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Investigating the volatility spillover of macroeconomic variables in the Iranian capital market with the multivariate GARCH approach

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ABSTRACT

The purpose of this article is to investigate the spillover of volatility of macroeconomic variables in Iran's capital market with the multivariate GARCH approach. Macroeconomic variables include inflation rate, exchange rate, oil price, gold coin price and GDP. Understanding the volatility spillover of macroeconomic variables in the capital market provides important information on the efficiency level of the capital market. In an efficient market, the risk and return of an asset should not be predicted based on the risk and past returns of other assets. For this purpose, monthly data from Farvardin 1386(March 2007) to Esfand 1402 (March 2024) and multivariate GARCH method with BEKK specification have been used to test the hypotheses. The results show that except for the interest rate, there is a significant relationship between the volatility of macroeconomic variables and the total stock market index; Therefore, the spillover of volatility of macroeconomic variables on Iran's capital market is confirmed, which shows the need to pay attention to the stability of economic policies in order to create stability in the capital market.

Keywords: volatility spillover, macroeconomic variables, total stock index, multivariate GARCH approach

1. Introduction

The current drastic changes in macroeconomic variables, including oil prices in global markets, have created a lot of interest in assessing the volatility spillover between macroeconomic variables and stock market returns (Sarwar et al., 2020); So that a number of studies have examined the relationship between macroeconomic variables and stock market returns (Narayan and Narayan, 2012; Hama et al., 2014; Kang et al., 2015; Bori and Demirer, 2016). Financial markets have recently witnessed periods of financial instability and crisis. These periods are characterized by extreme uncertainty and are reflected in a significant increase in the volatility of the stock market index. Diebold and Yilmaz (2015) have shown that the increase in the volatility of the stock market index is a reflection of the increase in the correlation between different assets; Therefore, it is not far from the expectation that the volatility of macroeconomic variables spill over to the capital market and lead to volatility in stock market returns. Volatility of stock market returns is one of the main features of capital markets, and its measurement and prediction has been a popular research topic since this concept was considered synonymous with the risk of a financial instrument. When analyzing the sources of stock market index volatility, news, capitalization or prices of other financial assets, including gold and foreign exchange, are considered, but rarely are GDP, inflation or other macroeconomic variables considered. Meanwhile, financial theory claims that the movement in stock prices is related to macroeconomic variables (Ali, 2021). The dividend discount model, the capital asset pricing model, and the arbitrage pricing theory predict that any shock to the economy is a source of systematic risk, and there is no way that even a perfectly diversified portfolio can transfer it elsewhere. Therefore, it is clear that the shock to the macroeconomic and the volatility of macroeconomic variables should affect the stock market returns (Metin, 2023).

Based on this literature, in this study, the evaluation of the volatility spillover between macroeconomic variables in the Iranian capital market has been done. Since Iran, as a developing country, has been associated with severe volatility in macroeconomic variables and frequent adjustment of economic policies in recent years, as well as periods of instability in the capital market, it is motivated that the spillover of volatility between To evaluate macroeconomic variables in Iran's capital market. Volatility spillover is especially important for policymakers, portfolio managers, and investors whose strategies and hedging decisions are often affected by shocks from macroeconomic variables (Jin, 2015). Because, for example, if the volatility of macroeconomic variables are transmitted to the capital market during a crisis, investors and portfolio managers should adjust their asset allocation (Yosef and Hassan, 2019) and economic policy makers should change their policies to reduce the contagion of volatility. give (Yang and Zhu, 2017).

The macroeconomic variables considered in this study include the six variables of inflation rate, exchange rate (US dollar rate in the open market), oil price, gold coin price, interest rate, and gross domestic product, and the volatility of these macroeconomic variables has been attempted in the capital market. to be evaluated using generalized conditional variance heteroskedasticity modeling. Empirical evidence has well established that periods of increased capital market volatility are characterized by increased coherence across markets, but it is less understood whether there is information in macroeconomic variables that helps predict future market volatility during financial crises. . Due to the increase in the number of index falls in the Iranian stock market and its impact on households, banks and finally on the entire economy, the attention of regulatory institutions, practitioners and researchers has increased on the impact of macroeconomic volatility on stock market volatility. Since macroeconomic variables are considered as powerful factors for predicting stock market volatility around the world, it is vital for investors and policy makers to know the impact of macroeconomic variables volatility on Iranian capital market volatility. In addition, the analysis of the spillover volatility of macroeconomic variables in the stock market is more important for developing countries like Iran, because the capital markets in these countries are very volatile, and on the other hand, macroeconomic variables are not stable.

This study contributes to the development of literature in several ways by examining the spillover of volatility of macroeconomic variables on the capital market of Iran. First, the present study contributes to the development of the growing literature conducted in the field of capital market volatility spillovers. Second,

this study will make a new contribution to the development of the literature by assessing the volatility spillover of macroeconomic variables. In addition, the present study also has practical benefits; Among other things, understanding the volatility of macroeconomic variables in the capital market provides important information on the efficiency level of the capital market. In an efficient market, the risk and return of an asset should not be predicted based on the risk and past returns of other assets. In addition, identifying volatility spillover mechanisms also plays an important role in portfolio management and can be used in choosing a stock portfolio and reducing risk. Also, the degree of volatility transfer of macro variables helps to predict the future volatility of stock market returns, and as a result, it is used in areas such as portfolio optimization, option pricing, risk management, or calculating value at risk.

2- Review of research literature

1-2- Theoretical literature and development of hypotheses

Risk spillovers, commonly referred to as volatility spillover effects, describe how shocks and volatility are propagated and transmitted across different markets (Diebold and Yilmaz, 2015). Due to the importance of changes in macroeconomic conditions for risk assessment and portfolio diversification strategies, a detailed investigation of the impact of shocks and volatility of macroeconomic variables on the capital market has been of interest to researchers. Economic policies formulated by governments along with financial and technological developments are the main factors of instability and unpredictability of any economy (Aydin et al., 2021), on the other hand, uncertainty is an inevitable part of capital markets. Financial and macroeconomic economists consider the relationship between macroeconomic factors and the capital market to be an interesting topic. It is argued that instability in the capital market is typically caused by various factors, including political unrest, natural disasters, financial fragility, and disruptions in macroeconomic components (Gangoli and Bunia, 2022). Shocks and volatility in macroeconomic variables often result from changes in macroeconomic conditions that affect asset markets, including stocks (Zhou et al., 2024).

The inflation rate is one of the macroeconomic variables, and the relationship between inflation rate volatility and stock market index returns has long been a topic of interest for academics, monetary policy makers, investment professionals, and almost everyone involved with stock markets. A clear understanding of this relationship is of vital importance to all market participants, as it determines the extent to which stocks are protected against inflationary volatility. For example, it helps investors in the stock market make good portfolio decisions based on their knowledge of the economy's past and expectations about the future. Theoretically, until the early 1970s, it was generally believed that the relationship between inflation rates and stock market index returns was positive. This argument is based on Fisher's (1930) hypothesis, which assumes that stock markets are independent of inflationary expectations, meaning that prices and inflation should move in the same direction because the expected nominal return on stocks consists of two components, the real return and the inflation rate. The expectation is formed. The generalized Fisher hypothesis or effect states that stocks are the opposite of a company's real assets and can act as a hedge against inflation. When inflation is announced, investors sell financial assets in exchange for physical or real assets such as stocks. If this happens, stock prices should fully reflect expected inflation, and the relationship between the two variables (inflation and stock index returns) should be positive. However, after the late 1970s, it became clear that the relationship between inflation rate and stock market index returns can also be negative, contradicting Fisher's (1930) hypothesis. For example, Fama (1981) disagreed with the generalized Fisher hypothesis and suggested that stock markets do not protect against inflation. The relationship between the inflation rate and the stock market index return works through the effect of expected changes in real production on the general price level, and according to Fama, the negative relationship between the inflation rate and the stock market index is caused by the relationship between inflation and future production. An increase in inflation causes uncertainty and reduces economic activities in the future and reduces future profits. The stock market return reflects the company's future profits, and the expected decrease in future profits with the increase in inflation causes a decrease in the stock price, so the relationship between the inflation rate and

the return of the stock market index is negative (Abdallah, 2012). Based on these two opposing arguments, it is expected that there is a significant relationship between inflation rate volatility and the total stock market index.

Another macroeconomic variable is the exchange rate, it is argued that exchange rate volatility strongly affect the foreign exchange transactions of companies and thus their market value, because exchange rate volatility affect their future cash flows and this in turn has a large impact. It will affect the overall performance of the country's stock market. Exchange rate volatility have real economic costs that affect price stability, company profitability, and the stability of a country. Changes in foreign exchange rates as an asset in the portfolio can affect demand and, in turn, cause changes in stock prices. In addition, depending on the degree of reliance on export or import companies and the exchange rate, any increase or decrease in the exchange rate can have different effects on listed companies and their resources. Depreciation of the currency in export industries causes a decrease in profit and subsequently a decrease in the company's stock price. In case of a decrease in the exchange rate, one should pay attention to the consequence of the increase in the stock price due to the decrease in the production cost, as well as the decrease in the stock price due to the decrease in the export value of each company. It is logical that this result is negative in exporting firms, but positive for firms that rely on imports. An increase in the exchange rate reduces the competitiveness of export markets and has a negative impact on the domestic stock market, but for a country dominated by imports, it may have a positive impact on the stock market by reducing input costs (Sichungoy, 2016). Therefore, it is expected that there is a significant relationship between exchange rate volatility and the total stock market index.

Another macroeconomic variable is the price of oil, which may affect the volatility of the stock market index. The oil markets in the world are known as the deepest markets in terms of the volume of transactions made in terms of position. On the other hand, oil is the input material of most companies and factories; Therefore, any volatility in the price of oil affect the price of manufactured products and are reflected in the stock market; This means that there is a close relationship between the price of oil and the capital market. In oil-exporting countries, including Iran, even though they have stock markets with little depth, there is still a close relationship between oil price volatility and the stock market, because the stock value is dependent on the current value of its future cash flows, and oil price volatility In exporting countries, it can be considered one of the most important macro components affecting the current value of future cash flows. The theoretical justification in this regard is that the stock value is equal to the sum of the discounted value of the expected future cash flows and these cash flows are clearly influenced by macroeconomic variables such as oil shocks. In oil-exporting countries, the increase in oil prices is expected to have a positive effect on government budget revenues, an increase in government general expenditures, and total demand, which may have a positive effect on the capital market. However, there is also this argument that because the oil exporting countries provide a major part of the goods they need from advanced and emerging economies; Therefore, an increase in the price of oil can lead to an increase in the cost of importing consumer goods and capital for oil exporting countries, which has an adverse effect on the return of the stock market index (Memipour and Faghal, 2017). In general, according to these two arguments, it is expected that there is a significant relationship between oil price volatility and the total stock market index.

As another macroeconomic variable in this study, the price of gold coins reflects the interaction of supply and demand in a market that has many potential buyers and sellers. Because gold is a good indicator of inflationary pressures, the price of gold coins tends to rise during currency volatility or political instability, encouraging people to choose this type of asset in their portfolios to preserve their value. Of course, speculation in the gold market is one of the reasons that affects the demand for gold, which in short is the main factor of price volatility in this market. Therefore, the gold market, along with other macroeconomic variables, can affect the stock market index. So that, when the price of gold increases, the desire of investors to invest in the stock market decreases, and as a result, the return of the entire stock market index decreases. In fact, it is argued that the price of gold and the return of the total stock market index have an inverse correlation (Raza et al., 2016). Therefore, it is expected that there is a significant

relationship between the price volatility of gold coins and the total stock market index in Iran.

Among the macroeconomic variables, the interest rate is considered a key variable that may have a significant impact on the stock market. Interest rate risk is an important financial and economic factor affecting the value of common stock, and many researchers assume that interest rate and stock market index have a negative relationship. A low interest rate leads to directing more capital flows to the stock market in anticipation of a higher rate of return, while a high interest rate encourages more savings in banks, thereby reducing capital flows to the stock markets. A decrease in the interest rate leads to a decrease in the cost of the loan; People tend to borrow more at a lower cost due to lower interest rates followed by expansionary monetary policy that can be invested in the stock market. In addition, falling interest rates make investing in fixed income securities less attractive, so people move their money from the bond market to the stock market. Both measures increase the stock price and then the stock market index (Hajili and Al-Nasser, 2017). Therefore, it is expected that there is a significant relationship between interest rate volatility and the total stock market index in Iran.

Finally, the spillover of GDP volatility has been investigated as one of the macroeconomic variables on the capital market volatility, and it is argued that an increase in GDP is associated with economic prosperity and an increase in per capita income of people, which can lead the savings of individuals and households to the market. Capital and the prosperity of the capital market. Also, an increase in GDP means economic growth, which is usually associated with an increase in the profitability of companies and an improvement in their financial situation. This issue can increase the demand for buying shares of companies in the capital market and lead to an increase in stock prices and positive volatility in the capital market. On the other hand, extreme volatility in GDP can lead to uncertainty in the capital market and more price volatility in the market. Investors usually behave more conservatively in the capital market in conditions of economic uncertainty, which increases price volatility (Metin, 2023). Therefore, it is expected that there is a significant relationship between the volatility of the gross domestic product and the total index of the stock market in Iran.

Based on these theoretical foundations, research hypotheses have been formulated as follows:

1) There is a significant relationship between inflation rate volatility and the total stock market index.
2) There is a significant relationship between exchange rate volatility and the total stock market index.
3) There is a significant relationship between oil price volatility and the total stock market index.
4) There is a significant relationship between gold coin price volatility and the total stock market index.
5) There is a significant relationship between interest rate volatility and the total stock market index.
6) There is a significant relationship between the volatility of the gross domestic product and the total stock market index.

2-2- Experimental background of the research

One of the first attempts to investigate the impact of macroeconomic volatility on stock market return volatility was made by Short (1989). His study showed a positive relationship between macroeconomic volatility and stock market volatility, so that it was found that stock market uncertainty is greater during contractionary policies than during expansionary policies, and macroeconomic volatility can explain about half of stock market volatility. After that, extensive studies have been conducted in this field; For example, Lilblom and Stenius (1997) examine the relationship between stock market volatility and macroeconomic volatility using Finnish monthly data for the period 1920–1991. The results of their study showed that macroeconomic volatility predict stock market volatility and one-sixth to more than two-thirds of stock market volatility are related to macroeconomic volatility. Morley (2002) investigated the relationship between stock market volatility and macroeconomic volatility using UK data from January 1967 to December 1995. This study showed that volatility of macroeconomic variables including industrial production, money supply, inflation and exchange rate do not explain stock market volatility. Chowdhury et al. (2006) investigated how

macroeconomic risk related to industrial production, inflation and exchange rate reflected on stock market returns in the Bangladesh capital market for the period January 1990 to December 2004. They concluded that there is a relationship between stock market volatility and macroeconomic volatility, but it is not as strong as suggested by financial theories. Chinzara (2010) examined how macroeconomic risk is related to the volatility of the South African stock market during different phases of the economy, i.e., calm time and crisis time. Their findings showed that although volatility in inflation, gold prices, and oil prices have played a role in stock market volatility, short-term interest rate volatility and exchange rates are the most important. Also, financial crises have increased the volatility in the stock market. Baroyan (2014) has investigated whether macroeconomic instability can affect stock market volatility in a sample of 5 emerging European countries. Results vary from country to country, but when a dynamic panel GMM is estimated, exchange rate volatility is the only significant variable in explaining stock market volatility. Adeniji (2015) investigated the relationship between stock market and macroeconomic volatility in Nigeria and showed that volatility in GDP, inflation and money supply do not cause stock market volatility, but interest rate and exchange rate volatility cause stock market return volatility. will be Ali (2021) investigated the impact of volatility in macroeconomic variables on the volatility of the Bangladeshi stock market in the period from January 2005 to December 2018 and showed that the increase in volatility in the consumer price index, treasury bill rates, and inflows in foreign remittances, the volatility of stock returns. increases. Using monthly data from January 1991 to December 2015, Mateen (2023) investigated the impact of macroeconomic variables on stock market volatility and showed that none of the selected macroeconomic variables can significantly explain long-term and short-term stock market volatility. Lee et al. (2023) investigated the spillover effect of US economic policy uncertainty on US and Asian stock markets in the post-pandemic era. The empirical results show a significant spillover effect of US economic policy uncertainty in US and Asian stock markets. Japanese and South Korean stock markets react more strongly to changes in US economic policy uncertainty. Spillover indicators are less volatile from the US stock market to the Asian stock market in 2020, indicating that the outbreak of the COVID-19 epidemic has a greater impact on the Asian stock market than on the US stock market.

In Iran, Mehrabian and Godarzi Farahani (1400) investigated the impact of macroeconomic variables on the efficiency of industries in the Tehran Stock Exchange. They showed that the bank interest rate had a negative effect and the inflation rate, exchange rate and gross domestic product had a positive effect on the efficiency of industries. Hosseinzadeh et al. (1401) designed a model explaining the effects of macroeconomic policies on the capital market. The results of this study showed that the capital market is directly and indirectly affected by the variables and policies applied in different markets. Mahboubi et al. (1402) have investigated the effect of macroeconomic indicators on the volatility of stock returns. They showed that the effect of exchange rate volatility on stock return volatility is positive and significant, but GDP per capita did not have a significant effect on stock return volatility. Betshekan and Mohseni (2017) investigated the spillover of oil price volatility on stock market returns and showed that there are conditional correlations in short-term volatility and oil price spillover effects on the stock market index. Mohseni and Sadeghi Shabhani (2018) investigated the spillover of exchange rate volatility on the capital market in Iran and showed that there is a negative short-term stability and a positive long-term stability of exchange rate shocks on the return of the Iranian capital market.

Most domestic studies have focused only on one of the macroeconomic variables, for example oil price or exchange rate, and limited studies have considered a set of macroeconomic variables; Therefore, the present study has filled this research gap.

3- research method

In this study, it is assumed that Iran's capital market is affected by the volatility of macroeconomic variables. Therefore, according to the selected macroeconomic variables, the following function has been explained in order to show this hypothesis:

〖TEPIX〗_t=f(INF,EXE,OIL.GOLD,INT,GDP) (1)

In this function, TEPIX is the symbol of Iran's total stock market index, INF is the symbol of inflation rate,

EXE is the symbol of exchange rate, OIL is the symbol of oil price, GOLD is the symbol of gold coin price, INT is the symbol of interest rate and GDP is the symbol of gross domestic product.

According to the objectives of the research, the variables have been calculated using monthly data from April 1386 to March 1402. Total stock market index data from the archives of Tehran Stock Exchange, inflation rate data, gold coin price and interbank market interest rate from the official website of the Central Bank of the Islamic Republic of Iran, exchange rate data in the free market from the gold and currency price information website, price data Iran's heavy oil in world markets are collected from OPEC website and GDP data from Iran Statistics Center.

All variables are transformed into monthly growing rates through their first logarithmic difference. Normally, the use of logarithmic difference removes the effects of invariance and unit root from time series (Keshavarz Haddad and Babaei, 2019).

$$G(V_i)_t = LN(V_i)_t - LN(V_i)_{t-1} \qquad (2)$$

In this relationship LN logarithm, (G(Vi)t) continuous growth (change) in variable i in month t and ((Vi)t) and ((Vi)t-1) respectively the level of variable I for month t and t are -1

To test the hypotheses, the spillover effect of the volatility of macroeconomic variables on the total capital market index has been estimated using multivariate generalized conditional variance heterogeneity modeling with the BEKK approach.

As it was said, in econometric modeling, the multivariable GARCH model has been used to investigate the spillover effect of the volatility of macroeconomic variables in the capital market. One of the methods of measuring the levels of connectivity between markets is to measure the volatility spillover between them. Volatility is the conditional variance of returns, that is:

E_(t-1) [(r_t-μ_t)^2] (3)

where r_t is the continuous compound return at time t, and μt is the conditional average return using all available facilities at time t-1. Spillover models including ARCH (ARCH) by Engel (1982) and its generalized form GARCH (GARCH) by Bollerslow (1986) are used to measure the continuity and dependence of markets. ARCH and GARCH conditional heterogeneity models are widely used to measure and predict market volatility due to their ability to measure time variances and show time series characteristics such as clustering of volatility. Recent studies in this field have shown that the mentioned models have a significant preference. These models provide a stable method and are stable in state-space-time dimensions and have a suitable generalization capability. Using conditional variance heterogeneity (ARCH) and generalized conditional variance heterogeneity (GARCH) models is the most common way to model the overflow of high-frequency time series data volatility. Multivariate generalized conditional variance heterogeneity models should be used to investigate the transfer of impulses and spillover of volatility between different markets. Multivariate GARCH models emerged to predict the volatility dynamics of the stock market among other financial markets. These models are widely used to investigate the correlation and covariance between different variables over time. The first step in the generalized conditional variance heteroskedasticity is to identify the best specification of the time series autoregressive process based on the information criteria of maximum likelihood, Akaike, Schwartz and Hanan-Quinn.

Then, in order to estimate the multivariate generalized conditional variance heteroskedasticity model, the famous BEKK specification can be used. The first type of multivariate GARCH models is the vector GARCH model (VECH), which was introduced by Bollerslev, Engel and Woldridge (1988). In 1991, another class of this model was introduced by Bubba, Engel, Kroner and Kraft, which became known as the BEKK model. This model with the characteristics of dynamic volatility and conditional correlations to measure the internal relationship of volatility and the transmission mechanism between different time series, are more efficient compared to single variable models. The important feature of this method is its generality. Another characteristic of this method is that the conditional variance and covariance of this time series influence each other, and on the other hand, in this method, fewer parameters are estimated than other methods. The BEKK model has the feature that by applying several restrictions, its conditional covariance matrix becomes positive and definite. This method

allows us to study the effect of shocks and volatility of one series on the volatility of other series. This effect can be symmetrical or asymmetrical (Mohammadinejad Pashaki et al., 1401).

Conditional variance (Ht) is a function of the value of its own intervals and the intervals of disturbance components, where Ht is the variance-covariance matrix, which is a function of the covariance intervals and the cross-multiplication intervals of disturbance components. This value has a mean of zero and is normally distributed.

Engel and Kroner (1995) propose a new parameterization of the multivariate conditional variance model that imposes the positive definiteness of Ht (i.e. the BEKK model) on the MGHARCH model. Consider the following model:

$$H_t = c\acute{c} + \sum_{k=1}^{k}\sum_{i=1}^{q} A_{ik}\, a_{t-i}\acute{a}_{t-i}\acute{A}_{ik} + \sum_{k=1}^{k}\sum_{i=1}^{p} B_{ik}\, H_{t-i}\acute{B}_{ik} \qquad (4)$$

In this model, cć is the width matrix from the origin and C is a lower triangular and positive pseudo-definite matrix. This model has the advantage that it can consider the diagonal MGHARCH process as a special case. For ease of presentation, we assume that k=1, then

$$H_t = c\acute{c} + \sum_{i=1}^{q} A_i\, a_{t-i}\acute{a}_{t-i}\acute{A}_i + \sum_{i=1}^{p} B_i\, H_{t-i}\acute{B}_i \qquad (5)$$

BEKK model without bivariate restriction is expressed as follows:

$$\begin{bmatrix} h_{11t} & h_{12t} \\ h_{21t} & h_{22t} \end{bmatrix} = W'W + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}\begin{bmatrix} \varepsilon_{1t-1}^2 & \varepsilon_{1t-1}\varepsilon_{2t-1} \\ \varepsilon_{1t-1}\varepsilon_{2t-1} & \varepsilon_{2t-1}^2 \end{bmatrix}\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} + \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}\begin{bmatrix} h_{11t-1} & h_{12t-1} \\ h_{21t-1} & h_{22t-1} \end{bmatrix}\begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} \qquad (6)$$

Also, the BEKK diagonal model is shown by the following equations:

$$h_{11t} = W_{11}^2 + a_{11}^2\varepsilon_{1t-1}^2 + 2a_{11}a_{21}\varepsilon_{1t-1}\varepsilon_{2t-1} + a_{21}^2\varepsilon_{2t-1}^2 + b_{11}^2 h_{11t-1} + 2b_{11}b_{21}h_{12t-1} + b_{21}^2 h_{21t-1} \qquad (7)$$

$$h_{22t} = W_{12}^2 + W_{22}^2 + a_{12}^2\varepsilon_{1t-1}^2 + 2a_{12}a_{22}\varepsilon_{1t-1}\varepsilon_{2t-1} + a_{22}^2\varepsilon_{2t-1}^2 + b_{12}^2 h_{11t-1} + 2b_{12}b_{22}h_{12t-1} + b_{22}^2 h_{22t-1} \qquad (8)$$

$$h_{12t} = h_{21t} = W_{12}W_{11} + a_{11}a_{12}\varepsilon_{1t-1}^2 + (a_{12}a_{21} + a_{11}a_{22})\varepsilon_{1t-1}\varepsilon_{2t-1} + a_{21}a_{22}\varepsilon_{2t-1}^2 + b_{11}b_{12}h_{11t-1} + (b_{12}b_{21} + b_{11}b_{22})h_{12t-1} + b_{21}b_{22}h_{22t-1} \qquad (9)$$

After estimating the parameters of the model, the conditional correlation between two variables can be estimated with the following equation:

$$r_{12t} = \frac{h_{12t}}{\sqrt{h_{11t}}\sqrt{h_{22t}}} \qquad (10)$$

where h_{11t} and h_{22t} represent the conditional variances of the two variables while h12t represents the corresponding conditional covariance.

It should be noted that the BEKK models are a special form of the VECH model, but the parameters of the BEKK model, unlike the VECH model, do not directly show the effect of interruptions on Ht elements. Despite applying various restrictions on BEKK models, the usually large number of parameters is still a major problem. Therefore, these models are used less in cases with dimensions of more than 3 or 4 variables (series). On the other hand, the assumption of constant correlation is rejected mainly by pre-tests in financial time series. In this regard, the CCC model has been extended to the Dynamic Conditional Correlation (DCC) model by Engel (2002). In fact, Engel did not consider the assumption of constant conditional correlations and presented the DCC model, in which the conditional correlation matrix is allowed to change over time. This model is widely and easily used for supplementary calculations. There is no difference between the DCC and CCC models in the definition of the Ht matrix, and in this model, the Ht matrix is also the variance-covariance matrix.

$$H_t = D_t R_t D_t \qquad (11)$$

Here, Dt is the diagonal matrix containing the conditional standard deviation (the square root of the conditional variances from the univariate Garch model

for each time series), Rt is the conditional correlation matrix, and its constancy over time from the conditional correlation model is constant. The model can be estimated in one step with maximum likelihood logic, whose logarithm function can be estimated as follows:

$$l(\theta_2|\theta_1) = \sum_{t=1}^{T} (\log |R_t| + u_t' R_r^{-1} u_t) \qquad (12)$$

where θ1 represents the unknown parameters that are estimated in the first stage and θ2 represents all the parameters estimated in the second stage (Betshekan et al., 2016). It should be noted that Eviuz version 12 software was used for econometric modeling.

4- Research findings

Descriptive Statistics

At the beginning of the data analysis, descriptive statistics were checked in order to better understand the status of the variables in the desired period of time, the results of which can be seen in Table (1).

Table 1- Descriptive statistics

GDP	INT	GOLD	OIL	EXE	INF	TEPIX	
۰,۰۶۲	۰,۰۰۱	۰,۰۲۶	۰,۰۰۱	۰,۰۲۰	۰,۰۰۶	۰,۰۲۶	Average
۰,۰۶۰	۰,۰۰۰۶	۰,۰۱۵	۰,۰۱۲	۰,۰۰۶	۰,۰۰۴	۰,۰۱۷	Middle
۰,۳۴۷	۰,۳۰۰	۰,۳۱۷	۰,۳۱۴	۰,۳۷۷	۰,۱۶۳	۰,۴۱۰	maximum
-۰,۲۳۲	-۰,۳۵۵	-۰,۱۶۵	-۰,۶۶۰	-۰,۲۴۵	-۰,۱۰۷	-۰,۲۲۳	minimal
۰,۰۸۶	۰,۰۴۹	۰,۰۷۳	۰,۱۰۸	۰,۰۷۱	۰,۰۵۳	۰,۰۸۲	standard deviation
-۰,۱۵۵	-۰,۷۹۴	۱,۰۶۲	-۱,۵۱۵	۱,۱۱۰	۰,۳۳۸	۱,۱۲۸	crookedness
۵,۰۸۳	۲۲,۴۸۳	۵,۶۴۸	۹,۹۳۷	۹,۴۹۴	۳,۱۲۳	۶,۳۲۷	Elongation
۳۷,۷۰۹	۳۲۴۸,۱۷۱	۹۷,۹۸۹	۴۸۷,۲۰۵	۴۰۰,۴۴۸	۴,۰۲۵	۱۳۷,۴۱۸	Jarek-bra
۰,۰۰۰	۰,۰۰۰	۰,۰۰۰	۰,۰۰۰	۰,۰۰۰	۰,۱۳۳	۰,۰۰۰	Significance level
۱۵۸,۳۵	۳۶,۸۵۲	۵۱,۴۲۷	۳۳,۸۱۶	۱۱,۱۵۱	۶۶۱,۴۴	۴۲,۷۱۵	Liang-Box statistics(۱۰)
۰,۰۰۰	۰,۰۰۰	۰,۰۰۰	۰,۰۰۰	۰,۰۴۸	۰,۰۰۰	۰,۰۰۰	Significance level
۲۰۴	۲۰۴	۲۰۴	۲۰۴	۲۰۴	۲۰۴	۲۰۴	Number of observations

By comparing the average values and standard deviation of the time series of the variables, it can be seen that these variables volatility a lot in the investigated time period. Skewness values show that the monthly growth rate of oil price, interest rate and GDP have a deviation to the left, but the monthly growth rate of the stock index, inflation rate, exchange rate and gold price have a deviation to the right. The elongation value also shows the wide sequence of the time series. The Jarque-Bera statistic and its significance level show that except for the inflation growth rate variable, other variables are asymmetric compared to the normal distribution. Based on the Liangbox test with an interval length of 10, which indicates the clustering of volatility in the growth series of variables, a significant serial autocorrelation has been identified among the sentences of the series. An important feature of some economic and financial time series is that they have clustered volatility, that is, large changes lead to large changes and small changes lead to small changes. In other words, the current level of volatility has a positive relationship with its past values. This phenomenon can be seen in the graphic charts of time series for the selected time period.

The graphs are a good evidence that the growth rate of the selected time series in the period under review has cluster volatility, because returns with large values are next to each other and small returns are also next to each other (cluster feature).

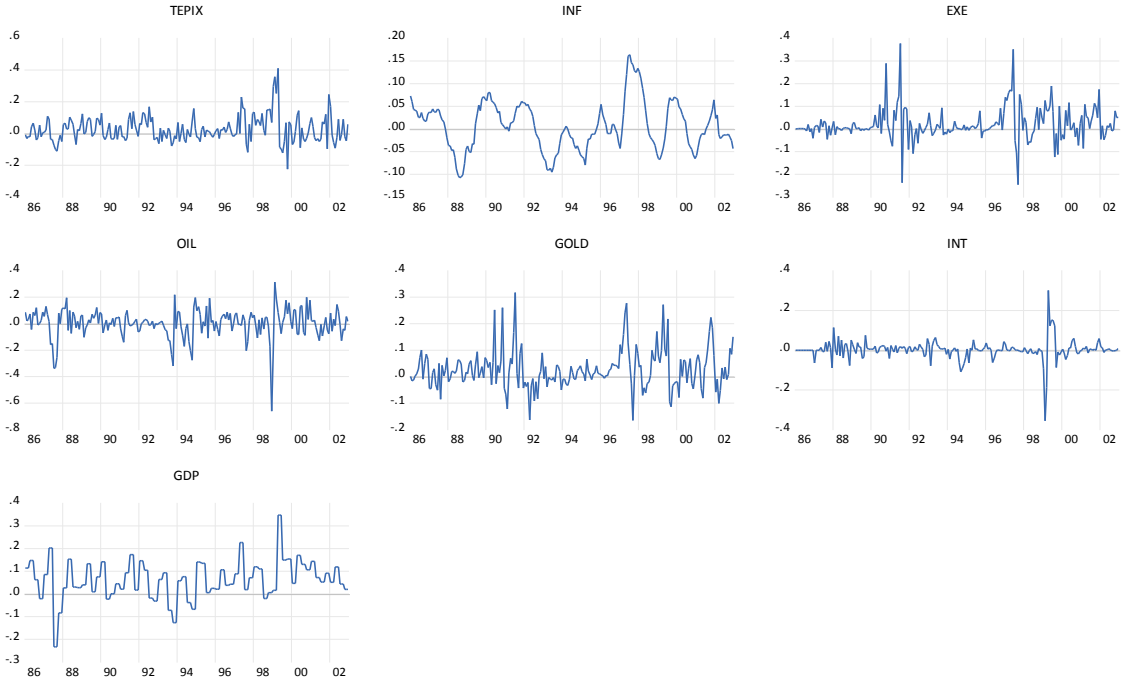

Chart 1- The trend of series growth changes

Correlation test

Table (2) shows the unconditional correlation between the total stock market index and selected macroeconomic variables using the Pearson matrix. Although this correlation has little accuracy and is not enough to draw conclusions, it can show a general perspective of the correlation between variables.

According to the results, the growth of the total stock market index has a positive correlation with the growth of the inflation rate, exchange rate, oil price, gold price and GDP, but it has a negative correlation with the interest rate. Although the correlation between the growth of the total stock market index and the growth of the inflation rate and interest rate are not statistically significant.

Table 2- Correlation test

GDP	INT	GOLD	OIL	EXE	INF	TEPIX	
						۱	TEPIX

					۱	۰,۰۶۲	INF
					-----	۰,۳۷۷	
				۱	-۰,۰۳۸	۰,۱۰۳	EXE
				-----	۰,۵۸۱	۰,۰۴۱	
			۱	۰,۰۳۶	۰,۰۲۵	۰,۱۶۷	OIL
			-----	۰,۶۰۵	۰,۷۱۹	۰,۰۱۶	
		۱	۰,۰۸۴	۰,۵۲۳	-۰,۰۶۸	۰,۱۱۴	GOLD
		-----	۰,۲۳۰	۰,۰۰۰	۰,۳۳۰	۰,۰۳۳	
	۱	۰,۰۶۵	-۰,۱۴۸	۰,۰۹۵	-۰,۰۰۲	-۰,۰۷۶	INT
	-----	۰,۳۵۲	۰,۰۳۴	۰,۱۷۳	۰,۹۷۴	۰,۲۷۳	
۱	۰,۱۸۱	-۰,۰۲۷	۰,۱۲۵	۰,۰۸۵	۰,۲۲۷	۰,۱۳۸	GDP
-----	۰,۰۰۹	۰,۷۰۰	۰,۰۴۳	۰,۲۲۲	۰,۰۰۱	۰,۰۴۸	

Mana test

Due to the non-stationary nature of time series data, it is important to check the validity of that data series. Manai is the main basis of time series analysis. If the null hypothesis of the variables is rejected and they are non-normal, the validity of the statistical tests will be damaged. For this purpose, the most common Manney test, the generalized Dickey-Fuller test, was used, the results of which can be seen in Table (3).

The results of the Mana test show that all the time series used in the variable level scale are Mana.

Table 3- Manay test on level scale

Result	Test mode	Significance level	ADF statistics	
manna	With the width of the origin and the time trend	۰,۰۰۰	-۵,۳۸۱	TEPIX
manna	With the width of the origin and the time trend	۰,۰۰۷	-۴,۱۱۲	INF
manna	With the width of the origin and the time trend	۰,۰۰۰	-۶,۰۰۶	EXE
manna	With the width of the origin and the time trend	۰,۰۰۰	-۶,۵۶۰	OIL
manna	With the width of the origin and the time trend	۰,۰۰۰	-۵,۹۷۹	GOLD
manna	With the width of the origin and the time trend	۰,۰۰۰	-۷,۹۷۷	INT
manna	With the width of the origin and the time trend	۰,۰۰۰	-۶,۳۶۹	GDP

Test for the presence of ARCH effects

The variance is not constant during the random process of the desired time series and is a function of the behavior of the error sentences. Arch family models can explain the trend of conditional variance according to their past information and can be used for time series that have volatility and their variance changes over time; Therefore, it is possible to estimate the model using GARCH methods when the existence of variance heterogeneity is confirmed by ARCH effects test. Arch effects test is related to the stability or variability of the variance of the error sentences, which should be investigated before modeling. For this purpose, a linear regression model such as AR(1) was estimated for each of the research variables and then the ARCH test was performed for each of the variables. The results of ARCH test to check the heterogeneity of variance of time series are reported in Table (4).

According to the obtained results, the existence of arch cannot be rejected, in other words, there is heterogeneity of variance in all time series, which guarantees the correct specification of the model.

Table 4- Test of heterogeneity of variance

Significance level	Chi-square statistic	Significance level	F statistic	
۰,۰۰۰	۳۸,۰۶۸	۰,۰۰۰	۴۶,۳۹۴	TEPIX
۰,۰۰۰	۱۷۲,۱۲۷	۰,۰۰۰	۱۱۲۰,۶۴	INF
۰,۰۰۰	۱۹,۹۲۳	۰,۰۰۰	۲۱,۸۷۴	EXE
۰,۰۰۱	۱۰,۷۲۸	۰,۰۰۱	۱۱,۲۱۵	OIL
۰,۰۰۲	۹,۰۹۲	۰,۰۰۲	۹,۴۲۵	GOLD
۰,۰۰۰	۳۲,۲۵۸	۰,۰۰۰	۳۷,۹۷۴	INT
۰,۰۰۰	۱۰۴,۰۱۸	۰,۰۰۰	۲۱۱,۲۲۸	GDP

Determining the optimal interval length

In order to estimate the multivariate GARCH model, it is first necessary to determine the optimal interval of the model. In order to determine the number of optimal intervals, the information criteria of Akaik, Schwartz, Hanan Quinn and also the maximum likelihood ratio can be used, the result of which can be seen in Table (5)

It is observed that there is a difference of opinion between the information criteria; So that according to the criteria of maximum likelihood, Akaik and Hanan Quinn, the optimal interval is interval 2, and according to Schwartz's criteria, the optimal interval is interval 1. Considering that the length of interval 1 is more economical and less degree of freedom is lost, and in this interval, there was no serial autocorrelation between the residuals, interval 1 was chosen as the optimal interval based on Schwartz's criterion.

Table 5- Determining the optimal interval length

Hanan Queen	Schwartz	Akaike	Maximum accuracy	The length of the break
-۱۴,۷۲۱۹۴	-۱۴,۶۶۳۰۳	-۱۴,۷۶۱۹۸	---	۰
-۱۸,۰۹۱۷۸	*-۱۷,۶۷۹۴۴	-۱۸,۳۷۲۰۸	۷۶۶,۲۲۹۸	۱
*-۱۸,۲۰۸۷۱	-۱۷,۴۴۲۹۳	*-۱۸,۷۲۹۲۸	*۱۳۴,۱۱۵۵	۲
-۱۷,۸۷۶۹۴	-۱۶,۷۵۷۷۲	-۱۸,۶۳۷۷۶	۴۸,۵۹۵۷۵	۳
-۱۷,۵۲۸۳۹	-۱۶,۰۵۵۷۳	-۱۸,۵۲۹۴۷	۴۴,۰۴۸۶۶	۴

Model specification

One of the types of multivariable GARCH models is the BEKK model, which is used in this study to evaluate the spillover effect of volatility of macroeconomic variables on the capital market of Iran. For this purpose, a first-order Garch-Beck model for p and q with the maximum likelihood method has been used to evaluate the spillover of each of the selected macroeconomic variables on the Iranian capital market**.**

The results of GARCH-BEKK(1,1) estimation to investigate the spillover effect of each macroeconomic variable (inflation rate, exchange rate, oil price, gold coin price, interest rate and GDP) on the stock market index as described in the table (6) and table (7). As can be seen in the estimated models, there are two parts of the mean equation and the variance equation. In the average equation, the efficiency spillover effect and in the variance equation, the shock spillover effect and volatility of each variable are estimated. Conditional average equation in table (6) shows the spillover effect of returns from macroeconomic variables to the total stock market index. Considering that the length of the optimal interval is determined as one, an interval has been used for macroeconomic variables in the average equation. In table (7), the coefficient Rt is the effect of return spillover from macroeconomic variables to the total index and coefficient A (1,1) is the effect of shock spillover from macroeconomic variables to the total index and coefficient B (1,1) is the effect of volatility spillover from macroeconomic variables is the total index and cc' are the constant coefficient of the conditional variance equation. In other words, the coefficients of matrix A express the effects of conditional variance (Arch effects) and the coefficients of matrix B express the effects of conditional covariance (Garch effects) (elements on the main diagonal of this matrix of conditional variances and other elements express conditional covariance).

Table 6- Specification of GARCH-BEKK

Average equation	
TEPIX=C(1)+C(2)*INF(-1)+C(3)*RESID	TEPIX=0.026+0.026*INF(-1)+0.999*RESID
TEPIX=C(1)+C(2)*EXE(-1)+C(3)*RESID	TEPIX=0.016+0.039*EXE(-1)+2.606*RESID
TEPIX=C(1)+C(2)*OIL(-1)+C(3)*RESID	TEPIX=0.026+0.015*OIL(-1)+0.999*RESID
TEPIX=C(1)+C(2)*GOLD(-1)+C(3)*RESID	TEPIX=0.012-0.136*GOLD(-1)+2.703*RESID
TEPIX=C(1)+C(2)*INT(-1)+C(3)*RESID	TEPIX=0.027-0.502*INT(-1)+1.003*RESID
TEPIX=C(1)+C(2)*GDP(-1)+C(3)*RESID	TEPIX=0.010+0.156*GDP(-1)+0.286*RESID
Conditional variance equation	
GARCH = M(1,1) + A1(1,1)^2*RESID1(-1)^2 + B1(1,1)^2*GARCH(-1)	

C(2)The effect of return of macroeconomic variables on the return of the total stock market index, M(1,1) is the width from the origin of the conditional variance equation regression, A(1,1) is the shock spillover effect of macroeconomic variables on the total stock market index (Arch effect) and B(1, 1) show the spillover effect of volatility of macroeconomic variables on the total stock market index (Garch effect).

Table 7- Spillover effects of volatility of macroeconomic variables in the capital market

GDP	INT	GOLD	OIL	EXE	INF	dependent variable (total index)
۰,۱۵۶ (۲,۸۶۰)*	-۰,۵۰۲ (-۱۵۱,۵۴)*	-۰,۱۳۶ (-۲,۵۴۱)**	۰,۰۱۵ (۵,۱۱۶)*	۰,۰۳۹ (۰,۶۴۳)	۰,۰۲۶ (۴,۱۲۷)*	R_t
M (1,1) ۰,۰۰۰۵ (۱,۷۵۱)***	M (1,1) ۰,۰۰۰۰۱ (۲,۴۷۵)**	M (1,1) ۰,۰۰۰۶ (۱,۹۴۴)***	M (1,1) ۰,۰۰۰۰۰۸ (۲,۰۵۶)**	M (1,1) ۰,۰۰۰۵ (۱,۹۶۸)**	M (1,1) ۰,۰۰۰۰۱ (۳,۰۱۳)*	cc'
A (1,1) ۰,۵۲۴ (۵,۷۲۰)*	A (1,1) ۰,۵۶۷ (۴,۳۳۱)*	A (1,1) ۰,۵۸۸ (۵,۸۹۵)*	A (1,1) ۰,۵۶۴ (۴,۴۸۴)*	A (1,1) ۰,۵۶۹ (۵,۷۴۴)	A (1,1) ۰,۵۹۹ (۵,۲۹۸)*	A
B (1,1) ۰,۸۰۰ (۱۱,۳۲۶)*	B (1,1) ۰,۳۹۹ (۱,۳۱۰)	B (1,1) ۰,۷۵۲ (۹,۷۷۶)*	B (1,1) ۰,۵۸۲ (۳,۲۱۹)*	B (1,1) ۰,۷۶۶ (۱۰,۴۲۸)*	B (1,1) ۰,۳۷۴ (۱,۷۱۸)***	B
*** ،** ،*They indicate significance at the error level of 1, 5 and 10%, respectively.						

In table (7), the numbers of the first row, the coefficients and the numbers in parentheses are the Z statistic whose significance level is marked with an asterisk. According to the results of the conditional average equation, it is clear that the return spillover from the inflation rate on the capital market is significant and positive at the error level of 1%; Therefore, a one percent increase in the return of the inflation rate leads to an increase in the return of the total index by 2.6 percent. Inflation decreases the value of the Rial and increases the value of capital assets such as stocks, for this reason, it is expected that with the increase in inflation and the decrease in the value of the national currency, investors will come to the capital market and stock transactions to maintain the value of their capital. The coefficient related to the shock spillover from the inflation rate to the total index is equal to 0.599 and is significant at the 1% error level; Therefore, if the conditional variance of the inflation rate increases by one percent, the conditional variance of the total stock market index increases by 59.9 percent. Finally, the coefficient related to the volatility overflow from the inflation rate to the total index is equal to 0.374 and is significant at the 10% error level; Therefore, the spillover of inflation rate volatility on the capital market is confirmed, so that with a one percent increase in the inflation rate, the volatility of the stock market index increases by 37.4 percent. This result supports the first hypothesis and shows that there is a significant relationship between inflation rate volatility and the total stock market index.

The return spillover from the exchange rate to the capital market is equal to 0.039, but it is not statistically significant. The coefficient related to the shock spillover from the exchange rate to the total index is equal to 0.569 and is significant at the 1% error level; Therefore, if the conditional variance of the exchange rate increases by one percent, the conditional variance of the total stock market index increases by 56.9 percent. Finally, the coefficient related to the volatility overflow from the exchange rate to the total index is equal to 0.766 and is significant at the 1% error level; Therefore, the spillover of the exchange rate volatility on the capital market is confirmed, so that with an increase of one percent of the exchange rate volatility, the volatility of the stock market index increases by 76.6 percent. This result supports the second hypothesis and shows that there is a significant relationship between exchange rate volatility and the total stock market index.

The yield spillover from the oil price on the capital market is significant and positive at the 1% error level; Therefore, a one percent increase in the yield of oil price leads to an increase in the yield of the total index by 1.5 percent. As the price of oil increases, the price

of oil products also increases and the value of shares of companies with oil products increases; Therefore, according to these results, it is expected that with the increase in the price of oil, investors will turn to the capital market and trade in the shares of oil companies. The coefficient related to the shock spillover from the oil price to the total index is equal to 0.564 and is significant at the 1% error level; Therefore, if the conditional variance of the oil price increases by one percent, the conditional variance of the total stock market index increases by 56.4 percent. Finally, the coefficient related to the volatility spillover from the oil price to the total index is equal to 0.582 and is significant at the 1% error level; Therefore, the spillover of oil price volatility on the capital market is confirmed, so that with an increase of one percent of oil price volatility, the stock market index volatility increases by 58.2 percent. This result supports the third hypothesis and shows that there is a significant relationship between oil price volatility and the total stock market index.

The yield spillover from the gold coin price on the capital market is significant and negative at the 1% error level; Therefore, a one percent increase in the yield of the gold coin price leads to a decrease in the yield of the total index by 13.6 percent. This result indicates the replacement of gold with stocks, that is, it is expected that as the price of gold coins increases, investors will move their capital towards the gold market. The coefficient related to the shock spillover from the gold coin price to the total index is equal to 0.588 and is significant at the 1% error level; Therefore, if the conditional variance of the gold coin price increases by one percent, the conditional variance of the total stock market index increases by 58.8 percent. Finally, the coefficient related to the volatility overflow from the gold coin price to the total index is equal to 0.752 and is significant at the 1% error level; Therefore, the spillover of the volatility of gold coin price on the capital market is confirmed, so that with a one percent increase in the price of gold coin, the volatility of the stock market index increases by 75.2 percent. This result supports the fourth hypothesis and shows that there is a significant relationship between gold coin price volatility and the total stock market index.

The yield spillover from the interest rate on the capital market is significant and negative at the 1% error level; Therefore, a one percent increase in the yield of the interest rate leads to a decrease in the yield of the total index by 50.2 percent, which shows that with the increase in the interest rate, funds are directed to the banks instead of the capital market, and it indicates the replacement of the banking market with the capital market. The coefficient related to the shock spillover from the interest rate to the total index is equal to 0.567 and is significant at the 1% error level; Therefore, if the conditional variance of the interest rate increases by one percent, the conditional variance of the total stock market index increases by 56.7 percent. Finally, the coefficient related to the volatility of the interest rate to the total index is equal to 0.399, but it is statistically insignificant; Therefore, the spillover of interest rate volatility on the capital market is not confirmed. This result does not support the fifth hypothesis and this hypothesis is rejected in the sense that there is no significant relationship between interest rate volatility and the total stock market index.

The yield spillover from the GDP on the capital market is significant and positive at the error level of 1%; Therefore, a one percent increase in the return of the gross domestic product leads to an increase in the return of the total index by 15.6 percent. An increase in GDP is associated with economic prosperity and an increase in the per capita income of people, which can lead the savings of individuals and households to the capital market and increase the total index of the capital market. The coefficient related to the shock spillover from the GDP to the total index is equal to 0.524 and is significant at the 1% error level; Therefore, if the conditional variance of GDP increases by one percent, the conditional variance of the total stock market index increases by 52.4 percent. Finally, the coefficient related to the volatility spillover from the GDP to the total index is equal to 0.800 and is significant at the 1% error level; Therefore, the spillover of volatility from the GDP on the capital market is confirmed, so that with an increase of one percent of the volatility in the GDP, the volatility of the stock market index increases by 80%. This result supports the sixth hypothesis and shows that there is a significant relationship between the volatility of GDP and the total stock market index.
In this way, it can be seen that except for the interest rate, the volatility of all macroeconomic variables has a significant effect on the capital market of Iran, and these findings are in line with previous studies in other countries.

5- Discussion and conclusion

The capital market is an effective financial institution that plays a central role in directing funds and allocating resources for the economy. The capital market acts as a barometer for economic growth and its role in the development and effective allocation of capital cannot be ignored. An efficient capital market creates opportunities for companies and governments to invest in future projects in various economic sectors. Also, it helps industries and investors to use long-term funds for rapid growth of their business, which ultimately injects growth into the economy. Therefore, stability in the capital market can be of great importance in the economy, however, volatility in the capital market has been raised as a major concern in global financial markets. Iran is not exempt from this and in some periods we see extreme volatility in the capital market. With the increase in volatility in the stock market, investors are hesitant to invest their surplus funds in the uncertain market, which can affect the flow of investment in the economy and the effective allocation of resources, and ultimately economic growth and development. Based on this, limiting the volatility of the stock market and increasing its stability has become very important for policymakers, and creating a stable and stable stock market has become a difficult challenge, especially for developing economies, including Iran. In order to be able to control capital market volatility well, policy makers need to gain a correct understanding of the factors affecting capital market volatility, which is the responsibility of academic researchers to identify the factors that cause capital market volatility by conducting empirical research. In this regard, in this article, the spillover effects of volatility of macroeconomic variables including inflation rate, exchange rate, oil price, gold coin price, interest rate and gross domestic product in the capital market of Iran using monthly data from April 2016 to March 2014 with an approach GARCH-BEKK(1,1) is checked. For this purpose, all variables were converted into monthly growth rates using logarithmic difference. The GARCH-BEKK(1,1) model estimates the conditional variance-covariance matrix, which allows the covariance to change over time, for the overall stock market index to examine the volatility spillover of macroeconomic variables. In other words, volatility of macroeconomic variables are entered as exogenous variables in the conditional variance equation, and the effect of volatility of macroeconomic variables on the total stock market index is estimated using the latest standardized squared residuals of macroeconomic variables as exogenous variables in the conditional variance equation of the total stock market index. will be The results of the specification of the model showed that the volatility of the total stock market index increases with the increase in the volatility of the inflation rate, exchange rate, oil price, gold coin price and GDP, and only the effect of the interest rate volatility on the total index is insignificant. Therefore, macroeconomic variables are important investment parameters in Iran's capital market, and macroeconomic policies can play an important role in the state of Iran's capital market. The explanation of this phenomenon is that when macroeconomic variables are fluctuating, investors may not be willing to adjust their portfolios and delay their order registration and transactions in the capital market, and stock transactions decrease, which leads to the spread of volatility in the capital market. . Investors pay close attention to macroeconomic parameters before injecting their surplus funds in any investment path, and with the increase in instability in macroeconomic variables, investors try to adapt to new information and economic changes and change their investment decisions. In addition, changes in macroeconomic variables affect the value of financial assets, including stocks, which can affect investment decisions. Finally, volatility in macroeconomic variables can weaken the performance of companies and cause changes in the sales, profitability and value of companies, which ultimately reduces the confidence of investors in the shares of these companies and the spillover of volatility to the capital market. The results of this study show that by estimating instability and uncertainty in macroeconomic variables, a large part of the increase in volatility in the capital market can be predicted.

These results can have useful consequences for capital market actors, as it shows that there is a correlation and connection between the macroeconomic environment and the capital market; Therefore, capital market activists, including investors and portfolio managers, must carefully monitor the volatility of macroeconomic variables in order to make investment decisions and also develop strategies for risk coverage and portfolio diversification. They can improve their portfolio performance in individual

markets by focusing on the importance of macroeconomic factors. From a policy perspective, the findings provide useful insights for the formulation and implementation of macroeconomic policies to achieve financial market stability. Since capital markets are linked to some macroeconomic variables, weakness in the macroeconomic environment, poor policymaking and implementation may be transmitted to this market as volatility, but well-planned domestic policies may achieve contribute to stability in the capital market. In particular, responsible governance and macroeconomic management through fiscal and monetary policies are necessary to create real and fundamental economic growth necessary for the development and stability of the financial market. Therefore, according to the results of this study, financial regulators and policy makers should consider macroeconomic volatility in the modeling and implementation of capital market policies. In fact, policymakers should use a more appropriate framework to accurately track and predict volatility patterns in macroeconomic variables in the process of formulating strict policies, implementing financial system regulations to maintain financial stability, making decisions about asset allocation, risk hedging strategies, and investment projects. Also, the government should control the volatility of macroeconomic variables by applying strict measures, because these are the instruments that affect the volatility of macroeconomic variables. Volatility spillover effects are useful for predicting financial crisis in the capital market.

Reflecting the relationship between macroeconomic variables and the capital market is still an attractive topic for further research, because it can be emphasized whether the relationship between the variables is bidirectional or how this relationship is at different stages of the business cycle; Therefore, researchers are advised to do this in future studies.

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