

Investigating the effect of Trading volume on Bid-Ask spread of Islamic treasury bills with a Microstructural approach

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Abstract

As a key tool in implementing monetary policy and government financing, government bonds play an essential role in financial markets. By means of Islamic financial innovations in the Islamic capital market, the instrument of Islamic treasury bill is published and tradable in the over-the-counter market. Islamic treasury bills have many risks in terms of execution, including the ease of trading and liquidity in the secondary market. Therefore, this research aims to examine some microstructural elements of government bonds using a vector autoregressive model. In this article, the effect of trading volume on bid-ask

spread of orders has been investigated. To survey the impact of these variables, the vector autoregressive (VAR) model has been used on intraday data of 17 symbols of Islamic treasury bills in the over-the-counter market, which had the most trading days from 2021 to September 2023. According to the studies, there is a significant relationship between the trading volume and bid-ask spread only in Islamic treasury bills with long-term maturity. Therefore, the effect of the bid-ask spread of orders in different periods is greater than the trading volume, especially in longer-term Islamic treasury bills. Hence, in this research, by analyzing the impulse response function, if there is a shock on the variables, the effect of the trading volume's shock remains for several periods and affects unremarkably the bid-ask spread of orders in most of the short-term and long-term Islamic treasury bills, while effects of the bid-ask spread shocks during initial periods for long-term and short-term Islamic treasury bills is excellent, but decrease sharply during the following periods. These results help traders pay attention and reduce the risk of trading in the over-the-counter market, specifically the long-term treasury bills.

Keywords: Islamic treasury bills, Trading volume, Bid-Ask Spread, Information asymmetry, Market microstructure

Introduction

So far, there have been many studies on transactions in the stock market, while there have been very few studies on the debt market. Meanwhile, debt instruments play an essential role in the financial market. Islamic treasury bills are risk-free debt instruments the government issues to finance itself. These Islamic treasury bills play an important and even unique role in the financial markets because, due to security, liquidity, and low transaction costs, Islamic treasury bills are often preferred for transactions.

According to the research of Nazarpur and Sadraei (2017), the budget deficit is a constant problem for governments, especially for developing countries, because these countries, due to the existence of a large number of development projects, always have a deficit of financial resources. On the other hand, the issuance of Islamic treasury bills, as usual in the conventional financial system, cannot be generalized to the Islamic financial system. As a result, one of the tools that can be a good substitute is Islamic treasury bills.

Capital market participants who intend to invest in the capital market without risk and with high reliance invest in these bills in order to have a good profit in a certain period. The validity and liquidity of these bills make them critical tools in the implementation of monetary policy and financing in various

situations. As a result, some capital market participants are concerned about the ease of trading these bills in the market. Therefore, it is necessary to study this market.

According to Fleming (2001), one of the most important criteria that affect the ease of trading in the financial market is the bid-ask spread of orders. Bid-Ask spread is the difference between the highest buying price and the lowest selling price at which the buyer and seller are willing to execute the transaction. On the other hand, the more this bid-ask spread increases, the ease of trading is reduced, and the liquidity of these bills is also reduced. As a result, the risk of trading these bills in the market increases (Hosseini et al., 2022).

According to Pasquariello and Vega (2007) and Vega (2006), the information advantages in this market may be due to private knowledge of order flows and transactions or a superior ability to analyze and interpret public information; some market participants may be more knowledgeable than others.

On the other hand, according to Fleming's (2017) studies, transactions have value-relevant information. As a result, informed traders influence other people's strategies in the market through their transactions. Also, Hasbrouck (1991) introduced a factor such as trading volume as one of the effective trading characteristics in the market, which is influenced by the discussion of information asymmetry in the market.

As said, the main goal is to investigate the ease of trading government bonds according to the amount of the bid-ask spread. On the other hand, according to Barakchian and Seyedsalehi (2022), the ease of executing transactions has a positive relationship with market depth and trading volume. Measuring and evaluating the ease of trading in the debt market is very important for people who make transactions in the market, control market conditions, and analyze market developments, events, and changes.

As a result, based on Fleming and Mizrach (2018), the bid-ask spread in orders as a measure of market conditions informs policymakers about the desire and enthusiasm of market makers and market participants to invest and take risks in the financial markets. These cases make it important to examine the ease of trading these Islamic treasury bills.

To define the problem statement, treasury bills are a key tool for the monetary policy of central banks and government financing, so the liquidity of the secondary market for these treasury bills is essential, causing traders to trust the market and invest in debt securities with more confidence and

reliance. Since the central bank was authorized in 2020 to implement open market operations in the over-the-counter market, executing monetary policies has also found its way to the secondary market. Therefore, the liquidity of this market is more essential than past.

Therefore, the main question in this article is to examine the effect of trading volume, one of the market microstructural elements, on the bid-ask spread, and to check the liquidity and ease of trading these Islamic treasury bills in the market, we chose the bid-ask spread variable. We modeled it with the help of the VAR model. This model is rooted in studies of information asymmetry in the market.

Literature Review

Treasury bills represent the government's commitment to covering the government's budget deficit. On the other hand, the issuance of treasury bills, as usual in the conventional financial system, cannot be generalized to the Islamic financial system. As a result, one of the tools that can be a good substitute is the Islamic treasury bills.

One of the most prevalent ways of compensating government budget deficits is to issue government treasury securities. These securities are published and can be bought and sold in secondary markets. Due to the Riba of the conventional treasury bonds, Islamic treasury bills have been proposed and institutionalized as an alternative to conventional treasury bills in the Islamic Republic of Iran. Islamic treasury bills are financial devices based on public sector accumulated debts to the banking system, contractors, and some other general treasury debts issued by the Ministry of Economic Affairs and Finance on behalf of the government (Towhidi, 2021).

Unlike the developed countries in the world, the Iranian economy is bank-oriented; about 80% of the supply is provided by banks, and only 20% is provided by the capital market. One of the important tools in the financial market is treasury bills. Due to the ban on Riba in Islam, traditional treasury bills can not be used in the Islamic financial system. Therefore, the Islamic capital markets require low-risk and short-term financial instruments that can fill the vacuum of traditional treasury bills (kheradyar et al., 2020).

Islamic Treasury bills are securities based on the debt. Assuming that the debt has a correct religious basis and is registered and not formal, The creditor can pay all or part of the debt to sell to a third party for less than the face value. With the sale of the debt, the ownership is transferred to the other one, and the

new owner can resell the debt. Therefore, Islamic Treasury bills are a financial instrument based on the country's registered debt to the banking system, stakeholders, and resource providers and are issued by the Ministry of Finance Treasury (Rashidi et al., 2023).

According to Kheradyyar, Maleki, and Pourreza (2020), one of the most important differences between Islamic treasury bills and other treasury bills is the real nature of government debt, which is the basis for issuing these bonds. These treasury bills are issued to be bought and sold in the secondary markets.

The world's financial markets mainly work based on interest rates, and assets and liabilities are adjusted with the interest rate instrument. It could be because they refer to the Islamic system as an interest-free system. Although they describe the Islamic financial system as an interest-free one, the description of it as an interest-free one needs to reflect a correct picture of the entire system.

According to Fleming (2020), treasury bills are issued to settle government debts to other creditors, implement monetary policies, control market liquidity, finance budget deficits, and manage the market. Also, these treasury bills are the primary tool of the money market for applying the central bank's monetary policies. The market price of treasury bills in the over-the-counter market is determined by the supply and demand mechanism and by two factors: the market's maturity and the expected interest rate. In other words, as we get closer to the maturity date of treasury bills, the difference between the nominal and market prices decreases.

Also, the expected interest rate is determined according to other investment options and their risk. Although these treasury bills are traded in the over-the-counter market, the ease of trading and liquidity greatly interest investors.

According to the studies of Pourhosseini, Sharifi Renani, and Karimzadeh (2022), one of the risk factors of financial assets is the liquidity of these assets, and the investigation of factors affecting the liquidity of these assets can help people predict the risk of financial assets.

According to Easley and O'Hara (1992) and the studies of Glosten and Milgrom (1985), a market with high liquidity has little or zero transaction costs, and transactions are executed with great ease.

In practice, we consider a market with meager transaction costs as a market with high liquidity and a market with high transaction costs as a market with low liquidity, where transactions are executed slowly. On the other hand, calculating these transaction costs is challenging because it depends on several

factors, such as the transaction size, time, location, and participants. In addition, the required information for its calculation is not readily available. As a result, various measures have been used to evaluate the ease of trading in the market.

Among the criteria for measuring the ease of trading in the market that Fleming (2001) puts forward is the bid-ask spread of orders in the market. The bid-ask spread measures transaction costs, showing the ease of trading and liquidity. The higher the spread, the lower the transactions and liquidity in the market, and on the contrary, the lower the spread, the higher the liquidity and trading and the lower transaction costs. The lower transaction cost means that if the buyer wants to sell his shares immediately after the purchase, he will not suffer a high loss due to the difference in the purchase and sale price, and the transaction between the purchase and sale orders will be done quickly.

According to Engel and Fleming (2019), trading and market liquidity are influenced by two critical factors: liquidity supply and liquidity demand. Market depth is a measure of liquidity supply. The depth of the market indicates the amount of buy and sell orders at different prices, which is verified separately for orders with the best buy and sell prices. The investigations are done in such a way that they check the number of buy orders and sell orders separately at the best prices. The more these orders are at the best prices, the deeper the market and its liquidity will be.

The second factor for market liquidity is liquidity demand. Trading volume is a measure of liquidity demand. In fact, the liquidity demand shows the number of orders executed. The more orders are executed, the more trading volume and the liquidity of the market will increase.

It should also be noted that the analysis of market liquidity will only be accurate by considering the concept of market volatility because market volatility causes inventory-based risk for liquidity providers and can affect their trading strategies.

According to Kyle (1985), the lack of orders in the market increases volatility and makes it harder for the market to absorb shocks. Kyle's model is a workhorse in the market microstructure literature. In this information-based model, an auctioneer sets the price after all informed and uninformed traders have submitted their orders.

At first, the informed trader observes the risky asset's return value at the period's end. The market orders are presented to the auctioneer, who must be made aware of the return value of the asset at the end of the period by the

informed and uninformed traders. Although the informed traders know the return value of the asset, they cannot know the order size of the uninformed traders before submitting their orders (Easley et al., 2008).

Kyle's model assumes free entry into the auction market, and therefore, the auctioneers have no monopoly power, so their profit is zero. To reach the equilibrium price, the auctioneer considers only the sum of the orders issued by informed and uninformed traders and determines the price according to the set of these orders.

Therefore, as Kyle's model shows, transactions also convey information and are tools for market price discovery. Therefore, the lower the number of orders and transactions, the prices are not determined correctly, the more the bid-ask spread and volatility in the market increase and transactions decrease.

Continuing Kyle's discussion regarding the information available in the transactions, Mizrach and Neely (2007) show that trades and minimal orders affect prices, and traders usually use limited orders to exploit their hidden information.

Therefore, Hai, Ingrid, and Rui (2021) studied, in addition to examining transactions, also examining the direction of transactions and orders. Evidence shows that Limit orders contain value-relevant information. Traders with limited orders who have hidden information want more transactions, so they quickly register orders and execute transactions to get maximum profit from their information in the market.

As a result, limit orders help discover the intrinsic value of the assets and reduce volatility. Based on Fleming and Remolona's (1999) research on the ease of trading and the formation of prices in the U.S. Treasury market, they have examined the bid-ask spread, the trading volume, and price volatility following the release of public and confidential information.

Among the types of standard orders in the market, we can mention market orders and limit orders, both of which have advantages and disadvantages. Market orders can guarantee the execution of the order but incur more opportunity costs, While limited orders guarantee price improvement. However, limit orders are also risky. The first risk, caused by the information asymmetry, can lead to loss or non-profit from the transaction. Also, another risk that these orders bring is the risk of the transaction's non-execution, which happens when the prices in The market will move away from the prices of the limit orders and will lead to the non-execution of the transaction (Handa, Schwartz, 1996).

Based on Fleming and Remolona's (1999) research on the ease of execution of transactions and the formation of prices in the U.S. treasury market, they have examined the bid-ask spread, trading volume, and price volatility following the release of public and private information. According to this research's findings, when informed traders' private information is identified during the flow of transactions in the market, the trading volume increases because informed traders want to use their information advantage.

Copeland and Galai (1983) were the first to develop a formal model considering information costs. Informed traders know the asset's intrinsic value, and uninformed traders who trade for external reasons do not need to know the asset's intrinsic value. If informed traders are quickly identified, no one will agree to trade with them. The main point of Copeland and Galai's article is that even in the presence of competitive brokers, the mere presence of knowledgeable and informed traders means that the difference between bid and ask prices in orders will be positive.

The goal of market makers is to choose the bid-ask spread in the orders by which they can maximize their profit. If market makers increase the bid-ask spread, they lose their expected income from uninformed traders, but potential losses from informed traders decrease. On the other hand, if they decrease the bid-ask spread, the probability of losses by informed traders increases. However, it is compensated by uninformed traders who are the liquidity traders in the market.

Based on Hasbrouck's (1995) theory, by analyzing the market microstructure, we realize that in a market where traders have asymmetric information, the transactions convey information and affect prices and bid-ask spread. Private information is inferred by observing the flow of transactions and affects the flow of subsequent orders.

In the information-based model, information asymmetry causes the order flow to be considered an influential variable, and transactions have value-relevant information (Vega & Miller, 2009). Finally, research in the field of market microstructure leads to the study of the market maker's learning from the flow of orders and, consequently, the formation of trading prices over time. Among the factors that are effective in the flow of transactions is trading volume.

According to the studies of Hasbrouck (1991), two factors affecting bid-ask spread are trading volume and signed trade volume (if the buyer initiates the transaction, the direction of the transaction will be +1, and if the seller initiates it, its sign will be -1) that may be determined during the trading and

affect the subsequent trades of traders in the market because transactions usually have value-relevant information.

According to Pasquariello and Vega (2007), the information advantage in this market may be due to private knowledge of the flow of orders and transactions or a superior ability to analyze and interpret public information. As a result, some market participants may be more aware than the rest of the participants in the market.

In theories based on information asymmetry, it is assumed that there are two types of informed and uninformed traders and market makers. Uninformed traders trade only to meet their liquidity needs, while informed traders trade to use their private information; then, with the help of the information advantage, they can gain profit, and in addition to gaining more profit, they also increase the volume of their trades.

The market maker can also be considered an uninformed trader. Easley and O'Hara (1987) described a model in which the market maker or the uninformed trader needs to be more confident about the other trader's awareness. Therefore, one of the components of recognizing informed traders is to be aware of the trading volume because usually, they increase the volume of their transactions in order to gain more profit and use their information advantage, which leads other traders to evaluate the probability of a news event and determine the prices of their orders in such a way as to reduce their losses and this can lead to an increase bid-ask spread in the market.

This research uses a method similar to Hasbrouck's (1991) VAR model to investigate the effect of transaction flow, which includes factors such as trading volume, on bid-ask spread. This VAR model is rooted in information asymmetry in the market, and the effect of transaction flow in the market is investigated.

Research Methodology

This research aims to investigate some microstructure elements of government debt bonds and their mutual effect on each other. The elements of market microstructure are trading volume, bid-ask spread, signed trade volume, the permissible amplitude of volatility, transaction prices, etc. In this research, according to the discussion of information asymmetry between traders in the market and, accordingly, the value-relevant information that the transactions of these traders impose on the market, the effect of trading volume on the bid-ask spread of orders in the market is investigated in this study.

In order to investigate some microstructural elements of Islamic treasury bills in the over-the-counter market, treasury bills that had the most trading days from 2021 to September 2023 have been used to increase the validity and accuracy of this research. As a result, three categories of Islamic treasury bills with maturity of 3 to 4 years, 2 to 3 years, and 1 to 2 years from 2021 to September 2023 are available for examination in this research. In determining the criteria for selecting treasury bills with the most trading days, the average trading days of each category of bills have been used. As a result, as can be seen in Table 1, 17 Islamic treasury bills with different maturities have been used for the research.

Table 1. Number of selected Islamic treasury bills based on trading days

maturity	Total number of Islamic treasury bills	Number of selected Islamic treasury bills	The average number of trading days (day)
3 to 4-year	17	12	469
2 to 3-year	7	4	31
1 to 2-year	2	1	44
Total	26	17	

Among the elements studied in this research, we use trading volume and bid-ask spread of orders. Python programming language was used to collect the studied intraday data during the target period, and the intraday data were extracted from the Tehran Securities Technology Management Co¹ website. According to the concept of bid-ask spread of orders based on the difference between the highest purchase price and the lowest sale price at which the buyer and seller are willing to execute the transaction, in collecting the information of orders in the market, we used the first level of the orders that include the best price for buying and selling.

To check the stationary of the data, the Augmented Dickey-Fuller test was used, and according to this test, the data with optimal lags obtained from the Akaike information criterion², is stationary. As can be seen in Table 2, at the confidence level of 90%, 95%, and 99% for 821- Islamic treasury bill, p_value is lower than the alpha error level. This test was taken for all data with the optimal lags determined by the Akaike information criterion, and according to this test, the data of this research is stationary.

¹ TSETMC.com

² AIC

Table 2. The results of the Augmented Dickey-Fuller test for 821- Islamic treasury bill

data	ADF test statistic	p-value	α	critical value
Bid-Ask spread	-8.390009e+00	2.380714e-13	1%	-3.433409e+00
			5%	-2.862892e+00
			10%	-2.567489e+00
Trading volume	-1.258137e+01	1.907182e-23	1%	-3.433404e+00
			5%	-2.862889e+00
			10%	-2.567488e+00

Results

In this research, considering the discussion of information asymmetry between traders in the market and, accordingly, the value-relevant information, the effect of the trading volume on the bid-ask spread of orders in the market is investigated.

Hasbrouck's (1991) VAR model was used to investigate the effect of trading volume on bid-ask spread. This VAR model is rooted in information asymmetry in the market, which is as follows:

$$S_t = b + \sum_i a_i S_{t-i} + \sum_i b_i |x_{t-i}^0| + \sum_i c_i |x_{t-i}| + \sum_i d_i |x_{t-i}^2| + v_t \quad (1)$$

In this model, the bid-ask spread is modeled using Hasbrouck's VAR model. In this model, S_t is bid-ask spread, $|x_t^0|$ is signed trade volume (if the buyer initiates the transaction, the direction of the transaction will be +1, and if the seller initiates it, its sign will be -1), $|x_t|$ is trading volume, and $|x_t|^2 = |x_t^2|$.

The advantages of the VAR model are as follows:

1. In this model, all variables are endogenous, and there is no need to separate independent and dependent variables. As a result, the interactions of all variables will be investigated.
2. The results obtained from the vector autoregressive model are usually better than other models.

Among the criteria for measuring the ease of trading in the market that Fleming (2001) puts forward is the bid-ask spread of orders in the market. The bid-ask spread measures transaction costs, showing the ease of trading and liquidity. The higher the spread, the lower the transactions and liquidity in the market, and on the contrary, the lower the spread, the higher the liquidity and trading and the lower transaction costs. The lower transaction cost means that

if the buyer wants to sell his shares immediately after the purchase, he will not suffer a high loss due to the difference in the purchase and sale price, and the transaction between the purchase and sale orders will be done quickly.

As a result, using this model makes it possible to study the effect of trading volume on the bid-ask spread of Islamic treasury bills.

As mentioned, this research aims to investigate the variables of the trading volume and the bid-ask spread of orders. The following equation is used to determine the bid-ask spread:

$$\text{Spread} = \text{Ask price} - \text{Bid price} \quad (2)$$

$$S_t = ask_t - bid_t$$

In information asymmetry models, the variable of bid-ask spread can be observed in the market. According to the information asymmetry discussion, traders are divided into two groups, informed and uninformed; there is a gap between the purchase and sale prices of the orders, which is caused by the value-relevant information of the transactions. In the above equation, Ask is the price of a sell order, and Bid is the price of a buy order.

One of the elements that have value-relevant information in transactions is trading volume. In the market, traders are divided into two categories: informed and uninformed; informed traders usually execute their transactions in a higher volume to get the maximum profit from the advantage of having private information. Therefore, the market is affected by the high volume of transactions with prices that informed traders specify.

One of the research that deals with the modeling of trading volume by the VAR model is Rui and Lee's (2002) model:

$$R_t = \alpha_0 + \alpha_1 v_t + \alpha_2 v_{t-1} + \alpha_3 R_{t-1} + u_t \quad (3)$$

$$V_t = \beta_0 + \beta_1 R_t + \beta_2 R_{t-1} + \beta_3 R_{t-1} + v_t$$

In this model, R is return, and V is trading volume. As mentioned, trading volume is one of the elements of transactions that have value-relevant information, and for this purpose, this variable is investigated in this research.

The vector autoregressive model has been used to investigate the effect of trading volume on the bid-ask spread of Islamic treasury bills. Since, in this model, the variables are endogenous, the mutual effect of each variable is investigated.

As a result, in this research, 17 Islamic treasury bills in three categories with different maturities have been estimated by the vector auto-regressive

model with the optimal lags determined by the Akaike information criterion.

As you can see in the tables below, the estimated coefficients using the vector autoregressive model for three categories of Islamic treasury bills are shown. In Table 3, in most bills with a maturity of 3 to 4 years, The trading volume variable with lags of 7 and 8 is significant in this model, which means that this variable had a significant effect on the bid-ask spread variable in the seven or eight previous periods.

On the other hand, the bid-ask spread of order is significant in most of the lags; that is, most of the bid-ask spread variables in previous periods affect the bid-ask spread of the current period.

Therefore, it can be said that in Islamic treasury bills with a maturity of 3 to 4 years, the trading volume and bid-ask spread variables in previous periods affect the bid-ask spread of the current period, but the effect of bid-ask spread variables in previous periods are more than the other variables.

Table 3. Estimation of VAR model for two samples of 3 to 4-year Islamic treasury bills

006- Islamic treasury bill			001- Islamic treasury bill		
Variables	Spread	P_value	Variables	Spread	P_value
L1.spread	0.369622*	0.00	L1.spread	0.517589*	0.00
L2.spread	0.137808*	0.00	L2.spread	0.097845*	0.00
L3.spread	0.105235*	0.00	L3.spread	0.016903*	0.045
L4.spread	0.028440*	0.00	L4.spread	0.051644*	0.00
L5.spread	-0.001179	0.877	L5.spread	0.017151*	0.042
L6.spread	0.018935*	0.013	L6.spread	0.006926	0.410
L7.spread	0.030398*	0.00	L7.spread	0.042826*	0.00
L8.spread	-0.001183	0.876	L8.spread	-0.002437	0.771
L9.spread	0.016364*	0.029	L9.spread	0.002149*	0.797
L1.Volume	-0.001402	0.565	L1.Volume	-0.002083	0.414
L2.Volume	-0.000291	0.907	L2.Volume	-0.000096	0.970
L3.Volume	0.001220	0.623	L3.Volume	-0.001446	0.577
L4.Volume	0.001250	0.615	L4.Volume	0.002943	0.257
L5.Volume	0.005315*	0.032	L5.Volume	0.000652	0.801
L6.Volume	0.000385	0.877	L6.Volume	0.003348	0.197
L7.Volume	-0.005268*	0.034	L7.Volume	0.006783*	0.009
L8.Volume	0.000121	0.961	L8.Volume	0.005970*	0.021
L9.Volume	0.004382	0.077	L9.Volume	-0.002478	0.339
R_square	0.2741		R_square	0.4422	

Description: * Estimated coefficients at a significance level of 95% confidence

According to the results in Table 4, in most Islamic treasury bills with a maturity of 2 to 3 years, the trading volume variable is insignificant or significant in only one lag, which means that this variable has minimal effect

on the bid-ask spread of orders. On the other hand, the bid-ask spread variable is significant in almost half of the lags. As a result, some of the bid-ask spread variables in previous periods significantly affect the bid-ask spread of the current period.

Table 4. Estimation of VAR model for two samples of 2 to 3-year Islamic treasury bills

105- Islamic treasury bill			104- Islamic treasury bill		
Variables	Spread	P_value	Variables	Spread	P_value
L1.spread	0.391296*	0.00	L1.spread	0.467680*	0.00
L2.spread	0.174232*	0.00	L2.spread	0.116044*	0.00
L3.spread	0.064927	0.095	L3.spread	0.062704*	0.045
L4.spread	0.054173	0.163	L4.spread	0.026110	0.00
L5.spread	0.066702	0.085	L5.spread	0.036657	0.042
L6.spread	-0.023601	0.536	L6.spread	-0.009820	0.410
L7.spread	0.097833*	0.006	L7.spread	-0.018861	0.00
L8.spread			L8.spread	0.035600*	0.771
L1.Volume	-0.003930	0.790	L1.Volume	-0.001571	0.414
L2.Volume	0.041612*	0.005	L2.Volume	0.001441	0.970
L3.Volume	-0.001951	0.895	L3.Volume	0.002217	0.577
L4.Volume	-0.007533	0.611	L4.Volume	-0.001429	0.257
L5.Volume	-0.07590	0.234	L5.Volume	0.0001410	0.801
L6.Volume	-0.013217	0.370	L6.Volume	0.000541	0.197
L7.Volume	0.014524	0.324	L7.Volume	0.001319	0.009
L8.Volume			L8.Volume	-0.001430	0.021
R_square	0.3349		R_square	0.3704	

Description: * Estimated coefficients at a significance level of 95% confidence

Finally, according to Table 5, in Islamic treasury bills with a maturity of 1 to 2- years, the trading volume variable is not significant in any lags, and it has no effect on the bid-ask spread variable of the current period. On the other hand, the bid-ask spread variables in previous periods have a significant effect only in 3 lags.

Table 5. Estimation of VAR model for two samples of 1 to 2-year Islamic treasury bills

106- Islamic treasury bill		
Variables	Spread	P_value
L1.spread	0.869692*	0.00
L2.spread	0.041794	0.00
L3.spread	0.064927	0.095
L4.spread	0.016313	0.163
L5.spread	-0.494497*	0.085
L6.spread	0.387338*	0.536
L1.Volume	-0.003930	0.790
L2.Volume	0.041612*	0.005
L3.Volume	-0.001951	0.895
L4.Volume	-0.007533	0.611
L5.Volume	-0.07590	0.234
L6.Volume	-0.013217	0.370
R_square	0.3349	

Description: * Estimated coefficients at a significance level of 95% confidence

As a result, in longer-term Islamic treasury bills compared to shorter-term ones, the trading volume and the bid-ask spread variables in previous periods significantly affect the bid-ask spread of orders in the current period.

After estimating the vector autoregressive model, one of the most critical tasks is to use the impulse response function and variance decomposition to get the final result. We have used the impulse response function to investigate the effect of shocks on variables and analyze the dynamic impact of one-time shocks on the variables within the model in this research. In fact, each of the residuals or errors is a shock for its variable. In this research, the estimated model is a vector autoregressive model; the variables are endogenous, which means that the shocks have a mutual effect.

The following figures show the impulse response function for three categories of Islamic treasury bills. Since variables in the vector autoregressive model are endogenous, the effect of the shocks on the variables can be seen mutually for each treasury bill in four diagrams. In Figures 1 and 2, the diagrams of the impulse response function for 3 to 4-year Islamic treasury bills can be seen. In both Islamic treasury bills, the effect of the shock on the bid-ask spread of orders during the first to the second period is significant and then significantly reduced and disappears during the following periods (up-left diagrams). Therefore, due to the occurrence of a shock on the bid-ask spread variable, its effect on the bid-ask spread in these documents remains for 1 to 6 periods, and after that, its effect on the bid-ask spread will be lower.

While the shock on the trading volume during ten periods has varied effects on the bid-ask spread of orders, its effect is not considerable (up-right

diagrams). Due to the endogenous nature of the variables in Figures 1 and 2, we can see two other diagrams that examine the shock on the two variables of trading volume and bid-ask spread and its effect on the trading volume variable.

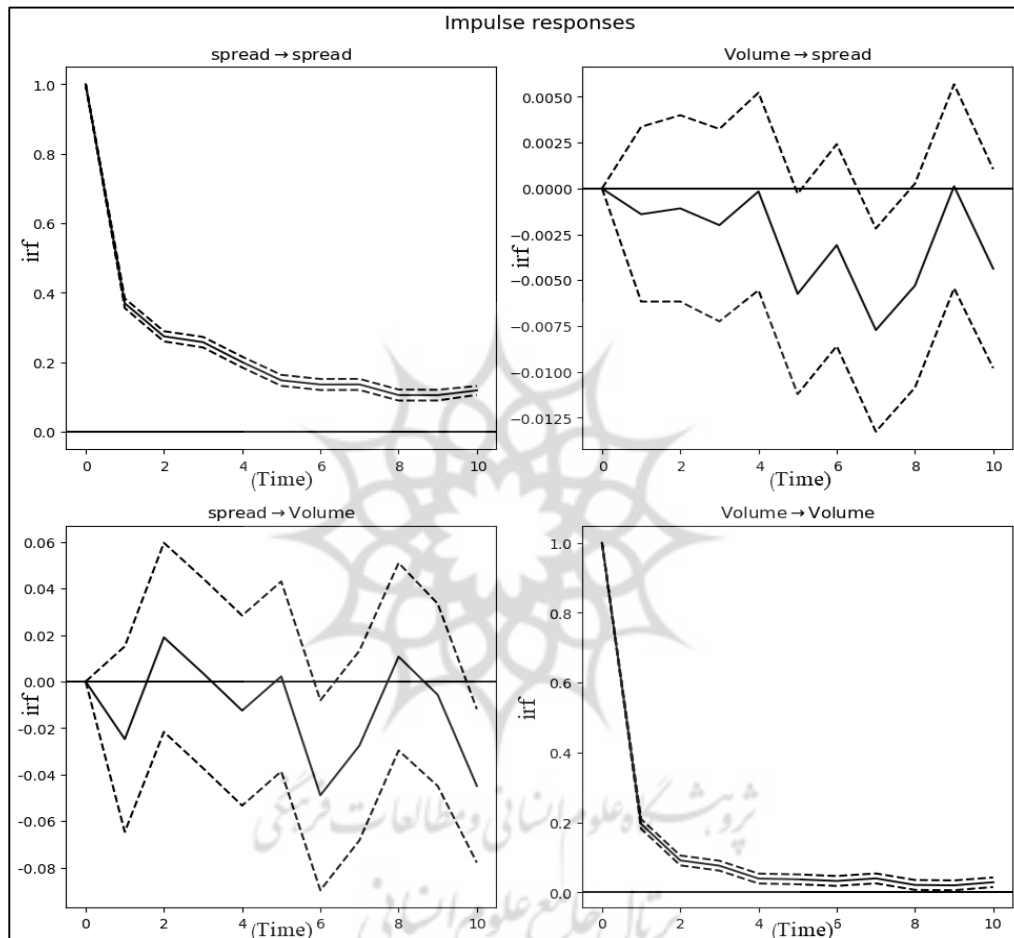


Figure 1. Diagrams of the Impulse response function for 3 to 4-year 006- Islamic treasury bill

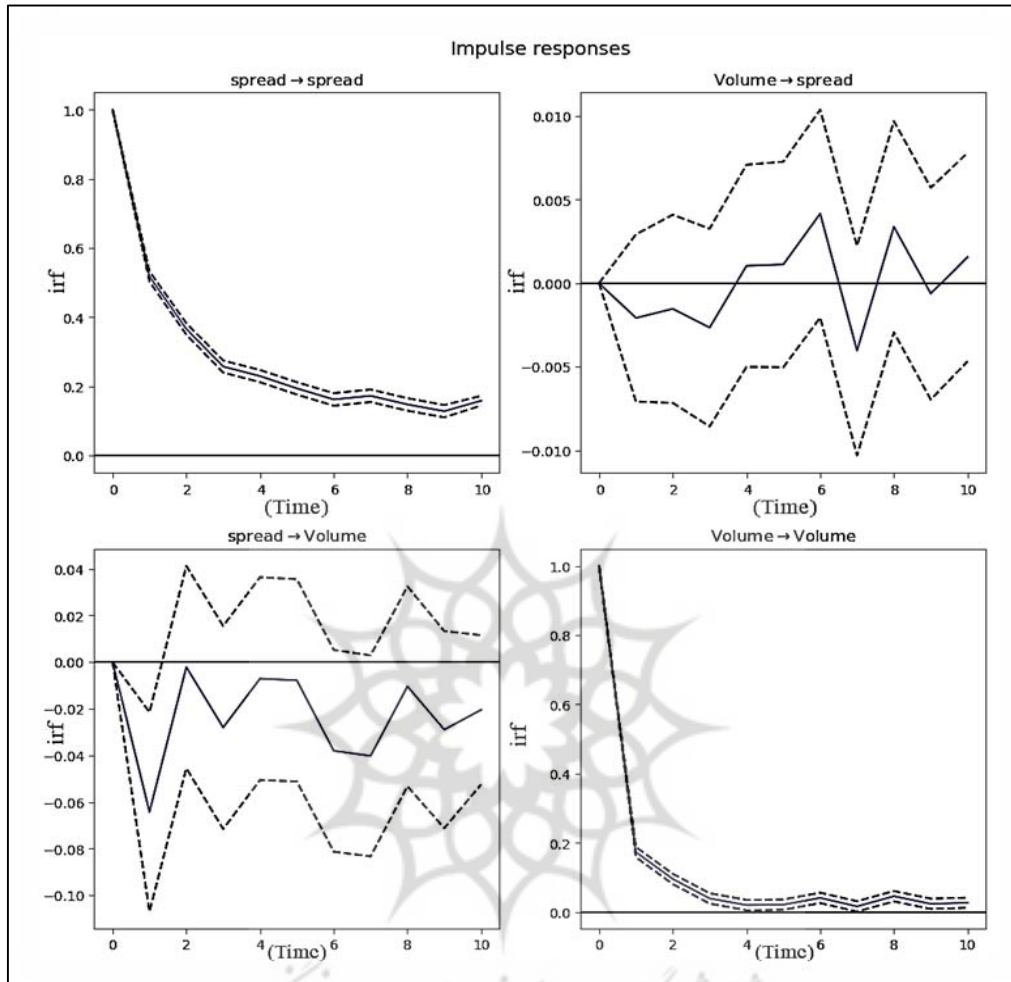


Figure 2. Diagrams of the Impulse response function for 3 to 4-year 001- Islamic treasury bill

Variance decomposition has been used to investigate the importance of the residuals or errors in the variables of the vector autoregressive model.

By examining Table 6 for 3 to 4-year Islamic treasury bills, it can be said that about a hundred percent of the source of volatility in the bid-ask spread orders during these ten periods is bid-ask spread in previous periods.

Table 6. Variance decomposition for 3 to 4- Islamic treasury bills

Variance decomposition				
Period	006- Islamic treasury bill		001- Islamic treasury bill	
	Spread	Volume	Spread	Volume
1	0.999986	0.000014	0.999971	0.000029
2	0.999978	0.000022	0.999959	0.000041
3	0.999953	0.000047	0.999920	0.000080
4	0.999955	0.000045	0.999916	0.000084
5	0.999749	0.000251	0.999912	0.000088
6	0.999694	0.000306	0.999819	0.000181
7	0.999336	0.000664	0.999736	0.000264
8	0.999172	0.000828	0.999680	0.000320
9	0.999179	0.000821	0.999681	0.000319
10	0.999074	0.000926	0.999674	0.000326

According to Figures 3 and 4, the impulse response function can be seen for 2 to 3-year Islamic treasury bills.

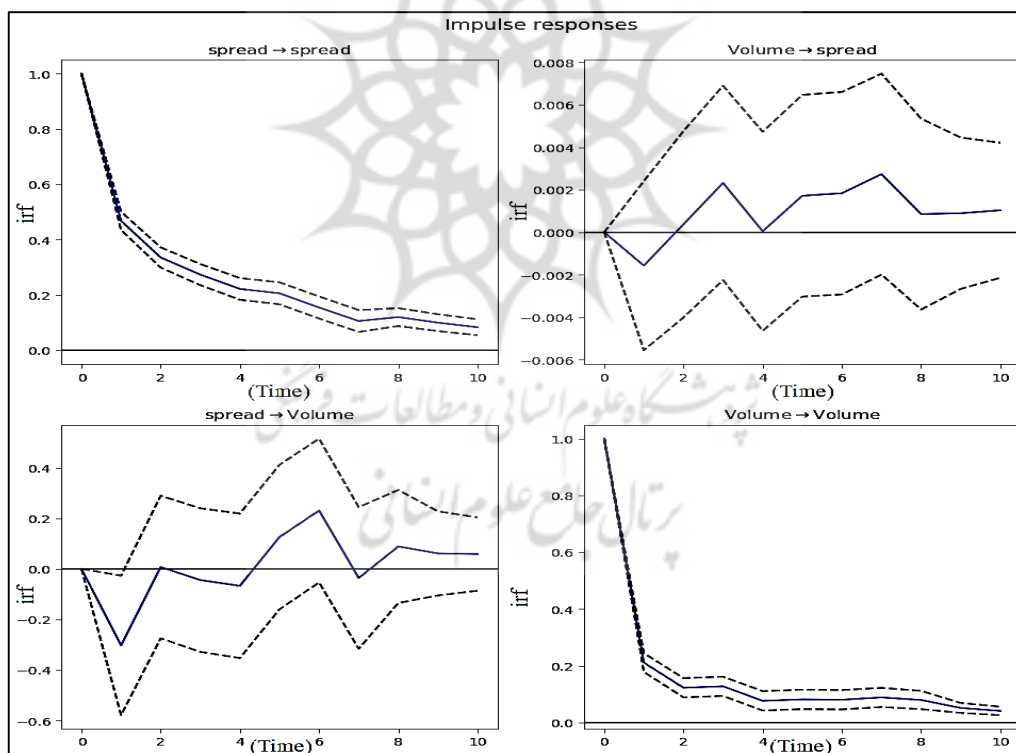


Figure 3. Diagrams of the Impulse response function for 2 to 3-year 104- Islamic treasury bill

In Figures 3 and 4, the effect of the shock on the bid-ask spread of orders decreases sharply in the first to the second period and disappears within ten periods. In investigating the shock of the trading volume variable and its effects on the bid-ask spread variable, we conclude that in the 105-treasury bill, the effect of the shock of the trading volume on bid-ask spread during ten periods is varied but not considerable, while in the 104-treasury bill, its unremarkable effect lasts up to 7 periods and decreases during the following periods.

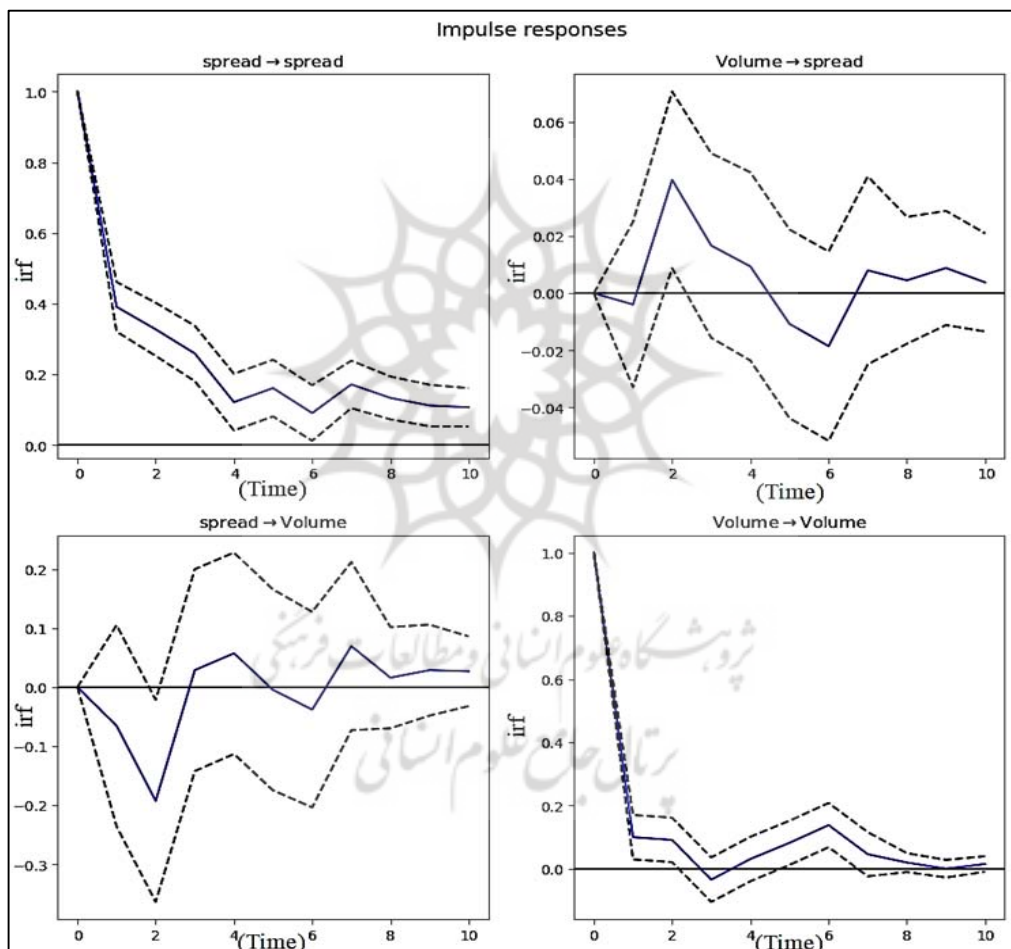


Figure 4. Diagrams of the Impulse response function for 2 to 3-year 105-Islamic treasury bill

By examining variance decomposition in Table 7, we come to the conclusion that about a hundred percent of the source of volatility in bid-ask spread in 2 to 3-year treasury bills is caused by the variable of bid-ask spread itself.

Table 7. Variance decomposition for 2 to 3- Islamic treasury bills

Variance decomposition				
Period	104- Islamic treasury bill		105- Islamic treasury bill	
	Spread	Volume	Spread	Volume
1	0.999860	0.000140	0.999921	0.000079
2	0.999864	0.000136	0.992642	0.007358
3	0.999606	0.000394	0.991804	0.008196
4	0.999619	0.000381	0.991516	0.008484
5	0.999494	0.000504	0.991190	0.008810
6	0.999349	0.000651	0.999804	0.010196
7	0.999016	0.000984	0.989756	0.010244
8	0.998992	0.001008	0.989801	0.010199
9	0.998963	0.001037	0.989578	0.010422
10	0.998921	0.001079	0.989603	0.010397

According to Figure 5, the impulse response function can be seen for 1 to 2-year treasury bills.

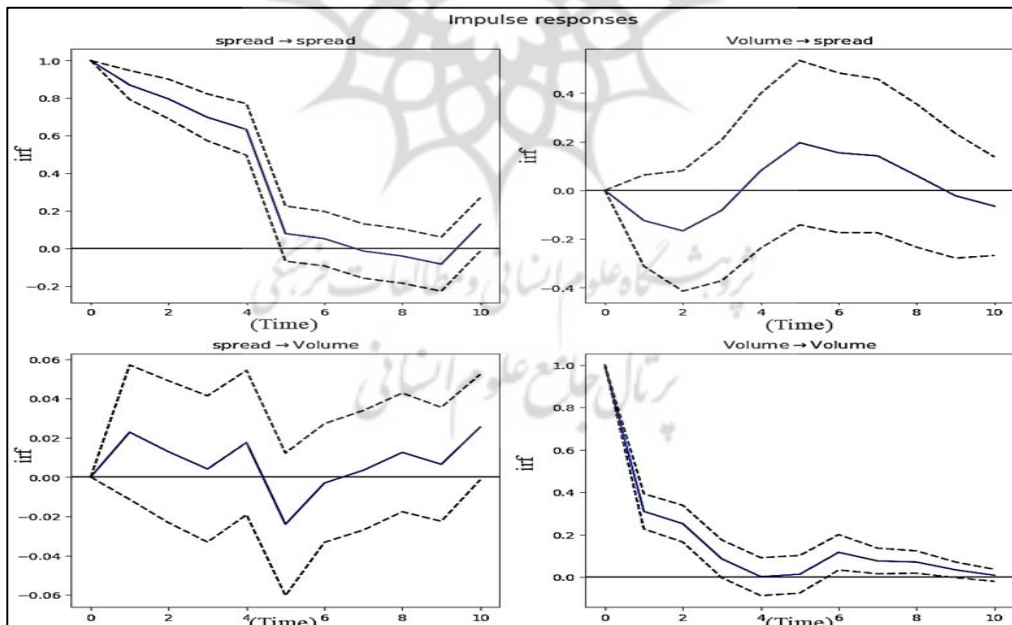


Figure 5. Diagrams of the Impulse response function for 1 to 2-year 106- Islamic treasury bill

As shown in Figure 5, the impulse response function of the 106-treasury bill shows the effect of incoming shock. The impact of the shock on the bid-ask spread variable decreases up to 7 periods, and its effect increases from that period onwards. The effect of the shock of the trading volume variable varies over ten periods and is not substantial.

Table 8 examines the variance decomposition of 1 to 2-year treasury bills. According to the obtained results, about a hundred percent of the source of volatility in bid-ask spread is caused by the variable of bid-ask spread in previous periods.

Table 8. Variance decomposition for 1 to 2- Islamic treasury bills

Variance decomposition		
106- Islamic Islamic treasury bill		
Period	Spread	Volume
1	0.998287	0.001713
2	0.996479	0.003521
3	0.996616	0.003384
4	0.996642	0.003358
5	0.994380	0.005620
6	0.992983	0.007017
7	0.991807	0.008193
8	0.991595	0.008405
9	0.991584	0.008416
10	0.991379	0.008621

Finally, according to the coefficient of determination or R^2 of the models, the variables used in this research have a proper distribution.

Discussion and Conclusion

This research investigates the influence of trading volume, one of the elements of the market microstructure, on the bid-ask spread of orders. According to the results obtained from the vector autoregressive model, in longer-term Islamic treasury bills, the effect of the trading volume variable on the bid-ask spread of orders in different periods is more significant than in shorter-term Islamic treasury bills, and the bid-ask spread variable in previous periods is influential in most shorter-term and long-term Islamic treasury bills.

By examining the impulse response function, the shock of trading volume in most long-term and short-term Islamic treasury bills has an unremarkable effect on the bid-ask spread variable. As a result, a shock to the trading volume can affect the bid-ask spread of orders in most of the Islamic treasury bills during several periods. However, it is not considerable; while the effects of the

bid-ask spread shocks during initial periods for long-term and short-term Islamic treasury bills are significant, they decrease sharply and disappear during the following periods.

Finally, variance decomposition was used to investigate the source of volatility in the bid-ask spread of orders, and according to the findings, the source of volatility is the bid-ask spread in previous periods.

Over the past few years, studies have been conducted on stocks in the stock market, and according to Pouyanfar's (2009) findings, trading volume did not have much effect on the bid-ask spread of orders. In most results, the bid-ask spread variable was more effective in previous periods. This research has reached almost the same results as the stock market by examining government bonds.

Also, according to the studies of Fleming and Engle (2019), the trading volume is one of the most influential factors in the ease of trading and the liquidity of government bonds. So, the trading volume in longer-term Islamic treasury bills is practical on the ease of execution of transactions and, consequently, on the bid-ask spread of orders.

Therefore, the effect of the bid-ask spread of orders in different periods is greater than the trading volume, especially in longer-term Islamic bills. As a result, traders during the trading of Islamic treasury bills, in most cases, pay attention to the bid-ask spread variable in the previous periods because most of the time, the source of volatility is the bid-ask spread variable in previous periods, and it affects the bid-ask spread of orders in the current period. Of course, if there is a shock in the variables, the shock of the trading volume remains for several periods. It unremarkably affects the bid-ask spread of orders in most of the short-term and long-term Islamic treasury bills.

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