. The power industry, a leading sector in Iran’s energy economy and

stock market, was also significantly impacted by COVID-19. In a year-over-year comparison, the sector's index grew by 97.7% in 2019 compared to 2018, before the pandemic occurred. With the global spread of COVID-19, this growth rate declined to 84.7% in 2020. For the fiscal years ending in 2021 and 2022, the sector's returns stood at 35.7% and 106.9%, respectively. However, following the official declaration of the pandemic's end in July 2023, the power sector index recorded a 0.9% decline compared to the end of 2022 (Zarei & Honarmandi, 2022). The year 2020, marked by the rapid spread of COVID-19, saw Iran accounting for 1.48% of global infections. Unfortunately, this share increased to 2.44% in 2021 due to medical and economic sanctions that hindered timely access to COVID-19 vaccines and treatments, representing a 64.8% increase in cases. However, as vaccines were developed and distributed globally in 2022 and 2023, Iran's share of total global infections followed a downward trend, decreasing by 0.3% and 0.13%, respectively. In contrast to the rise in infections during 2020 and 2021, Iran also experienced an increase in COVID-19-related deaths due to a lack of awareness, inadequate health measures, and the absence of vaccines. The country's share of global mortality rates was 2.84% in 2020 and 2.16% in 2021, respectively. Fortunately, with the widespread availability of vaccines, increased public awareness, and the implementation of preventive measures such as lockdowns and remote work, Iran's COVID-19 mortality rate declined to 1.05% in 2022 and 0.69% in 2023 (Cheshomi & Osmani, 2022). Economic variables, including the exchange rate, global gold prices, and OPEC oil prices, were also impacted by the pandemic, resulting in fluctuations that created challenges for global markets and economies. By the end of the 2019 fiscal year, the Iranian rial had depreciated by 15.4% against the U.S. dollar compared to the previous year. With the global spread of COVID-19 in 2020, the exchange rate saw a significant 61% increase, followed by a 9.2% rise in 2021 and an 84.1% surge in 2022. Following the official announcement of the pandemic's end on July 25, 2023, the dollar experienced a 3% increase compared to the end of 2022, according to the Central Bank website. At the

end of 2019, when COVID-19 first emerged, global gold prices rose by 12.2% compared to 2018. During the pandemic years of 2020, 2021, and 2022, gold continued to appreciate, registering growth rates of 18.7%, 10%, and 0.5%, respectively. However, following the pandemic's official conclusion in July 2023, global gold prices increased by 1.7% compared to the end of 2022. At the onset of the COVID-19 pandemic in late 2019, OPEC oil prices experienced a sharp decline of 59.3% compared to 2018. However, as the pandemic continued through 2020 and 2021, oil prices rebounded with growth rates of 144% and 57.2%, respectively. Despite this recovery, oil prices dropped again by 29.5% in 2022. Nevertheless, as the pandemic subsided and COVID-19 was officially declared over in July 2023 (Ehterami et al., 2024). The COVID-19 pandemic represents an unprecedented exogenous shock that simultaneously disrupted public health systems and economic activities worldwide. While a growing body of literature has examined the impact of COVID-19 on aggregate stock markets and selected industries, the specific effects of pandemic related health shocks on infrastructure based industries remain insufficiently explored. In particular, power generation companies play a vital role in economic stability due to their strategic importance in supplying electricity, gas, and related energy products to other industries. Despite this significance, there is limited empirical evidence on how COVID-19 infection and mortality dynamics have affected the performance of power generation companies listed on the Tehran Stock Exchange. Moreover, the interaction between pandemic indicators and key macroeconomic variables such as oil prices, gold prices, and exchange rates has not been adequately analyzed within a unified dynamic framework. This lack of focused and industry-specific analysis motivates the present study, which seeks to examine how COVID-19 related health shocks influenced the performance of power generation companies in Iran's capital market (Ma, 2025).

This study contributes to the existing literature in several important ways. First, it provides one of the earliest industry specific analyses of the impact of the COVID-19 pandemic on power generation companies listed on the Tehran

Stock Exchange, a sector that has received limited attention in prior research. Second, unlike many previous studies that rely on a single pandemic indicator, this research simultaneously incorporates both COVID-19 infection rates and mortality rates to capture the multidimensional nature of health related shocks. Third, the study employs a Structural Vector Autoregression (SVAR) framework, which allows for the identification of structural shocks and the dynamic transmission mechanisms among pandemic indicators, macroeconomic variables, and stock performance. Finally, by covering a relatively extended period from 2020 to 2023 encompassing both the peak and post-pandemic phases the study offers more robust and comprehensive insights into the short and medium term effects of COVID-19 on the power sector. During the study period, Iran's economy was characterized by high inflation, exchange rate volatility, and increasing reliance on the stock market as a hedge against macroeconomic uncertainty. These conditions amplified the sensitivity of stock prices particularly in infrastructure-based industries such as power generation to external shocks, including health crises. Consequently, the interaction between COVID-19 indicators and financial variables should be interpreted within this broader macroeconomic context (Zarei & Honarmandi, 2022).

The research structure will continue as follows: After presenting the problem and the necessity of the topic in the first section, the second section will outline the theoretical foundations of the research. In the third section, a review of major previous studies on the subject, both domestic and international, will be presented. The fourth section presents the research methodology, while the fifth section discusses the research findings. Finally, the sixth section will summarize the findings and provide policy recommendations related to the research topic.

2. Theoretical Foundations and Literature Review

Various factors, including the formation of bubbles in stock values, monetary shocks and fluctuations, wars between nations, and health and medical issues

such as the COVID-19 pandemic, contribute to financial volatility in stock markets. COVID-19 has had various effects on several economic factors, including oil, gold, and exchange rates, which in turn affect the financial transactions of industries and companies listed on the stock exchange, as well as their trading values. For instance, when the rapid global transmission of COVID-19 began, oil prices decreased by 20%. As the pandemic continued and intensified, oil prices fell by over 50%. The decline in oil prices affected the financial transactions of energy sector industries listed on the stock exchange, as revenues from the sale of oil and power products have a positive impact on economic growth and development. With the continuation of COVID-19, gold, often referred to as a safe asset by both individual and institutional investors, has also faced a decline in value. Exchange rates, another critical economic factor, experienced numerous fluctuations during the COVID-19 pandemic. These fluctuations, along with the implementation of timely and appropriate currency systems during a crisis, influence the export and import levels of power industries and the financial transactions of companies. Failing to implement a proper and suitable exchange rate system could pose significant challenges to the foundations and structure of stock markets and the economy. In general, the ongoing changes and fluctuations in key economic variables over time will impact the earnings, financial transactions, industry indices, and their trading values on the stock exchange. In general, the impact of COVID-19 on the stock market and various industries can be summarized in two key points. The first aspect primarily concerns the financial and economic aspects of industries, including factors such as production levels, sales volume, income, earnings, and net profits. Exports of goods from various countries have been impacted by import bans from importing nations and the closure of borders and visa restrictions between countries, which will reduce production, income, and profitability for industries and companies. Additionally, due to the lack of access to essential raw materials for production, companies and industries will face reduced production levels. Moreover, the production of goods is expected to decrease

due to the shift to remote work for company personnel and quarantine measures for those infected with COVID-19. The second aspect concerns how COVID-19 affects the volume of transactions in companies and the stock market. Over a short period, the effect of COVID-19 on the stock market and active industries can be viewed as a financial and economic shock to the market. However, over a longer period, as the pandemic persists, these effects will encompass both of the previously mentioned points. As a result of the decline in earnings, income, profitability, and production of industries, the volume of transactions, financial transactions, and the value of stocks of companies listed on the stock exchange, along with the overall stock market index and industry indices, will face unexpected challenges that could have adverse consequences for the market (Reagan et al., 2022). During the COVID-19 pandemic in Wuhan, China, which is recognized as the epicenter of the COVID-19 outbreak, the global economy and financial markets, including the power sector stock markets, faced significant challenges. This situation led to the development of various opinions regarding the performance of stock markets during the pandemic. Below is a more comprehensive review of the theoretical foundations for this research, along with the related sources that will be examined.

Immediate and Instant Reactions of Stock Markets to COVID-19: Financial markets, especially global stock markets, experienced a decline in value in the early stages of the COVID-19 outbreak. Researchers, such as Ashraf (2020), have noted that the decrease in stock prices and the rapid responsiveness of stock markets to COVID-19 led to increased risk and uncertainty, along with a rise in stock sales.

Different Industry Responses to COVID-19: COVID-19 had varying impacts on industries and companies listed on the stock market, with the energy, tourism, and transportation sectors being the most severely affected. However, industries in the healthcare, pharmaceutical, and technology sectors were less affected and experienced more stability (Baker et al., 2020).

Economic Policies by Governments, Central banks, and governments

have implemented various policies to maintain stability and preserve the value of capital markets. Researchers such as Miranda and Snowver (2022) have observed the implementation of monetary and fiscal policies aimed at protecting market value and preventing further decline in stock prices.

Behavioral and Psychological Aspects of Investors. Studies in financial and behavioral economics have examined how COVID-19 impacted the decision-making of both retail and institutional investors. Researchers, such as Ortman et al. (2020), have conducted studies on psychological and behavioral factors, confirming that fear, anxiety, uncertainty, and risk play significant roles in market responses.

Long-Term Structural Changes in Stock Markets. Some researchers believe that the COVID-19 pandemic acted as a catalyst for accelerating previous trends and leading to structural transformations in capital markets. Factors such as digitalization, remote work, and shifts in consumer behavior are recognized as key drivers of long-term market changes (Brynjolfsson et al., 2020).

Economic Responsiveness As COVID-19 spread, industrial production and demand for products dropped significantly due to the global reduction in economic activities, social distancing regulations, and the shift to online operations for employees. This led many industries listed on the stock market to face challenges in terms of profitability, revenue, and performance (Sarfaraz et al., 2022).

Social Responsiveness The enforcement of social distancing regulations and the shift to online businesses impacted human resources and the production capacities of companies. This shift in consumer behavior, such as reduced demand for non-essential goods, affected the demand for products produced by industries (Same, 2022).

Geographical and Trade Relations Responsiveness: A global health crisis can quickly spread across international borders, and due to the close relationship between global capital markets and economies, any event worldwide triggers an immediate market response. For example, the contagious nature of the virus and its global spread caused investors, both

retail and institutional, to react emotionally, leading to hasty decisions regarding stock sales (Sen Sa, 2020).

Risk-taking and Uncertainty Factors, such as the severity of the COVID-19 pandemic, restrictions on trade for vaccine distribution, speculation about future waves of the disease, and the inadequacy of preventive measures, all influenced investment decisions. These factors led to heightened risk and uncertainty in the stock market (Same, 2020).

Energy Price Shocks and Raw Material Costs: The epidemic caused a drop in demand for oil, a primary raw material for energy products, including those used in power plants. This reduction in production costs for some manufacturing companies may positively affect stock prices in those sectors. However, price shocks in energy commodities pose challenges for investors and create uncertainty regarding expected revenue and stock price forecasts (Antparin & Pinmani, 2023).

Motivational Feedback and Government Measures An increase in demand for energy products, especially power plants, and the overall economic recovery can be spurred by government stimulus policies aimed at exiting the recession. However, governments may also impose stricter regulations on environmental positions in response to the pandemic, which could increase production costs for power plant companies and impact their stock prices (Rashata, 2021). Moreover, recent literature, such as, Mojaverian et al. (2023) examined the impact of COVID-19 on the food stocks of the Tehran Stock Exchange during the period from June 2, 2020, to March 3, 2021, using the heteroscedasticity variance regression model. The results of this research indicate an inverse relationship between the number of infected individuals and the value of food stocks. As the number of infected individuals increases, the value of food stocks decreases. Additionally, there is an inverse relationship between risk and food stock prices, meaning that as the level of risk increases, the stock price decreases. Sarfaraz et al. (2022) analyzed investment behavior in the Iranian stock market during the COVID-19 period, utilizing data envelopment analysis from 2019 to 2020. The results of this

study indicate that among the 23 active industries in the Iranian capital market in 2019, only 9 industries were efficient, while this number dropped to 6 industries in 2020. Industries such as the banking sector, which had been efficient prior to the emergence of COVID-19, became inefficient after the pandemic. Alijani et al. (2021) in their study analyzed the relationship between market returns and COVID-19 in Iran during the period from September 23, 2020, to February 22, 2020, using the MAD model. The findings show that with the spread of the COVID-19 virus, the stock market followed a sharp upward and positive trend. This occurred despite the fact that in other countries, there was an inverse relationship between the spread of COVID-19 and stock markets, with severe impacts on these markets, unlike Iran's market. This could indicate the inefficiency of the Iranian capital market, as it shows that stock markets in other countries, unlike Iran, do not have a strong dependency on news, possible events, political rumors, and economic factors. Herjoto et al. (2021) examined how stock markets in both developing and developed countries responded during the COVID-19 period, from February 20, 2020, to January 14, 2021, using a multivariate regression model. The results showed that in developing countries, the increase in the number of deaths had a negative impact on market volatility and trading volume. In contrast, in developed countries, the number of infections had a negative impact on trading volume and market volatility. Investors in developing countries reacted more to the number of COVID-19 deaths, whereas in developed countries, investors were more affected by the number of infections and reduced their investment in this area. Ashraf (2020) examined the response of stock markets to the COVID-19 virus in a study spanning from April 17, 2020, to January 22, 2020, using a panel data regression model. The results show that the stock market reacts more strongly to the number of confirmed infections than to the number of deaths. After 40 to 60 days from the initial confirmation of cases, the stock markets exhibited a rapid and downward response during the early stages of the pandemic. Ultimately, the way stock markets react to different stages of the virus

outbreak depends on the specific time frames. Dadgar et al. (2020) examined the synchronization of exchange rate cycles with oil prices, gold prices, and stock market value in Iran using a Markov-switching model with a component structure. Their results indicate a statistically significant cyclical relationship between the exchange rate and both gold and oil prices, whereas the synchronization between the exchange rate and the stock market is statistically weaker. Moreover, the degree of cycle synchronization depends on the regime of the exchange rate and differs significantly between expansionary and contractionary periods. These findings highlight the importance of nonlinear and regime-dependent analysis in studying Iran's financial markets. Dadgar (2020) in an analytical study, examines the emergence of COVID-19 as a multidimensional phenomenon within the framework of political economy. He demonstrates that the pandemic has led to profound economic, political, and social consequences, including reduced economic growth, rising unemployment, declining financial markets, and widening inequalities. The findings emphasize the role of managerial weaknesses, institutional inefficiencies, and environmental degradation in exacerbating the crisis, and interpret COVID-19 as a manifestation of an extraordinary political economy.

3. Methodology and Data

The variables used in the proposed model are as follows: the dependent variable PPPC, which is the performance index of power plant companies, and the independent variables: DR (death rate), IR (infection rate), PO (oil price), PG (gold price), and ER (exchange rate). The data is collected in a time series format on a monthly basis for the period from 2020 to 2023. The study period from April 2020 to July 2023 was deliberately selected to capture the full dynamics of the COVID-19 pandemic, including its outbreak, peak, and post pandemic adjustment phase. This period corresponds to the availability of consistent and reliable monthly data on COVID-19 infection and mortality rates in Iran, as well as the official declaration of the end of the pandemic by the World Health Organization in July 2023. Therefore, the selected time span

allows for a focused examination of pandemic-related shocks while avoiding structural distortions unrelated to COVID-19. The regression model used in this study is based on the work of Cheshmi and Othmani (2021) and Reagan et al. (2022), as shown in Equation (1).

$$PPPC_t = c_0 + c_1 DR_t + c_2 IR_t + c_3 PO_t + c_4 PG_t + c_5 ER_t + e_t \qquad (1)$$

Table 1. Introduction of Research Variables

Source	English Name	Symbol
Tehran Securities Exchange Technology Management Co	Performance of Power Plant Companies	PPC
WHO	Death Rate	DR
WHO	Infected Rate	IR
Gold, Coin, and Currency Information Network	Price Oil	PO
Gold, Coin, and Currency Information Network	Price Gold	PG
CBI	Exchange Rate	ER

Source: Research Results

For the first time, the imposition of theoretical restrictions on the simultaneous effects of shocks was developed by Leper et al. (1996), Blanchard and Watson (1986), and Bernanke (1986). The Structural Vector Autoregressive (SVAR) model was later developed by Blanchard and DeLany (1988) and Clarida and Gali (1994) by applying theoretical restrictions on the long-term effects of shocks. Specifically, the SVAR model allows the imposition of structural parameters on the basic approach of an economic theory (Shahrazi et al., 2023). The SVAR framework is particularly suitable for this study because the COVID-19 pandemic represents an exogenous and unanticipated shock to the economic system. Unlike reduced-form VAR models, SVAR allows for the identification of structural shocks and the imposition of theoretically grounded restrictions, which is essential for distinguishing pandemic-related health shocks from macroeconomic and financial disturbances. Given the objective of analyzing dynamic responses

rather than forecasting, the SVAR approach provides a coherent and theoretically consistent methodology for examining the transmission of COVID-19 shocks to the performance of power generation companies in Iran.

$$BY_t = \Gamma_0 + \sum_{i=1}^{n} \Gamma_i Y_{t-i} + \varepsilon_t \quad (2)$$

In the above equation, $Y_t = (PPPC, DR, IR, PO, PG, ER)$ Represents a 1*6 vector of variables, B is a 6*6 contemporaneous matrix, Γ_0 It is a vector of constant terms, Γ_i It is a 6 × 6 matrix of autoregressive coefficients, and n denotes the number of optimal lags. Additionally, ε_t It is a 1 × 6 vector of structural innovations that are mutually uncorrelated. Once the elements of B^{-1} The vector of structural shocks can be computed. Consequently, the long-term coefficient matrix will be as follows.

$$e_t = \begin{bmatrix} e_t^{DR} \\ e_t^{IR} \\ e_t^{PO} \\ e_t^{PG} \\ e_t^{ER} \\ e_t^{PPPC} \end{bmatrix} = \begin{bmatrix} \alpha_{11} & 0 & 0 & 0 & 0 & 0 & 0 \\ \alpha_{21} & \alpha_{22} & 0 & 0 & 0 & 0 & 0 \\ \alpha_{31} & \alpha_{32} & \alpha_{33} & 0 & 0 & 0 & 0 \\ \alpha_{41} & \alpha_{42} & \alpha_{43} & \alpha_{44} & 0 & 0 & 0 \\ \alpha_{51} & \alpha_{52} & \alpha_{53} & \alpha_{54} & \alpha_{55} & 0 & 0 \\ \alpha_{61} & \alpha_{62} & \alpha_{63} & \alpha_{63} & \alpha_{64} & \alpha_{65} & \alpha_{66} \end{bmatrix} \times \begin{bmatrix} e_t^{DRShock} \\ e_t^{IRShock} \\ e_t^{POShock} \\ e_t^{PGShock} \\ e_t^{ERShock} \\ e_t^{PPPCShock} \end{bmatrix} \quad (3)$$

In the above matrix, a value of 0 indicates that no specific response to the expected shocks exists, while nonzero elements, such as α_{ij} (where i=1,2,3,4,5,6 and j=1,2,3,4,5), represent the response coefficients of variable i to shock j (Chen et al., 2016). The selection of variables in this study follows

the ordering from endogenous to exogenous variables based on the methodology of Chen et al. (2016) and Shahrazi et al. (2023). According to these studies, the dependent variable, which in this research represents the performance of power plant companies in the stock market, should be considered the most exogenous variable. Among the independent variables, the COVID-19 death rate is regarded as the most exogenous variable, as its impact is considered largely external. The second variable in the ranking, from most endogenous to most exogenous, is the infection rate, which is placed after the death rate, given that mortality is relatively more controllable and preventable than infection rates.

The ordering of the remaining variables—OPEC oil price, global gold price, and the U.S. dollar exchange rate—follows the studies of Chen et al. (2016), Chai et al. (2021), and Chen et al. (2016). Additionally, for greater robustness in the structural matrix, foundational studies such as those by Guigui (1978), Cheshire and Smolinski (2009), and McCrory (2001) have been utilized.

4. Results and Discussion

The Iranian economy has experienced numerous structural breaks over the past decades, particularly during the COVID-19 period. Consequently, this study employs the Zivot-Andrews (1992) unit root test, which can identify structural breakpoints. Additionally, various diagnostic tests are conducted, including the optimal lag length test, the serial correlation test, the heteroscedasticity test, the normality test for error terms, Hansen's (1992) parameter stability test, and the vector autoregression (VAR) model stability test. Table 2 presents the results of the Zivot-Andrews unit root test, considering a single structural break.

Table 2. Stationarity Test Results

Symbol	Variable	Test Statistic	Structural Break Date	Stationarity
PPPC	Power Plant Companies' Performance Index	-3.647 (0.000)	February 2023	I(0)
DR	COVID-19 Death Rate (per million)	-3.597 (0.010)	September 2021	I(0)
IR	COVID-19 Infection Rate (per million)	-4.724 (0.026)	May 2021	I(0)
PO	Oil Price	-6.431 (0.001)	March 2022	I(0)
PG	Gold Price	-6.423 (0.012)	May 2020	I(0)
ER	USD Exchange Rate	-4.418 (0.034)	August 2022	I(0)

Source: Research findings

Note: The values in parentheses indicate p-values.

As shown in Table 2, all research variables are stationary at level (I(0)) when considering a structural break. This ensures the feasibility of using the Structural Vector Autoregression (SVAR) model. To determine the optimal lag length in the SVAR model, the study employs information criteria such as the Akaike Information Criterion (AIC), the Hannan-Quinn Criterion (HQ), and the Schwarz-Bayesian Criterion (SBC).

Table (3). Optimal Lag Selection

Lag	AIC	HQ	SBC
0	74.890	74.721	74.628
1	67.676	68.321	71.431
2	67.159	68.356	70.555
3	66.467	68.217	69.505

Source: Research findings

As observed in Table 3, lag 3 is the optimal choice based on all three criteria.

Table 4 presents the results of diagnostic tests for serial correlation, heteroscedasticity, and normality of the error terms.

Table 4. Diagnostic Test Results

Test	Lag	Test Statistic	Degrees of Freedom	p-value
Serial Correlation (LM Test)	1	45.569	36	0.150
	2	90.264	72	0.156
	3	207.669	108	0.231
Heteroscedasticity Test		493.650	504	0.620
Normality Test		9.540	6	0.145

Source: Research findings

The results indicate that the null hypothesis of no serial correlation is not rejected. Additionally, the heteroscedasticity test yields a p-value above 0.05, confirming homoscedasticity. Moreover, the normality test confirms that the error terms follow a normal distribution. Table 5 presents the results of Hansen's (1992) parameter stability test.

Table 5. Hansen's Parameter Stability Test

LC Statistic	Random Trends (m)	Deterministic Trends (k)	Excluded Trends (p2)	p-value
0.825	5	1	1	0.203

Source: Research findings

Since the p-value is greater than 0.05, the null hypothesis of parameter stability is not rejected, confirming the stability of the model. Before analyzing the impulse response functions in the VAR model, the model's stability must be assessed. Thus, the inverse root unit test of the characteristic polynomial is conducted, as illustrated in Figure 1.

As observed in Figure 1, no roots lie outside the unit circle. Therefore, the vector autoregression (VAR) model satisfies the stability conditions, and there are no issues in interpreting the model's results. Although the coefficients in vector autoregression (VAR) models are not directly interpretable, a statistical interpretation of these coefficients will be provided based on their signs and significance levels. Then, the results of impulse response functions and

variance decomposition will be discussed. Table 7 presents the long-term estimation results from the structural autoregression model, where rows represent the dependent variables and columns indicate the response of each variable to shocks.

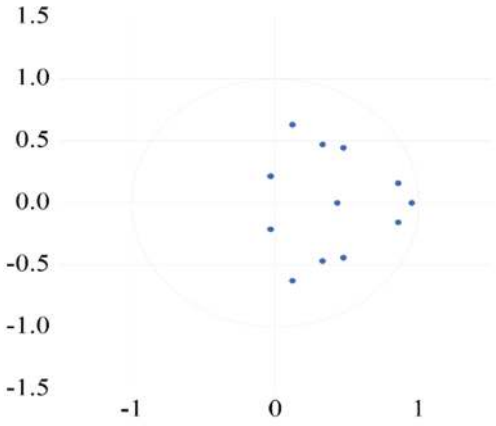


Fig 1. Inverse Roots of the Characteristic Polynomial Test
Source: Research Findings

Table 6. Results of the Structural Vector Autoregression Model

PPPC	ER	PG	PO	IR	DR
0	0	0	0	0	***350.992
0	0	0	0	**52.820	*-4.486
0	0	0	**212.85	***47.242	**10081.37
0	0	*0.797	**0.037	**0.142	**0.151
0	*43.255	**56.647	***0.984	**18.589	*19.790
***2.569	**1.658	**-3.477	***2.093	***-3.593	***-2.128

Source: Research findings
Note: ***, **, and * represent significance levels of 1%, 5%, and 10%, respectively.

As observed in Table 6, the COVID-19 mortality rate per million people (DR) and the COVID-19 infection rate per million people (IR) have a

significant negative impact on the Power Plant Companies Performance Index (PPPC). There are several reasons for this. The rise in mortality and infection rates leads to a decrease in demand for power plant products and a decline in economic activities across various sectors, especially industries that rely on power plant products as raw materials. Furthermore, the pandemic disrupts the supply chain of raw materials and power plant products, resulting in production and supply issues that lead to price increases. Power plant companies also incur additional costs to comply with health protocols and prevent the spread of the disease among their employees. These costs include purchasing sanitary equipment, conducting COVID-19 tests, and creating a safe working environment. Additionally, the COVID-19 pandemic significantly reduced economic growth in Iran and globally, due to a decline in economic activity, lower investments, and rising unemployment. As a result, the demand for power plant products declined. The pandemic also led to a sharp rise in inflation in Iran, driven by increased production costs, supply shortages, and higher demand for certain goods. Consequently, while power plant product prices increased, company profitability declined due to a decrease in demand. It is important to note that Iran's economy is simultaneously affected by long-standing structural challenges, including international sanctions and economic inefficiencies. These factors constitute the underlying economic environment, not isolated shocks. The present study focuses on the cumulative impact of COVID-19-related health shocks within this existing structural context.

The oil price (PO) has a significant positive impact on the Power Plant Companies Performance Index (PPPC). This positive effect is due to several key factors. Many Iranian power plant companies use crude oil and natural gas as primary inputs, and rising oil prices increase the cost of these inputs. Assuming other factors remain constant, higher input prices improve companies' profitability by increasing their gross profit margins. Additionally, a significant portion of Iran's power plant products are exported to global markets. When oil prices rise, global power plant product prices also increase,

benefiting Iranian power plant exporters by boosting their export revenues. Moreover, oil price increases are typically accompanied by a rise in the Iranian rial's exchange rate. A higher exchange rate increases the rial value of export revenues, benefiting companies and enhancing their performance.

In Iran, the electricity market is largely regulated, and the revenues of power generation firms are not mechanically tied to international oil prices in the way observed in liberalized energy markets. Therefore, the positive PO coefficient should be interpreted primarily through *macro-financial and fiscal channels* rather than a direct pass-through from oil prices to electricity profitability. Higher oil prices typically improve Iran's fiscal capacity and external balance, which can (i) strengthen government/utility payment ability to electricity producers, reduce receivable risk, and improve expected cash-flow timing, and (ii) raise market-wide inflation expectations and liquidity conditions in the Tehran Stock Exchange, affecting valuation and required returns. Hence, PO operates as a proxy for macro conditions and sovereign payment risk that shape expected performance and pricing of listed power generation companies. The gold price (PG) has a significant negative impact on the Power Plant Companies Performance Index (PPPC). There are several key reasons for this negative effect. When gold prices rise, some investors may withdraw from power plant company stocks and shift their investments to gold as a safe-haven asset. This reduces demand for power plant stocks, leading to a decline in their performance index. Additionally, higher gold prices can increase demand for foreign currencies in Iran. A rising exchange rate increases the cost of imported raw materials and production expenses for power plant companies, reducing their profitability and performance. Furthermore, higher gold prices are usually accompanied by rising inflation. Increased inflation raises production costs and lowers profitability, which negatively affects the performance index of power plant companies.

The U.S. dollar exchange rate (ER) has a significant positive impact on the Power Plant Companies Performance Index (PPPC). A higher exchange rate increases the rial-denominated revenue of Iranian power plant exporters,

benefiting their performance. Some raw materials and equipment used by power plant companies are imported, and a higher exchange rate reduces their cost in rial terms, favoring companies and their performance. Additionally, as the exchange rate rises, domestic power plant product prices increase, improving company profitability. A rial depreciation can increase operating and maintenance costs for power plants due to imported equipment, spare parts, and FX-exposed liabilities; under strict tariff regulation, this channel could imply a negative effect on fundamentals. However, the positive ER coefficient can still be consistent with the Tehran Stock Exchange structure because the exchange rate is a dominant driver of inflation expectations, replacement-cost valuation of real assets, and portfolio reallocation toward equities as an inflation hedge. For asset-heavy firms such as power plants, higher expected replacement costs and nominal revaluation effects may dominate in stock pricing, particularly when investors price equities as a store of value under currency depreciation. Accordingly, the ER effect in this study should be interpreted as a *market-pricing channel* rather than a pure production-cost channel, and the sign reflects how macro shocks transmit to equity valuation in Iran. Therefore, the estimated PO and ER effects should be read as macro-financial transmission mechanisms in an inflationary, FX-driven stock market, not as evidence of a direct operational pass-through from oil/FX to regulated electricity tariffs. Next, the impulse response functions and variance decomposition will be examined. Figure 2 illustrates the impulse response functions.

As shown in Figure 2, the impulse response of the power plant companies' performance index to shocks in DR is negative and decreases from the first period to the seventh period, then increases and remains negative until the ninth period, and finally reaches zero. The response to shocks in IR is nearly constant but negative. The impulse response of the power plant companies' performance index to shocks in PG is positive and increasing from the first to the third period, then negative and decreasing. The response to shocks in ER increases and remains positive from the second to the fifth period, then

decreases until the seventh period, and finally becomes negative, decreasing from the eighth period to the end. The impulse response of the power plant companies' performance index to shocks in PO is strongly increasing and positive from the first to the sixth period, then decreases but remains positive until the tenth period, and eventually reaches zero.

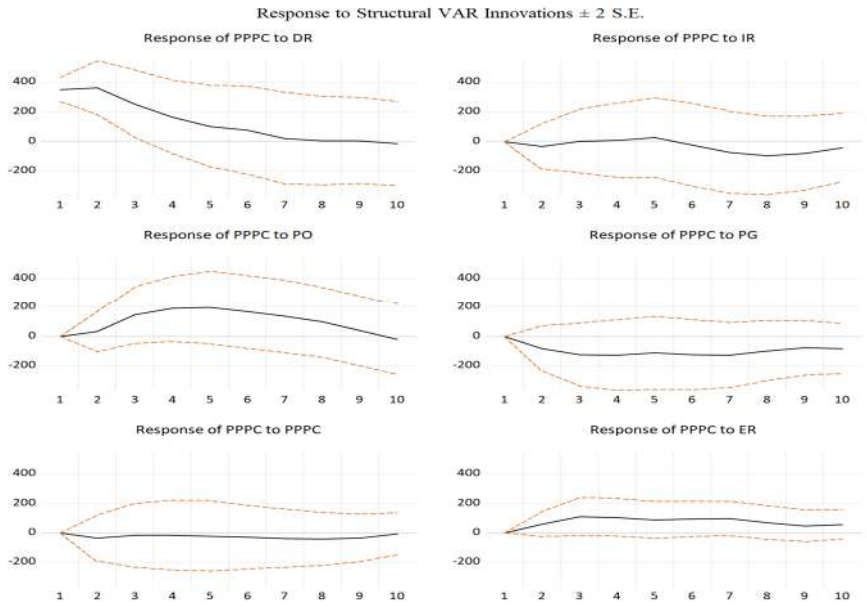


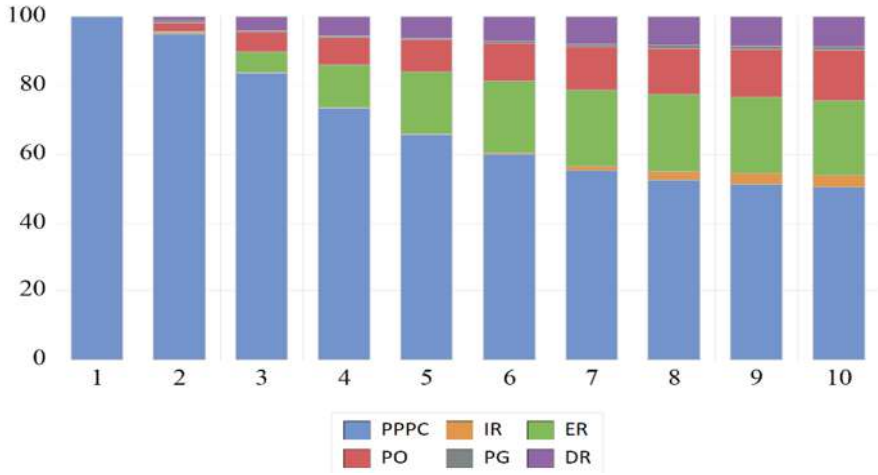
Fig 2. Impulse Response Functions in the SVAR Model
Source: Research Findings

Table 7. Variance Decomposition Table

Period	S.E.	Shock PPPC	Shock DR	Shock IR	Shock PO	Shock PG	Shock ER
1	350.99	100.00	0.00	0.00	0.00	0.00	0.00
2	517.80	94.92	0.40	0.40	2.46	0.47	1.33
3	618.54	83.46	0.28	5.91	5.79	0.40	4.13
4	688.27	73.26	0.24	12.35	8.10	0.37	5.65
5	738.42	65.60	0.34	17.95	9.36	0.40	6.31

Period	S.E.	Shock PPPC	Shock DR	Shock IR	Shock PO	Shock PG	Shock ER
6	778.15	60.03	0.39	20.84	11.01	0.51	7.19
7	811.04	55.33	1.20	22.11	12.58	0.67	8.08
8	832.49	52.52	2.48	22.39	13.33	0.89	8.36
9	842.77	51.26	3.29	22.06	13.84	1.04	8.48
10	850.20	50.40	3.47	21.73	14.56	1.02	8.80

Source: Research Findings



Figu 3. Variance Decomposition Graph
Source: Research Findings

The variance decomposition analysis reveals the percentage of variation in the dependent variable that is explained by the independent variables. As seen in Table 7 and Figure 3, the DR shocks explain about 0.40% of the changes in PPPC in the second period. The percentage increases, and eventually, in the tenth period, it stabilizes at 3.47%. On the other hand, the IR shocks explain about 0.40% of the changes in PPPC in the second period, then follow an increasing trend and stabilize at 21.73% in the tenth period, having the greatest effect on the dependent variable after its own shock. Moreover, the PO shocks account for approximately 2.46% of the changes in PPPC in the first period,

then follow an increasing trend and stabilize at 14.56% in the tenth period. The PG shocks account for approximately 0.47% of the changes in PPPC in the second period, then follow an increasing trend and stabilize at 1.02% in the tenth period. Finally, the ER shocks account for approximately 1.33% of the changes in PPPC in the second period, then follow an increasing trend and stabilize at 8.80% in the tenth period.

5. Conclusion and Policy Recommendation

This study examined the determinants of stock performance for power generation companies listed on the Tehran Stock Exchange by focusing on pandemic-related indicators and key macro-financial variables from April 2020 to July 2023 using SVAR model. The empirical results provide consistent evidence that pandemic severity exerts a statistically meaningful influence on the sector's equity performance. In particular, increases in infection and fatality indicators are associated with weaker stock outcomes, indicating that health shocks translate into financial stress for the sector through uncertainty, operational disruption, and deteriorating expectations about cash-flow stability. In addition to pandemic variables, the findings highlight the role of macro-financial conditions in shaping sectoral equity pricing in Iran. Oil price movements, the exchange rate, and gold price dynamics emerge as important drivers of stock performance. These variables should not be interpreted as simple operational pass-through mechanisms (given tariff regulation and institutional constraints in the electricity market), but rather as channels through which broader macroeconomic expectations, inflation dynamics, and market-wide portfolio reallocation affect equity valuation. Overall, the evidence suggests that the stock performance of listed power generation firms is sensitive to both (i) health-related shocks and (ii) macro-financial conditions that dominate investor expectations in Iran's equity market. The implications below are strictly limited to channels empirically examined in this study and are presented to avoid overgeneralization beyond the model's scope.

(1) Pandemic-risk management and sector continuity (IR, DR effects).
Because pandemic severity indicators are associated with lower stock performance in the power generation sector, strengthening operational continuity and crisis preparedness is a financially relevant priority. Measures such as structured business-continuity plans, workforce protection protocols, and contingency maintenance strategies can reduce uncertainty and mitigate the market's risk premium during health shocks. From a market perspective, credible continuity planning can improve the stability of expected cash flows and reduce volatility in sector valuations.

(2) Foreign-exchange exposure transparency and mitigation (ER effect).
The exchange rate is empirically important for sector equity performance, implying that currency-related shocks are priced by investors. Given that currency depreciation can affect valuation through inflation expectations and asset replacement-cost channels—while also raising costs for imported equipment and FX-exposed liabilities—firms and regulators should prioritize (i) disclosure of FX exposure (including debt composition, procurement dependencies, and sensitivity analysis) and (ii) practical FX-risk mitigation where feasible (e.g., liability matching, procurement planning, and contract structures that reduce FX mismatch). Improving transparency can reduce uncertainty premia and strengthen the informational efficiency of sector pricing.

(3) Safe-haven substitution and confidence effects (gold price effect).
The gold price is relevant to the sector's stock performance, consistent with portfolio shifts between equities and safe-haven assets during periods of heightened uncertainty. This implies that strengthening market confidence—through timely disclosures, clearer guidance on operational and financial resilience, and improved reporting quality—can reduce flight-to-safety behavior and limit excessive valuation discounts during turbulent periods.

(4) Oil-price–macro channel and payment/cash-flow credibility (oil price effect).

The oil price is empirically linked with sector stock performance. In the Iranian context, this relationship is most plausibly interpreted through macro-fiscal and liquidity conditions rather than direct tariff pass-through. Therefore, policies that reduce cash-flow uncertainty—particularly regarding settlement discipline and predictability of receivables—can lessen the sector's sensitivity to macro-fiscal cycles associated with oil-price fluctuations. Improving payment credibility strengthens cash-flow expectations and can reduce the equity risk premium.

The results should be interpreted in light of institutional features of Iran's electricity market and stock exchange, including regulation, price-setting mechanisms, and macroeconomic volatility. Future research can extend the analysis by incorporating firm-level fundamentals (e.g., leverage, receivables, generation technology, cost structure), alternative measures of uncertainty and policy responses, and structural breaks associated with major regulatory or macroeconomic episodes. In addition, examining heterogeneity across firms (e.g., size, ownership structure, and import dependence) may reveal differential exposure to pandemic and macro-financial shocks.

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Authors' contributions

All authors had contribution in preparing this paper.

Conflicts of interest

The authors declare no conflict of interest

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