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Providing an operational technique for hedging interest rate risk with debt issues in Iran

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ABSTRACT

Interest rate risk is one of the most important financial risks that economic enterprises faced. This risk is actually the probability of a decline in the value from unexpected fluctuations in interest rates in the market. Firms use different analytical models to evaluate the interest rate assessment and the effect of interest rate fluctuations on liabilities and assets and their cash flows. One of the risk hedging strategies is risk management using operational techniques.

In this research, with the aim of proposing an operational technique for hedging interest rate risk, the sensitivity coefficient of firms' stock returns to interest rate fluctuations in the period of 2011 to 2021 and after entering the debt market has been investigated and analyzed. In order to measure the interest rate sensitivity coefficient, a model similar to the model of Flannery and James (1984) and Deleze and Korkeamaki (2018) has been used. In this research, the autoregressive integrated moving average (ARIMA)model has been used to estimate the unexpected part of changes in interest rates, and the rolling window regression and panel data models have been used to estimate the interest rate sensitivity coefficient and analyze and investigate this sensitivity coefficient. The result of the research shows a decrease in the sensitivity coefficient to interest rate changes after the first entry into the debt market and finally the facilitation of interest rate risk management among debt bond issuers

Keywords:

Interest rate risk, interest rate risk management, debt issuers

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1. Introduction

Nowadays, major developments in business environments and markets, such as globalization and the high speed of technology changes, have increased competition and management difficulty in organizations. In complex environments, organizations need managers who consider and distinguish these inherent complexities when making important decisions. Effective risk management, which is based on valid conceptual principles, forms an important part of these decision-making conditions (Tari and Jolodar, 2011).

Due to continuous changes in environmental factors and economic systems, different risks affect the financial structure of different institutions every day. Various institutions, including financial institutions and even governments, face certain risks in their field of operation. These risks are in two financial and non-financial sectors, and interest rate risk is one of the important factors of financial risk. If organizations keep some of their assets as financial assets, they will face with this risk. Most of the balance sheet items of banks and financial institutions such as investment firms, include income and expenses that are somehow related to the interest rate (Hosseini and Motahari, 2013).

Interest rate risk is one of the most important financial risks faced by economic enterprises and especially financial institutions. Interest rate risk is actually the probability of loss due to decline in the value of an asset resulting from unexpected fluctuations in interest rates in the market. Interest rate risk is one of the types of market risk, which is usually under consideration by firms and financial market participants. This risk arises from unexpected and unpredicted interest rate fluctuations. (Sweeting, 2011)

The importance of managing this risk is that it enables business owners to plan future investments and develop the firm's activities by creating a stable cash flow for the firm. In addition, the reduction of fluctuations in cash flow and firm revenues leads to the reduction of financial crisis costs (by reducing the probability of the firm facing a crisis), smoothing the tax cost (if there is a progressive income tax) and reducing monitoring costs. In practice, interest rate risk management starts with decision-making and policy-making about the acceptable leverage of the firm and determining the optimal ratio of debt with a fixed rate on debt with a floating rate. Both of these ratios have a significant impact on the firm's interest rate risk management ability. Based on this, it is very important in managing the interest rate risk of firms to pay attention to finance using debt instruments that are appropriate to the firm's structure. While interest rate risk management has been studied more in the banking industry, non-financial firms also pay attention to interest rate risk and its coverage (Graham and Harvey, 2001).

Financing of firms can be from banks or the debt market or a combination of both. With the formation of the publicly traded bond market in Iran in recent years, it became possible for Iranian firms to benefit from financing opportunities from the debt market. The main issue in this research is whether firms have used the debt market in Iran to manage their interest rates risk, and whether the sensitivity to interest rate fluctuations among firms have decreased after entering to debt markets.

In this research, the main aim is to investigate stock return sensitivity to interest rate fluctuations among firms with bond issuance experience in Iran, especially in the first entrance to debt market. finally, if there is a relationship between the mentioned variables, an operational solution for managing the interest rate risk through the issuance of debt bonds can be provided for firms in Iran.

2. Literature Review and research review

2.1. Interest rate risk

Interest rate risk, as one of the market risk items, have a significant effect on the value of firms and especially financial firms. Interest rate risk generally appears in different situations. When interest rate increase, the financial cost of debts that have a floating interest rate increase, and this cost increase has a negative effect on the net profit of firms. In a situation where the interest rate increase is significant, it is even possible that firm will face a financial crisis; In the conditions of interest rate reduction, firm's income from deposit interest decreases, which is not favorable for firms with excess cash, and finally, when a firm has a large amount of loans with a fixed interest rate, in the period the reduction of the interest rate imposes a lot of opportunity cost for firm; Because these firms pay a higher interest cost than the rest of firms (i.e. firms that

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use floating interest rate loans or firms that took loans during the period of interest rate reduction).

In this case, interest rate risk is considered a significant competitive weakness for the firm. However, because it is not required to disclose it in the financial statements, so, there is always insufficient attention to it. In a point of economic view, the increase in interest rates causes people and businesses to save more and consume less and as a result, the consumption variable in the economy decreases. With the decrease in consumption, the demand for all goods and services in an economy decreases and the operating cash flow of firms decreases too. (Dhanani et al., 2008)

In general, interest rate risk is divided into four subgroups according to the origin of its creation:

1) Repricing risk: This risk is the most common type of interest rate risk and it comes from the time difference in maturity or pricing of assets and liabilities. (Khalili Iraqi and Hashemi, 2008)
2) Yield curve risk: When the yield curve changes, the price of bonds that were priced based on the initial yield curve will change. If the yield curve flattens, the yield spread between long-term and short-term interest rates narrows and bond prices change accordingly. If the yield curve becomes steeper, it means that the spread between long-term and short-term interest rates is widening; Therefore, the prices of long-term bonds will decrease compared to short-term bonds. The changes in the yield curve are based on the risk cost of bonds and expectations of future interest rates.
3) Basis risk: Basis risk comes from the lack of correlation and coordination of interest rates paid and received. For example, in a bank, the interest rates of a loan are based on Libor and its deposit rates are based on treasury bonds, the difference and lack of coordination in the changes of these rates may lead to losses to the bank.
4) Option risk: This risk is caused by options hidden in assets or liabilities. For example, if a firm has bonds that the issuer of bonds has the right to redeem before the maturity date, in the event of a decrease in the interest rate, the issuer of the bonds will redeem the bonds and the bond holder will suffer. Or in a bank, depositors have the right to withdraw before maturity and borrowers have the right to repay before maturity. (Asadpour, 2016)

2.2. Interest rate risk management

In the literature of finance, it is stated that under the assumption of a perfect market (there are no transaction costs, information is freely available to everyone, etc.) and there are no taxes, firms do not need to hedge interest rate risk, because management Risk does not affect the value of the firm and is irrelevant. (Modigliani and Miller, 1958). But in reality, there is no perfect market, risk management is relevant and important and affects the value of the firm; The importance of risk management is that it enables managers to plan future investments and develop the firm's activities by creating a stable cash flow for the firm. (Froot and Scharfstein,1994)

In addition, the reduction of fluctuations in cash flow and the firm's income leads to a reduction in financial crisis costs (by reducing the probability of the firm facing a crisis), smoothing the tax cost (if there is an income tax) and reducing monitoring costs. (Melbrak, 2002)

in the practice of interest rate risk management, it starts with decision-making and policy-making regarding the acceptable level of leverage of the firm and determining the optimal ratio of debt with a fixed rate to debt with a floating rate. Both of these ratios have a significant impact on the firm's interest rate risk management ability. (Dhanani et al., 2008)

firms use different analytical models to evaluate how much they are exposed to interest rate risk and the effect of interest rate fluctuations on liabilities, assets and cash flows. The most famous of these methods are duration analysis, gap analysis and value at risk. After evaluation, firms can use interest rate risk hedging tools to manage this risk. One of the risk hedging strategies is interest rate risk management using internal techniques (operational techniques). The most important methods of interest rate risk management using internal methods are:

1) Smoothing: in this method, based on the financial policies of the firm, balance is established between debts with a fixed rate and debts with a floating rate;
2) Leading and Lagging: In this method, based on the firm's prediction of exchange rate changes (according to the effect of interest rate fluctuations on the exchange rate), the time of payments and receipts of the firm is managed.
3) Matching: This method includes reconciling the nature of firm's assets and firm's liabilities.

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4) Netting: In this case, the net amount of exposed to interest rate risk is calculated, then this amount is covered using internal methods.

2.3. Debt market

Many researches have been done about bank financing or financing through public debt market. Diamond (1991) and Bolton and Freixas (2000) confirm the monitoring role of banks. In both articles, it is predicted that high-quality firms choose financing through the debt market whereas low-quality firms use bank financing due to the regulatory advantages of banks. Korkeamaki (2011), reports a significant change in interest rate sensitivity at the market level in Europe following the introduction of the Euro, and he documents observations from the corporate bond market. In his studies, he shows that there is a decrease in interest rate sensitivity at the same time as the growth of the corporate debt market in Europe. Financial structures in banks or debt market equip savings, price risks, capital allocation and absorption of shocks in different ways. Banks perform financial intermediation and bear risks on their balance sheets based on close relationships with their customers. In contrast, debt markets channel resources directly from savers to borrowers and act as platforms where equity and debt securities are priced, distributed, and traded. Alongside these differences, there is a long debate about the actual economic merits of bank-based versus market-based financial structures, and the results have changed over time. The literature published before 2008 does not favor one particular financial structure over another. But currently, the amount of financial development and liberalization is important for the real economy, and bank financing and the market are similarly important for economic growth. (Betts and Houben, 2017).

In Iran, the first bonds that issued was first Musharakah bonds in 1994. However, at that time there was no structured debt market for primary and secondary bonds transactions. It seems that the formation of the debt market took a new form with the start of the activities of investment banks in Iran in 2008 and the issuance of Islamic sukuks in 2010, and finally with the issuance of Islamic treasury bonds in 2017, the depth of the debt market increased and the volume of transactions became significant.

2.4. Research review

Ngalawa and Ngare (2014) investigated interest rate risk management in Kenyan banks. The researchers found empirically that the bank's exposure to interest rate risk or the income gap determines the structure of the balance sheet. These researchers showed that in Kenya, commercial banks usually retain a large exposure to interest rates that can be predicted through the income gap. The researchers also calculated the sensitivity of the income gap to the market interest rate set by the Central Bank of Kenya (CBK) through treasury instruments the researchers found that a 200-basis point change in CBK rates would lead to a change of net income equivalent to 0.4% of total assets of the bank

Akhtaruzzaman and et al. (2014) analyzed the dynamic relationship between interest rate risk and stock returns in Australia and America. In this article, by using the dynamic conditional correlation GARCH mode, the effects of spill-over effects of interest rate risk and return on Australian and US financial firms have been investigated. The researchers stated that Australian banks exhibit negative exposure to changes in both domestic and US interest rates, and interest rate fluctuations in the United States are an important predictor of the volatility of Australian banks' stock returns. The researchers in this research found that the time-varying conditional correlation between the stock returns of Australian and US financial institutions increases during financial crises. In addition, the conditional correlation increases (decreases) during contraction (expansion) periods of the US business cycle.

In addition to the importance of paying attention to interest rate risk management in banks, regarding the effect of interest rate changes on stock returns in the capital market, in an article, a researcher has examined this issue under the title "Conditional interest rate risk and cross-sectional excess stock returns". Atanasov (2016) stated in this article that the differences in excess stock returns can be related to its sensitivity to conditional interest rate risk. Value stocks, in particular, are sensitive to upside movements in interest rate growth, while growth stocks react strongly to downside movements in interest rate growth. According to asset pricing theory, the upside interest rate risk will have a negative risk premium that is higher than the risk premium associated with the downside interest rate risk.

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Pana and Xiao (2017) investigated the optimal dynamic management of assets and liabilities with interest rate risk and stochastic inflation. This article studies a continuous-time mean-variance asset-liability management problem under the Heston model. By using the Lagrange duality theorem and stochastic control theory, researchers have obtained closed-form expressions of the efficient investment strategy and the efficient frontier. They have also provided numerical experiments to analyze the sensitivity of the efficient frontier with respect to the relevant parameters in the Heston model.

Deleze and Korkeamaki (2018) investigated interest rate risk management by issuing debt securities in Europe. In this article, the researchers stated that compared to bank financing, the public debt market may allow firms to more quickly match maturity and risk structures between their assets and liabilities. The researchers stated in this research that new issuers in the European bond markets experience changes in their interest rate sensitivity due to the issuance of bonds.

Oberoi (2018) investigated interest rate risk management by combining floating and fixed rate debt. The researcher has analyzed the after-swap mix of fixed and floating rate debt in a sample of non-financial firms. The results of this research show that firms that have more fixed rate debt have higher liquidity ratios and lower operating income ratios. Also, individual firms are actively raising their fixed rate debt ratios significantly. The results show that more active firms use a different combination of debt in response to different motivations of risk coverage compared to less active firms.

Bozorg Asl and Razavi (2008) investigated the relationship between some macroeconomic variables and stock returns of firms listed on the Tehran Stock Exchange from 1997 to 2006. In this study, the seasonal returns of firms listed on the Tehran Stock Exchange is dependent variable and the seasonal data of interest rate, interest rate growth rate, GDP, GDP's growth rate, oil price and oil price growth rate in the time domain are independent variables. Using OLS regression, the results indicate that among macroeconomic variables, only interest rate has a significant effect on stock returns, and this effect is reversed. That is, with an increase in interest rates, stock returns are expected to decrease.

In a study, Saeedi and Pagheh (2013) investigated the effect of interest rate changes on stock returns and profitability of financial institutions listed in Tehran Stock Exchange. In this research, two measures of return on equity and return on assets have been used to measure profitability, and changes in short-term nominal interest rates (one year) and long-term real interest rates (five years) has been included as interest rate changes in the models. The results of this study indicate that there is a significant and inverse relationship between nominal interest rate changes and stock returns of financial institutions, but there is no significant relationship between real interest rate changes and stock returns.

Toroghe and Ahmadi (2015) evaluated the relationship between interest rate changes and stock returns of financial institutions listed in Tehran Stock Exchange using different methods. The results of fitting the researchers' model show that, at the 95% confidence level, interest rate fluctuations (both short-term nominal interest rates and long-term real interest rates) have a significant effect on financial institutions' stock returns, and this effect is of the opposite type. That is, increasing interest rate changes lead to a decrease in financial institutions' stock returns and vice versa.

In another research, Qayumzadeh and Rahimi Bafghi (2017) investigated the relationship between interest rate risk management and the combination of fixed and floating debt in Tehran Stock Exchange. In this research, the independent variable of interest risk management and the combination of fixed and floating debt are considered as dependent variables. Using five models, researchers have come to the conclusion that there is a significant relationship between interest rate risk management and debt composition in these firms, and all research hypotheses have been confirmed

Asiyabi Aghdam, Rahimzadeh and Rajaee (2021) investigated the effect of macroeconomic variables including interest rates on the behavior of stock prices of firms listed on the Tehran Stock Exchange. Researchers used the econometric methods of the TAR threshold self-return model. The data of the research variables are from 1991 to 2019 (a period of twenty-nine years). The results showed that there is a significant relationship between the economic variables and the stock price index in the stock exchange, but the behavior of the

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variables on the stock price index in the stock exchange is different.

3. Research methodology

In the current research, the main aim is to investigate and analyze the sensitivity coefficient of stock returns to interest rate fluctuations after entering the debt market in Iran. Therefore, it is of the post-event type and the past information is the basis of the analysis. This research is applied and is quantitative in nature. The statistical population includes all the firms accepted in Iran capital market and the statistical sample includes all the firms expect financial institutions (including banks, insurances, leasing, investment banks, holdings and investment firms) during the years 2011 to 2021 that their shares have been accepted and traded in Tehran Stock Exchange or Iran Fara Bourse. The research sample includes 285 firms.

3.1. Research questions

1) Is there a significant relationship between the unexpected part of interbank interest rate changes (the index of real interest rate changes) and stock returns?
2) Are the sensitivity of the firm's stock returns to interest rate fluctuations of bond issuers less than non-bond-issuing firms?
3) Does the sensitivity of firm's stock returns to interest rate fluctuations decrease when they enter the debt market for the first time?
4) Does the sensitivity of firm's stock returns to interest rate fluctuations for firms decrease in multiple times of issuing debt securities?
5) Is there a significant relationship between the sensitivity of firm's stock returns to interest rate fluctuations and leverage?
6) Is there a significant relationship between the sensitivity of firm's stock returns to interest rate fluctuations and the firms size?
7) Is there a significant relationship between the sensitivity of firm's stock returns to interest rate fluctuations and firms' profitability?
8) Is there a significant relationship the sensitivity of firm's stock returns to interest rate fluctuations and firms' taxes?

3.2. Research variables

3.2.1. Interest rate (I)

Considering that in Iran and based on the official statistics announced by Iran central bank, there is no real-time interest rate and interest rate fluctuations like floating interest rates in other economic structures. So, it is necessary to select another variable that is conceptually and structurally close to the real interest rate. It is clear that the real interest rate has always been fluctuating and changing depending on the supply and demand of money, which is reflected in the interbank interest rate in Iran's economy. In fact, the most important rate that has the function of guiding market interest rates in the money market is the reserve supply rate by the banking system. Therefore, in this research, the data related to the monthly interbank interest rate obtained from the central bank has been used as the short-term interest rate from the beginning of 2011 to the end of 2021. The variables in 3 stages of research are as Table 1 and three of these variables explain as bellow:

3.2.2. Unexpected changes in the short-term interest rate (ΔI)

Many researchers believe that interest rate time series contains predictable components. Based on this, an ARIMA model can completely predict the interest rate fluctuations. Therefore, an autoregressive integrated moving average (ARIMA) for estimation of unexpected changes in interest rate (ΔI) is used. The reasons for using the unexpected part of the interest rate in the model is that interest rate risk management is more focused on the unexpected part of the interest rate. Therefore, we follow Saunders and Yourougou (1990) and use the residuals of the ARIMA model as an indicator of unexpected interest rate fluctuations.

3.2.3. Interest rate sensitivity γ_{it}

This variable is actually the coefficient obtained from the implementation of linear regression in the second part of the research, which is actually the sensitivity coefficient of firms' stock returns to unexpected changes in interest rates. In this research, a regression model similar to Stone (1974), Flannery and James (1984), Deleze and Korkeamaki (2018) model was used to measure interest rate risk. A model in which interest rate sensitivity is measured by the coefficient of a factor in the regression for interest rate changes. In order to estimate the interest rate sensitivity, some researchers use the stock price, although this method is mostly used for financial institutions. The most common regression model to estimate the interest rate sensitivity for firms is as Eq. (1):

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$$R_{it} = \alpha_i + \beta_i R_{mt} + \gamma_i \Delta I_{it} + \varepsilon_i$$

Regarding other variables, the description of these variables and the methods of calculating them is described in the table 1. It is necessary to explain that three models (ARIMA, the rolling windows and panel data) were used in this study, and the variables of each model are separated in the table 1. In this article, we begin the analysis by estimating stock return sensitivity to interest rate fluctuations separately for each sample firm. Smith and Stulz (1985) suggest that firms' risk hedging activity will be reflected in lower stock return sensitivity to the state variable in our case interest rate changes.

3.2.4. Estimation models

In this research, according to the opinion of Smith and Stulz (1985) and similar research conducted at the level of European firms by Deleze and Korkeamaki (2018), the sensitivity of firm's stock returns to interest rate fluctuations with the entry into the debt market among listed firms is investigated. In fact, in the present research, the focus is more on the use of operational risk hedging instead of focusing on the use of financial derivatives with the purpose of hedging interest rate risk among firms except financial institutions. Guay and Kothari (2003) by examining the risk management programs of firms stated that operational risk hedging plays a greater role in corporate financial management compared to financial derivatives with the purpose of risk hedging.

In this research, it is assumed that the interest rate sensitivity of assets in the balance sheet is not affected by entering the debt market, and it is assumed that the interest rate sensitivity of liabilities in the balance sheet is reflected in the

Table1. Research variables

Model	Variable sign	Variable description	Variable type	Method for estimate variables
ARIMA	I_t	Interbank interest rate in month t	dependent variable	This data is obtained from Iran central bank.
	I_{t-1}	Interbank interest rate in month t-1	independent variable	The interbank interest rate with a one-month gap calculated in the ARIMA model.
Rolling windows regression	ΔI	Unexpected changes in the short-term interest rate	dependent variable	The residual of the ARIMA model implemented on the data related to the monthly interbank interest rate obtained from Iran central bank
	R_{it}	Monthly stock returns of firm i at time t	independent variable	It has been calculated according to the price at the beginning and end of the month of each share and taking into account the changes related to dividend and capital increase during the period.
	R_{mt}	Monthly return of total index at time t	independent variable	This return is calculated through the logarithm of the total market index figure at the end of each month to the total market index figure at the beginning of each month.
Panel data model	γ_{it}	the sensitivity of firm's stock returns to interest rate fluctuations	dependent variable	This coefficient is extracted after performing the rolling window regression.
	Lev	Leverage of firm i at time t	independent variable	Every year, it is calculated based on the ratio of the book value of long-term debt to the book value of assets.
	Size	Firm size i at time t	independent variable	To determine the size of the firms, the logarithm of the total assets of the firms has been used.
	TAX/EBIT	Tax-to-EBIT ratio	independent variable	This ratio is also calculated based on information about taxes and profits before deduction of interest and corporate taxes.
	EBIT/SALES	EBIT-to-sales ratio	independent variable	This ratio is also calculated based on the information related to sales and profit before deduction of interest and taxes of firms.
	BOUNDISSUER	First entrance to the debt market	Dummy variable	This variable is 1 when the firm issues its first bond and 0 otherwise.
	BOUNDUSING	Multiple uses of the debt market	Dummy variable	Taking the value of 1 when the firm publishes debt securities and 0 otherwise.
	ISSUINGFRIM	Bond issuer	Dummy variable	Issuers who have issued bonds during the period under review, number 1 and otherwise number 0

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sensitivity of stock returns to interest rate fluctuations. Access to debt financing has made interest rate risk management more possible. Also, it is presumed that the use of financing in the debt market through is related to the interest rate sensitivity of firms' stock returns. The basis of this research is that the sensitivity of stock returns to interest rate fluctuations at firm level that has been investigated

separately. Many researchers believe that the interest rate time series includes predictable components. Therefore, interest rate risk management can be focused on unexpected components of interest rate changes.

In the first stage of the research, based on Saunders and Yourougou (1990) model, an autoregressive integrated moving average (ARIMA) model has been used to predict unexpected changes in interest rates. For forecasting with ARIMA, Box – Jenkins Approach is used. ARIMA models are one of the famous modeling methods in time series, which are mainly used to forecast time series. In most cases, this model is shown as ARIMA (p, d, q), where p, d, and q are non-negative real numbers that determine the degree of autocorrelation, integration, and moving average. In this model, the future value of a variable is a linear function of past observations and random error sentences. The general form of a time series is as Eq. (2):

$$y_t = \alpha + \beta_1 y_{t-1} + \beta_2 y_{(t-2)} + \cdots + \beta_p y_{t-p} + \varepsilon_t - \phi_1 \varepsilon_{t-1} - \phi_2 \varepsilon_{t-2} - \cdots - \phi_q \varepsilon_{t-q}$$

In Eq 2, y_t is the time series value, β (i=1, 2..., p) and ϕ (i=1, 2..., q) are parameters of moving average model and autoregression model, respectively ε_t is a random process with zero mean and variance σ^2. In this research, the variable y_t is actually the monthly interbank interest rate or I_t. After estimating the ARIMA model to estimate the unexpected part of changes in the short-term interest rate (residuals extracted from the ARIMA model) in the second stage of the research, to estimate stock return sensitivity to interest rate fluctuations from a regression model similar to the Stone model (1974), Flannery and James (1984) and Deleze and Korkeamaki (2018) have been used. A model in which interest rate sensitivity is measured by the coefficient of a factor in the regression for interest rate changes.

$$R_{it} = \alpha_i + \beta_i R_{mt} + \gamma_i \Delta I_{it} + \varepsilon_i$$

In Eq (3), R_{it} is the stock return for each firm i in month t, R_{mt} represents market index return at time t, and ΔI_{it} is the unexpected changes in the interest rate obtained from the ARIMA model fitted from the first stage of the research. The regression is run at each year-end, using rolling 12-month windows during the research period from 2011 to 2021.

In the third stage of the research, the absolute value of annual γ_{it} for each firm has been used as sensitivity to interest rate changes to determine the risk limit. This research makes it possible for different firms to control the specific variables of each firm that potentially affect the interest rate sensitivity. To determine the control variables, Faulkender (2005) model was used and leverage (the book value of long-term debt to the book value of assets ratio), size (logarithm of assets), EBIT on sales ratio and the tax on EBIT ratio have been used.

Also, the effect of firm size is included in the model to determine the size effect on the ability to manage interest rate risk. Evidence from Graham and Harvey's (2001) survey shows that large firms differ from small in managing interest rate risk. Covitz and Sharp (2005) found that small firms are more likely to use practical risk hedging for interest rate management and generally have more incentives to manage interest rate risk. Rajan and Zingales (2003) argued that the increasing development of financing in Europe has benefited most large firms that have a better ability to provide information requested by financial markets.

Therefore, according to the results of previous researchers, the firm size entered in the model. Faulkender (2005) believes in the profitability effect on the interest rate sensitivity. Accordingly, in order to investigate the firm profitability effect on the interest rate sensitivity, the variable of EBIT on sales ratio and the tax on EBIT ratio is used. Among the control variables, leverage increases interest rate sensitivity, so leverage has also been used as a control variable. The next control variable (in addition to leverage, size, and profit margin) is tax, which is entered into the model as the tax on EBIT ratio. It seems that firms that have more taxes, in order to benefit as tax shield resulting from the financial cost of the firm's debts, they are more inclined to issue more debt securities.

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Deleze and Korkeamaki (2018) argue that bond issuers use debt markets to manage interest rate sensitivity and provide evidence of this issue at the level of bond issuers in the European Union. Therefore, in this research, along with the above control variables, three dummy variables, BOUND USING, BOUNDISSUER and ISSUING FRIM have also been used. The reason for using the BOUNDISSUER variable is whether the firm's ability to manage interest rate risk is affected by the first access to the debt market. This variable is one when the firm issues its first bond and zero otherwise. Regarding BOUN USING variable, the purpose of examining this variable is to examine the change in the interest rates sensitivity changes during the times when a firm issues bonds more than one during the study period. For the years the debt bonds are issued, number one and otherwise zero is included in the calculations. The purpose of adding this variable is to examine the impact of issuing bonds not only in the first entry into the debt market but also in the years when the bonds are issued. Regarding the ISSUING FRIM variable in the model, the analysis of the sensitivity of stock returns to interest rate changes for firms that have had the experience of issuing debt bonds at least once during the research period. Therefore, for the firms that have had the experience of issuing debt bonds, the number of one has been considered for the entire review period (years 2011 to 2021) and zero for non-bond issuers.

Considering the above explanations in a panel data model as Eq. (4), the influence of defined control and dummy variables on the interest rate sensitivity during the research period has been investigated.

$\gamma_{it} = \alpha_i + \beta_{1i}$ LEVERAGE$+\beta_{2i}$ SIZE$+\beta_{3i}$ (EBIT/SALES) + β_{4i}(TAX/EBIT) + β_{5i}BOUNDISSUER$+ \beta_{6i}$ BOUND USING$+ \beta_{7i}$ ISSUING FRIM$+\varepsilon i$

The results obtained from the above model show the influence of control and dummy variables on the sensitivity of stock returns to interest rate changes.

Table3.ARIMA model on the first difference of Interbank interest rate

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CONSTANT	0.0003	0.0011	0.2980	0.7662
AR (1)	0.2999	0.0789	3.8029	0.0002
MA (3)	-0.1982	0.1155	-1.7164	0.0888
SIGMASQ	0.0001	0.0000	13.5833	0.0000
Log likelihood	382/8937	Akaike info criterion		-6.36796
Mean dependent var	0.000302	Schwarz criterion		-6.27455
S.D. dependent var	0.010353	Hannan-Quinn criterion		-6.33003

4. Research results

According to the explanations provided in the research model, the findings in three stages of modeling are as follows.

4.1 Results of research models

First step: ARIMA model results

ARIMA model in the first step, the unit root test on the monthly interbank interest rate data obtained from Iran Central Bank during the years 2011 to 2021 has been done. Therefore, the Dickey-Fuller test was performed and the results were reported as described in bellow table.

Table2- Augmented Dickey-Fuller test statistic

variables	t-Statistic	prob
Interbank interest rate	-2.406985	0.1418
the first difference of Interbank interest rate	-8.252955	0.0000

According to the results of the above table, the monthly interbank interest rate has a unit root, which is solved by differentiating this unit root once.

In order to find the appropriate p and q in ARIMA model, estimates have been made in different states for p and q according to the correlogram and the results obtained using the lowest value of Akaike and Schwarz criteria and Hannan-Quinn criteria. The results of ARIMA model estimation for the data related to the monthly interbank interest rate indicate that the best order of the ARIMA model is ARIMA

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(1,3) as Table3. Also, an ARCH test to investigate the existence of heterogeneity of variance between residuals from ARIMA was used and according to the probability value of the relevant statistic, which is more than 5%, the residuals do not have the problem of heterogeneity of conditional variance, and the results are as described in Table 4.

Table 4. ARCH Test

Heteroskedasticity Test: ARCH			
F-statistic	0.013197	Prob. F (1,116)	0.9087
Obs*R-squared	0.013423	Prob. Chi-Square (1)	0.9078

Second step: Rolling windows regression

In the second stage of the research, as mentioned, a regression model similar to Stone (1974), Flannery and James (1984) and Deleze and Korkeamaki (2018) was used to estimate the stock return sensitivity to interest rate changes. The regression is run at each year-end, using rolling 12-month windows during the research period from 2011 to 2021.The table related to the statistical analysis of the variables related to this stage of the research is as described in table 5. At this stage of the research, the Dickey-Fuller test was used to test the significance of the research variables. The results are as described in table 6. According to the results of the Dickey-Fuller test, all research variables are stationarity. White's test was used to investigate the existence of heterogeneity of variance between the residuals in the model used in the research. The results of LR variance test are as described in table 7.

Table5. The statistical analysis of the variables

variables	mean	median	max	min	Std. Dev
Stock return	0.051668	0.0000	5.4974	-.71733	0.20021
Market return	0.038261	0.021460	.48630	-.180590	0.09318
Interbank interest rate	020138	0.1972	0.28818	0.09720	0.04066
Unexpected changes of interest rate	-0.00001	-0.000227	0.038741	-0.044638	0.01136

Table6, the Dickey-Fuller test results

Variables	t-Statistic	Prob.	results
Stock return	4847.21	0.0000	stationarity
Market return	3313.66	0.0000	stationarity
Interbank interest rate	7592.62	0.0000	stationarity
Unexpected changes of interest rate	7122.76	0.0000	stationarity

Table 7. White's test results

model	Type of test	t-Statistic	Prob.	results
1	LR	6926.88	0.0000	Variance heterogeneity
2	LR	6923.63	0.0000	Variance heterogeneity

In order to check the significance of the fixed effects method, two F-tests, Limer and Hausman, should be used. The results of F- Limer test is as described in table 8.

Table8. F- Limer test

model	Type of test	t-Statistic	Prob.	results
1	Cross-section F	0.541733	1.0000	pooled
2	Cross-section F	0.541698	1.0000	pooled

As can be seen, for the test of the first model of the research, there were no fix effects and there is no need to use the Hausman test.

In the following, the self-correlation has been examined. This classic assumption states that there is no correlation between the residuals of the regression. To check the independence of the residuals, the Breusch–Pagan test was used. In this test, the null hypothesis indicates the absence of autocorrelation and the opposite hypothesis indicates the existence of autocorrelation between residuals. Table 9 shows the

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results of the test for the absence of autocorrelation of the residuals.

Table9. Breusch–Pagan test results

model	t-Statistic	Prob.	results
1	204246.6	0.0000	Existence of correlation
2	204991.0	0.0000	Existence of correlation

The results of the test show that considering that at the 95% confidence level, the probability value of the F statistic is less than 5% in this model. In other words, the assumption of non-existence of autocorrelation in the error component in the model used in the research is not established and should be removed. Durbin-Watson statistic in

table 10 and 11 is equal to 2.001 and 2.005. Since this statistic is in the range of 1.5 to 2.5, it can be stated that in the research model, the absence of correlation between the residuals is accepted.

This means that this autocorrelation has been fixed according to the operational process of estimating the models.

The dependent variable in the first model, which is related to the investigation of the relationship between the firms' stock returns and the first difference of Interbank interest rate variable, is the stock return. The independent variables are the market return and the first difference of the monthly interbank interest rate. The results of this step are as described in table 10. The probability value of the total coefficient statistic (F statistic) is less than 5%, which indicates that there is a linear relationship between independent and dependent variables and the regression has the necessary statistical validity.

Table 10. Model 1 results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Market returns	0.7369	0.010926	67.4531	0.0000
the first difference of Interbank interest rate	-0.2538	0.08248	-3.077	0.0021
c	0.02359	0.00111	21.220	0.0000
AR (1)	0.04713	0.00522	9.030	0.0000
R-squared	0.1264	Durbin-Watson stat		2.0016
F-statistic		1777.963		
Prob(F-statistic)		0.00000		

It can also be seen in table 10 that the probability value for the variable of the first difference of Interbank interest rate is 0.0021 and the sign of the estimated coefficient for the said variable is negative. Therefore, it can be stated that interest rate fluctuations have a negative and significant effect on the firm’s stock returns in the capital market. Since the probability value is less than 5%, it can be said that there is a negative and significant relationship between the first difference of Interbank interest rate and stock returns.

In the second model, the independent variables are market returns and unexpected changes in the interbank interest rate. The test results of this model are as described in table 11. Therefore, it can be stated that interest rate fluctuations have a negative and significant effect on the firm’s stock returns in the capital market. Since the probability value is less than 5%, it can be said that there is a negative and significant relationship between unexpected changes in the interbank interest rate and stock returns. It can also be seen in table 11 that the probability value for the variable of unexpected changes in the interbank interest rate is

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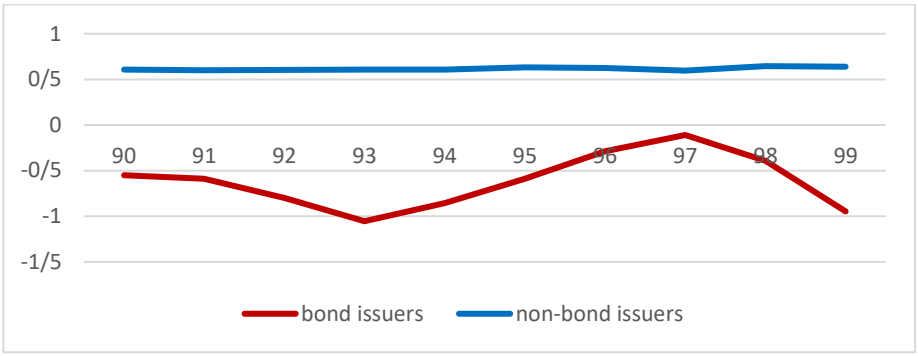

Fig1. Average of interest rate sensitivity

Table 11. Model 2 results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Market returns	۰,۷۶۲۳۸۳	۰,۰۰۹۰۳۲	۸٤,٤۰۷۷۱	۰,۰۰۰۰
Unexpected changes of Interbank interest rate	-۰,۳۹۵٦٤۱	۰,۰۷۲۵۹۸	-٥,٤٤۹۷٤٦	۰,۰۰۰۰
c	۰,۰۱۸۸۱۲	۰,۰۰۰۹۲۳	۲۰,۳۷۸۷۷	۰,۰۰۰۰
AR(1)	۰,۰٤٦۰۲۹	۰,۰۰٥۲۲٦	۸,۸۰۷۰۲۳	۰,۰۰۰۰
R-squared	۰,۱۸۰۰۸٤	Durbin-Watson stat		۲,۰۰٥۰۹۲
F-statistic		۲٦۹۸,۱٤٦		
Prob(F-statistic)		۰,۰۰۰۰۰۰		

0.0000 and the sign of the estimated coefficient for the said variable is negative. Since the value of the probability value is less than 5%, this indicates the existence of a relationship between the sensitivity of stock returns to unexpected changes in the interbank interest rate, and the negative coefficient indicates a negative effect on the firm's stock returns with an increase in interest rates. Therefore, it can be stated that interest rate fluctuations have a negative and significant effect on the firm's stock returns in Iran capital market. As a result, in response to the first question of the research, it can be stated that There is a negative and significant relationship between the fluctuations of the unexpected part of interbank interest rate (index changes in real interest rates) and stock returns. As the focus of the These coefficients are γ_{it}. Also, the results of further investigations on γ_{it} obtained from this section and the average of this sensitivity coefficient by separating debt bond issuers and non-bond issuers, indicate that the average sensitivity coefficient among debt bond issuers is lower than non-bond issuers during the period under review that it shows that in Fig1.

Therefore, in response to the second question of the research, it can be stated that the sensitivity of the stock returns of

debt bond issuers in Iran capital market to interest rate fluctuations is lower than none-bond issuers.

Table12. The statistical analysis of the variables

Variables	mean	median	max	min	Std. Dev
The sensitivity of firm's stock returns to interest rate fluctuations (γ_{it})	0.0838	0.04	14.02	-44	3.62644
Leverage of firm i at time t	0.55968	0.56	1.35	0.01	0.22564
Firm size i at time t	14.53579	14.29	20.77	10.17	1.749
EBIT-to-sales ratio	0.20648	0.16	0.99938	-0.85	0.23672
Tax-to-EBIT ratio	0.09543	0.09	0.25	0	0.08805
BOUNDISSUER	0.00883	0	1	0	0.09355
BOUND USING	0.01719	0	1	0	0.12999
ISSUING FRIM	0.08221	0	1	0	0.27475

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Third step: Panel data model

The γ_{it} coefficient extracted from the second stage of the research is actually the dependent variable of the third stage of the research. In a panel data model, the relationship of this variable with the specific characteristics of each firm like leverage, size, EBIT-to-sales ratio, Tax-to-EBIT ratio have been investigated.

Also, due to the existence of three dummy variables,BOUNDISSUER,BOUNDUSING,and ISSUING FRIM, investigating the sensitivity to interest rate changes by entering the debt market for the first time, investigating the sensitivity to interest rate changes by entering the debt market for several times, and finally, the change in the amount the sensitivity of stock returns to changes in interest rates has been investigated for bond issuers respectively. It is necessary to explain, considering the existence of 285 firms and examining the research topic during the years 2011 to 2021 and with monthly data, this model is a panel data.

The table related to the statistical analysis is as described in table 12.

Table 13. White's test results

Type of test	t-Statistic	Prob.	results
LR	550.64	0.0000	Variance heterogeneity

White's test was used to investigate the existence of heterogeneity of variance between residuals. The results of the variance-white LR heterogeneity test are as described in the table13.

As it can be seen, to test the third model of the research, it is necessary to use the generalized least squares method or EGLS. In order to check the significance of the fixed effects method, two F-tests of Limer and Hausman should be used. The results of Limer's F test are as the table14.

Table14. F- Limer test

Type of test	t-Statistic	Prob.	results
Cross-section F	1.550634	0.0000	panel

As can be seen, there were effects for the third research model test, and the type of effects was determined by using Hausman's test.

Table15. Hausman's test results

Type of test	t-Statistic	Prob.	results
Cross-section Random	45.7592	0.0000	Fixed effects

In the third research model, the obtained probability is less than 5%, therefore, we should use the fixed effects method in this model. The results of the implementation of the panel data model are in the form of table 16. The probability value of the overall coefficient statistic (F statistic) is equal to 0.000, which is less than 5%, which indicates that there is a linear relationship between the independent and dependent variables, and the regression has the required statistical validity. The Durbin-Watson statistic is 1.534, which is in the range of 1.5 to 2.5. The probability value of the test statistic for the financial leverage variable is 0.0000 and the sign of the estimated coefficient for this variable is positive. Since the probability value is less than 1%, it can be said that at the 99% confidence level, there is a positive and significant relationship between leverage and the sensitivity of firm's stock returns to interest rate fluctuations. Therefore, in response to the fifth research question, it can be stated that there is a significant relationship between sensitivity of firm's stock returns to interest rate fluctuations and leverage at the 99% confidence level. Firms with higher leverage are more sensitive to interest rate fluctuations.

The probability value for the firm size variable is 0.0000 and the sign of the estimated coefficient for the said variable is negative. The value of the probability value is less than 1%, therefore, in response to the sixth research question, it can be said that at the 99% confidence level, there is a negative and significant relationship between firm size and the sensitivity of firm's stock returns to interest rate fluctuations among the sample firms of the research. Firms with larger size are less sensitive to interest rate fluctuations.

The probability value for EBIT-to-sales ratio is 0.3787 and the sign of the estimated coefficient for the said variable is negative. Since the probability value is more than 5%. Therefore, in response to the seventh question of the research it can be said that there is no significant relationship between operating profit and sensitivity of firm's stock returns to interest rate fluctuations

The probability value for the Tax-to-EBIT ratio variable is 0.1941. Since the probability value is

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greater than 5%, it can be said that there is no significant relationship between tax and the sensitivity of stock returns to unexpected interest rate changes.

Table 16- The panel data results

Variables	Prob.	t-Statistic	Std. Error	Coefficient
Leverage of firm i at time t	2.5111	0.4766	5.2685	0.0000
Firm size i at time t	-0.7975	0.1000	-7.9743	0.0000
EBIT-to-sales ratio	-0.4158	0.4716	-0.8817	0.3781
Tax-to-EBIT ratio	-1.3666	1.0520	-1.2991	0.1941
BOUNDISSUER	-2.2923	1.0257	-2.2350	0.0255
BOUND USING	2.9009	0.7947	3.6504	0.0003
ISSUING FRIM	-0.1203	1.3543	-0.0888	0.9292
c	10.4874	1.5293	6.8577	0.0000
F-statistic	2.15066			
Prob(F-statistic)	0.00000			
Durbin-Watson stat	1.534767			

The probability value for the variable of the first access to the debt market (BOUNDISSUER) is 0.0255 and the coefficient of this variable in the model is negative and its value is 2.29231. Since the probability value is less than 5%, it can be stated in the answer to the third question of the research that the sensitivity of firm's stock returns to interest rate fluctuations decreases for firms when they first enter the debt market.

The probability value for the variable of using the debt market (BOUND USING) is 0.0003 and the coefficient of this variable in the model is positive and its value is 2.9. Since the probability value is less than 5%, it can be stated in the answer to the fourth question of the research that the sensitivity of firm's stock returns to interest rate fluctuations for firms doesn't changes in the many times of issuing debt securities. The reason for this issue can be due to the specific conditions of the industry or the

specific conditions of the year of issuance of debt bonds, the amount of interest rate fluctuations in the years of issuance of debt bonds, or in bull and bear market, which can be further investigated in future research.

The probability for Issuing Firms variable is 0.9292 and the coefficient of this variable is negative in the model and its value is 0.1203. Since the probability value is more than 5%, there is no significant relationship between this variable and the sensitivity of firm's stock returns to interest rate fluctuations, and it can be stated that the sensitivity of stock returns was not significant only because of being a debt issuer during the period under review. And other factors can also affect this issue, but definitely with the first entry into the debt market, the sensitivity to interest rate changes decreases.

4.2 Analysis of research findings

As stated in the previous parts of the research, the purpose of this research is to investigate and analyze changes in the sensitivity of firm's stock returns to fluctuations in interest rates by entering the debt market. Considering the importance of the unexpected part of interest rate changes in interest rate risk management. The unexpected part of interest rate changes was extracted using the ARIMA model, and then using a rolling window regression between the returns of firm's stocks and the unexpected part of interest rate changes, it was found that there is a significant and negative relationship between these two variables and the coefficient of sensitivity of firm's stock returns to interest rate changes was extracted from this rolling windows regression.

The results of the research models indicate that the average sensitivity coefficient among debt bond issuers is lower than non-bond issuers and therefore, their lower sensitivity to interest rate changes can be related to the size of the firm to some extent. Table 17 shows the mean and median of leverage, size, EBIT to sales ratio, tax to EBIT ratio and the sensitivity of firm's stock returns to interest rate fluctuations among the firms in the research sample. During the research period, it shows that the data related to debt bond issuers has been separated from other firms. As it is

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clear from the results, debt bond issuers have on average larger size, higher leverage, higher profit, tax less and have less sensitivity to interest rate changes compared to non-bond issuers. However, the sensitivity of firm's stock returns to interest rate fluctuations among debt bond issuers fluctuated during the research period, and Fig 1 shows the amount of these fluctuations, which if these fluctuations compare with picture number two, which shows interest rate fluctuations during the period under review.

It can be stated in this way that the sensitivity of firm's stock returns to interest rate fluctuations, can be related to the amount of interest rate fluctuations during the review period and bull and bear market. But what is clear from the results of this research is that the average sensitivity of debt bond issuers is lower than non-bond issuers, and also the results of the panel data implementation in the third part of the model of this research show a decrease in the sensitivity coefficient to interest rate changes in the first entry into the debt market, although firms may not have decided to enter the debt market for this exact reason.

Also, the Table 18 shows results of research in response to research questions:

Table17.Analysis data of firms

		Bond issuers	Non-bond issuers
Leverage	mean	61.94%	60.14%
	median	61.47%	59.80%
Firm size	mean	28.39%	19.62%
	median	26.56%	17.33%
EBIT-to-Sales	mean	16.38	13.52
	median	16.33	13.43
Tax-to-EBIT	mean	7.93%	8.94%
	median	8.05%	9.60%
The sensitivity of firm's stock returns to interest rate fluctuations (γ_{it})	mean	-11.89%	58.37%
	median	-15.75%	-0.27%

Table18.Response to research questions

Research Questions	Response	Kind of relation between variables
Is there a significant relationship between the unexpected part of interbank interest rate changes (the index of real interest rate changes) and stock returns?	Yes	Negative
Are the sensitivity of the firm's stock returns to interest rate fluctuations of bond issuers less than non-bond-issuing firms?	Yes	…..
Does the sensitivity of firm's stock returns to interest rate fluctuations decrease when they enter the debt market for the first time?	Yes	……
Does the sensitivity of firm's stock returns to interest rate fluctuations for firms decrease in multiple times of issuing debt securities?	No	…..
Is there a significant relationship between the sensitivity of firm's stock returns to interest rate fluctuations and leverage?	Yes	Positive
Is there a significant relationship between the sensitivity of firm's stock returns to interest rate fluctuations and the firm's size?	Yes	Negative
Is there a significant relationship between the sensitivity of firm's stock returns to interest rate fluctuations and firms' profitability?	No	……
Is there a significant relationship the sensitivity of firm's stock returns to interest rate fluctuations and firms' taxes?	No	……

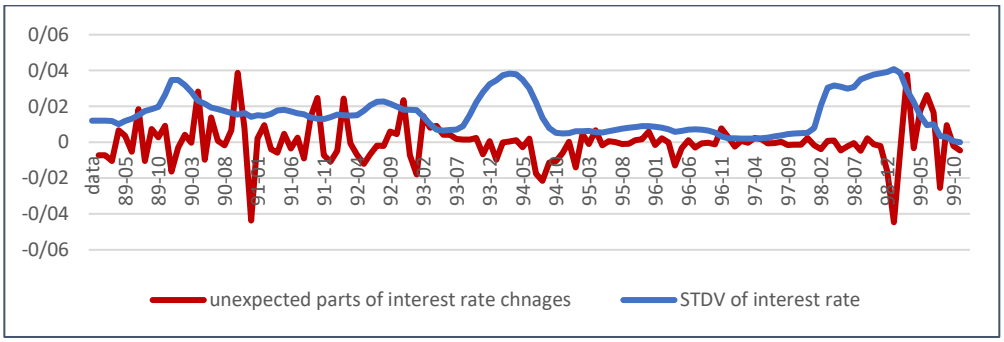

Fig2. Interest rate changes

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5. Conclusions

Interest rate risk is one of the most important financial risks faced by economic enterprises and especially financial institutions. Interest rate risk is actually the probability of a decline in the value from unexpected fluctuations in interest rates in the market.This risk arises from unexpected and unpredicted interest rate fluctuations. firms use different analytical models to evaluate how much they are exposed to interest rate risk and estimate the effect of interest rate fluctuations on their liabilities, assets and cash flows. Firms can use interest rate risk hedging tools to manage this risk. One of the risk hedging strategies is interest rate risk management using internal techniques (operational techniques). Researchers such as Guay and Kothari (2003) by examining the risk management programs of firms believe that operational risk hedging compared to financial derivatives with the purpose of risk hedging play a greater role in corporate financial management. In line with Guay and Kothari's comments, researchers such as Deleze and Korkeamaki (2018) investigated the sensitivity of stock returns to changes in interest rates in European countries and to this issue and found that debt bond issuers use debt markets to manage interest rate risk and have provided evidences about this issue. The researchers state that their results merely reflect the lower sensitivity of debt bond issuers to interest rate changes, while the bond issuers may not have made decisions related to debt bond issuance to manage interest rate risk. In line with the research of these researchers and with the aim of providing an operational solution to manage the interest rate risk in the Iran, especially in the situation where the use of financial derivatives is not available for the purpose of hedging the interest rate risk in Iran, this research continues the research of Deleze and Korkeamaki in Iran capital market.The statistical population includes all the firms listed in the capital market and the statistical sample includes all the firms other than financial institution during the years 2011 to 2021 that their shares have been listed and traded in Tehran Stock Exchange or Iran Far Bourse. The research sample includes 285 firms. In order to do this research, three ARIMA models, rolling window regression model and panel data model have been used. The results show a decrease in the sensitivity of debt bond issuers' stock returns to unexpected interest rate changes in Iran and by entering the debt market. Of course, the results of this research can be further investigated at a more detailed level and in terms of industry characteristics, interest rate fluctuations during the period under review and in bull and bear capital market. Because in some industries, the sensitivity to changes in interest rates will be higher and can be a subject for future research. In addition to this, the results showed that among the firms in the research sample, firms with Higher leverage are more sensitive to interest rate changes. Also, the results show that firms with a larger size is less sensitive to interest rate fluctuations. In addition, the results show that there is no significant relationship between EBIT and taxes with the sensitivity of firm's stock returns to interest rate fluctuations.

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