İnönü University International Journal of Social Sciences / İnönü Üniversitesi Uluslararası Sosyal Bilimler Dergisi

I N I J O S S

http://dergipark.org.tr/tr/pub/inijoss

Volume/Cilt 13 Number/Sayı 1 (2024)

ARAŞTIRMA MAKALESİ | RESEARCH ARTICLE

THE IMPACT OF INTEREST AND INFLATION RATES ON STOCK RETURNS: QUANTILE REGRESSION ANALYSIS FOR TÜRKIYE

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Atıf / Citation: Karagöz, K. (2023). The effect of interest and inflation rates on stock returns: quantile regression analysis for Türkiye. *İnönü Üniversitesi Uluslararası Sosyal Bilimler Dergisi*, (INIJOSS), 13(1), 227-244.

https://doi.org/10.54282/inijoss.1369804

Abstract

Fama's "proxy" hypothesis and Liquidity Preference Theory suggest that there is an inverse relationship between interest and inflation rates and stock prices/returns. On the other hand, according to the Fisher hypothesis suggests that there is a positive interaction between the stock market returns and inflation rate. The increase in the interest rate, on the one hand, due to the increase in the discount rate and, on the other hand, due to the alternative cost of investment, reduces the interest towards the stock market and increases the tendency towards the bond market, causing share prices to fall. However, it is seen that the relationships in question are far from certain, and the findings obtained from different samples with different methods give results that do not match the expectations implied by the hypotheses.

The nexus between the stock market and interest and inflation rates in Türkiye, which has been faced with high interest rates and inflation for many years except short-term periods, has been examined using different time series methods in the empirical literature. In this study, the subject is investigated in a different way through the Quantile Regression (QR) method. In the study, where the effect of the nominal interest rate on stock prices was examined by dividing it into two components: real interest and inflation rates, a four-fold sub-sector distinction was made, namely service, financial, industrial and technology indices. When it comes to the effect of nominal and real interest rates on returns in QR estimates, it is seen that the service and industrial sectors differ in terms of both tail and sign. The similarities between Least Squares estimates and QR estimates are striking. However, the potential of the volatility level of variables to create differentiation in relationships is also a point that should not be overlooked.

Keywords: Stock market, interest rate, expected inflation rate, quantile regression.

Received / Geliş Tarihi: 02.09.2023 Accepted / Kabul Tarihi: 29.06.2024

FAİZ VE ENFLASYON ORANLARININ HİSSE SENEDİ GETİRİLERİNE ETKİSİ: TÜRKİYE İÇİN KANTİL REGRESYON ANALİZİ

Öz

Fama'nın "temsil" hipotezi ve Likidite Tercihi Teorisi faiz ve enflasyon oranları ile hisse senedi fiyatları/getirileri arasında ters yönlü bir ilişki olduğunu öne sürmektedir. Buna karşılık Fisher hipotezi enflasyon ile hisse senedi piyasası arasında pozitif ilişki olduğunu öne sürmektedir. Faiz oranındaki yükselme, bir yandan iskonto oranındaki artış diğer yandan yatırımın alternatif maliyeti nedeniyle hisse senedi piyasasına ilgiyi azaltıp tahvil piyasasına yönelimi artırarak hisse fiyatlarının düşmesine neden olmaktadır. Bununla birlikte, sözkonusu ilişkilerin kesinlikten uzak olduğu, farklı yöntemlerle farklı örneklemlerden elde edilen bulguların hipotezlerin işaret ettiği beklentilerle uyuşmayan sonuçlar verdiği görülmektedir.

Kısa süreli dönemler hariç uzun yıllar boyunca yüksek faiz ve enflasyon ile karşı kaşıya bulunan Türkiye'de hisse senedi piyasası ile faiz ve enflasyon oranlarının ilişkisi ampirik literatürde farklı zaman serisi yöntemleri kullanılarak incelenmiştir. Bu çalışmada ise konu farklı bir yol izlenerek Kantil Regresyon (QR) yöntemi aracılığıyla araştırılmaktadır. Nominal faiz oranının reel faiz oranı ve enflasyon oranı şeklinde iki bileşene ayırılarak hisse senedi fiyatlarına etkisinin incelendiği çalışmada hizmet, mali, sınai ve teknoloji endeksleri şeklinde dörtlü bir alt sektör ayrımına gidilmiştir. KR tahminlerinde nominal ve reel faiz oranlarının getiriler üzerindeki etkisine bakıldığında, hizmet ve sanayi sektörlerinin hem kuyruk hem de işaret açısından farklılık gösterdiği görülmektedir. Enküçük kareler tahminleriyle QR tahminleri arasındaki benzerlikler dikkat çekmektedir. Bununla birlikte, değişkenlerin oynaklık düzeyinin ilişkilerde farklılaşma yaratma potansiyeli de gözden uzak tutulmaması gereken bir noktadır.

Anahtar Kelimeler: Hisse senedi piyasası, faiz oranı, beklenen enflasyon oranı, kantil regresyon.

Introduction

The effects of changes in macroeconomic variables on financial investment instruments, especially stock returns, have long attracted the attention of market players and academic circles. Changes that may occur in these macroeconomic factors, which can generally be described as non-market risk factors, have the potential to affect the activities and financial structures of the listed companies, which are economic units after all (Flannery and Protopapadakis, 2002; 751). Since the pioneering work of Chen et al. (1986), the relationship between macroeconomic factors and the stock market has been examined in numerous studies, and a certain consensus has emerged regarding the impact of inflation and interest rates on stock returns.

According to financial theory, an inverse relationship exists between interest rates, stock returns, and prices. In the Liquidity Preference Theory framework, an increase in interest rates causes the money to move towards higher interest rates, so demand for the stock market decreases and returns fall. On the other hand, according to the Fischer effect hypothesis, rising inflation causes interest rates to rise. Inflation caused by an unexpected increase in the money supply can cause an increase in output and the resulting rise in stock prices if monetary expansion is expected to continue. The behaviour of stock prices on interest rates and inflation has been investigated by various time series analysis methods. However, in this study, the subject is handled in a different approach by using the Quantile Regression (QR) method.

It would not be realistic to expect the sensitivity of stocks to macroeconomic developments to be the same in all sectors. Many studies reveal that the effects of fluctuations in macroeconomic variables may differ according to sectors (see Jareño et al., 2016; Aktürk, 2016). These impacts of macroeconomic factors on financial assets may also vary over time. A change in the direction and severity of this interaction may occur over time due to the impact of investor preferences, sectoral developments, and changes in financial markets.

The aforementioned interaction between stock returns and interest rates has been the subject of many empirical studies in the Turkish case, and different results have been obtained depending on the study design. In this study, the subject is re-examined by the quantile regression method and sub-sectors, which have not been used before for the Turkish stock market and allow for determining the effect of interest rates at different return levels. The results obtained show that the relationship in question varies by sectors and quantiles, and that the fluctuations in the real interest and expected inflation rates also affect the results.

1. Modelling Assets Returns

In the finance literature, various approaches have been developed since the 1960s to model the prices/returns of investment instruments. These approaches can be divided into three strands: Capital Asset Pricing Model (CAPM), Arbitrage Pricing Theory (APT), and multi-factor models which can be regarded as an extension of APT. Factor models and APT were developed as an alternative to the CAPM, which takes a single risk factor into account and eliminates the deficiencies in this model (Akkum and Vuran, 2005). CAPM and similar asset pricing models are used specifically to estimate the cost of capital and/or the investor's expected return. For this reason, the model has a wide range of uses, from project valuation, where the cost of capital needs to be calculated, to purchasing a single share and/or creating a portfolio. However, predicting returns is not only a necessary issue for investors. With the liberalization process of the markets, discussions have begun on what the pricing behaviour of companies, especially those operating in regulated sectors, should be (Kulalı, 2016).

Standard CAPM relates the expected returns of the assets in the portfolio to the expected excess returns. APT, on the other hand, establishes a relationship between the expected returns of assets and the expected returns in a portfolio. The difference between the two approaches is that in APT it is assumed that the portfolio does not have a fundamental impact. If the portfolio is well diversified with exposure to only one risk factor, the two approaches are almost equivalent. On the other hand, if the portfolio is exposed to risk factors specific to the assets in the portfolio in addition to the common risk factor, there will be a difference between the two models (Jarrow and Rudd, 1983).

CAPM was first proposed by Sharpe (1964) and later developed by Lintner (1965) and Mossin (1966). In CAPM, which is considered the first asset pricing model and expressed as in the equation below, the market portfolio is the only variable, and all risky financial assets are tried to be explained with the help of market portfolio.

$$R_i = R_f + \beta_i(R_m - R_f)$$

Here R_i, R_f, R_m are expected return of financial asset *i,* risk-free interest rate, and expected return of the market respectively. β_i denotes the sensitivity of the financial asset to the movement of the entire market. In this model, it is assumed that systematic risk, represented by the beta coefficient, is the only factor affecting returns associated with asset *i*.

In CAPM, which is based on Markowitz's modern portfolio theory, the concepts of risk and return are developed under the assumptions of the Efficient Market Hypothesis. In addition to the assumptions of the hypothesis in question, the model is based on additional assumptions such as all investors having the same investment period, being able to borrow and lend with the same risk-free interest rate, having free and instant access to information, and having homogeneous expectations. The CAPM approach has been criticized because most of the assumptions it is based on do not fit real life (Akkum and Vuran, 2005).

The beta coefficient in CAPM is far from explaining all expected returns. Therefore, in order to better model the behaviour of expected returns, more factors need to be taken into account, which requires resorting to multifactor pricing models. However, since CAPM will be applied period by period under very strict assumptions, the necessity of more factors becomes apparent from a theoretical perspective. At this point, two main theoretical alternatives can be mentioned. The Arbitrage Pricing Theory (APT) and the Intertemporal Capital Asset Pricing Model (ICAPM). APT is fundamentally based on arbitrage arguments while ICAPM developed by Merton (1973) was built on certain equilibrium arguments.

As an alternative approach to CAPM Ross (1976) proposed the Arbitrage Pricing Theory (APT) which is more comprehensive than CAPM because it includes more risk factors. Additionally, unlike CAPM, in the APT there is no need to define the market portfolio. However, this generalization brings with it some costs. In its most comprehensive form, APT allows defining an approximate relationship between the expected returns of assets besides a large number of undefined factors. When the model is so comprehensive, it becomes difficult to reject it.

In the Arbitrage Pricing Theory, the markets are assumed as competitive and frictionless. Under these assumptions the return-generating process for asset *i* can be described as follows:

$$R_i = a_i + \mathbf{b}_i'\mathbf{f} + \varepsilon_i$$

Here R_i is the return for asset *i*, whereas a_i is the intercept of the factor model. $\mathbf{b}_i$ and $\mathbf{f}$ are a $(K \times l)$ vector of factor sensitivities for asset *i* and $(K \times l)$ vector of common factor realizations, respectively. ε_i is the disturbance term as usual (Campbell et al., 2012: 219, 220).

Although APT argues that financial asset returns are affected by systematic risk factors, the number and definitions of these risk factors are not clearly stated in the model, and it is criticized for this aspect. For this reason, there is no consensus in the literature about the systematic risk factors that the researchers who tested this model included in their analysis, and it is observed that they added different variables such as exchange rate, inflation, interest, and market risks to the models. Following these theories, Fama and French (1993) expanded this model by adding two more factors to the market risk premium in the CAPM equation. These factors are called scale factor and value factor. In their study, they tested the effect of firm size and book-to-market value ratio on returns. Fama and French (2015) added two more factors to the three-factor model they previously developed and introduced a new five-factor CAPM model, which they argue explains stock returns better (Canöz and Yiğit, 2022). It seems that the factors added by Fama and French are variables that reflect the market microstructure.

2. Quantile Regression

When the empirical finance literature is examined, it is seen that symmetric linear connections are mainly taken into account in the analysis of the relationships between variables, and the effects of upward and downward movements of the markets or small and large-scale changes are not distinguished (Rejeb, 2017: 797). A suitable tool to investigate such multifaceted interactions between variables is the quantile regression (QR) method developed by Koenker and Bassett (1978) though as an idea can be traced back to 18th century (Allen et al., 2013). Estimates will not be effective and reliable if the distribution of the dependent variable is not normal in the OLS method. The QR approach, on the other hand, allows the dependent variable to explain the change in different quantiles. Furthermore, the QR method can capture the change in parameters for different quantiles.

Quantile regression method is more effective tool than Ordinary Least Squares (OLS) in analysing the extremes of a distribution (Allen et al., 2013: 90). The essence of the method is based on the principle of the minimization of the sum of absolute error terms which is weighted asymmetrically. In this process, depending on the selected quantile different weights are attained to positive and negative residuals.

The quantile regression model can be expressed in a compact way as follows:

$y_i = x_i'\beta_\theta + \varepsilon_{\theta i}$

$\text{Quant}_\theta(y_i|x_i) = x_i'\beta_\theta \; (i = 1, \dots, n)$

where β_θ and x_i are $(K \times 1)$ vectors, and $x_i \equiv 1$. Here, $\text{Quant}_\theta(y|x)$ stands for the θth quantile of y conditional on x. As Koenker and Bassett (1978) suggested the quantile regression estimator for β_θ (where x need not be discrete) to be a solution to

$$\min_\beta \frac{1}{N}\sum_{i=1}^{N} \rho_\theta(y_i - x_i'\beta)$$

The population θth quantile of y, μ_θ, is a solution to $\min_\mu E[\rho_\theta(y_i - \mu)]$. By analogy between population and sample, $\widehat{m}_\theta$ is a solution to $\min_\mu \frac{1}{N}\sum_{i=1}^{N} \rho_\theta(y_i - m)$. Since $\text{Quant}_\theta(y|x) = x'\beta_\theta$, a solution to $\min_\mu E(\rho_\theta(y - \mu)|x)$ is $\mu_\theta = x'\beta_\theta$. Thus β_θ is a solution to $\min_\beta E[\rho_\theta(y - x'\beta)]$ and by the analogy principle $\hat{\beta}_\theta$ is a solution to $\min_\beta \frac{1}{N}\sum_{i=1}^{N} \rho_\theta(y_i - x_i'\beta)$. The estimation of β_θ is obtained through the solution of the following optimization problem:

$$\beta_\theta = \text{argmin}_\beta \left\{ \sum_{i:y_i > x_i'\beta} \theta|y_i - x_i'\beta| + \sum_{i:y_i < x_i'\beta} (1-\theta)|y_i - x_i'\beta| \right\}$$

In solving this optimization problem, the simplex algorithm or the GMM framework, based on a linear programming representation can be used (Buchinsky, 1994: 410; Buchinsky, 1998: 94,95; Jareño et al., 2016).

3. Related Empirical Literature on the Turkish Stock Market

The effects of interest and inflation rates on stock returns in Türkiye have been empirically examined together with a group of other macroeconomic variables in dozens of studies. When these studies are evaluated in terms of finance theory, it is seen that a few of them are based on APT, while others examine the relationship based on the multi-factor model.

As can be seen in the summary given in Table 1, findings regarding the effects of interest and inflation rates on stock returns differ in the analyses carried out on the Turkish stock market example. While the effect of the interest rate is found to be significant and negative in most studies, in line with finance theory, it is noteworthy that the effect of the inflation rate is more unstable. In many studies, it is also seen that the variables in question have statistically insignificant effects. Although the dependent variables included in the studies are generally the BIST-100 index, company or sector-level indices are also used. It should also be taken into consideration that the results obtained in the studies are conditional on the indicators. In many studies, the consumer price index value is used directly under the name of inflation. A similar situation also applies to the dependent variable, the return series. Although return is mentioned in most studies, it is seen that the index value is used.

Table 1. Summary of the related empirical studies

Paper	Period	Method	Dependent Variable	Interest	Inflation
Akkum & Vuran (2005)	1999-2002	APT	Firm level (20) returns	S, 3/20	S, 5/20
Zügül & Şahin (2009)	2004-2008	MFM	ISE-100 index	S, N	S, P
Demir & Yağcılar (2009)	2000-2006	APT	Firm level (13) returns	IS	
Çil (2010)	1996-2009	TVECM	ISE-100 index		S, P/N
Cihangir&Kandemir (2010)	1998-2002	APT	Firm level (16) returns	IS	S, P
Yurttançıkmaz (2012)	1994-2010	MFM	ISE-100 index	S, N	
Kaya (2013)	2002-2012	MFM	ISE-100 index	IS	
Akbaş (2013)	1986-2012	TAR	ISE-100 index	S, P	
Aktaş & Akdağ (2013)	2008-2012	MFM	ISE-100 index	S, N	S, P
Çetin & Bıtırak (2015)	2000-2009	APT	BIST-100 index	S, N	
Özkan (2015)	2003-2014	MFM	BIST-100 index		S, N
Yeşildağ (2016)	2003-2016	APT	BIST sub-indices (27)	S, N	IS

Kendirli & Çankaya (2016)	2009-2015	MFM	BIST-Banking index		IS
Dinçergök (2016)	2000-2008	MFM	BIST sector indices (4)	S, N	
Eren & Başar (2016)	2005-2014	MFM	BIST-100 index	S, N	S, N
Coşkun & Ümit (2016)	2000-2014	MFM	BIST-100 index	IS	
Aktürk (2016)	1986-2013	MFM	BIST-100 index		S, N
Alper & Kara (2017)	2003-2017	MFM	BIST-Industry index	S	IS
Sancar et al. (2017)	2000-2016	MFM	BIST-100 index		S, P
Erol & Aytekin (2019)	2009-2018	MFM	BIST-100 index	S, N	S, P
Güney & Ilgın (2019)	2007-2018	MFM	BIST-100 index	S, N/P	
Gürsoy (2019)	2006-2017	MFM	Firm level (10) returns	IS	IS
Atıcı et al. (2019)	2010-2017	APT	BIST-30 index	S, P/N	S, N
Akyol (2020)	2006-2019	MFM	BIST-100 index		S, P
Okşak & Sarıtaş (2020)	2010-2020	MFM	BIST-100 index		S, P
Öndeş & Levet (2020)	2008-2018	MFM	Firm level (13) returns	S, N	IS
Yeşildağ (2021)	2009-2019	MFM	BIST-100 index	S, N	
İlhan & Bayır (2021)	2010-2021	MFM	BIST sector indices (2)	S, N	
Heidari & Rishekani (2022)	2000-2017	MFM	BIST-100 index		S, P/N
Sönmez & Noyan (2022)	2008-2022	MFM	BIST-100/30 index		IS
Özdemir et al. (2023)	1998-2022	MFM	BIST-100 index		S, P

Note: N: Negative, P: Positive, S: Significant, IS: Insignificant, MFM: multi-factor model, APT: Arbitrage Pricing Theory, TAR: Threshold VAR, TVECM: Time-Varying Error Correction Model. The name of the Istanbul Stock Exchange (ISE for short) was changed to "Borsa Istanbul" (BIST) on April 5, 2013.

Similar to the approach in this study, Özkan (2015) examined the effect of inflation expectations on stock returns and concluded that there was no significant effect while Aktürk (2016) found evidence that expected inflation has a significant and negative effect on returns. Considering the effect of market returns, Demir and Yağcılar (2009) found that the ISE-100 index, which they took into the model to represent the general market price, had a positive and significant effect on the stock returns of all 16 banks in the sample.

In the abovementioned studies, estimation was made using the OLS method, explicitly or implicitly assuming that there is a valid linear relationship between macroeconomic variables and stock returns on average. However, when assessing risk, investors may sometimes want to consider high or low risk separately rather than the average value, for which OLS would not be a suitable method. In this case, besides the threshold regression and regime-switching models, the quantile regression method which allows examining valid relationship types at different risk levels would be more appropriate.

4. Econometric Analysis

4.1. Model, Variables and Data

Fama (1981), and Geske and Roll (1983) explained the negative relationship between stocks and inflation with the macroeconomic chain of relations hypothesis, attributing it to the quantity theory of money and money demand. In this approach, it is accepted that contrary to the relationship revealed in the Philips curve, there is a negative relationship between inflation and real economic activities and that stock returns are directly related to real economic activities. In the structure proposed by Fama (1981) and Geske and Roll (1983), the relationship between stock return and inflation emerges depending on the inflation-real economic activities and real economic activities-stock return relations. While a rising inflation rate can be an indicator of a decrease in the demand for money due to a decline in real activity, it can also be an indicator of a decrease in expected future profits and therefore stock prices (Altıntaş and Tombak, 2011).

The model that forms the basis of the analysis was created based on the two-factor model of Stone (1974), which was also used by Jareño et al. (2016). Studies investigating the sensitivity of stock returns to interest rates are based on an extended version of the Capital Asset Pricing Model (CAPM) by adding interest rates. This linear two-factor model used by Stone (1974) includes the stock market return and the interest rate change. The model in question can be written as follows:

$$SR_{it} = \beta_{0i} + \beta_1 MR_t + \beta_2 NINT_t + \varepsilon_{it} \qquad (1)$$

where SR_{it} stands for the stock return of sector *i* at period *t*, MR_t is the indicator of overall market return, $NINT_t$ is the change in the nominal interest rate and ε_{it} is usual *i.i.d.* random error term.

There is a vast amount of evidence in the related empirical literature showing that stock returns (either realised and expected, or real and nominal) are inversely correlated with both realised and expected inflation rates. These surprising findings apparently do not coincide with the classical economic theory, especially the Fisher's hypothesis, which claims that expected nominal asset returns move in tandem with expected inflation such that expected real returns are independent of expected inflation. Another conclusion of the studies is that financial assets that represent claims for real payments, such as stocks, should provide a hedge instrument at times of unexpected inflation (Engsted and Tanggaard, 2002).

Fisher (1930) expresses the nominal interest rate as the sum of the expected real return and the inflation expectation. Accordingly, the information available in the market at a previous time, say $t - 1$, processed efficiently or rationally, the price of any asset will be set so that the expected nominal return on the asset for the period $[t - 1, t]$ is the sum of the appropriate equilibrium expected real return and the best possible assessment of the expected inflation rate for the period $[t - 1, t]$. Therefore, by separating the nominal interest rate into two components as the sum of the real interest and expected inflation rates, the above equation can be rewritten as follows:

$$SR_{it} = \beta'_{0i} + \beta'_1 MR_t + \beta'_2 RINT_t + \beta'_3 INFEX_t + u_{it} \qquad (2)$$

where $RINT_t$ and $INFEX_t$ denote the change in the real interest and the expected inflation rates respectively. To obtain the QR equations to be estimated these models can be re-expressed as follows:

Model 1: $SR_{it} = \beta^{\theta}_{0i} + \beta^{\theta}_1 MR_t + \beta^{\theta}_2 NINT_t + \varepsilon_{it} \qquad (3)$

Model 2: $SR_{it} = \beta^{\theta'}_{0i} + \beta^{\theta}_1{}' MR_t + \beta^{\theta}_2{}' RINT_t + \beta^{\theta}_3{}' INFEX_t + u_{it} \qquad (4)$

where θ denotes the θth quantile from 0.1 to 0.9.

The results obtained from the Bai and Perron (2003) test indicate that nominal and real interest rates and expected inflation rate variables show a structural break in 2018. For this reason, the entire sample was divided into two subsamples: 2013M01-2017M12 and 2018M01-2023M07. The first subsample period includes the period when interest rates and inflation rates were relatively more stable while the second subsample covers the impact of exchange rate attacks in 2018 (Erdoğan et al., 2020; Akkaya, 2022) and the turbulence caused by the global COVID-19 pandemic.

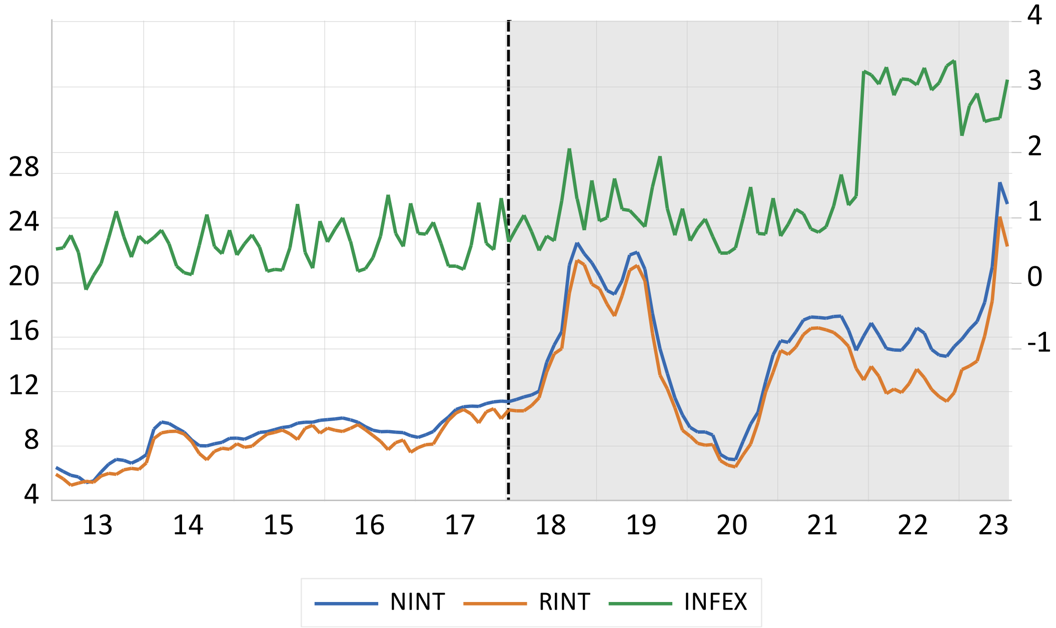

Figure 1. Distinctive behaviour of *NINT*, *RINT* and *INFEX* in two subsample periods. (Right axis for *INFEX*)

All data used in the analysis were compiled from the electronic data distribution system of the Central Bank of Republic of Türkiye. Stock market series consist of return values. The real interest rate is obtained by subtracting the average CPI inflation expectation for the next month from the nominal interest rate. The Central Bank of Türkiye conducts a Market Participants Survey every month, based on the opinions of decision makers and experts in the financial and real sectors, in order to monitor their expectations regarding various macroeconomic variables. In this context, participants are asked about their current, next month and 12 months ahead inflation expectations. Data for expected inflation is based on the outcomes of this survey.

Table 2. Descriptive statistics of the variables.

Variables	Mean	Median	Max	Min	St. Dev.	Skewness	Kurtosis	*J-B*
XU100	3.0874	2.5198	3.0979	−1.6941	7.9364	0.9581	5.3573	4.8841[a]
SER	2.4103	1.2119	3.0149	−1.2841	7.7338	0.8967	4.5022	2.8961[a]
FIN	1.8821	1.4907	2.5452	−1.6742	8.8282	0.3986	2.9501	3.3770
IND	2.6404	2.0223	2.7823	−1.8919	7.5726	0.5791	4.0725	1.3187[a]
TECH	3.1199	2.7154	3.9939	−1.6436	9.4495	0.8296	4.8589	3.2854[a]
NINT	12.331	10.420	27.2860	5.2640	4.8150	0.7974	2.8898	13.5253[a]
RINT	11.215	9.6700	24.7760	5.0760	4.3562	0.9439	3.2250	19.1278[a]
INFEX	1.1150	0.8000	3.3900	−0.1100	0.8897	1.3301	3.6566	39.7297[a]

Note: *J-B* stands for Jarque-Bera normality test statistics, *a* denotes significance at %1 level.

Descriptive statistics for the series are given in Table 2. When the values of return indicators are examined, it is seen that the performance of the general stock market and the performance of technology stocks are similar in terms of average return. Although the lowest average performance in terms of sectoral returns belongs to the financial sector, the distribution closest to the normal distribution also belongs to this sector. Returns of other sectors are more flattened and skewed to the right than normal. This shows that the thick tail phenomenon is valid for sectoral returns other than finance. Jarque-Bera statistics also indicate that all series except finance have non-Gaussian distribution.

4.2. Findings

4.2.1. Stationarity tests

To avoid the risk of a possible spurious regression, the stationarity properties of the series were investigated with different unit-root tests as a preliminary stage. Looking at the results reported in Table 3, it can be seen that all general and sectoral return series are stationary at the level. In terms of interest and inflation series, the results obtained from ADF and KPSS unit-root tests do not agree. According to the ADF test, all three series are not stationary at level, while according to the KPSS test, the series appears to be stationary. Zivot-Andrews test, which takes into account the structural break in the intercept and trend terms, was applied to the three series, considering that the structural break caused by the increase in volatility and regime change seen in the mentioned series in recent years will make it difficult to reject the null hypothesis in the ADF test. The results of the tests show that the unit-root hypothesis can be strongly rejected (see Table 4 below). Accordingly, it is seen that all series included in the analysis are stationary in terms of their level values. Therefore, regression relationships established between level values give reliable results.

Table 3. Results of ADF and KPSS unit-root tests

	ADF		KPSS	
	C	$C+T$	C	$C+T$
$XU100$	**– 12.3642**^{a}	– 12.3635^{a}	**0.2323**^{a}	0.1284^{b}
SER	**– 13.4107**^{a}	– 13.4384^{a}	**0.2007**^{a}	0.0631^{a}
FIN	**– 12.4163**^{a}	– 12.3856^{a}	**0.1973**^{a}	0.1364^{b}
IND	**– 11.6009**^{a}	– 11.6792^{a}	**0.2820**^{a}	0.1046^{a}
$TECH$	**– 12.6288**^{a}	– 12.5996^{a}	**0.0773**^{a}	0.0427^{a}
$INFEX$	– 1.0198	**– 2.5373**	0.8948	**0.1877**^{b}
$NINT$	**– 2.1131**	– 3.0132	0.7575	**0.0697**^{a}
$RINT$	– 1.8450	**– 3.0767**	0.8764	**0.0563**^{a}

Note: a and b indicate significance at the 1% and 5% level, respectively. Bold values indicate the specification found to be suitable according to the AIC criterion. In the KPSS test, the critical values for significance at the 1%/5%/10% level are 0.216, 0.146 and 0.119, respectively. The values for the specification with trend are 0.739, 0.463 and 0.347, respectively. C and T denote intercept and trend term.

Table 4. Results of Zivot-Andrews unit-root test

	Intercept	Trend	Both
$INFEX$	– 6,9782^{a} 2021M12	– 3,3404^{b} 2020M11	– 6,2333^{a} 2021M12
$NINT$	– 4,2495^{a} 2019M08	– 3,0538 2018M07	– 4,1757^{a} 2019M08
$RINT$	– 4,2858^{a} 2019M08	– 3,0459 2018M07	– 3,9848^{a} 2019M08

Note: a and b indicate significance at the 1% and 5% level, respectively. Detected break dates were given below the test statistics.

4.2.2. Estimation of Quantile Regressions

To start with, the conditional mean parameter estimates of both models based on the OLS method for overall and sub-samples are presented in Table 5. Overall market return rate seems highly and persistently significant across all the specifications. This means that the overall market return rate is the main reference for investors in Türkiye. While the nominal interest rate does not seem to have any effect in the first subsample period (2013M1-2017M12), it has a significant effect on the returns of financial and industrial sector stocks in the second subsample period (2018M1-2023M07). When we look at the overall sample, negative significant effects are evident in the industrial and technology sub-sectors. It can be said that these results are compatible with the QR findings given in Table 6.

In the first sub-period, where inflation and nominal interest rates follow a relatively lower and stable course, the nominal interest rate does not significantly affect stock returns. On the other hand, the significant effect of the nominal interest rate on financial and industrial sector returns is evident in the second sub-period, where a fluctuating pattern of movement emerged as of mid-2018, first with exchange rate attacks, then with the COVID-19 pandemic and the subsequent macroeconomic deterioration. In an increasing risk environment, the effect of the nominal interest rate is positively reflected in the financial sector returns, while the effect is negative for the industrial sector returns. This situation can be explained by the expectation that increasing interest rates will have a contractionary effect on real sector activities and therefore profitability will decrease.

Table 5. Estimations of the models via OLS

	Model 1			**Model 2**			
Sectors	***XU100***	***NINT***	***R^2***	***XU100***	***RINT***	***INFEX***	***R^2***
Whole sample (2013M01-2023M07)							
SER	0.8851^a	0.0673	0.8400	0.8652^a	-0.0107	0.7840^b	0.8652
FIN	1.0794^a	0.0413	0.9473	1.0800^a	0.0437	0.0198	0.9473
IND	0.9072^a	-0.0903^c	0.8771	0.9125^a	-0.0698	-0.2786	0.8775
TECH	0.9288^a	-0.2336^b	0.5762	0.9430^a	-0.1778	-0.7460	0.5779
Subsample (2013M1-2017M12)							
SER	0.7837^a	-0.2055	0.7672	0.7928^a	-0.1991	-0.5830	0.7677
FIN	1.1071^a	0.0271	0.9520	1.1003^a	0.0224	0.3069	0.9521
IND	0.8388^a	0.0096	0.8691	0.8489^a	0.0166	-0.4036	0.8697
TECH	0.7100^a	0.7031	0.3742	0.6313^a	0.6478	3.9510	0.3910
Subsample (2018M1-2023M07)							
SER	0.9249^a	0.0711	0.8616	0.9011^a	0.0167	0.9081^c	0.8687
FIN	1.0696^a	0.1218^c	0.9466	1.0669^a	0.1157	0.2162	0.9467
IND	0.9305^a	-0.2626^a	0.8891	0.9445^a	-0.2306^b	-0.7541^c	0.8917
TECH	0.9930^a	-0.2792	0.6806	1.0151^a	-0.2286	-1.0554	0.6850

Note: $a/b/c$ indicate significance at the 1%/5%/10% level, respectively.

When we look at the OLS estimates of Model 2, where the nominal interest rate is decomposed into the real interest rate and the expected inflation rate, it is seen that the situation has not changed in the first sub-period, and in the second sub-period, the real interest rate for industrial sector returns has a negative coefficient. It is seen that high inflation expectations also negatively affect industrial sector returns, such as the real interest rate. It is noteworthy that, unlike Model 1, the (real) interest rate does not have a significant effect on the financial sector, whereas the expected inflation rate positively affects the service sector returns.

QR estimation results of Model 1 are reported in Table 6. Considering the whole sample period, it is seen that the nominal interest rate is effective in service and financial sector returns, and industrial and technology sector returns in extreme cases. However, these effects are opposite in terms of both tail and signal. While the positive effect is valid in the upper quantiles for the service and financial sectors, the negative effects are observed in the lower quantiles in the industrial and technology sectors. If it is accepted that the financial sector is a kind of service sector and the technology sector is a kind of industrial sector, it can be said that there is a structural sectoral separation in stock returns in terms of the effect of the nominal interest rate. As in OLS estimates, it is seen that returns are insensitive to the nominal interest rate in the first sub-period in QR estimates. On the other hand, in the second sub-period, industrial sector returns have negative coefficients in almost all quantiles. Technology sector returns have a negative coefficient in the top two quantiles.

Table 6. QR estimates of Model 1

	Quantiles								
Sectors	**0,1**	**0,2**	**0,3**	**0,4**	**0,5**	**0,6**	**0,7**	**0,8**	**0,9**
Whole sample (2013M01-2023M07)									
SER	-0.1122	-0.0779	-0.0255	-0.0563	0.0401	0.1318	0.1781[b]	0.2414[a]	0.2006[b]
FIN	-0.1183	-0.0112	0.0259	0.0262	0.0486	0.0748	0.0793[c]	0.1291[b]	0.1200[c]
IND	-0.2213[b]	-0.1347[c]	-0.0921	-0.0736	-0.0579	-0.0767	-0.0427	-0.0473	-0.0549
TECH	-0.1432[b]	-0.1537[b]	-0.0784[a]	0.0006[a]	-0.2143	-0.2723	-0.3586	-0.3989	-0.6419
Subsample (2013M1-2017M12)									
SER	0.1981	-0.3485	-0.4021	-0.5593	-0.2802	-0.4931	-0.2218	-0.1360	-0.0578
FIN	-0.0561	-0.0261	-0.0888	-0.2348	-0.0736	0.0177	0.0804	0.2996	0.3439
IND	-0.0874	-0.2130	-0.1030	0.0425	-0.0578	0.0183	0.0040	0.1084	-0.0106
TECH	0.3928	0.5740	0.5430	0.7498	0.3477	0.8306	1.5104[c]	1.5391	-0.4279
Subsample (2018M1-2023M07)									
SER	-0.0335	-0.1238	-0.1685	0.0097	0.0414	0.1493	0.1897	0.1813	0.1036
FIN	0.1202	0.0733	0.1116	0.1779[c]	0.1169	0.1207	0.0691	0.1003[c]	0.1725
IND	-0.3336	-0.2893[b]	-0.2732[b]	-0.2817[b]	-0.3028[b]	-0.2311[b]	-0.2446[b]	-0.2155[b]	-0.2893[b]
TECH	0.1593	-0.1049	0.0347	-0.0234	0.0375	-0.2722	-0.3989	-0.6827[a]	-0.4818[b]

Note: $a/b/c$ indicate significance at the 1%/5%/10% level, respectively. The composite index return is significant at the 1% level in all sectors and quantiles.

In the QR estimates of Model 2, it is seen that the real interest rate is effective in the upper quantiles in sectors other than the industrial sector for the overall sample period, and this effect is negative in the returns of the technology sector. While the general insensitivity to the interest rate is still valid in the first sub-sample, it is noteworthy that in the second sub-sample, as in Model 1, industrial sector returns are under a negative effect against the real interest rate throughout all quantiles. A similar effect is observed in the upper quantiles of the returns of the technology sector. Meanwhile, positive effects of the real interest rate are observed in some quantiles on financial sector returns.

Table 7. QR estimates of Model 2 - Real interest rate

	Quantiles								
Sectors	**0,1**	**0,2**	**0,3**	**0,4**	**0,5**	**0,6**	**0,7**	**0,8**	**0,9**
Whole sample (2013M01-2023M07)									
SER	-0.1710	-0.1237	-0.1782	-0.1215	-0.0331	0.0476	0.0044	0.1490	0.1607^{c}
FIN	0.0148	0.0150	0.0653	0.0726	0.0523	0.0738	0.0761	0.1334^{b}	0.1115^{c}
IND	-0.1573	-0.1232	-0.0493	0.0073	-0.0316	-0.0797	-0.1146	-0.0130	-0.0634
TECH	-0.0872	-0.0918	0.0409	0.0302	-0.1513	-0.2543	-0.3457^{b}	-0.4167^{b}	-0.6595^{a}
Subsample (2013M1-2017M12)									
SER	0.0367	-0.2050	-0.3766	-0.5920	-0.3229	-0.2614	-0.1842	-0.0569	-0.0424
FIN	-0.0618	-0.0165	-0.0835	-0.0898	-0.0851	0.0283	0.0502	0.2228	0.3483
IND	-0.0082	-0.2068	-0.1089	0.0284	0.0661	0.0509	-0.0270	-0.0152	0.0543
TECH	0.3382	0.5010	0.3653	0.6205	0.6638	1.2951	1.3218^{c}	1.5089^{c}	-0.1961
Subsample (2018M1-2023M07)									
SER	-0.2873	-0.1208	-0.0848	-0.0761	0.0555	0.0087	0.1238	0.1726	0.1394
FIN	0.1032	0.0721	0.1594^{c}	0.1814^{c}	0.1399	0.1160	0.0681	0.1411	0.1466^{c}
IND	-0.2769	-0.2621^{b}	-0.2318^{c}	-0.2398^{c}	-0.2439^{b}	-0.2099^{c}	-0.2346^{b}	-0.2234^{b}	-0.2835^{b}
TECH	0.0889	-0.0399	-0.1006	-0.0189	0.0400	-0.2579	-0.2590	-0.7362^{a}	-0.5041^{b}

Note: $a/b/c$ indicate significance at the 1%/5%/10% level, respectively.

QR estimates regarding the effects of inflation expectations on sectoral stock returns in the context of Model 2 are given in Table 8. In terms of inflation expectations, as in the real interest rate, complete insensitivity prevails in all sectors in the first sub-period. It seems that this situation is also valid in the second subperiod, except for a few quantiles for the service and industrial sectors. The effect manifests itself very weakly in the quantiles in question. The same situation is observed throughout the 2013-2023 period, except for the upper quantiles of the service sector. From this point, it can be concluded that BIST sub-sector returns do not develop a statistically significant reaction against the expected inflation rate.

Table 8. QR estimates of Model 2 - Expected inflation rate.

	Quantiles								
Sectors	**0,1**	**0,2**	**0,3**	**0,4**	**0,5**	**0,6**	**0,7**	**0,8**	**0,9**
Whole sample (2013M1-2023M07)									
SER	0.6727	0.4423	0.4169	0.7441	0.7708	1.1933[b]	1.0754[b]	0.7789[c]	0.8139[b]
FIN	-0.5059	-0.5340	-0.2243	-0.2985	-0.1187	0.1161	0.1113	-0.2614	0.7150
IND	-0.4073	-0.3403	-0.5292	-0.7540	-0.1650	0.3019	0.0964	-0.1332	-0.0166
TECH	-1.0854	-0.3655	-0.5946	-0.1169	-0.6764	-0.9797	-0.8832	-0.2885	-0.5694
Subsample (2013M1-2017M12)									
SER	0.5399	0.3685	0.5319	-0.3280	0.2897	-1.2831	-1.7080	-1.6920	-0.3956
FIN	-0.1368	0.3740	0.3475	0.3932	0.1541	0.3180	1.5035	1.1451	0.3229
IND	0.8615	0.1306	-1.5147	-1.6803	-0.9326	-1.1629	-0.7870	1.3200	0.5184
TECH	0.9798	2.8587	3.2237	3.7986	5.5101	7.0732	6.3400	2.3666	7.9418
Subsample (2018M1-2023M07)									
SER	1.2505[c]	0.5127	0.5925	0.8452	1.0067	1.4523[b]	1.4226[c]	0.5799	0.7458
FIN	0.2312	-0.3208	-0.1082	0.0111	0.4901	0.1422	0.0810	-0.2364	0.9047
IND	-0.5818	-0.8798[c]	-0.9497[c]	-1.0242[c]	-0.6965	-0.6642	-0.2946	-0.2725	-0.7659
TECH	-0.6266	-0.8531	-0.6293	-0.5854	-0.0501	-1.1674	-1.0523	-0.5053	-1.0910

Note: *b* and *c* indicate significance at the 5% and 10% level, respectively.

Conclusion

According to financial theory, there is an inverse relationship between interest rates and stock returns and prices. In the Liquidity Preference Theory framework, the rise in interest rates causes the money to move towards higher interest rates, so demand for the stock market decreases and returns fall. The behaviour of stock prices on interest rates and inflation has been investigated by various time series analysis methods. However, in this study, the subject is handled in a different approach by using the Quantile Regression (QR) method. QR analysis was developed by Koenker and Basset (1978) as an alternative to the Ordinary Least Squares (OLS) method. Estimates will not be effective and reliable if the distribution of the dependent variable is not normal in the OLS method.

In the study, the nominal interest rate is decomposed into real interest rate and inflation components, and their effects on stock prices are examined for the period January 2013 - July 2023 separately for services, financial, industrial, and technology sector indices. When it comes to the impact of nominal and real interest rates on returns in QR estimates, it is seen that the service and industrial sectors differ in terms of both tails and signs. Under the assumption that the financial sector can be included in the service sector, and the technology sector in the industrial sector, it can be said that this separation arises from the structural characteristics of the sectors. Accordingly, while the sensitivity of sectors based on physical production and therefore high capital input to the interest rate is higher and negative, the effect of the interest rate on the returns of service sectors based on intangible products and with relatively low capital manifests itself in higher quantiles and in a positive direction.

Overall findings of the study are partially compatible with the findings of Jareño et al. (2016) who investigated the relationship between interest rate and sectoral stock returns in a similar vein for US stock returns. The findings indicate that the interest rate risk on returns exhibits a heterogeneous structure according to sectors and the level of risk. Jareño et al. (2016) attribute this situation to the structural differences between sectors in terms of growth potential, borrowing opportunity, liquidity, and company size. On the other hand, similar to the results reached by Jareno (2008) in the case of Spain, returns appear to be more sensitive to the real interest rate than to inflation, especially in periods when volatility is higher.

According to the findings of the study, the difference in the relationship between nominal interest rate and stock prices according to sectors producing intangible and concrete products contains useful information for market players investing in these sectors as well as for company managers operating in these sectors. The variation in interest rate changes according to sectoral characteristics may help individual investors to take appropriate positions. In addition, it can give company decision-makers an idea about the trend of the company's market value and the financing policies to be applied according to the movements of macroeconomic variables such as interest and inflation rates.

Çıkar Çatışması Bildirimi/ Conflict of Interest Statement:

Yazar, bu makalenin araştırılması, yazarlığı ve yayımlanmasına ilişkin herhangi bir potansiyel çıkar çatışması beyan etmemiştir. / The authors declared no potential conflict of interest regarding the research, authorship, and publication of this article.

Destek/Finansman Bilgileri/ Support Financing Information:

Yazar, bu makalenin araştırılması, yazarlığı ve yayımlanması için herhangi bir finansal destek almamıştır. / The authors have received no financial support for the research, authorship, and publication of this article.

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