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Dynamic Algorithmology of Macroeconomic Data on the Stock Market with Emphasis on Economic Turbulences of the TARCH BEKK and VAR Model Performance

Amin Gholami[1], Mohammad Hossein Ranjbar[2,*], Bijan Abedini[3], Zadolah Fathi[4]

[1] *Ph.D. Student, Department of Accounting, Zahedan Branch, Islamic Azad University, Zahedan, Iran.* *Amingholami99@yahoo.com*
[2] *Associate Professor, Department of Accounting and finance, Bandar Abbas Branch, Islamic Azad University, Bandar Abbas, Iran.* *Mhranjbar54@Iau.ac.ir, 0000-0003-3454-0200.*
[3] *Associate Professor, Faculty member of Department of Management and Accounting, University of Hormozgan, Bandar Abbas, Iran.* *Bizhanabedini.48@gmail.com*
[4] *Assistant Professor, Department of Management, Islamic Azad University Tehran Branch, Iran.* *Z_fathi46@yahoo.com*

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ABSTRACT

Economic algorithmology is used to understand data structure, relationships, and dynamics and the models used to analyze them. In macroeconomics, data includes complex information such as inflation rates, interest rates, GDP, and related financial variables that significantly impact financial markets. This requires specialized knowledge of economic, statistical, and information technology concepts. Therefore, given the importance of this issue, the present study aims to analyze dynamic algorithmic data on the stock market with an emphasis on the economic turbulences of the TARCH BEKK and VAR models in the Tehran Stock Exchange. For this purpose, using information related to macro variables and capital market indices over 10 years, from 2013 to 2022, the research hypotheses were examined and in this regard, the TARCH-BEKK, VAR, and Granger causality models were used to test the research hypotheses. The results show that the release of news resulting from changes in inflation rates, interest rates, exchange rates, and oil prices can affect stock returns.

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1. Introduction

Economic patterns and associated turbulence, especially in the macroeconomic domain, have a significant impact on the dynamics of financial markets and stock behavior. These effects are more evident in conditions of economic uncertainty and require a more detailed analysis of market correlations and fluctuations (Bhardwaj et al., 2023). In this study, the complex relationships between macroeconomic data and the stock market are analyzed using advanced models such as TARCH-BEKK and VAR. The main goal of this study is to identify and model common dynamics and mutual reactions in conditions of economic turbulence, which can play an important role in extracting knowledge and improving investment decisions (Rashid et al., 2022). The approach used, while emphasizing temporal and structural analyses, provides a suitable platform for a deeper understanding of market co-dynamics (Alammar et al., 2024).

In the current era when economic data is generated and shared at an increasing rate, dynamic analysis of this data has become one of the fundamental challenges in financial and economic studies (Wei et al., 2023). Advanced econometric models, such as TARCH-BEKK and VAR, provide powerful tools for extracting hidden patterns and understanding the interaction of economic variables on the stock market (Bouri et al., 2022). The use of these models not only allows the investigation of nonlinear relationships and the impact of economic fluctuations, but also can lead to improved market predictability and the development of data-driven approaches to risk management. By focusing on economic turbulence and examining the role of macro variables in stock market dynamics, this paper provides a platform for extracting applied knowledge in financial decision-making and economic policy-making. The proposed methodology, by combining data mining and advanced analytics, helps to discover new insights in the field of macroeconomic and stock market interactions (Taleblou et al., 2023).

Macroeconomic data, including inflation rates, interest rates, gross domestic product (GDP) growth rates, and exchange rates, have profound effects on stock markets. These variables are always considered in economic and financial analysis due to their decisive role in investment decisions (Ali et al., 2023). Statistical and econometric models, including conditional volatility models, provide powerful tools to examine the effects of economic shocks and volatility on stock returns and risk. Knowledge in this field requires a deep understanding of how these variables interact, the impact of economic shocks, and the temporal and spatial relationships between them (Song, 2024). Dynamic algorithms, such as TARCH-BEKK and VAR, have been developed based on macroeconomic theories and advanced statistics to accurately analyze the volatility, correlations, and temporal dynamics of data. Knowledge in the design and use of dynamic algorithms plays a vital role in selecting the appropriate model, tuning parameters, and interpreting results. For example, in the TARCH-BEKK model, it is essential to understand the asymmetric aspects of fluctuations and the effects of shocks on macroeconomic data (Raza et al., 2023). These models not only help in analyzing the past but also provide tools for predicting future trends. Similarly, the VAR model relies on dynamic knowledge of causality between variables, and its proper use requires understanding the structural relationships in the data and analyzing different economic scenarios (Wang et al., 2023). Ultimately, knowledge in this area will pave the way for improved forecast accuracy, better risk management, and optimal decision-making in complex economic environments (Mensi et al., 2023).

It has long been proven that information, and especially macroeconomic news, has a significant impact on prices and various dynamics in financial markets (Wallot et al., 2018). This idea is also relevant to capital

market efficiency, which has become one of the most extensive research areas in finance.

Announcements based on central bank policy measures, public debt programs and government bond issuance, unemployment rates, or capacity utilization rates are examples of such announcements. Although the main stock market indicators have improved somewhat in mid-April 2020, there is still a lot of financial uncertainty (Cepoi, 2020).

Although the impact of macroeconomic news on forex markets has been widely proven, the number of studies on the impact of macroeconomic news on stock exchanges is limited. However, there is a lot of research on the role of some factors affecting stock returns, such as political influence, order imbalance, trading volume, and face market volatility. Since the global financial crisis in 2008, Asia-Pacific markets have experienced significant volatility, inspiring a large body of related financial research to examine issues such as price discovery and spillovers in markets (Hao et al., 2021). Information input can affect the underlying volatility states, potentially triggering structural changes. Others have tested the idea that assets react to macroeconomic news (Feng et al., 2022). The efficient market hypothesis (EMH) states that stock prices should reflect all available information. Therefore, the profits of financial markets should be exploited as soon as they are known. Other key concepts of efficient markets are that prices are formed rationally and any changes in prices are expected to be random and unpredictable (Fama, 1970). However, Lo & MacKinlay (1990) have suggested that returns do not follow a random path. With the increasing interest in media news and text mining techniques, new sources of indicators have emerged that can be useful in fundamental analysis (Guan-Ru et al., 2019). Media coverage of economic news is an important determinant of investors' information environment, as media coverage during the COVID-19 pandemic has had a significant impact on financial markets during the coronavirus outbreak (Möller & Reichmann, 2023). Given the volatility trend in recent years and the role of news releases related to macroeconomic factors (oil, inflation, exchange rates, interest rates), the need for this research is important from this perspective to investigate whether the volatility time, macroeconomic variables, capital markets fluctuate or not and whether stock returns will be affected by changes in economic factors? Since studies show that people react to published news, very little research has been conducted on the impact of macroeconomic news on stock returns, and it is better to say that it is considered a kind of research gap. Accordingly, the present study aims to study the forecasting of the impact of macroeconomic news on stock returns with an emphasis on economic turbulence in the Tehran Stock Exchange.

The VAR (vector auto regression) model is used as a tool to analyze the causal relationships and dynamics between macroeconomic variables and the stock market. This model is particularly useful in identifying the interactions between variables and predicting their future behavior. In contrast, the TARCH-BEKK model helps analyze conditional volatility and manage stock market risk in the face of economic turbulence. The combination of these two models provides a comprehensive approach to understanding the impact of macroeconomic shocks on stock market turbulence. For example, in a situation where interest rates increase due to monetary policies, the VAR model can analyze short-term market changes, while the TARCH-BEKK model examines the long-term effects of these turbulences on stock return fluctuations. This combination provides a dynamic and accurate perspective for risk management and investment decision-making.

2. Literature Review

Recently, research has focused on the relationship between news and changes in asset dynamics (Du et al., 2022). Increased uncertainty resulting from positive or negative news can increase price volatility

and transmit this uncertainty to other markets. The oil price war within the Organization of the Petroleum Exporting Countries (OPEC) combined with low oil demand during the COVID-19 pandemic has increased price volatility (Apostolakis et al., 2024). The motivation for this paper is largely driven by the seminal work of Veronesi (1999), who argues that investors may overreact to bad news in good times and underreact to good news in bad times. The stock market is often considered a barometer for a country's economic health, with stock prices fluctuating based on a wide range of economic, financial, political, and global factors. To understand how these factors, affect stock market volatility, it is necessary to consider the impact of daily news signals and events. This is particularly important in the context of developing countries, where stock markets are often more volatile and prone to sudden changes (Raza et al., 2023).

However, such empirical evidence on the importance of macroeconomic and firm-specific news on asset volatility is mixed. According to the efficient market hypothesis (EMH), stock prices in an efficient market fluctuate within their intrinsic value, but sometimes, due to the release of new information such as shocks, prices increase dramatically without any fundamental or economic justification. This process is referred to in the financial literature as price bubbles (Moradi et al., 2022).

For example, Mitchell & Mulherin (1994) use a number of news announcements and observe that the relationship between volatility and information flows is statistically weak. Other researchers, such as Brenner et al. (2009), found stronger evidence for the relationship between firm-specific announcements and macroeconomic and asset volatility (Feng et al., 2022).

The claim that economic variables such as inflation, liquidity, exchange rates, and other economic factors drive and affect changes in stock prices has been accepted as a theory. Asset pricing theory has a long history that relates the quantity and quality of information flow to changes in asset prices.

For example, information that leads to the removal of uncertainty about a company's future prospects can lead to a revision of the current price. According to this view, an important process that affects price movements is the information process (Jeon et al., 2022). Regarding the Iranian market, it can be emphasized that Iran has faced the most severe economic sanctions in recent years, which have led to financial problems for many of its companies. The economic sanctions against Iran have been so severe that the gross domestic product (GDP) has declined sharply in recent years and the value of the national currency has been further reduced due to a significant increase in the exchange rate. In such adverse economic conditions, the supply of raw materials required by companies is very expensive and increases the cost of products.

In such an inflationary economy where prices are increasing day by day, people's purchasing power decreases over time. As a result, the demand for manufactured goods in the Iranian market will decrease significantly (Moradi et al., 2022).

The entry of new information into the market, both favorable and unfavorable, increases market volatility and, as a result, the risk premium increases. Although this increase in risk somewhat reduces the positive effect of good news, it strengthens the negative effect of bad news. Therefore, the decline in stock prices due to the entry of unfavorable news into the market will be greater than the increase due to the entry of favorable information, which ultimately leads to a decrease in stock prices.

Therefore, it can be said that managerial hoarding of bad news has always been one of the key factors in the sudden fall in stock prices in various financial markets (Moradi et al., 2022). Interest rates are an important factor for investors and economic enterprises; Because they rely on it for investment and increasing production capacity. Changes in interest rates affect the profitability of companies; on the other

hand, the timing of shareholder dividends is also affected by this. Shareholders replace interest-bearing financial assets with stocks due to a price decrease. This leads to low savings and a decrease in demand for stocks, which consequently causes a minimum price.

A low exchange rate is beneficial for importing countries because it helps reduce production costs, and it is undesirable for exporting companies. On the other hand, when high exchange rates enter the stock market, more currency conversion is carried out, which increases foreign investment, and due to this growth rate, stock prices also reach a maximum trend (Verma & Bansal, 2021).

Positive growth in GDP gives shareholders a positive signal of good performance in various sectors of the economy. This attracts shareholders to invest more to get better returns because industrial sectors perform well in such conditions. The increase in oil prices not only increases the cost of production but also maximizes the cost of transportation; this causes fluctuations in stock prices. Whenever stock prices decrease, investors demand gold as an alternative to stocks (Verma & Bansal, 2021).

Shareholders react strongly to the publication of negative economic news by newspapers and television because negative news increases the profits of newspapers and increases the number of viewers of television channels. As a result, these media outlets, by publishing such news, increase the sense of uncertainty and risk among investors, which in turn is a driver of stock sales in the financial market. Managers' profit forecasts are arbitrary and economic reasons have also been provided for this.

As a result, managers make decisions about the company's activities under the influence of internal factors. Therefore, to the extent that these internal factors depend on the country's economic situation, managers' forecasts are expected to reflect existing expectations regarding the state of economic variables. Therefore, in a country like Iran that suffers from a high inflationary economy, the impact of macroeconomic variables such as GDP, inflation rate, unemployment rate, and exchange rate can affect the accuracy of managers' performance forecasts (Moradi et al., 2022).

The theories presented show that the ground is ready for proposing new issues and proposing scientific hypotheses.

Accordingly, some related research is discussed first to better prepare the ground for proposing the hypotheses of this research. Ranjbar et al. (2018) also tested the effect of exchange rate uncertainty on the stock price index and investment in the Tehran Stock Exchange using GARCH and VAR models and concluded that bank interest rate fluctuations, regulatory stability, yield fluctuations, stock trading volume, inflation rate, official and free market exchange rates, and investment in the entire economy had the greatest impact on attracting investment in the financial sector of the economy. On the other hand, in the long run, there was a negative relationship between changes in bank interest rates, free market exchange rates, and stock exchange returns. In a study, Amri Asrami (2014) examined the quality of performance, stock returns, and company-specific volatility.

The results showed that in companies with high performance quality, company-specific volatility has a direct relationship with stock returns, and in companies with low performance quality, company-specific volatility has an inverse relationship with stock returns.

The desirable quality of company performance causes an increase in specific volatility and leads to positive returns, and the undesirable quality of company performance causes an increase in specific volatility and leads to negative returns. Also, there is a nonlinear relationship, ∩-shaped, between stock returns and company-specific volatility. Increasing specific volatility to a certain level initially increases the company's stock returns, but as it increases further, it will lead to a negative market reaction and a negative impact on stock

returns. Osmani et al. (2024) studied the reaction of stock returns of different industries in Iran to inflation and interest rates in a study. The empirical results show that inflation in the short and long term has a positive and significant effect on the nominal stock returns of different industries in the period under study, but inflation has a negative and significant effect on the real return in the long term. Nominal interest rates in the short and long term reduce the nominal and real returns of stocks of different industries. In addition, the exchange rate, world oil price and liquidity variables are also considered as control variables.

Taghavi et al. (2021) in a study examined the asymmetric effects of monetary policy and exchange rate fluctuations in terms of economic value added on stock returns in the Tehran Stock Exchange. The results of the study indicate that the estimated model is nonlinear, such that the effect of exchange rate shocks, liquidity volume, and value-added on stock returns is asymmetric in the short and long term. A one percent increase in positive and negative exchange rate shocks is directly and significantly effective on stock returns by 2.87 and 19.69, respectively.

A one percent change in positive and negative liquidity shocks is also directly and significantly effective on stock returns by 16.95 and 4.12, respectively. The asymmetric effect of economic value added as a national account criterion on stock returns is also direct and significant.

Hosseini and Dadras Moghadam (2023) in a study identified and examined the effect of monetary and financial shocks on stock returns and stock industries in the country. The modeling results showed that out of 10 macro variables affecting the stock returns of companies, four variables, free exchange rate, OPEC oil price, coin price and the optimal interest rate, are the best. The effect of the two variables coin price and interest rate on the stock returns of companies and the average return of listed industries was negative and significant. The results also showed that the stock returns of companies are highly affected by oil and coin price shocks and the government exchange rate has a significant effect on the average return of listed industries. Farhadian and Nilchi (2022) investigated the oil market volatility spillover in the stock market with a multivariate Bayesian random fluctuation model in a study. The results show that the multivariate Bayesian structural model between stock returns and oil returns confirms the existence of a positive volatility spillover (0.838) between these two markets. Therefore, the occurrence of positive shocks in oil prices will lead to growth in the stock index.

Heidari et al. (2021) evaluated macroeconomic policy uncertainty, information competition, and liquidity in a study. The results of the study show that the effect of the independent variable of macroeconomic policy uncertainty had a negative and significant effect on stock liquidity, indicating that increased uncertainty will lead to increased financial risk and decreased stock returns and liquidity. The results of the study also show that the effect of the independent variable of information competition had a positive and significant effect on stock liquidity, indicating that increased information competition will lead to increased transparency and shareholder trust, reduced financial risk, and increased stock returns and liquidity.

The results of the study show that the effect of the independent interactive variable of macroeconomic policy uncertainty and information competition had a positive and significant effect on stock liquidity. Mohammadi et al. (2021) studied the effect of macroeconomic variables on the relationship between financial reporting quality and stock returns in companies listed on the Tehran Stock Exchange.

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The test results indicated that the quality of financial reporting and stock returns had a significant relationship; also, macroeconomic variables including inflation rate fluctuations and GDP growth moderated the relationship between financial reporting quality and stock returns, in a way that caused a reduction and adjustment of this relationship.

Taleblo and Mohajeri (2021) examined the modeling of volatility in Iranian asset markets using a multivariate factorial stochastic volatility model. The findings show that firstly, there are two hidden factors.

Secondly, the specific volatility of the returns of 3 assets including stocks, dollars and gold has intensified since mid-2017 and exhibits cluster behavior.

Thirdly, most of the inflation rate volatility is explained by hidden factors and the specific volatility of inflation has an almost smooth trend.

Fourthly, the volatility of stock returns is highly correlated with inflation and dollar volatility.

A high correlation is observed between the volatility of the inflation rate and the dollar yield and interest rates. Apostolakis et al. (2024) studied the spillover of volatility in crude oil and futures markets after news announcements. The results indicate that there is an asymmetry in the response to shocks during the Russian-Saudi oil price war. In addition, the volatility responses were larger for futures and spot prices after negative shocks during the COVID-19 period compared to the pre-COVID-19 period.

Ma et al. (2023) studied a portfolio with return and volatility forecasts for the energy stock market. The empirical results show that using return and volatility forecasts to drive portfolio models is usually significantly effective.

Raza et al. (2023) studied the impact of news signals on daily stock market performance. The results show that political and global news have a significant impact on the KSE-100 index.

Our findings show that ARCH/GARCH models are better at predicting stock market volatility than simple OLS.

Ali (2023) investigated the integration relationship between macroeconomic variables and stock returns in a study. The test result shows that the variables are combined and the vector error correction model shows that the system's level of imbalance corrects its previous period by 5.98% per month. Granger causality test is also conducted to estimate the causal relationship and the result shows one-way causality from consumer prices and foreign remittances to stock prices and two-way causality between import payments and stock prices, but there is no causal relationship between GDP and stock prices.

Möller, R., & Reichmann (2023) studied TV news and Covid-19-related volatility and stock return prediction.

The results show that COVID-19-related television content has had a significant impact on financial markets during the pandemic. In a review paper, Jeon et al. (2022) examined research on news as a source of stock return volatility. The results showed that stock return volatility (including temporal changes in the distributions of volatility size and volatility intensity) is significantly related to the frequency and content of news streams, and these effects have been increasing significantly over the past few decades. The sensitivity of the probability of volatility to news is stronger for companies with higher media visibility, analyst coverage, and institutional ownership.

Feng et al. (2022) examined the effects of news sentiment on stock return volatility.

The findings indicate that news occurrence and sentiment, especially macroeconomic news, are a key factor that significantly drives the volatility of Japanese stock returns. This information provides the necessity for Japanese stock market traders to optimize their trading strategies and risk management plans to combat volatility.

Guan-Ru Wu et al. (2019) examined the impact of economic news on Taiwan stock market returns in a study. Empirical analysis shows that news variables provide useful information for predicting Taiwan stock market returns. A review of research literature shows that news announcements related to economic variables can have different effects on different segments of the capital market. However, limited research has examined the dynamic relationship between macroeconomic news announcements and stock returns in the presence of economic turbulence. Therefore, this study is innovative in this respect.

3. Method

The present study, which aims to investigate the dynamic effect of macroeconomic news announcements on stock returns with an emphasis on economic turbulence, is therefore an applied and practical study from the perspective of its purpose; and is descriptive and survey in terms of its implementation method. In the present study, data were examined daily over a ten-year period from 2013 to 2022.

The statistical population of this study includes stock returns, oil prices, and macroeconomic indicators.

For this purpose, information related to the 10-year period from 2013 to 2022 and in the relevant sections was selected and evaluated as the sample size. It is worth noting that the theoretical foundations and data collection section of the research were carried out using the library method. In this study, the stability of the data was evaluated using the Dickey-Fuller and Phillips-Peron tests; Also, in order to test the dynamic effect of macroeconomic news announcements on the stock market with an emphasis on economic turbulence, the TARCH BEKK model and the VAR autoregressive model have been examined to evaluate the effects of positive and negative news and its effects on the aggregate index and stock returns. The Granger causality test was conducted to find the cause-and-effect relationships between macroeconomic dynamics and stock returns.

$$R_{it} = \alpha_0 + \beta_3 Inf_{it} + \beta_4 Inr_{it} + \beta_6 EXCHANGE_{it} + \beta_7 Oil_{it} + \varepsilon_{i.t}$$

The chosen time frame for the study was selected based on the specific context of the research, ensuring it captures a sufficient number of data points to analyze the dynamics over time while considering the frequency and relevance of the events or variables under study.

By selecting a period that reflects both the stability and volatility in the data, the time frame facilitates the accurate identification of patterns, trends, and potential shifts in the underlying processes. Additionally, this period allows for a meaningful analysis of both short-term and long-term effects, offering a clearer picture of the impact over time.

The use of TARCH (Threshold Autoregressive Conditional Heteroskedasticity), BEKK (Baba, Engle, Kraft, and Kroner), and VAR (Vector Autoregression) models offers significant advantages in analyzing time-series data with complex relationships and volatility.

TARCH models are particularly useful for capturing asymmetries in volatility, enabling a more nuanced understanding of market dynamics when positive and negative shocks have different impacts. BEKK models, on the other hand, are effective in modeling multivariate volatility, capturing the interactions between multiple variables in a more sophisticated manner than univariate models. Finally, VAR models are ideal for modeling the interdependencies between several time-series variables, allowing for the examination of causal relationships over time. Together, these models provide a comprehensive framework for understanding the volatility and co-movements between variables, offering more robust insights compared to simpler techniques.

In the above relationships:

R_{it} it stock returns;

INF= inflation rate, which in this study was extracted using data available from the Central Bank's statistical website and the Economic and Financial Data Bank.

Inr: Interest rate: The interest rate or interbank interest rate is the amount that banks pay each other in exchange for borrowing from each other.

Exchange = Exchange rate is extracted daily from the Economic and Financial Data Bank website. Exchange rate in this study is a control variable that is taken as a logarithm.

Oil = Oil price is extracted daily from the Economic and Financial Data Bank website and OPEC website.

Research Hypotheses

1. Publishing news about inflation rate affects the stock returns of companies that are members of the Tehran Stock Exchange.
2. Publishing news about interest rate affects the stock returns of companies that are members of the Tehran Stock Exchange.
3. Publishing news about exchange rate affects the stock returns of companies that are members of the Tehran Stock Exchange.
4. Publishing news about oil price affects the stock returns of companies that are members of the Tehran Stock Exchange.

4. Finding

Descriptive statistics

According to the observations in Table 1, the highest standard deviation among the variables studied in this study is related to oil prices and

the lowest standard deviation is related to interest rates.

Table 1. *Descriptive statistics related to research variables*

	Mean	**Median**	**Maximum**	**Minimum**	**Standard deviation**	**Skewness**	**Kurtosis**
Stock returns	0.07	0.05	0.18	0.02-	0.48	0.12	4.07
Inflation rate (percentage)	44.40	40.10	53.0	9.00	7.64	0.45	6.12
Interest rate	0.19	0.20	0.24	0.17	0.01	0.15	5.20
Exchange rate	4.41	4.58	5.41	4.41	4.91	0.10	5.45
Oil price	68.28	65.76	104.83	42.49	20.97	0.10	1.92

Also, in examining the skewness and kurtosis of the research variables, the stock return variable has a normal distribution because the skewness and kurtosis are between zero and 6.

Stationarity test

In this study, the Dickey-Fuller unit root test and the Flipspron unit root test were used to examine the stationarity or kurtosis of the time series, the results of which are in the following tables.

Table 2. *Results of the Dickey-Fuller unit root test*

Width from origin with trend					**Status**	**Variables**
Probability	**Critical values**			**t-statistic**		
	10%		1%			
0.000	-2.57	0.000	-3.43	57.53-	Level	**Stock returns**
0.652	-2.57	0.652	-3.43	1.25-	Level	**Inflation rate**
0.000	-2.57	0.000	-3.43	53.53-	1st order difference	
0.825	-2.57	0.824	-3.43	0.77-	Level	**Interest rate**
0.000	-2.57	0.00	-3.43	9.52-	1st order difference	
0.664	-2.57	0.664	-3.43	1.22-	Level	**Exchange rate**
0.000	-2.57	0.000	-3.43	54.46-	1st order difference	
0.781	-2.57	0.781	-3.43	2.09-	Level	**Oil price**
0.000	-2.57	0.00	-3.43	40.68-	1st order difference	

The test results show that except for the stock return variable, in other research variables, the p-value in the level test has values greater than 0.05, therefore rejecting the null hypothesis of stationarity, but with one order of difference, the p-value reaches zero and stationarity is achieved.

Table 3. *Phillips Perron Unit Root Test*

Width from origin with trend					Status	Variables
Probability	Critical values			t-statistic		
	10%	5%	1%			
0.000	-2.56	-2.86	-3.43	-57.60	Level	Stock returns
0.651	-2.56	-2.86	-3.43	1.56	Level	Inflation rate
0.000	-2.56	-2.86	-3.43	-53.53	1st order difference	
0.824	-2.56	-2.86	-3.43	-0.778	Level	Interest rate
0.000	-2.56	-2.86	-3.43	-53,529	1st order difference	
0681	-2.56	-2.86	-3.43	1.18	Level	Exchange rate
0.000	-2.56	-2.86	-3.43	-54.48	1st order difference	
0446	-2.56	-2.86	-3.43	2.11-	Level	Oil price
0.000	-2.56	-2.86	-3.43	-87.30	1st order difference	

The results show that except for stock returns, other variables at the level have a p-value greater than 0.05 and reject the hypothesis H_0, and also the t-statistic is greater than the critical values, so they have a unit root. If, with one order of differentiation, except for the stock return index, the p-value becomes zero and the t-statistic becomes smaller than the critical values, and stationarity is achieved.

Multivariate GARCH Model Estimation

The results obtained from the BEKK TGARCH- output are as follows:

Hypothesis 1: The release of inflation rate news has an impact on the stock returns of companies that are members of the Tehran Stock Exchange.

Table 4. *TARCH-BEKK model with the spillover effect of fluctuations caused by inflation rate news on stock returns*

Duration	Variables	Coefficient	Z-statistic	Probability
Short term	Stock Return	0.15	6.691	0.000
Medium term	Stock Return	1.12	0.191	0.849
Long term	Stock Return	0.15	2.094	0.036

In the first hypothesis of the study, the publication of inflation rate news on stock returns in the short, medium and long term has been examined. Regarding the effect of publishing inflation rate news on stock returns, according to the results, it is observed that in the short and long term periods, publishing inflation rate news can have an effect on stock returns. This is determined by the value of its statistics in the short and long term, respectively, with values of 6.691 and 2.094 (more than 1.96) and with a significance level of 0.000 and 0.036 and positive coefficients.

It can be stated that the inflation rate can have a positive and significant effect on stock returns in the short term, but in the long term, this effect is less. However, in the medium term, it has no effect because the significance level is more than 0.05 and the Z test for the medium term is less than 1.96. Therefore, the first hypothesis of the study can be confirmed.

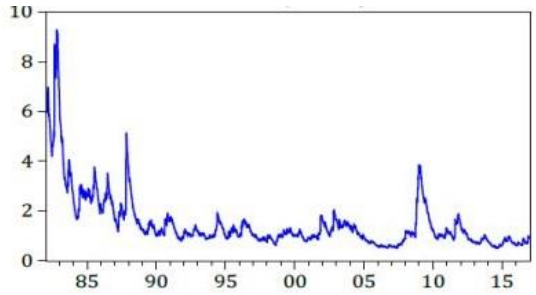

Figure 1. *Graphical procedure of hypothesis one*

Hypothesis 2: The release of interest rate news has an impact on the stock returns of companies that are members of the Tehran Stock Exchange.

Table 5. *TARCH-BEKK model with spillover effect of interest rate news volatility on stock returns*

Duration	Variables	Coefficient	Z-statistic	Probability
Short term	Stock Return	0.02-	4.023-	0.000
Medium term	Stock Return	0.01-	2.035-	0.042
Long term	Stock Return	0.04-	6.636-	0.000

In the second hypothesis, the publication of interest rate news on stock returns has been examined in the short, medium and long term.

According to the results of the research, as is clear from the table above, the Z test values in the short, medium and long term have all been more than 1.96 and the significance level is less than 0.05. Therefore, the interest rate can have a negative effect on stock returns during the mentioned time period; but considering the amount of statistics and the significance level of the time period, it can be said that this effect has a smaller effect in the medium term than in the other two times. Therefore, it can be stated that the second hypothesis of the research is confirmed.

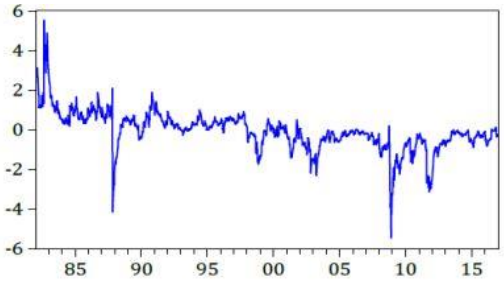

Figure 2. Graphical procedure of hypothesis 2

Hypothesis 3: The publication of exchange rate news has an effect on the stock returns of companies that are members of the Tehran Stock Exchange.

Table 6. *TARCH-BEKK model with the spillover effect of fluctuations caused by exchange rate news on stock returns*

Duration	Variables	Coefficient	Z-statistic	Probability
Short term	Stock Return	-0.03	-7.198	0.000
Medium term	Stock Return	-0.03	-6.703	0.000
Long term	Stock Return	-0.01	-6.086	0.000

In the third hypothesis, the publication of exchange rate news on stock returns has been examined in the short, medium and long term. The Z test values in the short, medium and long term have all been more than 1.96 and the significance level is less than 0.05. According to the results of the research, as is clear from the table above, in the short, medium and long term periods, the publication of negative news about the exchange rate can have a significant impact on stock returns.

This issue has been determined by the value of its statistics in the short, medium and long term

with the values of -7.198, -6.703 and -6.086, respectively, and all three have a significance level of 0.000 and negative coefficients. Therefore, it can be stated that the third hypothesis of the study is confirmed.

The third hypothesis of the research examines the impact of exchange rate news on stock returns over three distinct time horizons: short, medium, and long term. According to the findings, the publication of negative news regarding exchange rates consistently has a significant effect on stock returns in all three periods. This is evident from the Z-test values in each time frame, which are all greater than 1.96, and the significance level, which is below 0.05 for each period. Specifically, the Z-test values for the short, medium, and long term are -7.198, -6.703, and -6.086, respectively, with all corresponding significance levels being 0.000. These results strongly suggest that negative exchange rate news leads to a significant negative impact on stock returns in all examined time periods.The negative coefficients associated with the exchange rate news publication further reinforce the adverse relationship between exchange rate fluctuations and stock market performance. In the short term, the Z-statistic of -7.198 reflects a strong initial market reaction to the negative news about the exchange rate. This immediate response could be due to investor concerns regarding the implications of unfavorable exchange rate movements on the broader economy, such as increased import costs, reduced exports, or inflationary pressures. Such market reactions are typically observed in times of economic uncertainty when investors tend to seek safe-haven assets or adjust their portfolios in anticipation of potential economic challenges resulting from a depreciating currency.In the medium and long term, the significance of negative exchange rate news persists, although the Z-test values slightly decrease over time. The values of -6.703 and -6.086 in the medium and long term still reflect a strong and statistically significant negative effect on stock returns. This indicates that the effects of exchange rate fluctuations extend beyond the short-term, influencing investor sentiment and market behavior over an extended period. Negative news about exchange rates could lead to a prolonged period of market volatility, especially if the news signals worsening economic conditions or a continued trend of depreciation. As such, the long-term effects of exchange rate shocks may reflect deeper economic adjustments, such as changes in trade balances, capital flows, and overall economic growth. Given the persistent negative impact in all three time periods, the research confirms that the third hypothesis—asserting that negative exchange rate news significantly affects stock returns—is supported by the data. This highlights the crucial role of exchange rates in shaping investor behavior and financial market performance over both short and long horizons.

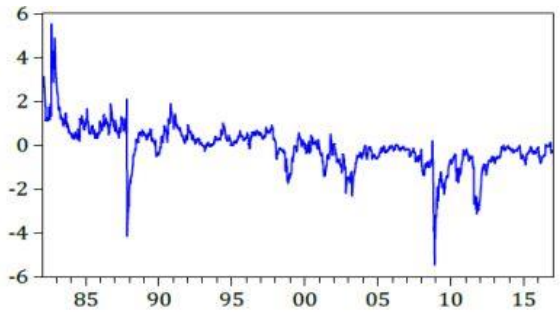

Figure 3. *Graphical procedure of hypothesis 3*

Hypothesis 4: The publication of news related to oil prices has an effect on the stock returns of companies that are members of the Tehran Stock Exchange.

Table 7. *TARCH-BEKK model with spillover effect of volatility caused by oil price news on stock returns*

Duration	Variables	Coefficient	Z-statistic	Probability
Short term	Stock Return	-1.540	-0.848	0.397
Medium term	Stock Return	-1.125	-0.800	0.424
Long term	Stock Return	0.25	2.764	0.004

In the fourth hypothesis, the release of oil price news on stock returns has been examined in the short, medium and long term. According to the results of the research, as is clear from the table above, the Z test values in the long term are more than 1.96 and the significance level is less than 0.05.

However, the Z statistic values in the short and medium term are less than 1.96 and the significance level is less than 0.05. The results related to the effects of the release of oil price news on stock returns indicate that, in the long term, the release of positive news about oil prices can have a significant effect on stock returns.

This is determined by the long-term statistic value of 2.764 and a significance level of 0.004 and a positive coefficient. However, the effect of the release of oil price news cannot affect stock returns in the short and medium term. Therefore, it can be stated that the fourth hypothesis of the research is confirmed.

In the fourth hypothesis of the study, the impact of oil price news releases on stock returns is analyzed across three time horizons: short, medium, and long term. The findings indicate a distinct variation in the significance of these effects depending on the time frame. Specifically, in the long term, the Z-test values exceed the threshold of 1.96, with a significance level below 0.05, suggesting that oil price news releases significantly influence stock returns over a prolonged period. In contrast, the Z-statistic values for the short and medium terms fall below 1.96, indicating no significant effect in these periods, even though the significance levels remain under 0.05.

The results further demonstrate that positive oil price news has a substantial long-term effect on stock returns. With a long-term Z statistic of 2.764 and a significance level of 0.004, along with a positive coefficient, the study confirms that favorable oil price news tends to improve stock returns in the long run. This indicates that investors may react positively to expectations of higher oil prices, which could signal growth in oil-dependent sectors and overall economic activity. The long-term significance underlines the cumulative nature of such news, suggesting that the effects take time to fully materialize in stock returns.

However, the research highlights that oil price news does not have an immediate or medium-term effect on stock returns. Despite the significance level being below 0.05 in both the short and medium terms, the Z-test values fail to reach the critical threshold of 1.96, indicating no statistically significant impact. These findings suggest that while investors may initially react to oil price changes, the full effects are only observable in the long term. Therefore, the fourth hypothesis, which posits that oil price news has a significant effect on stock returns, is confirmed only for the long-term impact, with no immediate or medium-term significance.

Granger causality

The results from the causality test are as follows:

Table 8. *Causal relationship of variables*

Lag	2	3	4	5	6	7	8
Stock return → Inflation rate	0.500	0.662	0.810	0.835	0.907	0.951	0.976
Inflation rate → Stock return	0.540	0.741	0.834	0.895	0.948	0.973	0.987
Stock return → Interest rate	0.901	0.962	0.989	0.994	0.998	0.999	1.00
Interest rate → Stock return	0.143	0.219	0.265	0.392	0.519	0.634	0.734
Stock return → Exchange rate	0.285	0.443	0.450	0.430	0.472	0.435	0.528
Exchange rate → Stock return	0.003	0.004	0.005	0.009	0.018	0.027	0.030
Stock return → Oil price	0.034	0.167	0.267	0.233	0.242	0.314	0.376
Oil price → Stock return	0.000	0.000	0.000	0.000	0.000	0.000	0.000

The exchange rate also has a one-way causal relationship with stock returns at all lags. However, there is a two-way causal relationship between stock returns and oil prices in the short term, and as the lags get longer, there is a one-way causal relationship from oil prices to stock returns.

VAR Vector Autoregressive Test

Table 9. *Vector Autoregressive Test*

	Inflation rate	Interest rate	Exchange rate	Oil Price
Stock Return (-1)	0.028	0.003	0.01	0.00
	2.10498-	-2.01603	1.990	-2.2634
Stock Return(-2)	0.002	0.001	0.01	0.00
	3.36357	2.38496	-2.010	2.1501

Table 10. *Vector autoregressive test*

	Stock Return		Stock Return
Inflation Rate (-1)	0.002	Inflation Rate (-2)	0.001
	-2.99502		2.97274
Interest Rate (-1)	0.002	Interest Rate (-2)	0.001
	-2.69620		2.60824
Exchange Rate (-1)	0.001	Exchange Rate (-2)	0.001
	2.20264		2.55202-
Oil Price (-1)	0.000	Oil Price (-2)	0.000
	-2.42588		2.18739

As the results of Tables 9 and 10 show, inflation rate, interest rate and oil price can cause negative shocks in the short run and positive shocks in the long run on stock returns, and stock returns will also be affected by the shocks. On the other hand, the results indicate that news releases regarding exchange rates can cause positive shocks in the short run and negative shocks in the long run on stock returns.

In addition to these economic factors, the study points to the role of exchange rate news releases in influencing stock returns. The results show that news about exchange rates can cause positive shocks in the short run, suggesting that immediate market reactions to exchange rate movements can drive up stock returns, likely due to investor optimism or favorable trade conditions. However, in the long run, the same news releases can result in negative shocks on stock returns, indicating that the long-term impact of exchange rate changes may be more detrimental, possibly due to inflationary pressures or uncertainties in global trade.

These findings underscore the dynamic nature of stock markets, where short-term reactions to economic news and data can differ substantially from long-term outcomes. While certain macroeconomic variables such as inflation, interest rates, and oil prices might initially depress stock returns, they can later create a foundation for growth. Conversely, news related to exchange rates, which may have an immediate positive effect, could lead to negative long-term consequences as markets adjust to the broader economic implications. This duality in responses emphasizes the importance of both short-term and long-term perspectives in financial decision-making.

5. Discussion

The findings of this study confirm that the release of news related to changes in macroeconomic indicators such as inflation rates, interest rates, exchange rates, and oil prices can have a significant impact on stock returns. These effects are especially pronounced in times of economic turbulence, indicating the critical role of these variables in determining the behavior of financial markets. The models used, such as TARCH-BEKK and VAR, were able to effectively analyze the fluctuations and time correlations between these variables and stock returns. This emphasizes the importance of using advanced econometric methods in examining the complex interactions between the macroeconomic and stock markets.

The results also indicate that policymakers and market participants can make more informed decisions in the field of risk management and investment by closely

monitoring macroeconomic indicators and analyzing the impact of related news. In addition, this study shows that data-driven and advanced model-based approaches can help extract deeper knowledge of market behavior and develop more effective strategies in the face of economic fluctuations. Therefore, the results of the present study can be used as a practical guide for future research and an analytical tool for decision-making in the field of macroeconomics and the stock market. The results of this study not only reveal the impact of macroeconomic indicators on stock returns, but also highlight the importance of extracting knowledge from economic and financial data.

Using TARCH-BEKK and VAR models, this study has succeeded in identifying the complex and dynamic relationships between economic variables and the stock market. This data-driven approach provides a platform for analyzing nonlinear structures and more accurate forecasting of fluctuations, which can be very useful in designing intelligent tools for financial decision-making and risk management. Extracting this knowledge not only helps researchers better understand the interactions between macroeconomics and financial markets, but also allows policymakers and executives to formulate more effective strategies in the face of economic turbulence.

These findings emphasize the need to develop advanced data processing methods and integrate them with economic theories to gain a deeper understanding of market behavior and external influences on them. In a world full of variable and dynamic data, these results show that the use of complex models and the combination of data mining with econometrics is a new way to extract practical insights and improve decision-making in the field of economics and finance. This research can be used as a model for future studies and the development of innovative analytical tools to process and extract knowledge from macroeconomic data.

Crude oil price shocks have been notable in the past few decades due to their significant impact on the real economy. Movements in crude oil prices have been largely considered as the main source of business cycles and are strongly related to macroeconomic performance through supply and demand channels. Shocks caused by macroeconomic factors not only greatly affect economic performance, but also lead to increased uncertainty in economic policies.

As the results showed, macroeconomic factors affect the total stock return index over the short, medium and long term. During periods of short-term, medium-term and long-term time frames, stock returns are affected by shocks from macroeconomic factors; so that the effects of inflation, as evidence has shown, can affect stock returns in the short and long term. Of course, the degree of impact in the short term can be greater than in the long term. On the other hand, interest rates will also cause a decrease in stock returns. Perhaps one of the factors that will cause a decrease in stock returns is the instability of stock returns due to interest rates and people's desire for stable profits (such as long-term bank deposits).

The stability of foreign stocks can also be mentioned as a second factor. Other factors that can affect the decrease in stock returns are news related to the exchange rate. Evidence shows that currency fluctuations, because the amount of liquidity in this field is easily exchangeable, will also reduce stock returns. An increase in oil prices in the long term can improve the conditions for stock returns. What is clear is the type of strategy investors use to benefit from stock returns. As economic factors rise above the threshold, there will be significant reactions from oil price shocks to stock return shocks. Macroeconomic news can be useful for investors and analysts in using appropriate strategies in the short, medium and long term. Economic factors often explain monthly movements. On the other hand, investors react quickly to negative news, creating a potentially risky stock market. In addition to macroeconomic, economic and

financial news, negative political news can lead to risky stock markets. Therefore, it is important to monitor international and political news and the potential risks associated with negative news.

Based on the findings of this study, the following practical recommendations can be made:

- Investors and financial analysts should closely monitor news related to key macroeconomic indicators such as inflation rates, interest rates, exchange rates, and oil prices. Given the significant impact of these variables on stock returns, understanding the timing and nature of these announcements can help in formulating better investment strategies, particularly in periods of economic turbulence. This can be achieved by developing proactive risk management frameworks that adjust portfolios based on anticipated macroeconomic shifts.
- Financial institutions, policymakers, and analysts should adopt advanced econometric methods like TARCH-BEKK and VAR models to analyze the dynamic relationships between macroeconomic indicators and stock market behavior. These models can provide deeper insights into volatility patterns and the correlations between variables, allowing for more accurate forecasting and informed decision-making. Additionally, these techniques can be integrated into automated trading systems to optimize response strategies to macroeconomic news events.
- Policymakers should consider the findings of this study when making decisions related to macroeconomic policy, as changes in inflation rates, interest rates, exchange rates, and oil prices can have far-reaching consequences on financial markets. Clear communication of such policy changes can help stabilize market expectations and reduce uncertainty, especially during times of economic volatility.

6. Conclusion

One of the most important economic and capital sectors of any country is the capital markets, the importance of which is not hidden from anyone. However, micro and macro-economic factors are dynamically evolving over time.

One point that should be noted is that different sectors of the economy are not all affected by these changes to the same extent, which depends on the size of that sector of the economy. It seems that the Iranian stock exchange is very small compared to the size of the country's economy, and cannot reveal the real changes in the economy in a desirable way. On the other hand, since the Iranian economy is a state economy, due to the bureaucratic atmosphere and the slow decision-making process until the announcement, the reaction to economic variables takes place with a time delay (Pourzamani et al., 2011).

In this regard, it is suggested that economic policymakers help improve the Iranian stock market by creating working groups to control capital market conditions and prevent shocks such as inflation. On the other hand, the Central Bank, regarding the conditions of inflation and interest rates, two factors affecting economic policy, should control inflation by creating organizations to control the amount of liquidity. Because the withdrawal of financial resources from the capital market due to fluctuations can cause the stock market to face problems such as reduced stock returns and loss of shareholders' capital. Shareholders can diversify investments in sectors to reduce the risks caused by negative news and control the conditions of fluctuations in short-term, medium-term and long-term periods by using professional consultants.

On the other hand, they should examine the conditions of stock returns over time and consider them in their decision-making. Policymakers in this field should adopt monetary policies with the aim of maintaining interest rates at the lowest possible levels. This reduces the cost of capital for companies trading in the stock market and, as a result, increases profitability, which leads to an increase in stock returns. It is also better to have coordination between the official lending

rate of the central bank and the deposit banks in the country. When this issue is coordinated and under control, the fluctuations of interest rates in the country will decrease and investors will not have to pay a lot of money to get credit for investing in stocks. It has been found that inflation increases the returns of stocks in the capital market.

Regarding the increase in the inflation rate on the returns of stocks, it is also recommended to implement monetary policies in order to maintain the optimal level of the inflation rate, which may lead to other negative consequences in the country. In fact, it is clear that a reasonable level of inflation rate will be beneficial for the stock market.

Since exchange rate fluctuations have a negative impact on stock returns, this study recommends that the government adopt relevant fiscal policies in order to stabilize the exchange rate and increase the value of the national currency. It is also recommended to use relevant monetary and financial instruments to control inflation in the economy, maintaining a balance between money supply and economic activities.

It is obvious that when too much money circulates in an economy, it increases inflation and devalues the currency. On the other hand, it is suggested that the government adopt policies that reduce the budget for imports and at the same time increase oil exports to increase capital flow. Since this study showed that an increase in oil prices leads to an increase in stock returns, it is recommended that fiscal and monetary policies that increase GDP growth be adopted in the country. This will be important in increasing stock returns for the capital market.

Companies listed on the stock exchange should try to make their shares attractive to investors because corporate shares are seen as a good hedge for investors for a long period. This means that companies should undertake projects that are sustainable to increase their performance over time, because investors are motivated to invest in companies with good financial performance. The results of this study are consistent with the results of studies by Ali (2023), Ma et al. (2023), and Muller and Richman (2023).

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