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The Impact of Oil Price Shocks on Sector Indices: Evidence from Borsa İstanbul

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Abstract: *We analyze the dynamic relationship between daily Brent oil prices and selected sector index returns of Borsa İstanbul. To perform an elaborate analysis, because oil price fluctuations affect sectors differently, the sectoral index returns are classified as oil-user, oil-related, oil-substitute, and financial. Employing Johansen and Juselius (1990) cointegrating technique, the long-run relationship is examined between the oil price changes and sectoral stock returns. After the investigation of the causal relationship between these two variables, Impulse Response Functions and Variance Decomposition Analysis are used to evaluate how shocks to variables rebound through a system. Given that significant changes have occurred across capital markets throughout the period, it would appear to be worthwhile to investigate whether changes in interactions among oil prices and sectoral stock returns have occurred as a result. The findings indicate that; there is cointegration between returns of half of the sectoral indices analyzed and oil prices Granger causes sectoral index returns.*

Keywords: Oil Price Shocks, Borsa İstanbul, Sub-sectors, Causality, Variance Decomposition, Impulse Response Function

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1. Introduction

Oil, a non-renewable and strategic commodity, is considered as a major indicator of economic and industrial activity; therefore, any shocks or variations in oil prices are of special interest to investors, policy makers and market participants. There is some specific evidence that very large and immediate rises in oil prices may have a significantly negative effect on a country's economic development. These may result in higher inflationary trends, and an increase in production costs. Moreover, a loss of confidence means loss of investment (Hamilton, 2003; Lardic & Mignon, 2008). Most existing studies focus on the effect of oil price shocks on the performance of stock market. Theoretically, this relationship can be comprehensively explained by using equity pricing model, suggesting that the value of equity is calculated as finding the present value of discounted future cash flows. Based on the discounted cash flow model, when oil is considered as a direct or indirect production factor for most firms, oil price changes affect the firms' expected earnings, and thereby, cash flows. Also, they will indirectly have an impact on the dividend payout ratio, stock prices and also retained earnings (Huang et al., 1996; Aloui & Jammazi, 2009). In addition, higher oil prices result in an increase on inflationary pressures; therefore, Central Banks raise interest rates to combat inflation. The combined effect of higher interest rates and inflation results in higher discount rates. Higher

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discount rate in the discounted cash flow method leads to lower stock prices (Basher & Sadorsky, 2006). More practically, oil price changes cause a decline in economic growth, and higher inflation, reducing consumer confidence, and thereby, slowing overall consumption and investments (Chen, 2010). Traders also follow the movements in the commodity (especially oil) and stock markets to forecast their short-term directions, and base their investment decisions on these (Choi & Hammoudeh, 2010). Consequently, it is expected that oil price fluctuations will affect the stock markets to some extent.

Since economic growth in developed and developing economies is likely to be affected by oil production and supply, and stock markets are the most important indicator of the economic and financial development, the link between oil price changes and performance of stock market has been of major academic interest. Although many earlier studies examining the association between oil price changes and stock markets focus on developed economies, the recent decade has witnessed greater interest in developing economies (Nandha & Hammoudeh, 2007; Cong et al., 2008; Narayan & Narayan, 2010; Masih et al., 2011; Nguyen & Bhatti, 2012; Broadstock et al., 2012). However, surprisingly few studies focus on the Turkish stock market, as an important emerging market (Eksi et al., 2012; Eryiğit, 2009; Alper & Torul, 2010). The purpose of this study is to examine whether stock returns of eleven sector indices in the Turkish stock market are sensitive to oil price changes. We use Johansen cointegration approach, together with the Granger causality test to investigate the long and short-term linkages between stock returns and oil price. Moreover, we examine the interactive reactions between stock markets and oil price changes to identify the contribution of oil price shocks to the variability in the stock market, within the framework of Impulse Response Functions and Variance Decomposition Analysis.

Four main types of industries are analyzed; oil-substitute (electricity), oil-user (construction, chemical, metal, machinery, transportation), oil-related (mining), and financial (banking and insurance). We adapt the same type of classification in the study of Elyasiani et al. (2011). In this study, we aim to contribute to the debate on the oil-price change and stock return nexus in four respects. First, many sectors in the Turkish economy are highly dependent on imported oil products used as an input for, amongst others, transportation, electricity, construction, as well as in various other sectors. Therefore, the Turkish economy is very sensitive to changes and shocks in oil prices, which can affect profits, dividends, investments and stock prices.

Second, as Turkey is a developing country in all aspects, including economic development, and population profile, the demand for all segments of the energy sector has long been increasing. According to Turkey's Energy Profile and Strategy report, prepared by Ministry of Foreign Affairs, unfortunately, a great proportion of the total energy demand (75%) is met by imports, and a much smaller from domestic resources. Turkey meets 35% of its total energy demand from gas, 28.5% from coal, 27% from oil and 9.5% from renewables. At present, 99% of natural gas demand is imported. In recent decades, Turkey has ranked second only after China, in terms of growth in natural gas demand and oil supply imports.

Third, it is crucial to analyze whether oil price changes and stock market developments have a direct or indirect effect on the return generating process of the sector indices. Especially, increased globalization has led to a decline in the international diversification benefits. Therefore, the risk-return trade-offs based on industry-based diversification across the stock markets of individual countries has gained much more attention recently (Baca et al., 2000). Moreover, the knowledge of which industry stock returns are most affected by the oil price changes is important in allowing individual investors, arbitrageurs and hedgers to determine investment strategies for risk management purposes. For example, the knowledge that oil price changes will have a positive or negative effect on a particular sector will play a key role in investment decisions.

The final contribution of this paper is to focus on the effect of oil price shocks on the sectoral stock returns in an emerging market, i.e. Turkey. This is important because there is no consensus in the existing literature on the magnitude and sign of the effect of oil price movements on the different sectoral index of the Turkish stock markets. Therefore, this paper aims to fill the gap in the literature by analyzing the impact of oil price changes on eleven sector industries, divided into 4 main sub-categories. Thereby, industry-level analysis is important for investors to account for the differences in sectoral oil sensitivities, while implementing sector-based investment strategies. Additionally, to the best of authors' knowledge, this is a pioneering effort to measure the impact of oil price changes on the different sector returns on the basis of sub-sectors, and utilizing a much broader data set compared to previous studies (Eryiğit, 2009; Alper & Torul, 2010; Toraman et al., 2011).

The rest of the paper is organized as follows: Section 2 presents previous findings on the links between stock markets and oil price. Section 3 describes the data set and methodology of the study. Our empirical results are introduced and discussed in Section 4. Section 5 offers some concluding remarks on the findings together with suggestions for further research.

2. Literature Review

Although there exists a substantial body of literature analyzing the relationship between the oil price changes and stock prices, the majority focus on developed economies. Kling (1985) first who investigates the impact of oil spikes on the S&P 500 and the price indexes of five US industries, by employing vector autoregression model. Later, using multivariate factor analysis, Chen et al. (1986) and Hamao (1988), examine the oil price risk on US and Japanese market, respectively, finding no evidence of oil price impact on stock markets. However, the study conducted by Sadorsky (1999) and Kanoke and Lee (1995) highlight that shocks in oil prices are factors contributing to the explanation of the movements in the stock markets of both US and Japan. Jones and Kaul (1996), who examine the reaction of stock markets to oil shocks in four developed countries, namely, the US, Canada, Japan and the UK, find that in each case, oil price movements negatively affect the stock returns. Using the vector autoregreesion (VAR) model, Huang et al. (1996) examine the link between the oil futures returns and US stock returns. The authors conclude that despite oil futures returns having positive and significant effect on individual oil company and petroleum industry stock returns, there is no crucial impact on either returns for other industries or the aggregate S&P 500 index. In a similar line of study, Faff and Brailsford (1999) analyze the sensitivity of the equity stock returns in the Australian market to changes in oil and gas price. Their results show that oil price change is a crucial indicator in return-generating process. As expected, the direction and magnitude of the changes in oil price varies with respect to different industry sectors.

Ghouri (2006) reveals a very strong negative relationship between West Texas Intermediate and US monthly stocks positions. This result is partly confirmed by Chang et al. (2013), who, employing the VARMA-GARCH and VARMA-AGARCH methods, find a weak evidence of dependence between oil and financial markets. The empirical results from these models suggest that VARMA-AGARCH is superior to the VARMA-GARCH and CCC models in terms of the modeling the asymmetric effects.

McSeweeney and Worthington (2008) analyze the extent to which oil price changes have a significant effect on Australian industry stock returns, as well as macroeconomic variables, for the period 1980-2016. Their findings show that increase in oil price negatively affect the stock returns of three sectors, namely, transportation, retail and banking. However, energy sector return will be positively affected by the increase in the oil price; and moreover, there is no effect of oil price changes on insurance, property trust, insurance, materials, and financial sector.

Apergis and Miller (2009) investigate the impacts of structural shocks in oil market on stock prices in developed countries, showing that various structural shocks in oil-market have a crucial role in the explanation of the stock return adjustments. According to the findings, for the majority of countries, there is a significant contribution of oil supply shocks, aggregate global-demand shocks, and oil-market idiosyncratic demand shocks to the explanation of stock-market returns from the variance decompositions.

Nazlioglu et. al. (2015) differently examine oil price and financial stress relationship by especially focusing on 2008 crisis. The results exert significant volatility spillover between energy and financial markets. Accordingly, Phan et. al. (2016) do research on volatility interaction between oil and stock markets after crisis period with high frequency data, and obtain strong relationship.

The majority of studies investigating the linkages between these two important variables, oil price and stock return focus on developed countries, but others directly shed light on the emerging countries. The earliest of these is Hammoudeh and Eisa (2004), which investigates the relationship between oil prices and returns in the six Gulf Cooperation Council countries. This stimulated great academic interest in this relationship in emerging economies; for example, using an international multi-factor model, Basher and Sadorsky (2006) find that oil price shocks have a strong influence on stock returns of these emerging markets. Sadorsky (2014) finds correlation between oil prices and emerging market index and oil as the cheapest hedge for emerging market stock prices in the study which focuses on volatility and correlation. Jouini (2013) shows the return and volatility transmission between oil price and stocks in Saudi Arabia. In a similar vein, Bouri (2015) finds volatility transmission from oil prices to the Lebanese stock market with varying transmission effect in analyzed sub-periods.

Aloui et al. (2012) find a positive correlation between stock prices and oil price movements in especially emerging economies. In addition, the direction of the correlation between the stock returns and oil-related beta depends on whether the country is oil-dependent or a net-oil exporter. Despite a positive relationship between these two variables in oil-dependent countries during bullish markets, the relationship turns out to be negative during bearish markets for countries with the largest net oil export.

Similarly, Narayan and Narayan (2010) reveal that the growth of the Vietnamese stock market was accompanied by rising oil prices. In contrast, Filis (2010) found that oil prices exercise significant negative influence on the stock market. This position is supported by Sadorsky (2014), who argues that correlations between oil price and MSCI Emerging Markets Index priced in US dollars increased considerably after 2008, and have yet to return to their pre 2008 values.

Turkey is the largest economy in the emerging markets of Eastern Europe and Middle East. Despite the existence of some evidence about the relationship between oil price and stock returns in Turkey, relatively little is known about the relative sensitivity of the effects of oil price changes on stock returns in different sectors. In one of the latest studies about Turkey, Yıldırım (2016) finds that increase in oil price has no effect on Borsa İstanbul 100 (BIST-100) index and decrease in oil price affects positively BIST-100 index both in long and short run by following asymmetric modelling technique for 2003-2016 period. Avcı (2015) examines the effect of oil prices on stock market return for 2003-2013 period and finds a long-term relationship between variables and also a causal relationship from oil prices to stock returns. Kılıç et. al. (2014) analyze the relationship between Borsa İstanbul industrial index and crude oil prices for 1994-2013 period by using Gregory-Hansen co-integration test and dynamic ordinary least squares, and find long run relationship between crude oil prices and industrial price index. Abdioğlu ve Değirmenci (2014) investigates long run and short run relationship between oil prices and stock prices for BIST at the sector specific level by using daily data for 2005-2013 period and finds that oil prices are not Granger cause of stock prices. Acaravcı and Reynaoğlu (2013) explore long-run relationship between energy prices and capital market by using Johansen cointegration and vector error correction for 2001-2010 period. According to the findings there is long-run relationship between ISE 100 index, oil prices, and industrial production index, and additionally oil price shock leads to decline on ISE 100. Differently, Yıldırım et. al. (2014) find that crude oil price index is Granger cause of industrial index and crude oil price index affects industrial index positively. Özcan (2012) analyzes the relationship between macroeconomic variables (interest rates, consumer price index, money supply, exchange rate, gold prices, oil prices, current account deficit and export volume) and Istanbul Stock Exchange (ISE) industry index for 2003-2010 period. The results indicate that macroeconomic variables exhibit a long run equilibrium relationship with ISE industry index. Eryiğit (2012) analyzes Istanbul stock exchange market index (ISE-100), interest rates, exchange rates and oil price by using a vector autoregressive (VAR) approach for Turkey. Findings prove the dynamic relationship among oil price shocks, Istanbul stock market index, exchange rate and interest rate. Toraman et al. (2011) analyze the effects of oil price changes on ISE 100 composite index, services index, industrial index and technology index over a specific period of 2009-2011. Employing cointegration and Vector Error Correction Models, their studies demonstrate evidence that the industrial index is the most sensitive, and the technology index is the least. Alper and Torul (2010) investigate the sensitivity of the manufacturing sub-sectors in Turkey to changes in oil prices over the period

1990-2007 by using multivariate VAR estimations. The results indicate that oil price increases do not impede production growth overall, but reduce growth in certain manufacturing sub-sectors. İşcan (2010) analyzes the long-term relationship between oil-prices and stock prices using ISE-100 Index daily data and does not find any relationship between oil prices and stock prices. Güler et. al. (2010) examine impact of oil prices volatility on energy stock prices, which are traded in İstanbul Stock Exchange for 2000-2005 period and find that oil price is a significant indicator of stock prices and electricity index. Eryiğit (2009) analyzes the linkages between oil price changes and sector indices of the ISE over the period 2000 and 2008 using daily data and OLS method. This provides strong evidence of significant impact of oil price movements in specific sector indices, namely, Investment, the Wholesale and Retail Trade, Insurance, Basic Metal, Metal products, Non-Metal and Mineral Products, Electricity, Holding, Machinery, and Wood, Paper and Printing.

On the other hand, volatility is also considered in Turkish Literature as well. Çelik et. al. (2015) investigates the effect of oil price volatility on return volatility for a long time span (2000-2014). Their results show no effect of oil price volatility on BIST 100, BIST Manufacturing and BIST Chemical return volatility. From a different perspective, Yılmaz and Altay (2016) search the effect of oil price change on exchange rate volatility for thirty-year period (1985-2015). Their results indicate long-run relationship between those variables.

A few studies investigating the importance of oil price shocks on stock market return performance use similar methodologies to the current study, but our paper extends these studies by utilizing sub-sector indices: oil-user, oil-related, oil-substitute, and financial, as well as extending the data span. To the best of the authors' knowledge, this is a pioneering study in that it covers a much longer sample period for these sectors, thus making a contribution to the literature.

3. Data and Methodology

To examine the dynamic linkages between oil prices and Turkish sub-sector stock returns, daily closing prices were obtained from the Thomson Reuters database for the stock prices, and Energy Information Administration (hereafter EIA) for the crude oil prices. The sample data consists of stock returns for the sub-sectors of (BIST); banking (XBANK), basic metal (XMANA), chemistry, petrol and plastic (XKMYA), construction (XINSA), electricity (XELKT), information, technology (XTEK), insurance (XSGRT), metal product and machinery (XMESY), mining (XMADN), SME industrial (XKOBI), transportation (XULAS). Price series of sub-sector indices, and crude oil are transformed into the natural logarithm forms. There are variations in the periods for sectoral stock return data due to data availability. The sample period for each sub-sector is reported in Table 1.

Table 1. Sample and Data Specification

Sub-sectors	Sample Period (DD/MM/YY)
Oil Substitute	
Electricity	02.01.1997-09.02.2016
Oil Related	
Mining	04.02.2013-09.02.2016
Oil User	
Basic Metal	02.01.1997-09.02.2016
Chemical, Petroleum and Plastic	02.01.1997-09.02.2016
Construction	04.02.2013-09.02.2016
Information Technology	05.07.2000-09.02.2016
Metal Product Machinery	02.01.1997-09.02.2016
Transportation	02.01.1997-09.02.2016
SME Industrial	02.12.2013-09.02.2016
Financial	
Banking	02.01.1997-09.02.2016
Insurance	02.01.1997-09.02.2016

Sectoral stock return series, and oil prices are all expressed in US dollars. The West Texas Intermediate (WTI) crude oil price, quoted in US dollars per barrel, is highly correlated with other crude oil markets, and is therefore used as a benchmark for market pricing. An attempt is also made to analyze the unconditional correlations between each sub-sector index, and crude oil price in Table 2. Oil price correlates positively with all the sub-sector indices, except electricity. Transportation and information technology sector returns are not greatly affected by oil price.

Table 2. Unconditional Correlation Matrix

	Oil	*Electricity*
Oil	1.000000	-0.519929
Electricity	-0.519929	1.000000
	Oil	*Mining*
Oil	1.000000	0.774549
Mining	0.774549	1.000000
	Oil	Basic metal
Oil	1.000000	0.817656
Basic metal	0.817656	1.000000
	Oil	*Chemical , Petrol &Plastic*
Oil	1.000000	0.660642
Chemical, Petrol&Plastic	0.660642	1.000000
	Oil	*Construction*
Oil	1.000000	0.896210
Construction	0.896210	1.000000
	Oil	*Info Technology*
Oil	1.000000	0.453481
Info Technology	0.453481	1.000000
	Oil	*Metal Product &Machinery*
Oil	1.000000	0.727099
Metal Product& Machinery	0.727099	1.000000
	Oil	*Transportation*
Oil	1.000000	0.548703
Transportation	0.548703	1.000000
	Oil	*SME Industrial*
Oil	1.000000	0.884043
SME Industrial	0.884043	1.000000
	Oil	Banking
Oil	1.000000	0.835296
Banking	0.835296	1.000000
	Oil	*Insurance*
Oil	1.000000	0.866797
Insurance	0.866797	1.000000

3.1. Unit Root and Cointegration Tests

The first step in modeling time series data is to determine the order of integration of the variables, and ensure that it is equal for all series. For this purpose, the non-stationarity of the series is checked with the unit root testing procedure suggested by Augmented Dickey and Fuller (Dickey and Fuller, 1979) (ADF test), and Philips Perron (Phillips & Perron, 1988) (PP test)- with a constant, trend and without trend. Both ADF and PP tests are based on the equation that the null hypothesis is $H_0 = \gamma = 0$, i.e. γ has a unit root, but the alternative hypothesis is $H_1 < 0$. However, test statistics are calculated differently.

After confirming that all the series are integrated of the same order, the next step is to perform cointegration tests for long-run relationship. The existence of any cointegrating relationship is tested by using Engle and Granger (1987) and Johansen's (1988, 1991) approaches. Johansen's methodology takes its starting point in the Vector Autoregression (VAR) of order p given by

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + \ldots + A_p y_{t-p} + \varepsilon_t \qquad (1)$$

where y_t is an $nx1$ vector of I(1) variables, and ε_t is an $nx1$ vector of innovations. VAR model in the reduced form can be re-written as

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \varepsilon_t \qquad (2)$$

where

$$\Pi = \sum_{i=1}^{p} A_i \quad I, \quad \Gamma_{\boldsymbol{i}} = -\sum_{\boldsymbol{j}=\boldsymbol{i}+1}^{p} \boldsymbol{A_j} \qquad (3)$$

Johansen's (1988) approach determines the number of cointegrated vectors among the variables of the same order. In order to estimate the loadings and the vectors of cointegrating relationship, r largest eigenvalues and corresponding eigenvectors of the characteristic equations are used. This approach proposes two different likelihood ratio tests, and thereby, the reduced rank of the Π matrix: the trace test and maximum eigenvalue test. The Trace and maximum eigenvalue statistics for the determination of the order of cointegrated vectors is represented by:

$$\lambda_{trace}\,(\mathrm{r}) = -T \sum_{i=r+t}^{n} \ln(1 - \hat{\lambda}_i) \qquad (4)$$

$$\lambda_{max}(r, r+1) = -T ln(1 - \hat{\lambda}_{r+1}) \qquad (5)$$

where T is the sample size and $\hat{\lambda}_i$ denotes the estimated values of characteristic roots or eigenvalues. The trace test statistic is used to test the null hypothesis of r cointegrating vectors against the alternative hypothesis of n cointegrating vectors, while, the maximum eigenvalue test is used to test the null hypothesis of r cointegrating vectors against the alternative hypothesis of $r + 1$ cointegrating vectors. If the computed values of $\lambda_{trace}$and λ_{max} are less than the critical values, then the null hypothesis cannot be rejected.

3.2. VAR Model

Engle and Granger stated that if the series *X* and *Y* are individually integrated of order the same order, I(1) and also cointegrated, the remaining analysis can be tested by employing Vector Error Correction Model (VECM). However, if the variables used are I(1) but not cointegrated, it is possible to use a basic unrestricted Vector Autoregression Model (VAR). In VAR system equation model, each variable has a linear relationship between its own lagged value and lagged values of all the other variables in the system. The VAR model in the reduced form can be expressed as;

$$y_t = \wedge + \Gamma_1 y_{t-1} + \ldots\ldots\ldots + \Gamma_p y_{t-p} + \varepsilon_t \qquad (6)$$

where y_t is a vector of N stationary variables, p is the order, which represents the number of lags and ε_t is a vector of Gaussian white noise errors. ε_t is assumed to be serially uncorrelated. Since the selection of the number of lags included in the model is especially important, the lag length is determined by employing Akaike's Informarion Criterion (AIC).

3.3. VECM and Granger Causality

The existence of the cointegration between the variables suggests the presence of causality in at least one direction. The causal relationship is tested with the help of a Granger-Causality procedure, based on Vector Error Correction Model (VECM) in the cases where the two series are cointegrated. This procedure allows for a causal linkage between two (or more) variables stemming from an equilibrium relationship, thereby depicting a long-run equilibrium alignment that persists beyond the short-run adjustment. When the variables are cointegrated and stationary in the first difference, VECM is formulated as follows:

$$\Delta y_t = \alpha_y + \sum_{i=1}^{n} \beta_{y,i}\, \Delta y_{t-i} + \sum_{i=1}^{n} \gamma_{y,i}\, \Delta x_{t-i} + \varphi_y ECT_{y,t-i} + \varepsilon_{y,t} \quad (7)$$

$$\Delta x_t = \alpha_x + \sum_{i=1}^{n} \beta_{x,i}\, \Delta x_{t-i} + \sum_{i=1}^{n} \gamma_{x,i}\, \Delta y_{t-i} + \varphi_x ECT_{x,t-i} + \varepsilon_{x,t} \quad (8)$$

where $\alpha, \beta, \gamma's$ are parameters to be estimated, $\varepsilon's$ are the serially uncorrelated error terms, and ECT represents the vector error correction terms, representing the deviation from the long-run relationships at time t, and φ_x and φ_y are the parameters of the ECT, estimating the response of the dependent variable to departures from the equilibrium. The significant F-statistic and t-statistics of the error correction model provide the existence of short-run and long-run casual effect among the variables, respectively. As the results of the causality tests are very sensitive to the lag length selected, the lag length p is based on Schwarz-Bayessian (SBC) and/or Akaike Information Criateria (AIC).

3.4. Impulse Response Function (IRF) and Variance Decomposition Analysis (VD)

As the coefficients of the standard VAR models are difficult to interpret, we employ Impulse Response Functions and Variance Decomposition Analysis to clarify the dynamic impacts of the shocks on the endogenous variables. Impulse response function essentially maps out the responsiveness of the endogenous variable in the VAR analysis to shocks to each of the variables (Brooks, 2008). In order to isolate the effect of any specific shocks, many researchers used the orthogonalized impulse-response function based on Cholesky decomposition, for which is should be noted that the ordering of the variable is important and not invariant.

Another way of illustrating the dynamics of the VAR is the variance decomposition analysis, which is employed to analyse the short-run dynamics by determining the amount of information each variable contributes to the others in VAR models. Forecast error variances provide information about the percentage of the movements caused by own shocks vis-à-vis shocks in other variables. Similar to the *IRF*, the results are sensitive to the ordering of the variables.

4. Empirical Results

To investigate the stationarity properties of the data, the order of integration in each series is tested by using Augmented-Dickey Fuller (ADF), and Philips Perron (PP) unit root tests. Three separate specifications are applied: with an intercept and trend, with only an intercept, and with no intercept or trend. The results of unit root tests, both the level and differenced variables, are presented in Table 3.

For all the variables, the null hypotheses of a unit root cannot be rejected in log levels. However, upon taking first differences, the null hypothesis of a unit root is rejected at the 1% significance level. Therefore, it can be concluded that all the variables are integrated of order one, I(1).

Table 3. Unit Root Tests

		ADF		Philips-Perron	
Oil Substitute		Intercept	Trend&Int.	Intercept	Trend&Int.
Electricity	*Level*	-1.712	-1.864	-1.724	-1.883
	First Difference	-65.381*	-65.376*	-65.361*	-65.356*
Oil Related					
Mining	*Level*	-1.077	-2.146	-1.077	-2.242
	First Difference	-26.232*	-26.215*	-26.231*	-26.215*
Oil User					
Basic Metal	*Level*	-1.376	-2.114	-1.396	-2.158
	First Difference	-67.742*	-67.735*	-67.749*	-67.741*
Chemical, Petroleum &Plastic	*Level*	-2.089	-2.752	-2.076	-2.741
	First Difference	-69.415*	-69.408*	-69.407*	-69.399*
Construction	*Level*	-1.346	-2.931	-1.229	-2.813
	First Difference	-27.774*	-27.775*	-27.866*	-27.871*
Information Technology	*Level*	-2.002	-3.731	-2.040	-3.733
	First Difference	-61.913*	-61.953*	-61.911*	-61.953*
Metal Product Machinery	*Level*	-1.864	-2.732	-2.090	-3.078
	First Difference	-66.743*	-66.736*	-67.095*	-67.088*
Transportation	*Level*	-1.422	-2.500	-1.493	-2.590
	First Difference	-67.081*	-67.077*	-67.127*	-67.123*
SME Industrial	*Level*	-1.641	-4.134	-1.640	-4.332
	First Difference	-22.319*	-22.305*	-22.311*	-22.297*
Financial					
Banking	*Level*	-2.155	-2.164	-2.179	-2.225
	First Difference	-66.663*	-66.669*	-66.663*	-66.668*
Insurance	*Level*	-1.966	-2.304	-2.018	-2.462
	First Difference	-65.295*	-65.294*	-65.307*	-65.305*
Crude Oil					
	Level	-1.362	-0.632	-1.302	-0.435
	First Difference	-68.803*	-68.819*	-68.877*	-68.904*

Notes: ** and * denote that a test statistic is statistically significant at the 5% and 1% level of significance, respectively. The null hypothesis of ADF and PP test is the series has a unit root.

Table 4. Johansen Cointegration Tests

	Trace Statistics		Max-Eigen Statistics	
	None	At Most 1	None	At Most 1
Oil Substitute				
Electricity	4.180	1.454	2.725	1.454
Oil Related				
Mining	6.668	0.004	6.663	0.004
Oil User				
Basic Metal	10.461	1.569	8.892	1.569
Chemical, Petroleum and Plastic	18.661**	1.429	17.231**	1.429
Construction	4.833	0.170	4.662	0.170
Information Technology	44.860***	2.491	42.369***	2.491
Metal Product Machinery	32.510***	1.359	31.150***	1.359
Transportation	7.176	0.333	6.843	0.333
SME Industrial	17.712**	0.1483	17.564**	0.1483
Financial				
Banking	2.410	0.069	2.341	0.069
Insurance	13.881*	1.719	12.162	1.719

Notes: ** and * denote the rejection of null hypothesis of no cointegration at the 5% and 1% level of significance, respectively.

We now proceed to examine the Cointegration properties of each pair of variables by performing Johansen's test; oil substitute (oil-electricity), oil related (oil-mining), oil user (oil-basic metal, oil- chemical, petroleum and plastic, oil, construction, oil-information technology, oil-metal product machinery, transportation, SME industrial) and financial (oil-banking, oil-insurance). The findings of the Cointegration test are reported in Table 4. According to the Johansen test results, both the maximum eigenvalue and trace test statistics indicate the existence of one cointegrating relationship between oil prices and five of the eleven industry sector indices; namely, chemical, petroleum and plastic, information technology, metal product machinery, SME industrial and insurance sector.

Surprisingly, oil prices have no long run cointegrating relationship with either electricity or mining sector returns, meaning that oil-substitute and oil related sector returns do not converge to equilibrium over time. However, they have a significant long-run relationship with four of the seven oil-user sectors; namely, chemical, petroleum and plastic; information technology; metal product machinery; and SME industrial. Moreover, the results show the existence of one cointegrating relationship between oil prices and insurance industry returns. The results of oil-user sectors are consistent with our expectations, and support partially similar results reached by Gencer and Demiralay (2013), and Eksi et al. (2012), regarding the significant long run relationship with the chemical-petroleum and plastics sector returns.

For the above series that are cointegrated, Vector Error Correction Model (VECM) is used to capture the variations related with adjustment to a long-run relationship. A significant and negative error correction term suggests that any short run deviations among the variables will result in a long run relationship. For the remaining series, Vector Autoregressive Model (VAR) is used to capture the short-run dynamic relationship with the oil price. Before the implementation of VECM and VAR model, the appropriate number of lag length is determined using Akaike Information Criterion (AIC) and Schwartz Information Criterion (SC). The results show that all the series are tested with 1 lag.

The error correction term, ECT_{t-1}, measures the speed of adjustment from short-run to long-run dynamics. Table 5 presents the error correction terms. A statistically significant and negative error correction term provides an empirical evidence of a short-run adjustment speed to long-run equilibrium relationship between Chemical Petroleum and Plastic, Information Technology, Metal Product Machinery, SME Industrial, Insurance sub-sector return and oil prices.

Table 5. Estimated Error Correction Terms

Dependent Variable	ECT_{t-1}	p-value
Oil User		
Chemical, Petroleum and Plastic	-0.002	0.016**
Information Technology	-0.002	0.017**
Metal Product Machinery	-0.003	0.044**
SME Industrial	-0.025	0.001*
Financial		
Insurance	-0.002	0.02)**

After the establishment of a long run relationship between the sub-sector returns and oil prices, the next step involves the analysis of short-run causal relationship among the variables. Table 6 and 7 reports the results of the VECM Block Exogeneity Wald test and Standard Granger Causality tests, respectively. If the variables are cointegrated, VECM Block Exogeneity Wald test is used to indicate whether lagged values of the independent variable jointly affect a particular dependent variable. However, standard Granger causality test is employed for the variables in the VAR system.

Table 6. VECM Granger Causality / Block Exogeneity Wald Test

Dependent Variable	χ_2	p-value
Oil User		
Chemical, Petroleum and Plastic	1.196	0.549
Information Technology	0.021	0.883
Metal Product Machinery	0.945	0.330
SME Industrial	0.522	0.469
Financial		
Insurance	0.001	0.982

Table 7. Standard Granger Causality Test

Dependent Variable	F statistics	p-value	Decision
Oil Substitute			
Oil does not granger cause Electricity	0.476	0.620	Accept
Oil Related			
Oil does not granger cause Mining	0.468	0.493	Accept
Oil User			
Oil does not granger cause Basic Metal	4.661	0.030**	Reject
Oil does not granger cause Construction	20.350	0.000*	Reject
Oil does not granger cause Transportation	1.569	0.210	Accept
Financial			
Oil does not granger cause Banking	1.651	0.198	Accept

Notes: (*) denotes the rejection of the hypothesis at 5% significance level, (**) denotes the rejection of the hypothesis at 10% significance level, Rejection means there is causality between the variables

The results in Table 6 indicate that we cannot reject the null hypothesis that oil does not granger cause between Chemical Petroleum and Plastic, Information Technology, Metal Product Machinery, SME Industrial, Insurance sector returns. This suggests that the lags of oil prices do not contribute to the prediction of current value of these above indices, implying no evidence of short term causality. Granger causality is found through the use of VECM, derived from the long-run equilibrium model. Even if there exist long-run cointegration among these variables, there is no short-run causal relationship from oil price to sector returns. Interestingly, the results of standard Granger causality test in Table 7 show that oil price granger causes Basic metal and construction sub-sector returns.

Our findings are in line with the studies in the existing literature, such as Dagher and El Hariri (2013), who analyze short and long run relationship between stock returns and oil prices in Lebanon, as a small economy. These results may not be expected for larger and more developed economies, in which economic shocks affect both stock returns and oil prices (Kilian and Park, 2009).

In order to determine the robustness of the VECM and VAR models, some diagnostic tests are employed and the results are reported in Table 8. It can be concluded that the test results for the VECM and VAR model residuals pass all these diagnostic tests for each pair.

Granger causality test results indicate the qualitative relationship between the variables; however, variance decomposition analysis, a quantitative measurement, shows the extent to which the movement in a particular sector index can be explained by oil prices, and/or by its own variation in terms of the percentage of the forecast error variance. The results of the orthogonalized variance decomposition analysis for the periods 1 day, 15 days and 30 days are summarized in Table 9.

Table 8. Diagnostic Test Results

VECM Residual Diagnostic Tests		
	Breusch-Godfrey Serial Correlation Test	ARCH LM Statistics
Oil User		
Chemical, Petroleum and Plastic	0.199 (0.655)	101.668 (0.122)
Information Technology	1.294 (0.274)	82.388 (0.082)
Metal Product Machinery	1.486 (0.226)	77.752 (0.117)
SME Industrial	1.136 (0.321)	31.302 (0.295)
Financial		
Insurance	1.303 (0.208)	12.215 (0.216)

VAR Residual Diagnostic Tests		
	Breusch-Godfrey Serial Correlation Test	ARCH LM Statistics
Oil Substitute		
Electricity	1.918 (0.146)	48.604 (0.176)
Oil Related		
Mining	0.307 (0.735)	13.255 (0.334)
Oil User		
Basic Metal	0.101 (0.903)	96.634 (0.158)
Construction	1.819 (0.162)	5.350 (0.210)
Transportation	0.857 (0.424)	9.588 (0.105)
Financial		
Banking	2.053 (0.128)	5.049 (0.089)

The values in Table 9 show the percentage of the forecast error variance in the indices in oil-related, oil-user, oil-substitute and financial group attributed to their own innovations versus innovations from oil prices. Among all the sector indices, oil price shocks have greater explanatory power for oil related and oil user sectors compared to the others. 98.18% of the variability in the oil related (mining) index changes is explained by its own innovation for 5 day ahead. Only around 1.82% is attributable to oil price shocks in 5 days, increasing slightly to 1.83% after 10 days. Surprisingly, the other most important sector directly affected by oil price shocks is the information and technology index. Approximately 1.82 % (1.85%) of the forecast error variances at the end of the 5 and 10-day period is explained by the oil price shocks. However, the orthogonalized variance decomposition in each sector return reveals that most of the variability is explained by its own innovation. In terms of variance decomposition of SME industrial index, 98.24% of the variability is explained by its own shock after 1 day, 98.23% after 5 days, and remains at that level after 10 days. That is, 1.76% of the forecast error variance in SME industrial is attributable to oil price shocks after 1 day, increases slightly to 1.77% after 5 days, and remains at that level during the 10 day period. Additionally, in the construction sector, which is most affected sector in the oil-related field, 1.73% (1.79%) of the variability is explained by oil price shocks after 1 day (5 days). However, oil price shocks have minimal impact on changes in the transportation index in the oil-related group.

Table 9. Orthogonalized Variance Decomposition (VD) Results

Oil-Substitute				
VD of Electricity index	Period	S.E	Oil	Electricity index
	1	0.033	0.763	99.237
	5	0.034	0.786	99.214
	10	0.034	0.786	99.214
Oil-Related				
VD of Mining index	Period	S.E	Oil	Mining index
	1	0.030	0.680	99.319
	5	0.031	1.824	98.175
	10	0.031	1.826	98.173
Oil-User				
VD of Chem., Petrol and Plastic index	Period	S.E	Oil	Chem., Petrol and Plastic
	1	0.0304	1.564	98.436
	5	0.0305	1.574	98.426
	10	0.0305	1.574	98.426
VD of Construction index	Period	S.E	Oil	Construction index
	1	0.020	1.729	98.271
	5	0.021	1.797	98.203
	10	0.021	1.797	98.203
VD of Basic Metal index	Period	S.E	Oil	Basic Metal index
	1	0.033	1.414	98.586
	5	0.034	1.471	98.529
	10	0.034	1.471	98.529
VD of Inf. Tech. index	Period	S.E	Oil	Inf. Tech. index
	1	0.030	1.683	98.317
	5	0.031	1.823	98.177
	10	0.031	1.847	98.152
VD of Transportation index	Period	S.E	Oil	Transportation index
	1	0.033	0.501	99.499
	5	0.033	0.513	99.487
	10	0.033	0.513	99.487
VD of Metal Mach. index	Period	S.E	Oil	Metal Mach. index
	1	0.0308	1.486	98.514
	5	0.0309	1.513	98.487
	10	0.0309	1.513	98.487
VD SME Industrial index	Period	S.E	Oil	SME Industrial index
	1	0.018	1.765	98.235
	5	0.019	1.772	98.228
	10	0.019	1.772	98.228
Financial				
VD of Banking index	Period	S.E	Oil	Bank index
	1	0.035	1.467	98.533
	5	0.036	1.473	98.527
	10	0.036	1.473	98.527
VD of Insurance index	Period	S.E	Oil	Insurance index
	1	0.033	1.296	98.704
	5	0.033	1.297	98.703
	10	0.033	1.297	98.703

As expected, in the electricity index, considered as an oil-substitute sector, oil price shocks explain only 0.76% of the forecast errors variances in 1 day, increasing to 0.77% after 5 days and remaining at that level in 10 days. In summary, the findings indicate that, for all sector indices, a high percentage of forecast error variance is influenced by its own innovations. The oil-user sectors are the most affected by the oil-price shocks and the oil-substitute sector, the least. A further remarkable point is that an average of 1.5% of the variability, in the banking and insurance index is also explained by the oil price shock, revealing a much more marked impact of oil price shocks in these indices compared to other sector indices in the oil-related, oil-user, and oil-substitute group. The dominant role of the SME industrial index highlights that shock in oil prices have a direct impact on the cost of small and medium sized companies.

The orthogonalized impulse response functions are used to examine the effect of linear oil price shocks on each sectoral stock return. Figure 1 presents the orthogonalized impulse response function curves of sectoral stock returns from one standard deviation shock of the oil price, with their corresponding two standard error bands in the linear case. Following the ordering of the variables according to importance suggested by Park and Ratti (2008), and Dagher and El Hariri (2013), oil prices are placed before the stock returns in the estimation of the VAR model. Depending upon the ordering of the variables in the VAR model, the results demonstrate for each sector whether oil prices can have possible contemporaneous effects on the stock return. The blue line in the centre of the figure represents the impulse response function, and the bands show the confidence intervals.

Figure 1. Impulse Response of Stock Return of Each Sector Index to Oil Price Shock

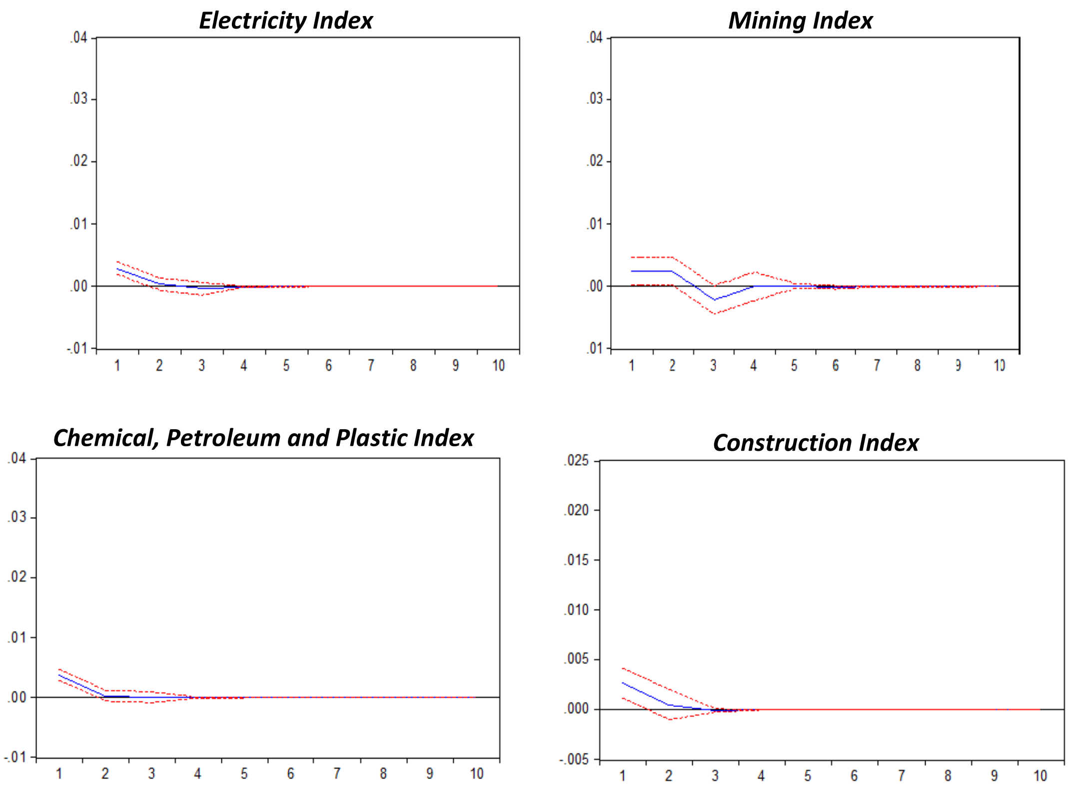
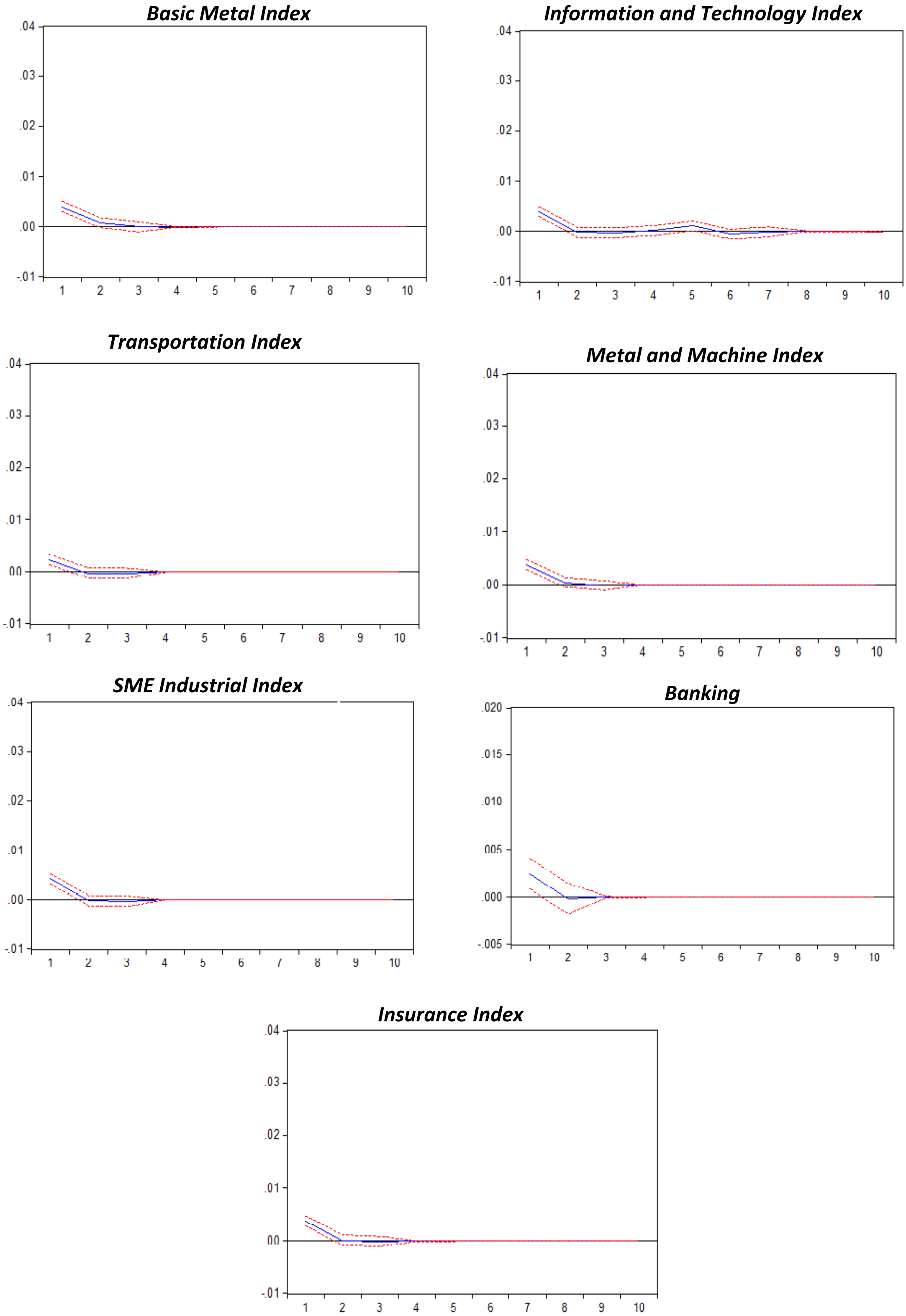


Figure 1. Impulse Response of Stock Return of Each Sector Index to Oil Price Shock (Continue)



The results reveal that the response of stock return for all sectors to oil price shocks continue until the third and fourth quarter, with the exception of the information and technology index, whose response continues until the 8^{th} quarter. The response of information and technology index to oil price shocks is positive in the 1st quarter, turns to negative within 2^{nd} and 3^{rd} quarters, and then fluctuates between positive and negative trends. In terms of oil-substitute group, the electricity index responds positively to the oil price shocks in the 1^{st} quarter, then turns to negative in the 2^{nd} and 3^{rd} quarters. As a proxy of the oil-related group, the response of mining index to oil price shocks are positive in the 1^{st} and 2^{nd} quarters, becomes negative in the 3^{rd} quarter, and then fluctuates around the zero line. Unexpectedly, the results show that the response of all stock returns of oil-user and financial group to oil price shocks are positive in the 1^{st} quarter, and then fluctuate around the zero line until the end of the period.

5. Conclusion

This study investigates the dynamic short and long-run linkages between world oil prices and 11 selected sub-sector indices from the Borsa İstanbul over a specific sample period, with the aim of the contribution to oil-price and stock price nexus in Turkey. The results provide valuable information to investors and policy makers for this key emerging markets. Given the increased volatility in the price of energy, especially crude oil, and strong evidence from previous studies that the impact of oil price shocks differs between the sectors, we examine the following sub-sectors: banking (XBANK), basic metal (XMANA), chemistry, petrol and plastic (XKMYA), construction (XINSA), electricity (XELKT), information, technology (XTEK), insurance (XSGRT), metal product and machinery (XMESY), mining (XMADN), SME industrial (XKOBI), and transportation (XULAS). Since oil price is a major cost factor in most industries, companies in all sub-sectors are highly likely to be to some degree affected by its movements.

The empirical results indicate that there exists one cointegrating relationship between oil prices and five of the eleven industry sector indices; namely, chemical, petroleum and plastic, information technology, metal product machinery, SME industrial, and the insurance sector. Four of these five are categorized as oil-user sectors, for which oil is a key raw material. In addition to these four, the results show the existence of one cointegrating relationship between oil prices and insurance industry returns.

Regarding the short term causal relationship, we find that oil price changes granger causes electricity, mining, basic metal, chemical, petroleum and plastic, metal product machinery and insurance sector returns. This suggests that oil prices can contribute to the prediction of the current value of the above indices; however, there is no evidence of the opposite relationship. Additionally, we conclude that oil price granger causes construction and information technology index at the 10% level of significance, and also it granger causes SME industrial index at 5% significance level. Our findings corroborate previous studies showing significant causal relationship from the oil price to stock returns, indicating high sensitivity to oil price changes for these sub-sectors, in which oil is a direct input. These findings, which are consistent with the study of Dagher and El Hariri (2013), Avcı (2015), Yıldırım et al. (2015), are expected for smaller countries and also for emerging countries, such as Turkey, but may not apply to larger and more developed countries, as the economic shocks that affect stock returns may also affect global oil prices globally (Kilian & Park, 2009). However, our findings are not in line with some previous studies (Abdioğlu & Degirmenci, 2014).

As for the variance decomposition analysis, the findings indicate that, for all sector indices, a high percentage of forecast error variance is influenced by its own innovations. The oil-user sectors are the most affected by the oil-price shocks, and oil-substitute sectors, the least affected. The orthogonalized impulse-response function is used to analyze the spread of shocks in the oil market to industry stock returns. The results show great similarity in the behavior of all sector indices, responding significantly to a shock in oil price changes on the same day, and the following day, but thereafter, showing the disappearance of the impact. The results of this study provide important policy implications for financial market participants, portfolio managers and investors, in particular, for portfolio allocations, by enabling optimal investment decisions, as well as improved risk management. Given the long-term and causal relationship between the oil price and specific industry sector returns mentioned above, it is important that the shocks and volatilities in the oil market are closely monitored by market participants and investors. Additionally, for the sectors most seriously affected, policy makers should take into account the availability and suitability of alternative energy sources. Moreover, given the importance of the impact of oil price changes/volatility on the sub-sector return performance in this study, “hedging” becomes an intriguing issue among the firms and investors. The firms, which operate in specific industries of Borsa İstanbul and are affected more by the oil price changes/volatility, should concentrate on hedging instruments, including oil-related forward and future contracts in Borsa İstanbul. Depending on industry specific conditions, the oil price volatility could be eliminated with the intense use of these hedging instruments, and then, this precaution would enhance the stock market performance. This would be a good point for the market development.

This research has thrown up many questions in need of further investigation. Therefore, a number of possible future studies on this issue are apparent. A further study investigating the influence of changes in the oil returns and oil return volatility on return volatilities of these sub-sectors using GARCH techniques would be interesting. Additionally, the investigation of the conditional correlations and volatility spillovers among the crude oil and sub-sector returns using different types of well-developed volatility models, such as DCC-GARCH, VAR-GARCH, VAR-BEKK GARCH, and also asymmetric GARCH models.

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