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June, 2020

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Thesis M.Sc. Finance

The Effect of Macroeconomic Variables on Istanbul Stock Exchange

Abstract

This paper investigates the effects of macroeconomic variables on the stock market in Turkey. The BIST-100 index is used as dependent variable representing the Turkish stock market. Inflation, industrial production, interest rate and CDS are selected as independent variables. Multivariate regression, Granger Causality test, the impulse response and variance decomposition analysis are performed in order to determine the relationship between selected macroeconomic variables and the BIST-100 index. Regression output shows that the interest rate and CDS have significantly negative relationships with BIST-100 index. The Granger causality test shows that industrial production and inflation have bidirectional causality relationships with BIST-100 index. Interest rate and CDS unidirectional Granger-cause on BIST-100. The variance decomposition results indicate that all the selected macroeconomic variables have considerable power to explain the variance of BIST-100 index.

Keywords: Macroeconomic variable, stock market, BIST-100, causality, impulse response

Contents

1. Introduction

Stock markets play a mediation role between companies that want to meet their long-term capital needs and individuals who are willing to invest their excess funds. With the development of financial markets, stock indexes are seen as a mirror of fluctuations in the real economy. This idea is supported by Fama's (1969) the Efficient Market Hypothesis in which all the given information is transferred to the prices based on the balance of supply and demand. Furthermore, the hypothesis points out three efficiency levels in the market.

The investors in financial markets have consistently questioned the basic dynamics of the stock markets in order to generate much more return. Thus, the effects of macroeconomic progress on stock markets have attracted attention due to the tight interaction between each other. This relationship concerns not only market participants like investors and companies, but also all actors of the economy, including policy-makers. Although this relationship is the matter of many studies, a consensus has not been reached yet.

The differences between economic structures of the countries cause this relationship to differ. Even studies covering different periods for the same country shows even different results. Different economic characters of each period may cause this differentiation. As a result, a common answer to the question of how the macroeconomic variables affect stock markets could not be found. Due to more fluctuation in the stock markets of developing countries, these countries are more frequently exposed to this question. The stock market in Turkey has been recently experiencing frequent price fluctuations. Therefore, the impact of macroeconomic variables on the stock market has been an ongoing debate in Turkey.

1.1 Research Question

This study's main research question is as follows:

How do macroeconomic variables affect Istanbul Stock Exchange?

1.2 Objectives

In this study, the effects of macroeconomic variables on Istanbul Stock Exchange are investigated. The outcomes of this research are aimed to help investors properly analyze the effect of systematic risk stemming from macroeconomic variables on the stock market in Turkey. Thus, this study is aimed to be beneficial for investors' investment decision by identifying the

effect of macroeconomic variables on the stock market in Turkey. This study aims to be a guide for policy-makers who want to implement macro and monetary policies that provide simultaneously financial and macroeconomic stability together. The outcome can be very crucial in a manner for Turkey, a candidate member of the European Union (EU). If the direction of the relationship between macroeconomic variables and the stock market is determined, it will be easier for policymakers to see the potential financial results of common EU monetary and macroeconomic policies when they are implemented in Turkey. Therefore, determining the causal relationships and dynamic interactions between macroeconomic variables and the stock market in Turkey has an important place in forming common macroeconomic policy within the EU and Turkey. Thus, this research helps to increase the predictability of results of the common economic and monetary policies within Turkey and the EU.

1.3 Structure of the Paper

The remainder of the thesis is organized as follows: The first part is the introduction that consists of background information and defining the problem. The second part of the study is the literature review. This section is divided into three groups as literature in the developed countries, in the developing countries and in Turkey. In section three, the methodology and data are presented. The fourth part consists of the findings of the analysis. The last part is the conclusion.

2. Literature Review

The interrelationship between financial markets and macroeconomic developments has led to a continuous questioning of the direction and extent of the interaction.

2.1 Developed Countries

Since organized financial markets primarily started to emerge in developed countries, pioneering studies on this issue were primarily carried out in developed countries. The US (United States) is one of the leading countries in the research on this subject. Fama & Schwert (1977) investigated the relationship between common stock returns and inflation in the US for the period between 1953 and 1971. They found stock returns are negatively correlated with expected inflation. Fama (1981) confirmed the previous study by detecting a negative relationship between inflation and stock returns. Chen, Roll, & Ross (1986) found a significant relationship between the US stock market and several macroeconomic factors like industrial production and inflation. Chen (1991)

found a significant intertemporal interaction between excess market return and economic growth. Abdullah & Hayworth (1993) examined a larger macroeconomic spectrum in the US. This study found a positive link between stock return and inflation, unlike previous literature. They also reached significant results that stock returns are inversely correlated with the budget deficit and long-term interest rate. Marathe & Shawky (1994) divided the aggregate output into two parts and investigated their potential link with stock return in the US market. They found that permanent part of economic output has useful information to predict stock returns, while the transitory part of economic output has no information about stock return predictability. Flannery & Protopapadakis (2002) investigated the daily effects of 17 macro variables on the US stock returns for the years between 1980 and 1996. The research showed that announcements of six macroeconomic variables have significant effects on the stock returns on announcement days. These are three nominal variables like inflation, M1 money supply, producer price index and three real variables like trade balance, housing starts and employment data. Sharma & Ratanapakorn (2007) found that S&P500 index has an inverse relationship with long-term interest rate, but have a positive link with industrial production, inflation, exchange rate, short-term interest rate and money supply. Hsing (2011) found that the US stock market is positively correlated with some macro variables like real GDP (Gross Domestic Product) and nominal effective exchange rate, while it is negatively correlated with government debt to GDP ratio, M2 to GDP ratio, expected inflation rate and interest rate. The study also found a positive link between the US stock index and the UK (The United Kingdom) stock index. Jareño & Negru (2016) concluded that the US stock market is positively correlated with economic growth and industrial production, while negatively correlated with unemployment and interest rate.

There are similar studies for the European economies. Asprem (1988) investigated the link between macroeconomic variables and ten major European stock markets for the period from 1968 to 1984 by using quarterly data. The study showed that stock prices are negatively correlated with interest rates, inflation, import and employment, while expectations for economic activity and money supply are positively correlated with the stock market movement. The study also indicated that the link between macroeconomy and the stock market is powerful in Germany, the Netherlands, the UK and Switzerland. Peiro (1996) compared three big European countries (UK, Germany and France) with the US. This research showed that interest rate changes are more influential than production on the European stock markets while future production is more

influential than changes in the interest rate on the US. Lai & Cheung (1999) pointed out that the co-movement of the stock prices in France, Germany and Italy may be due to several macroeconomic variables such as dividend, industrial production and money supply. Sættem & Gjerde (1999) investigated this link for Norway that is a relatively small country for the years from 1974 to 1994 by using the multivariate vector autoregressive (VAR) approach. The study showed that the interest rate and oil price influence the stock market, while the stock market reacts to GDP changes with delay. Nasseh & Strauss (2000) examined six major European countries' (France, Germany, Italy, the Netherlands, Switzerland and the UK) macroeconomics indicators and stock price indexes for the period from 1962 to 1995 by using quarterly data. They found that stock prices in these European countries are affected by some domestic macroeconomic variables such as industrial production, manufacturing orders survey and long-term interest rates. The paper showed that the European stock markets are also influenced by foreign stock prices, foreign short-term interest rate and foreign economic activity. By using variance decomposition, they concluded that the stock market movement can be explained by macroeconomics variables. Peiró (2016) analyzed three biggest European countries' (France, Germany and the UK) some macroeconomic variables and stock market direction. The research found that the interest rate and industrial production can explain nearly half fraction of annual movement of the stock market for the period between 1969 and 2012. The paper stressed that this result is valid for all three countries, while the US market seems only related with production for the same period.

Hsing (2013) investigated the tie between the Japanese stock market and macroeconomic variables for the years between 1975 and 2009. The study concluded that Japanese stock price index has a positive correlation with industrial production, while it is negatively correlated with the real interest rate, expected inflation and government deficit to GDP ratio. The study also revealed that the stock index has a non-linear link with money supply and exchange rate.

Some studies examine several developed countries' stock markets together. Cheung & Ng (1998) found some significant clue about long-run co-movements of several developed stock market indexes (Canada, Germany, Italy, Japan and the US) with some macroeconomic variables like real oil price, real consumption, real money and real output. Rapach, Wohar, & Rangvid (2005) searched the relationship between nine main macroeconomic variables and stock market

predictability in twelve developed countries like US, Canada, France, Germany, Japan, UK, Norway, Sweden, the Netherlands, Belgium, Italy and Denmark. The research showed that the interest rate and the inflation rate are the most influential macro variables related to stock market returns. It was also observed that the relationship between interest rate and stock market return has shaped in the short-term in most countries. However, the study revealed that industrial production and unemployment rate contain less information about stock market return than other macro variables.

2.2 Developing Countries

Studies for developing countries are not based on long periods as in developed economies due to the fact that financial markets of developing economies were late-established. In the literature, it is seen that the results of particular studies for similar developing countries differ visibly. Furthermore, the sharp differences between countries and frequent fluctuations in their stock markets make it more attractive for researchers to investigate the interaction between the stock markets and macroeconomic progress. However, it should be clarified that relatively few studies have been conducted for this country group in the literature.

Muradoglu, Taskin, & Bigan's (2000) study, covering 19 emerging countries for the period between 1976 and 1997, is an important demonstration of how the impact of macroeconomic variables on the stock market differs in each emerging country. According to the results, the inflation rate is only related to stock markets in Argentina and Brazil, while foreign exchange rate influence stock return only in Brazil, Colombia, Greece, Korea and Mexico. Sharma & Wongbangpo (2002) examined the ASEAN-5 countries' (Indonesia, Malaysia, Philippines, Singapore, Thailand) stock markets and macroeconomic fundamentals for the years between 1985 and 1996. According to the results, there is a negative link between the stock markets and the interest rate in the Philippines, Singapore and Thailand, while Indonesia and Malaysia have a positive correlation. Moreover, it showed that there exists a positive link between the foreign exchange rate and the stock price in Indonesia, Malaysia and the Philippines and a negative link in Singapore and Thailand. Gay (2016) found no clue between stock prices and exchange rate for BRICS countries (Brazil, Russia, India, South Africa and China) by using Autoregressive Integrated Moving Average (ARIMA) model.

On the other hand, Chandrashekar, Sakthivel, Sampath, & Chittedi (2018) studied on India and Brazil, and they found a long-term equilibrium among macroeconomic variables (inflation, industrial production, real exchange rates and interest rate) and stock prices. They also found that industrial production and exchange rate positively influence stock prices. Chan, Fung, & Zhang (2009) found a significant link between CDS (Credit Default Swap) and seven Asian stock markets. They also indicated a long-run integration between CDS and the stock prices. Khan & Khan (2018) concluded that Karachi Stock Market is long-term cointegrated with money supply, exchange rate and interest rate, while the exchange rate only affects stock prices in short-term. Similarly, Nisha (2015) reported that Bombay Stock Exchange is significantly affected by the interest rate, gold price, foreign exchange rate, and money supply. Peng, Cui, Groenewold, & Qin (2009) showed that there is a significant long run causal relationship from GDP to the stock prices, while the short run influence is relatively weaker.

2.3 Turkey

Studies in Turkey cover the period post-1986 when Turkish stock market initiated to transaction. Kasman (1997) compared Turkish stock market volatility with macroeconomic variables' volatility for the years between 1986 and 2003. The paper showed that money supply has an influence on the stock market fluctuations, while industrial production and foreign exchange rate have a joint and simultaneous influence on the stock market. Aydin & Dayioglu (2019) also compared macroeconomic variables' volatility and stock market volatility for the years between 2006-2018. They found that industrial production, exchange rate and money supply affect stock market volatility. Durukan (1999) showed that the interest rate is negatively correlated with the stock prices and industrial production is positively correlated with the value of Turkish Lira and US Dollar base stock index. Acikalin, Aktas, & Unal (2008) found a long-term relationship between the stock market and some variables like economic activity, interest rate, foreign exchange rate and current account balance. They also found a causality from macroeconomic variables like GDP, current account balance and foreign exchange rate to the stock market. Surprisingly, they concluded that the interest rate does not cause to the stock market. Tursoy, Gunsel & Rjoub (2008) tested different sector portfolio indexes with macroeconomic variables. However, they could not find any significant clue about any macroeconomic variables to explain the stock prices.

Kaplan (2008) examined the relationship between economic activity and stock prices by using quarterly data. The paper concluded that stock prices have a long-term relationship with economic activity. Aydemir & Demirhan (2009) concluded that there is a negative causality from the foreign exchange rate to the national stock index and its sub-sector indexes. Buyuksalvarci & Abdioglu (2010) did not find a long-term causality from macro variables (exchange rate, gold price, money supply, industrial production and inflation) to the stock market. However, they stressed that the stock market index affects these variables in the long run. Koc & Celik (2016) examined the interaction between CDS and the stock market, and they found a bidirectional causality relationship between two sides. Tiryaki, Erdogan, & Ceylan (2017) found a positive relationship between the stock prices and some macroeconomics variables like inflation, real effective exchange rate, oil price and current account balance to export ratio. They also found an inverse relationship between interest rate and the stock prices. Bildirici, Sonustun & Gokmenoglu (2019) found similar bidirectional causality between CDS and the stock market by performing a chaotic causality test. Altinbas, Kutay & Akkaya (2015) showed that exchange rate negatively affects the stock prices. They also found that industrial production and foreign exchange rate have a Granger causality on the stock market.

After the global financial crisis, unconventional monetary policies implemented by central banks of developed countries have increased the global liquidity to a higher level than ever before. New global financial market conditions have created a transformation in asset pricing structure in Turkey as well as in other developing countries. New financial conditions are thought to change the direction or coefficients of this close relationship between macroeconomics and the financial market. In the literature, there are few studies covering the period of post-2010. This study aims to help filling the gap in the literature.

3. Data, Methodology and Hypothesis

3.1 Variables Explanation

3.1.1 BIST-100 Index

BIST-100 Index is calculated by weighting 100 listed stocks selected according to various criteria with a certain formula. BIST-100 index is the main indicator of Borsa Istanbul Equity Market. It also includes sub-indexes like BIST-30 (Borsa Istanbul, 2020).

3.1.2 Interest Rate

Interest rate is defined as the nominal rate of return that the borrower undertakes to pay to the lender. The interest rate can also be defined as the rate paid by the borrower to enable the lender to give up consumption (Unsal, 2009). Interest rate affects the stock market in different channels. Increase in the interest rate leads to a drop in disposable income since it increases the borrowing costs of the household. Eventually, this negatively affects the sales of companies. As the interest rate affects borrowing expenses of companies, they prefer to borrow less. Hence, companies have to postpone or cancel some investment decisions. These three channels adversely affect the stock prices of the companies. Moreover, rising in the interest rates increases the demand for the bond market, which is less risky compared to stocks. The increase in demand for the bond market negatively affects the stock prices, as they are two markets that are considered to be substitutes for each other (Percin, 2019). Company value is calculated by adjusting the company's expected future dividend payments and the future value of the company with a discount rate to date. The increase in the interest rate decreases the company value as it increases the discount rate (Keran, 1971).

Therefore, a negative relationship is expected between stock prices and interest rate.

3.1.3 Inflation

Inflation refers to a continuous increase in the overall price level in an economy. Inflation rate is calculated by comparing the current general price level with the previous period. Price index is frequently used in the calculation of inflation. The consumer price index is a common method for figuring out price changes in consumer goods and services (Unsal, 2009).

Theoretically, there is no clear relationship between inflation and the stock market. Firstly, Fama (1981) stated that the negative relationship between stock prices and inflation is the result of a positive relationship between economic activity and stock prices. Also, the increase in inflation rises the discount rate used in stock valuation. Therefore, the increase in inflation decreases stock prices, as it reduces the present value of future dividend payments (Sharma & Wongbangpo, 2002). On the other hand, Fisher Theory asserts stock market returns should include unexpected inflation in addition to expected inflation. This indicates that the stock market may be an investment tool that acts as a hedge against inflation in the long term. This approach indicates a positive relationship between inflation and stock return (Sellin, 2001).

3.1.4 Industrial Production

Industrial production index is widely used in order to reflect the economic activities of the countries. Industrial production index is calculated by summing the sub-sectors with certain weights in order to calculate the changes in the industrial sector (Turksat, 2020). Abdullah & Hayworth (1993) and Chen, Roll, & Ross (1986) used industrial production in their studies as a sign of real economic activity. As industrial production is announced monthly, it is preferred over GDP or GNP (Gross National Product).

The increase in real activity positively affects the cash flow of companies. Hence, the profitability of companies increases, which positively reflects on stock prices (Sharma & Wongbangpo, 2002). Therefore, a positive relationship is expected between stock prices and industrial production.

3.1.6 Credit Default Swap(CDS)

Credit default swap is a financial derivative including the transfer of credit risk of a country or a company to another counterparty (Kuepper, 2020). CDS was being started to be recognized in the 1990s. However, it has become more popular in recent conjuncture, in which the opinions of credit rating agencies about the countries' economic outlook are questioned. In brief, CDS is a common result of countries' credit risk and economic data set (Eren, 2014).

As the credit ratings remained stable during the global financial crisis, the interest towards CDS increased as a credit risk indicator. CDS is considered to be a more feasible and market-based indicator, as they respond to market information more rapid and harmoniously (Flannery, Houston, & Partnoy, 2010). Naturally, a negative relationship is expected between the CDS and the stock market.

3.2 Data

This part of the study gives information about dependent and independent variables used in the analysis. BIST-100 index is used as the dependent variable. Inflation rate, industrial production, interest rate and CDS which are frequently used as the explanatory variables in the literature, are selected as independent variables. 96 monthly data of each variable for the period between 2010 and 2017 are examined. The study covers the post-global financial crisis. Therefore, the year 2010 is chosen as the beginning.

Table 1 Data Description

Variable	Name	Description	Source
BIST-100 Index	BIST	Monthly average of daily closing BIST-100 index	Central Bank of Turkey
Inflation	INF	Consumer price index excluding seasonal products (2003=100)	Central Bank of Turkey
Industrial Production	INDP	Calendar adjusted index level total industry (2010=100)	Turkish Statistical Institute
Interest Rate	INT	Weighted Average Interest Rates For Deposits in Turkish Lira up to 1 Month Flow, (%)	Central Bank of Turkey
Credit Default Swap	CDS	Turkey CDS 5 Years USD	Investing.com

BIST-100 index, the main indicator of the stock market in Turkey, is used as the dependent variable. Monthly average of daily closing values of BIST-100 index is included in the paper. The consumer price index is often used in Turkey as the main indicator of price movement. In the study, a specified coverage CPI (consumer price index) that does not include seasonal products is selected in order to remove the seasonal effects of price movements. Industrial production index is preferred because it is the main indicator of the production level in Turkey. Interest rate valid for time deposits with of maximum one month maturity is preferred as interest rate proxy. Monthly maturity is preferred in the interest rate because the data of other variables are monthly and the 1-month maturity is frequently used in time deposit. CDS, which has an effect on borrowing costs, is included in the study because it directly concerns many macroeconomic items such as budget balance and private sector debt.

Logarithmic transformations are taken for easier interpretation of CDS and inflation index. Since the industrial production index is around one hundred, it is not necessary to take logarithm. It is preferred that interest rates are remained as percentage. Variables are expressed during the paper as the abbreviations in Table-1. Very few missing data are imputed by giving the average of that year.

Table 2 Descriptive Statistics

This table provides certain summary descriptive statistics for selected macroeconomic variables and BIST-100 index. Statistics belong to monthly data for the period between 2010 and 2017. Each variable has 96 observations. The table includes the number of observations, mean, minimum and maximum value, standard deviation, skewness and kurtosis statistics of each variable.

	N	Mean	Maximum	Minimum	St. Dev.	Skewness	Kurtosis
BIST	96	74244,6	109478,5	51933,6	13646,3	0,59	3,18
CDS	96	207,8	319,5	121,1	47	0,30	2,19
INDP	96	118,1	146,4	85	12,2	-0,19	2,99
INF	96	243,4	336	180	45,1	0,34	2,00
INT	96	8,3	11,2	5,3	1,4	0,03	2,32

3.3 Methodology

In order to determine the relationship between macroeconomic variables and BIST-100 index, multivariate regression is established. First, the natural logarithms of the independent variables (excluding interest rate and industrial production) are taken. The letter "L" is added to the beginning of each variable name to represent logarithm. Then, the unit root test is applied to test whether the variables are stationary or not. Since the series are not stationary at the level, the unit root test is repeated by taking their first differences. The data that became stationary in the first differences are analyzed by OLS (Ordinary Least Square) method in the following regression. The letter "D" represents the first difference of each variable. A constant term is not added to the regression due to performing with the first degree differences of the variables.

$$D(BIST)_t = \beta_1 D(LINF)_t + \beta_2 D(INT)_t + \beta_3 D(INDP)_t + +\beta_4 D(LCDS)_t + \varepsilon_t$$

A Vector Autoregressive model (VAR) is established with stationary time series in order to employ causality test. In VAR (Vector Autoregression) model, information criteria are used for the appropriate lag selection. After the VAR model is correctly established, the Granger Causality Test is applied to determine the direction of the lagged relationship between BIST-100 index and macroeconomic variables. Then, Granger causality test results are analyzed with impulse response functions. With this function, it can be understood how other variables react to shock that occurs in one variable. Lastly, Variance Decomposition analysis is performed.

3.4 Hypothesis

Studies that search the relationship between the stock market and macroeconomic variables may find quite different results. The characteristic features of each country and period cause these relations to differ. Nevertheless, more frequent results may create an expectation about the direction of the relationship.

According to the general expectations, the hypotheses are as follows:

Table 3 Expectations for each variable

Hypothesis 1:	Inflation is negatively correlated with the BIST-100 Index
Hypothesis 2:	The interest rate is negatively correlated with the BIST-100 Index
Hypothesis 3:	Industrial production is positively correlated with the BIST-100 Index
Hypothesis 4:	CDS is negatively correlated with the BIST-100 Index

4. Results

4.1 Unit Root Test

This study examines the movements of variables in time series. The time series must be stationary for the analysis. The results of the analysis with non-stationary time series may not reflect a correct relationship. The fact that analysis with a non-stationary variable may reveal a spurious relationship (Granger & Newbold, 1974).

There are many tests to check the unit root in the time series. One of the most commonly used methods is the Augmented Dickey Fuller test. This model was originally developed by Fuller and Dickey (1979). The model was expanded by Dickey and Fuller for the error terms in correlation, named Augmented Dickey-Fuller (ADF) (Gujarati & Porter, 2009). In the study, ADF test is performed to check possible unit root. The hypotheses for this test are as follows:

Null hypothesis: $H0 : \delta = 0$ (there is a unit root or the time series is non-stationary)

Alternative hypothesis: $H1 : \delta < 0$ (the time series is stationary)

Table 4 ADF test results with trend and intercept

The table shows the ADF unit root test results of the variables at the level and first differences. Statistics belong to monthly data for the period between 2010 and 2017. Schwarz information criterion (SIC) is used for optimal lag length selection.

	At Level		First Difference	
Variables	**Prob.**	**Result**	**Prob.**	**Result**
BIST	0.6452	Non-stationary	0.0000	Stationary
LCDS	0.2840	Non-stationary	0.0000	Stationary
LINF	0.0505	Non-stationary	0.0000	Stationary
INT	0.0911	Non-stationary	0.0000	Stationary
INDP	0.1968	Non-stationary	0.0023	Stationary

According to ADF test results, the null hypothesis is accepted for all variables at their level value. Thus, all the series contain unit root at level. Analyzes with nonstationary time series may contain spurious results. Thus, unit root tests is repeated with the first differences of the series. It is seen that all the variables become stationary at their first difference.

4.2 Regression Results

In this section, the OLS regression analysis is performed with first differences of the variables. The regression whose results are analyzed is as follows;

$$D(BIST)_t = \beta_1 D(LINF)_t + \beta_2 D(INT)_t + \beta_3 D(INDP)_t + +\beta_4 D(LCDS)_t + \varepsilon_t$$

For interpreting the results obtained, a series of diagnostic tests must be performed. Firstly, Jarque Bera test is performed whether residuals show normal distribution. The test shows that the residuals show normal distribution. Breusch-Godfrey Serial Correlation LM Test and Breusch-Pagan-Godfrey show that the residuals are not serial correlated and their variances are all equal (homoscedastic). Variance Inflation Factors (VIF) find that there is no multicollinearity problem in the regression. Thanks to CUSUM (Cumulative Sum Control Chart) tests, it is concluded that the model has a stable structure for the analyzed period. The Wald test is performed to see if all the independent variables affect the independent variable collectively. With the probability value remaining below 0.05, it is concluded that the model is collectively significant. Details of these diagnostic tests and regression outputs are available in the appendix.

Table 5 Regression Results

This table contains the regression results between macroeconomic variables and BIST-100. The dependent variable of regression is the first difference of the BIST-100 index. The independent variables are industrial production (DINDP), interest rate (DINT), Credit default swap (DLCDS) and inflation rate (DLINF). The letter "D" represents the first difference of each variable. The letter "L" is added to the beginning of each variable name to represent logarithm. A constant term is not added to the regression due to performing with the first degree differences of the variables. The second column shows the coefficients and standard deviations for each macroeconomic variable. Standard errors in parentheses.

Variables	DBIST
DLCDS	-20519.71***
	(2401.1)
DINDP	-58.64
	(41.48)
DINT	-1661.59**
	(808.09)
DLINF	49618.14
	(35408.84)
Observations	95
R-squared	0.46

*** p<0.01, ** p<0.05, * p<0.1

According to results, there is a negative relationship between DLCDS and DBIST at 1% significance level. It is concluded that an increase in CDS negatively affects the BIST-100 index. This result is in line with the results of Yilmaz & Bali (2012), Degirmenci & Pabuccu (2016), Hanci (2014) and Sovbetov&Saka (2018). Secondly, DINT has a negative effect on DBIST at 5% significance level. There is a significant negative relationship between interest rates and stock market index. The negative coefficient of interest rate is highly compatible with the bulk of previous studies related to Turkey and other countries. In the studies of Durukan (1999), Kandir (2008) and Ozer, Kaya, & Ozer (2011) , they pointed to a negative relationship between interest rates and the stock market index. Although DLINF is not significant, positive coefficient gives important clues about the relationship between the stock market and inflation. The positive coefficient coincides with the results of Horasan (2008) and Sayilgan & Suslu (2011). The results support the Fisher Theory, which shows a positive relationship between inflation and the stock market. According to the regression results, no significant relationship is detected between industrial production and BIST-100 index. Although the coefficient is negative, it is quite close to zero.

4.3 Granger Causality Test

There are many tests for examining causality between two variables. The Granger causality test is applied to determine the lagged relationship between two time series. The test gives information about the direction of the relationship (Granger, 1988). If one time series eases the prediction of another time series, it may be called the presence of Granger cause (Gujarati & Porter, 2009). In order to perform the Granger causality test, the vector autoregressive (VAR) models, developed by Sims (1980), must be correctly specified. VAR model is used in the analysis of multivariate time series. It is important to choose the most suitable lag number for designing a VAR model.

With the Akaike Information Criterion (AIC), the optimal lag length is selected as eight for our model. In order to test that our VAR model meets the stability condition, inverse roots of the characteristic AR polynomials are examined. The result showed that our VAR model is stable because all modulus of the roots remain below 1 and the inverse roots of the AR polynomials lie inside the unit circle. Then, autocorrelation and heteroskedasticity tests are carried out for the residuals. Consequently, it is found that there is no autocorrelation presence in the model residuals. Also, it is concluded that the residuals are homoscedastic. Details of these three diagnostic tests are available in the appendix.

Table 6 Granger Causality Output

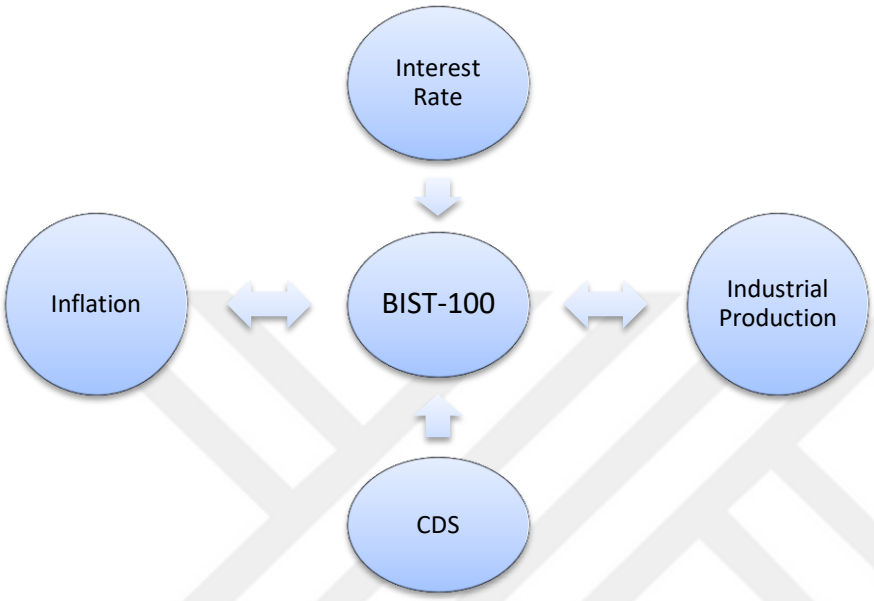
Prob denotes the probability value. For the test, optimal lag length is selected as eight according to AIC.

Null Hypothesis	Prob.	Result
DINDP does not Granger Cause DBIST	0.0043	Reject Null
DBIST does not Granger Cause DINDP	0.0671	Reject Null
DINT does not Granger Cause DBIST	0.0467	Reject Null
DBIST does not Granger Cause DINT	0.2603	Do not reject Null
DLCDS does not Granger Cause DBIST	0.0005	Reject Null
DBIST does not Granger Cause DLCDS	0.7182	Do not reject Null
DLINF does not Granger Cause DBIST	0.0309	Reject Null
DBIST does not Granger Cause DLINF	0.0012	Reject Null

DLCDS and DINDP Granger cause DLBIST at 1% significance level, while DLINF and DINT Granger cause DLBIST at 5% significance level. DBIST Granger causes DLINF at 1% significance level, while DBIST Granger causes DINDP at 10% significance level. In other

words, industrial production and the inflation rate have bidirectional causality relationships with BIST-100 Index. Interest rate and CDS unidirectional Granger cause BIST-100.

Figure 1 Granger Causality Between Variables



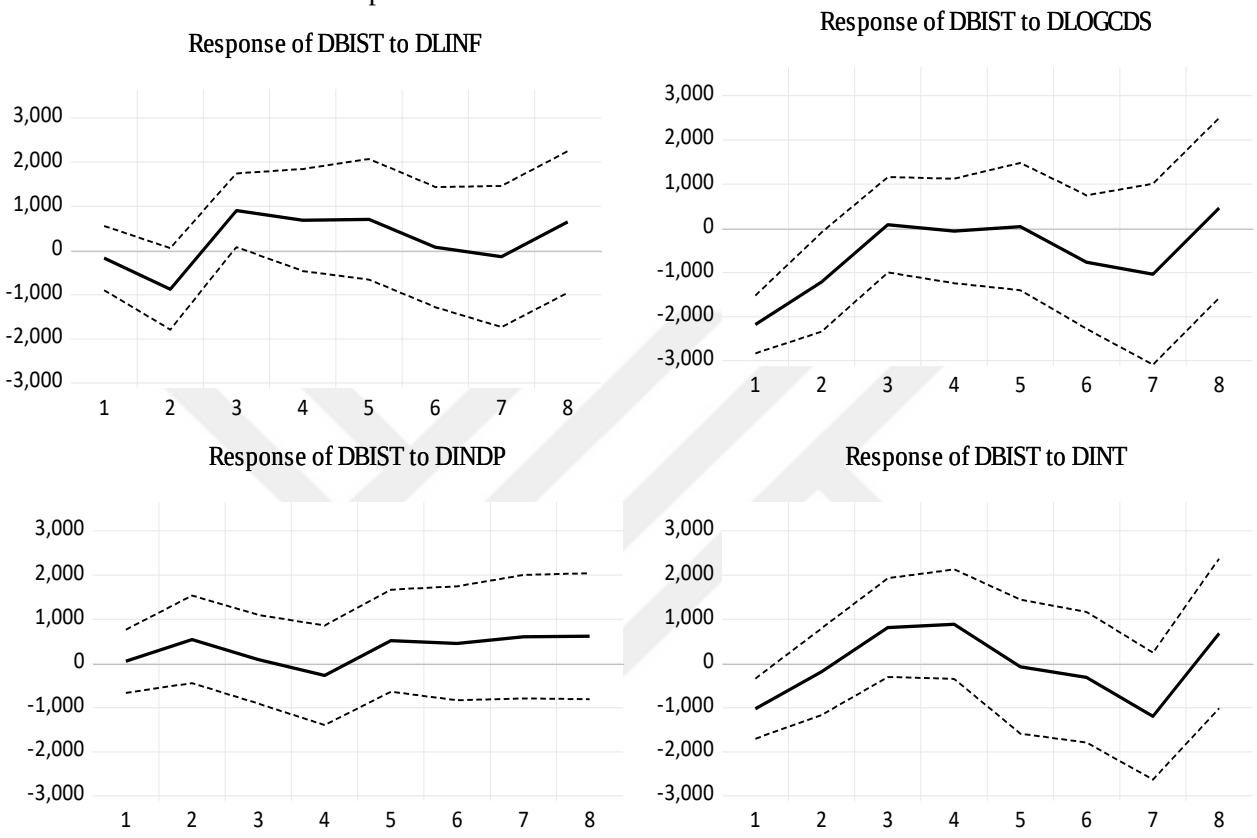
4.4 Impulse Response

The impulse response function can be used to measure the responses of other variables to shocks occurring in one of the variables. This function can give useful outcomes in order to see the consequences of a sudden change in one of the variables.

The BIST-100 index responds negatively to changes in CDS since the first month. Although this negative response temporarily disappears around the fourth month, it continues after the 5th month. This result supports Granger causality outcomes, the expectations and the regression results. Secondly, it is seen that the BIST-100 index generally reacts negatively to changes in interest rates except for two months. The negative reaction of the stock market to the interest rate changes matches up with the regression results and general market expectation. Thirdly, BIST-100 index responds negatively to changes in inflation in the first two months, but positively in almost the next 6 months. This result is to support the positive coefficient resulting from the OLS regression. The reaction of the BIST-100 index to changes in the industrial production index is positive in almost the entire period analyzed.

Figure 2 Responses of BIST-100 to Changes in Macroeconomic Variables

The graphs show the impulse response function inside the 95% confidence interval. The area between dashed lines shows the confidence interval. The line in the middle refers to the impulse response function.The horizontal axis shows the time. The vertical axis shows the response of the BIST-100 index to the shocks that occur in independent variables.



4.5 Variance Decomposition

Table 7 Variance Decomposition of D(BIST)

Period	S.E.	DBIST	DLCDS	DINDP	DINT	DLINF
1	3105.041	100	0	0	0	0
2	3439.235	84.78401	10.12232	1.438018	0.099709	3.55594
3	3696.774	75.74988	10.22869	1.26155	3.622013	9.13787
4	3986.365	69.02815	13.47266	1.902737	4.837571	10.75888
5	4130.033	64.86093	13.29805	3.55991	4.895712	13.38539
6	4239.182	64.8109	13.22377	4.301317	4.669113	12.9949
7	4494.941	63.44913	12.53605	5.293188	7.075741	11.64589
8	4691.679	59.06414	11.74169	6.79215	9.876822	12.5252
9	4807.322	60.136	11.27042	6.56369	9.667586	12.3623
10	4857.244	59.04828	11.77723	7.390446	9.53429	12.24975

The BIST-100 index is more affected by its lag values than explanatory variables. However, this effect decreases within months. Most importantly, it is understood that all the macroeconomic variables have significant power to explain the variance of BIST-100 index. The explanatory power of CDS on the variance of BIST-100 index reaches its highest level (13.5%) in the 4th month. While the explanatory power of inflation reaches the highest level (13.4%) in the 5th month, the explanatory powers of industrial production and interest rate reach their highest values at the end of the 10th month.

5. Limitations and Suggestions for Future Research

There are several limitations in the study. In the paper, monthly data are used. However, quarterly announced macroeconomic variable such as economic growth could not be included in the study. Data announcement frequency causes restrictions on data selection. In addition, announcing some data one month after the relevant period requires additional attention in interpreting the results.

Future research could include more macroeconomics variables in their analysis. Furthermore, different frequency data like daily or weekly could be used. In this way, it can reveal a more sensitive potential relationship between the stock market and macroeconomics indicators. Different periods could be analyzed. In addition, further research could focus on the sub-sectors in BIST-100. There could be further research including Turkey and different emerging countries.

6. Conclusion

In this study, the effects of macroeconomic variables on the stock market in Turkey are examined. The macroeconomic variables involved in the study are inflation, industrial production, interest rate and CDS.

The regression output shows that the interest rate and CDS are negatively related with BIST-100 index. The increase in CDS has a negative effect on the Turkish stock market. As CDS is an indicator of the country risk, it is expected to have a negative relationship with the stock market. As the bond market is an alternative to the stock market, a negative relationship is expected between the interest rate and stock prices. Besides, rising in the interest rates increases the borrowing costs of companies and decreases their profitability. These two reasons support a negative relationship between the interest rate and BIST-100 index. The result shows that inflation has an insignificant positive relation with the BIST-100 index. The positive coefficient

corresponds to the Fisher theory, which indicates that stocks can be a hedging tool against inflation. The industrial production index has an insignificant negative relation with the BIST-100 index.

The Granger causality analysis shows that industrial production and inflation index have bidirectional causality relationships with BIST-100 index. Interest rate and CDS unidirectional Granger cause BIST-100. Eventually, four selected macroeconomic variables Granger cause BIST-100 index. Similarly, BIST-100 index Granger causes industrial production and inflation. The stock market can give a leading sign for inflation and industrial production. Impulse response analysis also confirms the negative response of BIST-100 index to CDS changes at different lags. The analysis also shows that the response of BIST-100 index to inflation is positive in the periods after the first two months. The function shows that the direction of the response of the BIST-100 index to interest rate shocks changes over the months, but is generally negative. The response of BIST-100 index to changes in the industrial production index is positive in almost of the entire period analyzed. The variance decomposition results show that all the selected macroeconomic variables have a considerable power to explain the variance of BIST-100.

As a result of the analysis, it is concluded that all the selected variables have a relationship with the BIST-100 index in the current or lag periods. Although the changes in industrial production and inflation index do not simultaneously affect the stock market, they affect BIST-100 index in the following months. CDS and the interest rate affect the stock market both in the same period and during the following periods. Although the post-crisis period is selected for the analysis, the impact of macroeconomic variables on the stock market continues in accordance with the general expectation and the literature.

Findings of the study include notable numeric and non-numeric results about the relationship between Turkish stock market and macroeconomic variables. The results can primarily contribute to the predictability of domestic and foreign investors for Turkish stock market. This contributes to the progress of the stock markets in Turkey. Increased predictability makes it easier for the policy-makers to predict the financial results of the macroeconomic and monetary policies that they implement. Furthermore, the results underline that the concept of CDS, which is relatively new in the world of economy and finance, is highly effective on the Turkish stock market.

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8. Appendix

Table 8 VAR Residual Heteroskedasticity Test (Levels and Squares)

Joint test:

Chi-sq	df	Prob.
1190.443	1200	0.5722

Individual components:

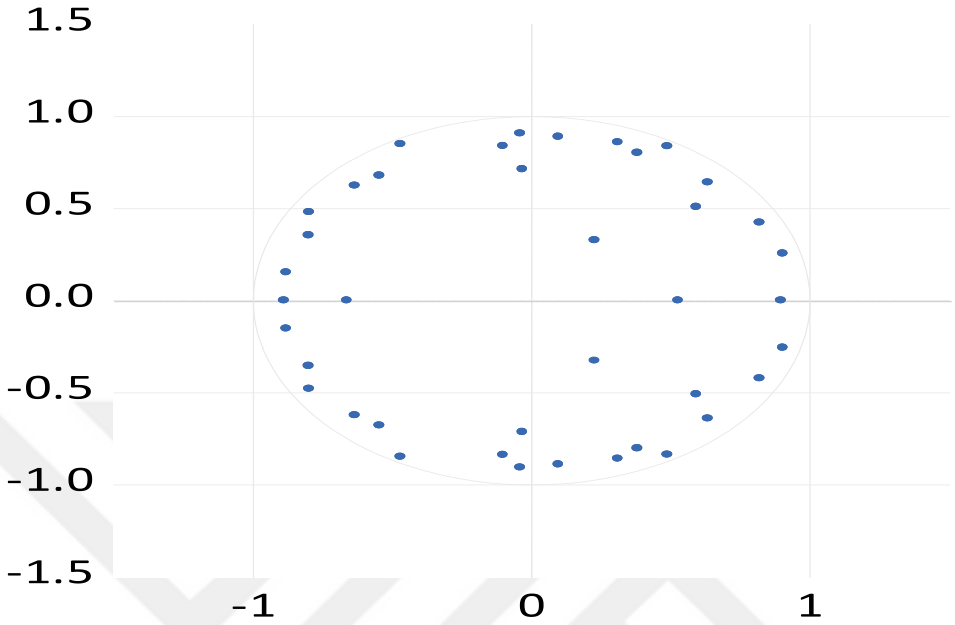
Dependent	R-squared	F(80,6)	Prob.	Chi-sq(80)	Prob.
res1*res1	0.978343	3.388149	0.0624	85.11588	0.3269
res2*res2	0.944907	1.286337	0.4100	82.20692	0.4108
res3*res3	0.908557	0.745180	0.7515	79.04443	0.5092
res4*res4	0.968801	2.328916	0.1427	84.28568	0.3500
res5*res5	0.989408	7.005582	0.0100	86.07847	0.3011
res2*res1	0.967976	2.266982	0.1508	84.21390	0.3520
res3*res1	0.912413	0.781293	0.7240	79.37994	0.4986
res3*res2	0.966712	2.178041	0.1635	84.10391	0.3551
res4*res1	0.949466	1.409137	0.3572	82.60351	0.3989
res4*res2	0.768359	0.248776	0.9986	66.84720	0.8530
res4*res3	0.972514	2.653660	0.1083	84.60872	0.3409
res5*res1	0.937814	1.131057	0.4894	81.58981	0.4296
res5*res2	0.952101	1.490802	0.3265	82.83281	0.3921
res5*res3	0.868030	0.493311	0.9285	75.51862	0.6210
res5*res4	0.965954	2.127914	0.1713	84.03801	0.3570

Table 9 VAR Model Autocorrelation Test

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	22.13596	25	0.6279	0.880979	(25, 139.0)	0.6305
2	24.06716	25	0.5155	0.964163	(25, 139.0)	0.5185
3	22.47900	25	0.6080	0.895677	(25, 139.0)	0.6107
4	30.45254	25	0.2078	1.246935	(25, 139.0)	0.2104
5	31.79188	25	0.1641	1.307784	(25, 139.0)	0.1665
6	24.61038	25	0.4844	0.987755	(25, 139.0)	0.4874
7	21.23251	25	0.6796	0.842429	(25, 139.0)	0.6820
8	19.45384	25	0.7749	0.767206	(25, 139.0)	0.7768
9	16.97250	25	0.8828	0.663742	(25, 139.0)	0.8839

Note: The null hypothesis is that no serial correlation at lag ‘h’

Figure 3 VAR Model Stability Control



Note: Points represent inverse roots of AR characteristic polynomial. Since no root lies outside the unit circle, VAR model satisfies the stability condition.

Table 10 OLS Regression Output

This table details the regression outputs. DLCDS and DLINF represent respectively the first difference of the log values of credit default swap and inflation index. DINT and DINP represent respectively the first difference of the interest rate and industrial production.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLCDS	-20519.71	2401.141	-8.545815	0.0000
DINDP	-58.63722	41.47948	-1.413644	0.1609
DINT	-1661.586	808.0893	-2.056191	0.0426
DLINF	49618.14	35408.84	1.401292	0.1645
R-squared	0.458841	Mean dependent var		579.0678
Adjusted R-squared	0.441001	S.D. dependent var		3710.349
S.E. of regression	2774.089	Akaike info criterion		18.73523
Sum squared resid	7.00E+08	Schwarz criterion		18.84276
Log likelihood	-885.9232	Hannan-Quinn criter.		18.77868
Durbin-Watson stat	2.263824			

Table 11 OLS Regression diagnostic tests

For Breusch-Godfrey Serial Correlation LM Test, the null hypothesis is that there is no serial correlation between residuals. For Breusch-Pagan-Godfrey test, the null hypothesis is that the residual variances are all equal (homoscedasticity). The Wald test is performed to see if all the independent variables affect the independent variable collectively. For the Wald test, all the coefficients are zero in the null hypothesis. VIF results show the multicollinearity in the regression.

Breusch-Godfrey Serial Correlation LM Test			
F-statistic	1.133561	Prob. F(2,89)	0.3265
Obs*R-squared	2.359848	Prob. Chi-Square(2)	0.3073

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	0.282308	Prob. F(4,90)	0.8887
Obs*R-squared	1.177197	Prob. Chi-Square(4)	0.8818
Scaled explained SS	0.885693	Prob. Chi-Square(4)	0.9266

Wald Test			
Test Statistic	Value	df	Probability
F-statistic	20.32429	(4, 91)	0.0000
Chi-square	81.29714	4	0.0000

Multicollinearity Test: Variance Inflation Factors (VIF) Result				
	DLCDS	DINDP	DINT	DLOGINF
Coefficient variance	5765480	1720,55	653008,4	1,25E+09
Uncentered VIF	1,02	1,02	1,02	1,02

Figure 4 Jarque Bera Normality Test

Jarque Bera test analyzes whether residuals show normal distribution. For Jarque Bera Normality Test, the null hypothesis is that the residuals are normally distributed.

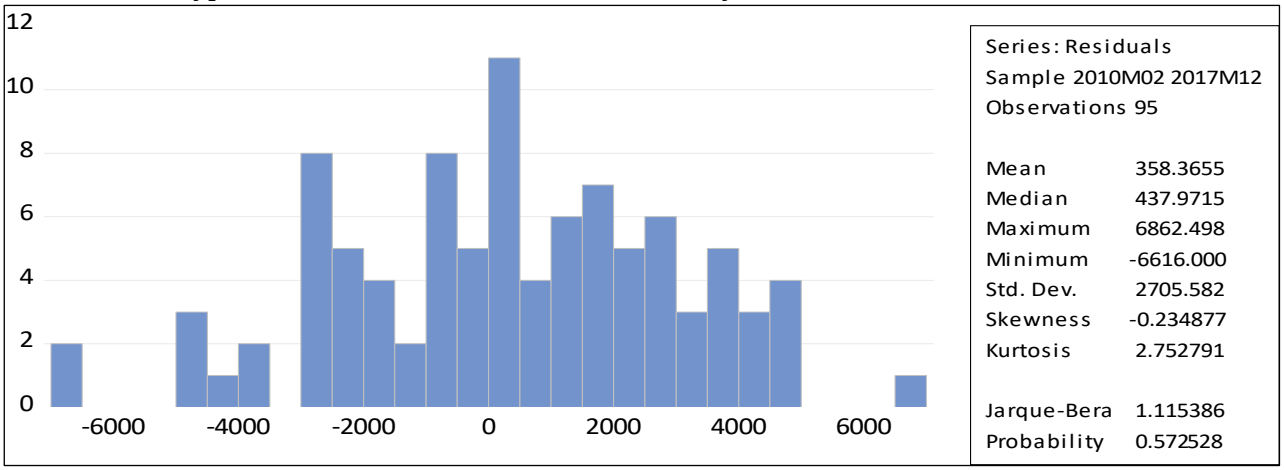


Figure 5 OLS Parameter Stability Test (CUSUM)

Cumulative Sum Control Chart shows whether the coefficents are stable during analyzed period. The area between dashed lines shows the confidence interval.