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Dynamic Effects of Macroeconomic Fundamentals on Stock Market Movements: Evidence from BIST100

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ABSTRACT

In this study we examine whether the Efficient Market Hypothesis (EMH) is valued in Turkey (BIST100[1]) or not and we also examine the ability of essential macroeconomic variables to predict the volatility of Istanbul stock market returns. The relationship is examined through the analysis of the quarterly data concerning the Istanbul stock market index (BIST-100) and selected essential macroeconomic indicates in Turkey over the period of 2003Q01 until 2019Q01. In order to investigate the relationship between the variables and BIST-100, Phillips-Ouliaris Cointegration, Asymmetric Cointegration and Dynamic Multipliers in a Nonlinear ARDL (NLARDL) models and also Bayesian Vector Autoregression (Litterman-Minnesota Bayesian VAR) are employed. The findings of the NLARDL test indicates that variables are cointegrated and there is positive and statistically significant asymmetric long run relationship from inflation to Istanbul stock market and also GDP, nominal exchange rate, S&P500 have significant and positive long run effect on Istanbul stock market return. These results suggest that the Istanbul stock market return (BIST-100) has consistent with the Efficient Market Hypothesis (EMH).

Keywords
BIST-100,
Stock Return Volatility,
NLARDL,
Bayesian VAR,

JEL Classification
E44, F65, R53, C11

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[1] The BIST 100 index is a commonly used abbreviation for the Borsa Istanbul stock exchange, Turkey's main stock exchange

1. Introduction

The stock market plays an important role for financial organizations and portfolio managers in the modern economics. volatility in stock market return is one of the essential tools between lenders and borrowers that help them to assessing the risk of portfolios and predicting return of future investment's income. Because predictability of volatility of stock returns help portfolios managers to minimized risks of investment in formwork of Efficient Market Hypothesis (EMH), Arbitrage Price Theory (APT) and other Asset Pricing Models. By considering related literature, those theories mainly emphasis on relationship between the stock market returns and economic activities. Also the Asset Pricing Theory and Efficient Market Hypothesis (EMH) explain the relationship between stock market and overall economic activity which it proxied by different macroeconomic variables in this case of study.

Stock market has three main important functions or effect channel through the overall economy. The first one is efficient allocation of investment resources; second one is improve of savings and better utilization of the existing resources (Leigh, 1996). According to (Fama, 1965) , the Efficient Market Hypothesis (EMH) refers that stock market prices fully and rationally combine all related information. But (Alshogeathri, 2011) emphasis that some theories such as Efficient Market Hypothesis (EMH) and Arbitrage Price Theory (APT) are silent about which economic factors have the ability to influence asset prices. This silence helps to study a wide range of related economic factors to search at the different failed of economics of a stock market return, interest rate or discounted cash flows of the present value model (PVM) or the expected returns. Present Value Model (PVM) simply states that the price of a stock is the present discounted value of the expected future dividends received by the owner.

According to (McMillan, 2010) stock price (Pt) equation is as follow as:

$$P_t = \sum_{i=1}^{\infty} \delta^{i} E_t D_{1+I}, \qquad (1)$$

Where; $\delta = 1/(1+R_i)^i$

E_tD_{1+I}: Discount rate of future cash flows

R_i: Essential variables which may impact expected returns.

In other words, the stock price (Pt) is related by Rİ which can be directly or indirectly affected by any macroeconomic factors. Aforementioned factors and information will be helpful

to predict volatility of stock market. By review existing literature, there are so many empirical researches have analyzed the dynamic relationships between stock market returns and economic activity. According to (Semmler, 2006) and, (Ross, 1976) some of asset pricing theories such as APT, and the Present Value Model (PVM), refer that there is a dynamic relationship between the stock market returns and economic activities. By considering some factors such as market efficiency, the efficient market hypothesis some of the researchers such as (Asprem, 1989), (Brooks & Del Negro, 2004), (Click & Plummer, 2005), (Gohar et al., 2018), (Awokuse et al., 2009) and (Beine et al., 2010), focus weather stock market and economies are integrated or not. The other group of researcher such as (Hassan & Naka, 1996) , (Sohail and Hussain 2009), (Mwaanga & Njebele, 2017) focus on short or long run relationship between macroeconomics and stock markets. Also there are some research such as (Ioannidis & Kontonikas, 2006), (Neuhierl & Weber, 2016), (Bjørnland & Leitemo, 2005), and (Lütkepohl & Netšunajev, 2018) focus on effect of monetary policy on the stock market.

2. Literature Review

As we noted in above, the EMH has been discussed among finance scholars more than five decades. Table 1 shows some of related researches.

Table 1.

Summary of Literature Review

Author(s) & Year	**Country**	**Period**	**Analysis method(s)**	**Major Results**
(Demir, 2019)	Turkey	2003Q1-2017Q4	ARDL Bounds Test	BIST100 was positively affected by economic growth, exchange rate, portfolio investments and foreign direct investments. But effect of interest rate and crude oil is negative.
(Soumaré & Tchana Tchana, 2015)	Emerging economies	1994-2006	VAR	According to this study there is relationship between foreign direct investment and financial market development.
(Kim & Moreno, 1994)	Japan	1970-1993	VAR	Increase in Japanese bank lending caused to increase in Nikkei stock. Therefore, there is a positive relationship between them.

(Hajilee & Al Nasser, 2014)	Panel data	1980-2010	VECM	According this study, Effect of the exchange rate on stock market return in China, Mexico, Pakistan and Venezuela is negative While for Philippines and South Africa is positive.
(Chaudhuri & Smiles, 2004)	Australian	1960-1998	Johansen cointegration and impulse response function	All variables have long-run relationship.
(Darrat, 1990)	Canada	1972-1987	Granger causality	The results show that stock market efficiency hypothesis is valid in Canadian stock market and Canadian stock market returns are Granger caused by lagged changes in fiscal deficits but stock market and the monetary policy don't have significant relationship with each other.
(Gan et al., 2006)	New Zealand	1990-2003	Johansen cointegration, Granger causality tests, and IRF	According this study, variable which have selected are cointegrated and also there is long run relationship between them.
(Rahman & Mustafa, 2008)	U.S. A	1974-2006	VECM	There is no long run relationship but the result shows the exists of short run relationships.
(Léon, 2008)	Kore	1992-1998	GARCH models and conditional variance.	Stock market returns and interest rate have a significantly negative relationship with each other.
(Patra & Poshakwale, 2006)	Greece	1984-2010	Granger Causality Test, and VECM	The selected variable are cointegrated and there are both short and long run relationship between stock returns and other variables. But there is no any relationship between exchange rate and stock returns and also Greek stock market was informationally inefficient during time which authors selected.

(Ratanapakorn & Sharma, 2007)	U. S. A	1975-1999	Forecast Error Variance Decomposition analysis, Johansen Cointegration and, Granger Causality Test	Stock market returns was effected negatively by long term interest rate but industrial production, money supply, inflation, the short term interest rate the and exchange rate have positive relationship with stock prices. And also all selected macroeconomic variable have long run causality to stock returns.
(Lu et al., 2001)	Emerging Market	1988-1989 And 1990-1992	Johansen Cointegration Test	According to this study variables are not cointegrated with stock market returns during the perıod which has been taken but monetary variables were cointegrated.

3. Model, Data and Meteorology

The analysis covers the period from 2003Q01 to 2019Q01 quarterly data. We selected series to analyze for three main reasons. Firstly, according to Present Value Model theory these variables theoretically have a significant effect on the stock market returns. Second, these variables are commonly used in the literature to analyze the theoretical links between stock market and real economic activities and third, these variables are available at a quarterly frequency. These macroeconomic variables[2] are short-term interest rate (i), inflation in the Turkey measured by the consumer price index (π); Brent crude price selected as proxy for world oil price, Industrial production index (IP), the nominal exchange rate of Dollar to Turkish Lira (EX), as proxy of international stock markets return Standard and Poor's 500 stock price index (S&P 500) and Borsa Istanbul (BIST-100) as proxy for local stock market returns.

3.1. Macroeconomic Variables in the Model

3.1.1. Industrial production index

Following many researchers such as (Chen et al., 1986), (Errunza & Hogan, 1998) and (Junttila et al., 2005), industrial production index was selected as proxy of production and also real activity. Industrial production index - which is proxy for real economic activity - is one of the most important factors that has significant effect on return of stock market.

[2] Source of the data for BIST-100 and S&P-500 is https://www.investing.com, for Brent oil price, fred.stlouisfed.org and for the other series is Central bank of the Turkey and Turkish Statistical Institute (TÜİK).

3.1.2. Oil price

Oil price is used in Bayesian VAR system as exogenous variable. Because oil prices are generally determined by world supply and demand. So there are not any economic factors which effect oil price in inside the country. (Hamilton, 1983) and (Hamilton, 1996) considered oil price changes as exogenous. Following (Hamilton, 1983), some researcher such as (Lee & Ratti, 1995), and (Bernanke et al., 1997) maintained to use oil price as exogenous variable.

3.1.3. İstanbul Stock Market index (BIST)

Istanbul Stock Market Index (BIST-100), is an indicator which measures the returns of the top 100 stocks traded on Borsa Istanbul in terms of market transaction and value. XU100 is transaction code of the BIST 100 index.

3.1.4. Short term interest rate

Monetary policies affect economies through the credit channel that changing in availability and cost of the external funding ((Xu, n.d.) and also within Monetary policy (Bernanke, & Blinder, 1992) emphasis that monetary shocks have effect on all economics especially have effect on small firms than on big firms. While other existing theoretical emphasis that monetary policy has no long-run impact on real stock prices (Bjørnland & Leitemo, 2005).

3.1.5. Inflation

Inflation (π) is calculated on a monthly basis from the Consumer Price Index and given on percentages that we use this data quarterly. The relationship between developed stock markets and economics variable generally reflect a negative correlation with inflation (Acikalin et al., 2008).

3.1.6. Exchange rate

The exchange rate is mainly linked to international competiveness. According to “good market approaches” which developed by (Dornbusch & Fischer, 1980) focused on changes in exchange rates impact international competitiveness of firm by effect on income and cost of borrow in foreign currencies. And also according to “portfolio balance approaches” discussed by Frankel, (1993) emphasis on the role and effect of capital account transactions on determining the relationship between the exchange rate and stock market returns.

3.1.7. Standard and Poor's 500 Index (S&P-500)

Following the many researchers, we select S&P-500 to understand how international market index effects on BIST-100. Because of effect of international crises and also using international stock to profile diversification, volatility of international stocks is so important for portfolio managers to managing profile and also for prediction of local stock markets (Alshogeathri, 2011). The S&P-500 Index or the Standard & Poor's-500 Index is a market capitalization weighted index of the 500 largest U.S. publicly traded companies.

3.2. Unit Root Test

For clarification of stationary of time series Augmented Dickey–Fuller (ADF) and Phillips-Perron (PP) unit root test has applied. Table 2 shows all variable are stationary at the I (0), I (1) and none of them is stationary at I (2). In addition, all variables seasonally adjusted.

Table 2

Unit Root Test

Variables	**ADF**		**PP**	
	Intercept	Intercept and trend	Intercept	Intercept and trend
IP	-0.60	-2.52	-0.45	-2.52
ΔIP	-8.08***	-8.01***	-8.29***	-8.21***
OP	-2.65*	-2.49	-2.13	-1.91
ΔOP	-6.29***	-6.36***	-5.76***	-5.87***
Π	-4.66***	-3.41**	-3.71***	-3.42**
BIST-100	-1.40	-3.81**	-1.40	-3.40*
Δ BIST-100	-7.03***	-6.99***	-7.03***	-6.99***
S&P 500	0.54	-0.86	0.33	-1.09
Δ S&P 500	-7.11***	-7.24***	-7.14***	-7.24***
EX	5.46	3.12	6.99	2.60
ΔEX	-6.07**	-5.38***	-6.08***	-6.99***
I	-5.31***	-3.22*	-4.81***	-3.14*

Note. The sighs *, ** and *** represent 10%, 5%, and less than 1% significance level, respectively.

3.3. Single Equation Analysis : Cointegrating Regression (Residual-Based Tests)

We consider a standard triangular representation of a regression with existence of a single cointegrating vector. cointegrating equation of n+1 dimensional time series vector for y_t, x_t' is:

$y_t = x'_t\beta + D'_{1t}\gamma_1 + u_{1t}$

where $D_t = (D'_{1t}, D'_{2t})'$, n: stochastic regressors and $x_t = \tau'_{21}D_{1t} + \tau'_{22}D_{2t} + \varepsilon_{2t}$ where $\Delta\varepsilon_{2t} = u_{2t}$.

Alternative hypothesis of null hypothesis of no cointegration is cointegration which corresponds to the null of nonstationary against the alternative of stationarity. For p-lag augmented regression form:

$\Delta u_{1t} = (\rho\text{-}1)\, u_{1t\text{-}1} + \sum_{j=1}^{p} \delta_j \Delta u_{1t-j} + v_t$

where,

$\hat{\tau} = \frac{\hat{\rho}-1}{se(\hat{\rho})}$ and $\hat{z} = \frac{T(\hat{\rho}-1)}{1-\sum_j \hat{\delta}_j}$; $se(\hat{\rho})$ for usual estimator of the standard error of the estimaton $\hat{\rho}$:

$$se(\hat{\rho}) = \hat{s}_v(\sum_t u_{1t-1}^2)^{-1/2} ,$$

Some of the variables are not stationary at the level, therefore for Phillips-Ouliaris analyses first differences of non-stationary variable is taken. Following to literature the baseline Cointegrating Regression model is obtained as follow as:

Change in BIST-100 index= f (growth of industrial production, Interest rate, change in exchange rate, inflation rate, change in sp500 index)

Table 3

Phillips-Ouliaris Cointegration Test

Parameters	**Phillips-Ouliaris Cointegrating Regression**
$\hat{\tau}$	-4.76**
z	-33.90**
$\hat{\rho}$ **-1**	-0.62
$\hat{\rho}^{*}$ **-1**	-0.616
$\hat{\rho}$ ***S.E**	0.129

Note: sighs *** represent 1% significance level.

According table 3 variables are cointegrated. In case of using growth or change of non-stationary series, series has lost its long run feature. NLARDL allows use to use combination of

I(0) and I(1). Therefore, by using Nonliner ARDL model we will test cointagration, short and long run relationship between variables at level.

NLARDL model developed by (Greenwood-Nimmo et al., n.d.) and (Shin et al., 2011) that refer to combines a non-linear long run relationship with nonlinear and asymmetric error correction by use of constructed partial sum decompositions.

NLARDL long-run relationship:

$$y_t = \beta^+ x_t^+ + \beta^- x_t^- + u_t$$

Where x_t is a k × 1 vector and $x_t = x_0 + x_t^+ + x_t^-$

Where x^{pos}_t and x_t^{neg} are partial sum processes of positive and negative changes in x_t defined by

$$x_t^+ = \sum_{j=1}^{t} \Delta x_j^+ = \sum_{j=1}^{t} \max(\Delta x_j, 0), x_t^- = \sum_{j=1}^{t} \Delta x_j^- = \sum_{j=1}^{t} \min(\Delta x_j, 0)$$

And β^{pos}, β^{neg} are the related asymmetric long-run elements. error-correction form of the system is as follows:

$$\Delta y_t = \rho y_{t-1} + \theta^+ x_{t-1}^+ + \theta^- x_{t-1}^- + \sum_{j=1}^{p-1} \gamma_j \Delta y_{t-j} + \sum_{j=0}^{q} (\pi_j^+ \Delta x_{t-j}^+ + \pi_j^- \Delta x_{t-j}^-) + \varepsilon_t ,$$

where null hypothesis $\rho = \theta^{pos} = \theta^{neg} = 0$

long-run steady state of the system can be written as follows by the asymmetric cumulative dynamic multipliers:

$$m_h^+ = \sum_{j=0}^{h} \partial y_{t+j} \Big/ \vartheta x_t^+ \qquad h= 0, 1, 2, \ldots$$
$$m_h^- = \sum_{j=0}^{h} \partial y_{t+j} \Big/ \vartheta x_t^-$$

where m_h^+ and m_h^- tend toward the respective asymmetric long-run coefficients $\beta^+ = \theta^+ / -\rho$ and $\beta^- = \theta^- / -\rho$, respectively, as $h \to \infty$.

In our case of asymmetric or Non-linear ARDL (NLARDL):

$$\Delta BIST100_t =$$

$$= \alpha_0 + \sum_{q=1}^{p1} \alpha_{1q} \Delta BIST100_{i,t-q} + \sum_{q=0}^{p2} \alpha_{2q} \Delta \pi^{pos}_{i,t-q} + \sum_{q=0}^{p3} \alpha_{3q} \Delta \pi^{neg}_{i,t-q} + \sum_{q=0}^{p4} \alpha_{4q} \Delta IP_{i,t-q} + \sum_{q=0}^{p5} \alpha_{5q} \Delta EX_{i,t-q} +$$

$$\sum_{q=0}^{p5} \alpha_{6q} \Delta I_{i,t-q} + \sum_{q=0}^{p6} \alpha_{7q} \Delta SP500_{i,t-q} + \beta_1 BIST_{i,t-1} + \beta_2 IP_{i,t-1} + \beta_3 EX_{i,t-1} + \beta_4 I_{i,t-1} + \beta_5 \pi^{pos}_{i,t-1} + \beta_6 \pi^{neg}_{i,t-1} + \varepsilon_t$$

Because of important rule of inflation on monetary policy and also in real economic activity, Inflation is selected as asymmetric variable in Non-ARDL equation.

Table 4

Direct Long and Short Run Effect on BIST-100

Variables	**NLARDL Model (1,1,3,0,0,2,3)**	
	Long Run Coefficients	Short Run Relationship From Variables to BIST-100 (f-stat)
C	132259.8***	--
π^{pos}	3490.49***	14.93*** (There is short run relationship)
π^{neg}	4390.49***	4.02** (There is short run relationship)
IP	183.20	0.04 (no short run relationship)
I	-4391.65***	0.17(no short run relationship)
EX	7571.908	3.59** (There is short run relationship)
S&P500	38.74***	6.71***(There is short run relationship)
F-Bounds	4.400***	--
ECt-1	-0.54***	--
Breusch- Godfrey- Serial Correlation LM**:**		F=1.52 (0.22)

Note. The sighs *** following the t-statistics represent 1% significance level, and parantes shows probability.

This result of NLARDL in Table 4 indicates that all selected variables have long run relationship and they are cointegrated. Therefore, this result of NLARDL was consistent with the

result of the Phillips-Ouliaris cointegration test. According to results of NLARDL there is long run positive relationship between Istanbul stock market index and macroeconomic variables. While, just short term interest rate (i) has statistically significant and negative long run relationship with Istanbul stock market. The Industrial production and short-term interest rate have no significant short run effect on BIST-100. While other variables have statistically significant and short run effect on BIST-100.

3.4. Bayesian VARs and Impulse Response Functions

Bayesian analysis is required to have knowledge of the distributional properties of the prior, likelihood, and posterior. The prior distributional is the external distributional information which reflects researchers' beliefs on parameters of research and interest.

For setting distributional properties of the prior are followed a normal prior on with fixed $\sum_{\varepsilon}$ Litterman or Minnesota prior method. According to (Doan et al., 1986) and (Litterman, 1986) priors is based on an assumption that $\sum_{\varepsilon}$ is known as prior elicitation and computation of the posterior.

Since $\sum_{\varepsilon}$ is replaced by $\hat{\Sigma}_{\epsilon}$. The Litterman prior assumes that the prior of θ is

$$\theta \sim N(\theta_0, V_0)$$

V_0 is a diagonal matrix with elements V_{ij}^1 for I =1,….p

$$v_{ij}^1 = \begin{cases} \left(\frac{\lambda_1}{1^{\lambda_3}}\right)^2 & \text{for i=j} \\ \left(\frac{\lambda_1 \lambda_2 \sigma_i}{1^{\lambda_3} \sigma_j}\right)^2 & \text{for i≠j} \end{cases}$$

where σ_i^2 is the i th diagonal element of $\sum_{\varepsilon}$. This prior setting indicates that the complicated choice of specifying all the elements of down to choosing three scalars, and; λ_1 measures the tightness of the prior:

When $\lambda_1 = 0$ the prior is imposed exactly, while as $\lambda_1 = \infty$ estimates will reflect the Ordinary Least Squares. λ_2 reflects the standard deviation of the prior on lags of variables other than the dependent variable. And $\lambda_2 = 1$ there is no distinction between lags of the dependent variable and other variables. λ_3 controls the decay over lags.

According to (Marcellino et al., 2012) and (Giannone et al., 2015) there are ways to choose hyperparameters optimally. While considering our hypotheses and also following (Carriero, n.d.). The priors parameters were improve with new alternatives for forming the underlying covariance matrices that make up essential additives of the prior. The covariance matrices and related earlier specification are generally formed by specifying a matrix alongside a number of hyper-parameters which define any non-zero factors of the matrix. The hyper-parameters themselves are both selected by the researcher, or taken from an initial error covariance estimate. Sensitivity of the posterior distribution to the selection of hyper-parameter is a well researched topic, with practitioners often choosing many unique hyper-parameter values to check their analysis does no longer change based completely on preference of parameter. μ6 is related to initial observation dummies which is not set up in our models. we set hyperparameters which shown in table 5;

Table 5

Bayesian VAR Litterman-Minnesota Hyperparameters:

AR (1)	**0**
μ6	There is no initial observation dummies
$\boldsymbol{\lambda_0}$	0
$\boldsymbol{\lambda_1}$	0.2
$\boldsymbol{\lambda_2}$	1
$\boldsymbol{\lambda_3}$	1

According to some studies such as (Ashley & Verbrugge, 2009) modeled a VAR in levels to apply IRF confidence interval estimation perform adequately. Also (Ojaghlou, 2019), (Rüffer & Stracca, n.d.), (Sousa & Zaghini, 2008), use I(0) instead of I(1) variables to IRF. Therefore, level of HP-filtered series used to 10 period of IRF of Bayesian VAR. The result summarized Figure 1.

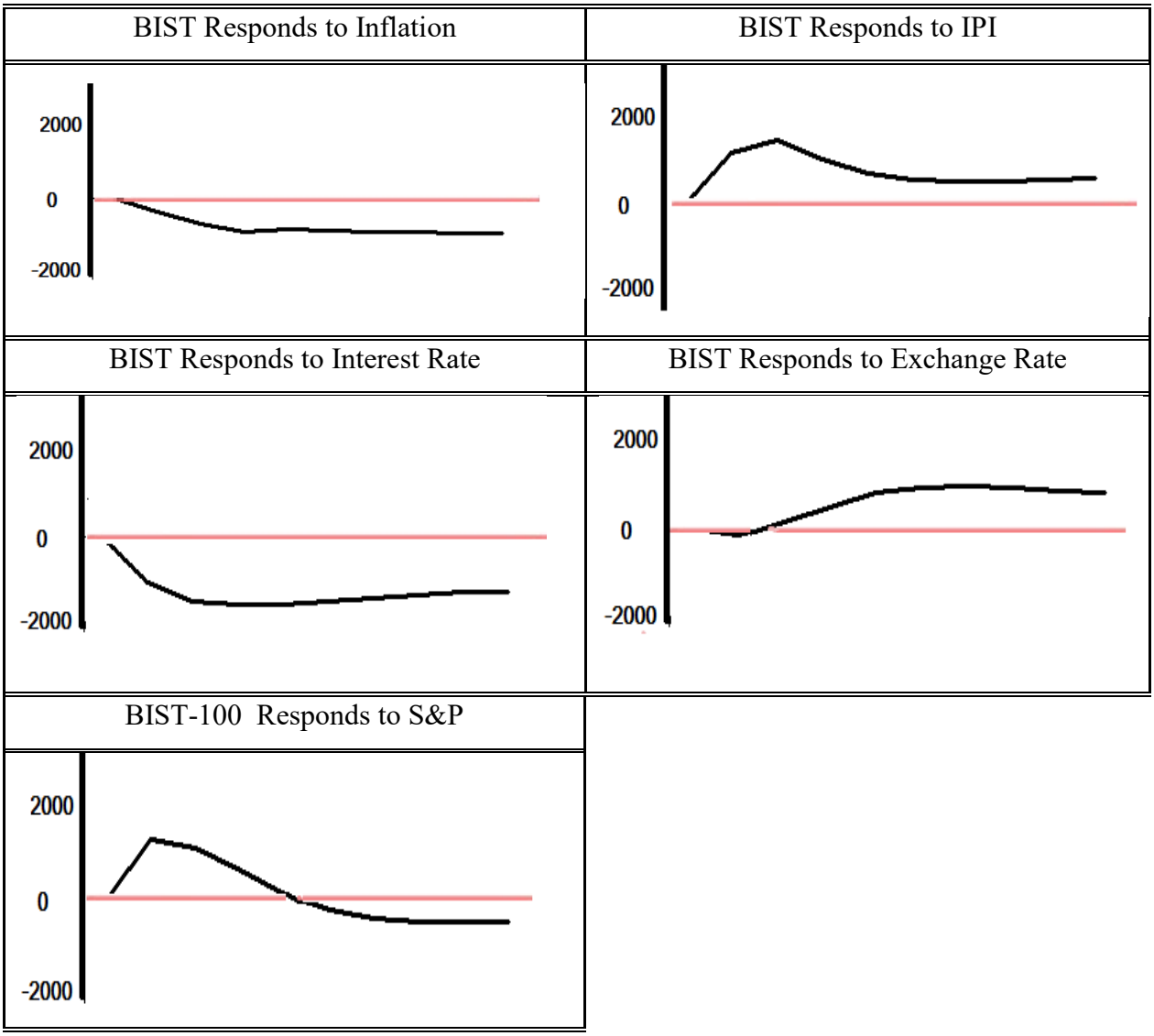

Figure 1. Impulse Response Functions of Bayesian VAR (Litterman-Minnesota)

Based on panels in Figure 1 the Impulse Respond Functions (IRF) indicate that the effects of inflation and interest rate on BIST are negative. Our results is same with (Alshogeathri, 2011) and (Bjørnland & Leitemo, 2005). Effect of Income and exchange rate are positive. The effect of S&P on BIST partly is positive. Except inflation the result of Bayesian VAR is generally same with results of NLARDL. Also we test dual-side causality between BIST and inflation which shows there is generally negative relationship between inflation and BIST. The international stock market shocks (S&P 500) has generally positive affect to BIST-100. BIST-100 responds positively to nominal exchange rate that shows BIST-100 has been used as asset to keep value.

4. Conclusion and Implications

The main objective of this study is to analyses whether the most important macroeconomic factors selected in this study have long and short run effect on the Istanbul stock market returns or not. The other word, long and short runs dynamic relationships between BIST-100 and essential macroeconomic variables over the period from 2003Q01-2019Q01 are examined.

Bayesian VARs models including the Phillips-Ouliaris cointegration test, NLARDL test impulse response functions analysis were used to estimate the short and long run relationships between the selected macroeconomic series and the Istanbul stock market (BIST-100).

By considering unit root test, we use growth and changes of variables to use the Phillips-Ouliaris cointegration test. The results suggest that macroeconomic variables have long run relationship that it indicate each variable in the system tends to adjust proportionally to bring in the system back to its long run equilibrium. Also for testing both long and short run relationship NLARDL method were used that the results indicate all selected variable are cointegrated and there is long run relationship in between variables.

The findings of the NLARDL test indicate that there is significant and positive asymmetric long run relationship from inflation to Istanbul stock market and IP, nominal exchange rate, S&P500 had significant and positive long run effect on Istanbul stock market return. However IP shows no significant effect on Istanbul stock. While only short-term interest rate affected negatively. These results suggest that the Istanbul stock market price has consistent with the efficient market hypothesis (EMH).

The Bayesian VAR - IRF analysis shows evidence that there are significant long run relationships between the Istanbul stock market returns and all other macroeconomic variables that show the findings of IRF are consistent with the EMH and financial theories.

As implication Istanbul stock market returns mainly are predictable as the volatility of macroeconomic variables especially in the long run. Financier in the Istanbul stock market should consider change and volatility revealed by the monetary policy driven by short term interest rates, inflation, oil price, nominal exchange rates, and the international stock market. Efficient market hypothesis (EMH) is mainly valued in Turkey and it should be considered by finance and monetary authorities when they plan financial policies. Also this study by using oil price as exogenous

variable may help to understand role of the oil in financial sector for non-oil exporter countries such as Turkey.

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