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Shock and Volatility Spillovers between Oil Prices and Turkish Sector Returns

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Abstract

The objective of this paper is to examine the shock and volatility spillovers between the oil market and five sectors in the Turkish equity market. We conduct a bivariate GARCH model to simultaneously estimate the mean and conditional variances between the series. We investigate daily returns from January 4, 2005 to June 12, 2013 and report significant unidirectional volatility transmission from oil market to all the sectors under investigation in addition to significant unidirectional shock transmission from oil market to some of the sectors. Our findings are suggestive for a deeper understanding of portfolio risk management in the presence of oil price fluctuations.

Keywords: oil prices, sector returns, multivariate GARCH, volatility transmission

1. Introduction

The expanding global economy, ever increasing mass production and the proliferation of world trade accompanied by the widespread usage of technology, put oil in a very special position. Oil has become almost the most important production factor globally with an utmost effect on all industries and markets simultaneously as the main source of energy. Oil price fluctuations increase uncertainty and decrease market confidence with its direct effect on production costs and inflation rates. In general, the level of business activity is highly influenced by oil price movements which impact stock prices through two channels. Firstly, the business earnings and cash flows are directly affected by oil prices and secondly, the investors' required rate of return is determined as a consequence of inflation, risk and interest rates.

The relationship between oil price movements and stock markets is studied extensively during the last three decades. The results of these studies are mixed. Several studies conclude a negative relation while some others report a positive relation and even some others find no significant relation. These changes in the results mainly stem from the data sets used in the analyses. Apart from the time span of the data set, the choice of either the market level data or the industry level data has a significant effect on the outcomes of the research.

Studies elaborating the effect of oil price variations on stock markets are various and analyze both the emerging and developed markets. Huang et al. (1996) report no significant effect of oil returns on S&P 500. Sadorsky (1999) studies the relation among oil prices, S&P 500 returns and the three-month US Treasury interest rates for the period between January 1947 and April 1996 and find that sudden increases in oil prices have a positive correlation with the three-month US Treasury interest rates and a negative correlation with real stock prices performing a vector autoregressive (VAR) analysis. Jones and Kaul (1996) evidence a negative relation between oil price shocks and stock prices using data from US, UK, Japan and Canada. Basher and Sadorsky (2006) investigate the effects of oil price changes on 21 emerging stock market returns including Turkey, during the period 1992–2005, and find out significant linkage between oil price shocks and emerging market returns. Park and Ratti (2008) assert that oil price shocks negatively affect stock returns in US and 13 European countries using data over 1986 to 2005. Ewing and Thompson (2007) analyze the dynamic co-movements between oil prices and stock markets based on the cyclical components of oil prices and stock prices and aver that crude oil prices are pro-cyclical and lag stock prices by six months. Lee and Chiou (2011) conclude that significant higher fluctuations in oil prices have negative impacts on S&P 500 stock returns, applying a univariate regime-switching GARCH model. Contrarily, Narayan and Narayan (2010) argue that oil prices have a positive and statistically significant effect on stock prices in Vietnam.

Some studies further distinguish the effects of oil price shocks on oil-importing and oil-exporting countries. For an oil-exporting country, oil price increases are expected to improve the macroeconomic indicators since the country income is to increase. These improvements are expected to lead to higher spendings and investments founding a boom in the stock market. Contrarily, any oil price increase would result in increased costs, restrained profits and decreased shareholders' wealth for an oil-importing country. In this context, Filis et al. (2011), examine the contemporaneous and lagged-time varying correlation between stock markets and oil prices for three oil-importing (US, Germany, Netherlands) and three oil-exporting countries (Canada, Mexico, Brasil) for the period between 1987 and 2009 and document findings in line with the points mentioned above. Al-Fayomi (2009) examine the impacts of oil prices on stock returns in Turkey, Tunisian and Jordan, which are all net oil-importing countries and find that oil price changes have no significant effect on stock returns in these countries.

Studies focusing on the link between oil prices and industry returns are inconclusive. Fan and Jahan-Parvar (2012) distinguish between first and second order impacts of oil prices on sector returns. The first order impact is a direct effect of oil price movements on stock returns. As oil is either a key input or a direct output of a company, the level of cash flows to the company is tied to the fluctuations in oil prices. The second order impact is defined as a general effect on the overall economy since oil prices impel GDP which in the end determine the cash flows to all businesses in an economy. Driesprong et al. (2008) depict lower predictability for sectors in which oil prices have a dominant first-order effect, while sectors in which oil prices have a second-order impact demonstrate a more pronounced oil effect. This is explained by the fact that industries that are highly sensitive to oil prices incorporate any changes in oil prices efficiently and quickly in current stock prices, whereas industries that exhibit second-order oil impact are predictable which is attributed to investors' bounded-rationality (Hong & Stein, 1996). Sadorsky (2001) depict positive relation between crude oil prices and stock returns of Canadian oil and gas companies. Nandha and Faff (2008) investigate the relation between oil price shocks and equity returns using data of 35 global sector indices and evidence a negative impact of oil price shocks on stock returns for all sectors apart from mining, oil and gas sectors.

Apart from the literature centering upon return linkages of oil prices and stock markets, a relatively more recent branch of literature models volatility dynamics between oil price movements and equity markets. Arouri and Nguyen (2010) analyze the impact of oil price volatility on sectoral returns in Europe, documenting sectoral differences in the direction and magnitude of the relationship. Hong et al. (2007) conclude that high returns for the petroleum industry predict lower returns for the US stock market. Elyasiani et al. (2011) investigate the effect of changes in oil return and oil return volatility on stock returns and stock return volatilities for thirteen industries in US economy, hypothesizing oil prices to constitute a systematic asset pricing risk at the industry level. They find significant effect of oil future returns on sector returns in nine of the thirteen sectors, using data between 1998 and 2006. Hammoudeh et al. (2010) investigate the relation between oil prices, federal funds rate, sector-specific variables as P/B ratio, and trading volume on stock return volatilities of 27 different sectors in US. They apply Standard GARCH and Asymmetric Power GARCH models and evidence that increases in oil prices increase the return volatility of the sectors that are intensive oil consumers, while the opposite is true for oil and related sectors. Arouri et al. (2011) explore the volatility transmission between oil and sector returns in Europe and US and report unidirectional oil spillover to stock sector returns in Europe and a bidirectional spillover transmission in the US. Hammoudeh and Malik (2007) study the volatility and shock transmissions among oil, US stock and Gulf equity markets (Kuwait, Bahrain, & Saudi Arabia), depicting unidirectional spillover from oil markets to Gulf equity markets with the exceptional case of Saudi Arabia where there is a bidirectional volatility transmission. Malik and Ewing (2009) document significant volatility transmissions between oil prices and five sectors, namely financials, industrials, services, health care and technology.

In this study, we analyze shock and volatility spillovers between Brent oil prices and five Borsa Istanbul sector indices, namely banking, chemicals-petroleum-plastics (C-P-P), industrials, services and BIST 100. We apply a bivariate GARCH model (BEKK specification) to simultaneously estimate the mean and conditional variances of daily returns of the series from January 4, 2005 to June 12, 2013. Overall, our results suggest significant uni-directional spillovers from global oil market to the investigated sectors. Comprehending the volatility transmission mechanism between oil and sector returns is eminent for investors and portfolio managers both to make optimal portfolio allocation decisions and to manage portfolio risk.

This paper contributes to the literature in several aspects. First of all, it examines the uncertainty caused by oil prices in equity markets of Turkey, which is an emerging market and at the same time an oil-importing country. Almost 10% of total imports of Turkey are crude oil imports and about 50% of the current deficit stem from the energy imports. Also, to the best of our knowledge, none of the studies in the previous literature examine volatility spillovers between oil prices and Turkish sector indices. The rest of the paper is organized as follows; section 2 represents the methodology, section 3 explains the data, Section 4 presents the empirical results and section 5 concludes.

2. Methodology

In order to examine volatility spillovers between Brent oil prices and aforementioned sub-sector returns, we employ full-parameterization BEKK model proposed by Engle and Kroner (1995) as follows;

$$H_t = C'C + A'u_t u_t A + B' H_{t-1} B \tag{1}$$

where the individual elements of C, A, and B matrices are given as;

$$A = \begin{bmatrix} a_{11} \; a_{12} \\ a_{21} \; a_{22} \end{bmatrix}, \; B = \begin{bmatrix} b_{11} \; b_{12} \\ b_{21} \; b_{22} \end{bmatrix}, \; C = \begin{bmatrix} c_{11} \; 0 \\ c_{21} \; c_{22} \end{bmatrix} \tag{2}$$

The elements of matrix A measure the effects of past shocks or unanticipated news on the current volatility, while the elements of matrix B determine the effects of past conditional variance on the current volatility. The model provides parsimonious cross market effects in the variance equation and ensures positive semi definiteness. Quasi maximum likelihood (QML) method used permits the above BEKK system to be estimated efficiently and consistently. We assume normally distributed innovations and maximize the following log-likelihood function;

$$L(\theta) = -T \ln(2\pi) - \frac{1}{2}\sum_{t=1}^{T} (\ln |H_t| + \varepsilon_t^{'} H_t^{-1} \varepsilon_t) \tag{3}$$

where θ represents the vector of estimated parameters, T is the number of observations and L denotes log likelihood. Several iterations were performed with the simplex algorithm to obtain the initial conditions. Bernardt-Hall-Hall-Hausman (BHHH) algorithm is used to obtain the final estimates of variance-covariance matrix.

3. Data

In order to investigate volatility transmission between oil returns and sub- sector indices, we consider Brent oil prices and major sector returns (Banking, Chemicals-Petroleum-Plastics (C-P-P), Industrials, Services, BIST 100) of Borsa Istanbul in daily frequency. We conduct the analyses in log returns as;

$$R_{t+1} = \log(P_t) - \log(P_{t+1}) \tag{4}$$

Sample period employed spans from January 4, 2005 to June 12, 2013 (2110 observations). We provide visual representation of return series in Figure 1. It can be observed that large (small) changes tend to be followed by large (small) changes in the daily returns.

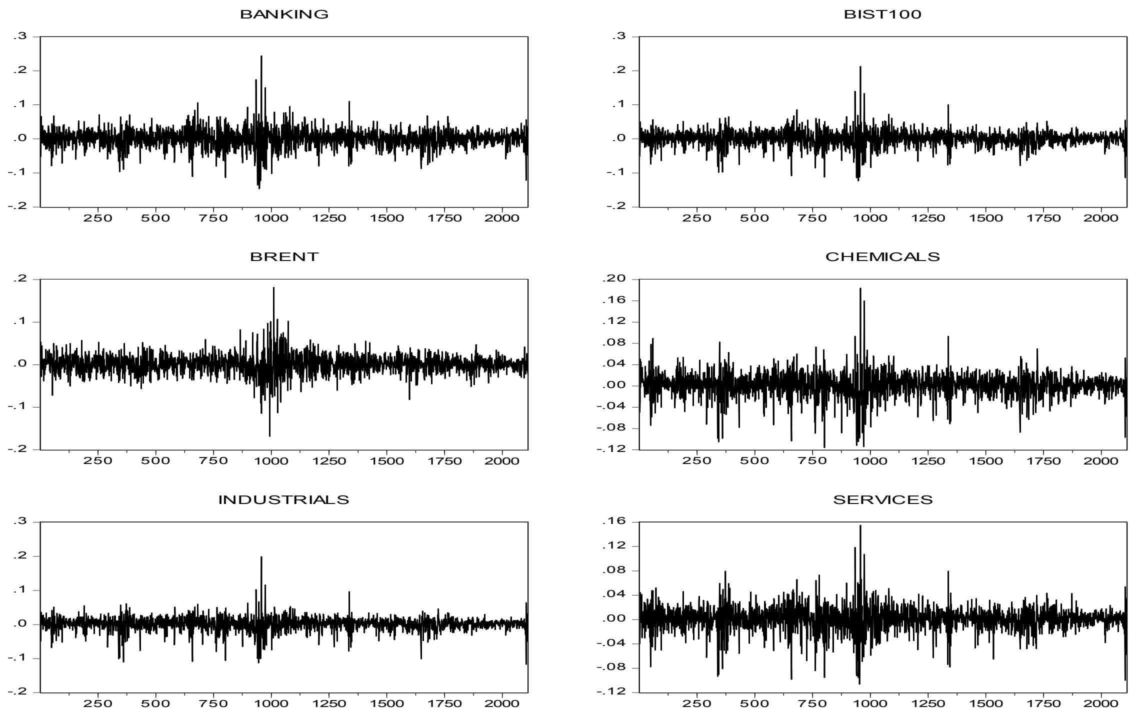

Figure 1. Returns of the series

Table 1 presents descriptive statistics of the series. Based on Table 1, we can notice that the series exhibit leptokurtosis, indicating fat-tailed distribution of the return series. Box- Pierce test for returns *Q(10)* and squared returns $Q^2(10)$ indicate the rejection of the null hypothesis of no serial correlation at the 1% significance level. Also, ARCH LM test shows the existence of ARCH processes in the conditional variance. Therefore, GARCH modeling seems to be a natural choice for this study.

Table 1. Descriptive statistics

	Banking	C-P-P	Industrials	Services	BIST100	Oil
Mean	0.049	0.062	0.053	0.053	0.046	0.042
Min.	-14.668	-11.619	-11.719	-10.636	-12.357	-16.832
Max.	24.381	18.39	19.924	15.508	21.325	18.130
Std. Dev.	2.802	2.338	2.094	2.064	2.375	2.192
Skewness	0.020	-0.340	-0.562	-0.299	-0.191	-0.005
Kurtosis	5.469	5.514	8.543	4.913	6.476	5.997
Jarque-Bera	2629.8[a]	2713.9[a]	6528.6[a]	2154.0[a]	3700.8[a]	3162.3[a]
Q(10)	42.197[a]	54.104[a]	59.139[a]	29.043[a]	46.011[a]	24.986[a]
Q^2(10)	580.818[a]	598.830[a]	511.507[a]	723.216[a]	606.371[a]	338.570[a]
ARCH(10)	36.642[a]	34.652[a]	29.275[a]	35.803[a]	35.008[a]	17.756[a]

We employ three unit-root tests to the return series, namely Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), Kwiatkowski–Phillips–Schmidt–Shin (**KPSS**) tests. The null hypothesis of ADF and PP tests imply that a time series contain a unit root and KPSS test has the null hypothesis of stationarity. As can be seen from Table 2, none of the return series have a unit-root at 1% significance level and KPSS test results indicate the non-rejection of the null hypothesis, therefore all the return series are stationary.

Table 2. Unit-root tests

	Banking	***C-P-P***	***Industrials***	***Services***	***BIST100***	***Oil***
ADF Test	-41.980[a]	-40.781[a]	-40.424[a]	-43.330[a]	-41.449[a]	-45.649[a]
PP Test	-41.953[a]	-40.737[a]	-40.488[a]	-43.256[a]	-41.463[a]	-45.651[a]
KPSS Test	0.048	0.054	0.059	0.040	0.050	0.062

Note: The Mackinnon's 1% critical value is -3.435 for the ADF and PP tests. The critical value for the KPSS test is 0.739 at a 1% significance level. The superscripts (a), (b) and (c) indicate statistical significance at 1%, 5% and 10% respectively.

4. Empirical Results

Table 3 represents the estimation results of the bivariate BEKK-GARCH(1,1) model for the five oil-sector pairs. We take into consideration of banking, chemical, petroleum, plastic (C-P-P), industrials, services and BIST 100 composite sub-indices. Based on the results, we find that current conditional volatility of oil and all sector returns are significantly affected by their own past shocks (news) and volatilities.

Evaluating the empirical findings related to shock and volatility transmissions between oil and sector indices in Turkey, we depict that volatility of banking sector returns is affected by the news and volatility in the oil market. However, no empirical evidence is found that past shocks or volatility of the banking sector is transmitted to the oil market. Increasing oil prices directly impact fiscal and monetary policies which determine the interest rates and the unidirectional transmission from oil market to the banking sector can be attributed to this situation. The results for the oil, chemical, petroleum and plastic index (C-P-P) suggest that while conditional current volatilities of both oil and the index depend on their own past shocks and volatilities, the sector return current volatility is impacted by one lag conditional volatility in the oil market. Our findings suggest that companies in this sector should implement more effective hedging strategies to shelter from uncertainty in the oil market. The oil-industrials index model reveals that the sector return volatility is affected by the news and volatility stemming from oil market as the companies in the sector are major consumers of petroleum related products. Our results are contrary to Malik and Ewing (2009) and Arouri et al. (2011) who find that firms in the industrials manage the oil dependency with efficient hedging strategies in the U.S. and Europe, respectively. The results of services index-oil model indicate that the current volatilities of both the index and oil return are influenced by their own past innovations and past conditional variances. Additionally, current volatility of the index is affected by past news and volatility of oil price thus implying unidirectional shock and volatility spillover from the oil market to the index. The fluctuations in the oil market increases the uncertainty in the energy prices which impact general demand for goods and services. Investigating the oil-BIST 100 composite index model, we verify that innovations emanating from oil market do not have an impact on conditional return volatility of the sector. However, past volatility of oil returns is found to be significant on the current volatility of the sector. BIST 100 is a composite index, consisting the 100 stocks with the highest trading volumes, including the largest producers and sellers of petroleum products. Oil market volatility directly influences the return volatility of the more oil-dependent firms, while increased volatility in the oil market surmounts the uncertainty in the aggregate economy, which indirectly impacts the other firms in the index.

As diagnostic checks, we conduct tests based on standardized residuals. Ljung-Box test statistic is lessened considerably, suggesting that serial correlation is substantially decreased. Above all, we accept the null hypothesis of ARCH test and verify that there are no remaining ARCH effects. Hence, BEKK-GARCH (1,1) model is empirically sufficient to capture shock and volatility dynamics of oil and sector returns.

In summary, the BEKK models employed eventuate unidirectional volatility spillovers from global oil market to the sectors under investigation. Moreover, banking, industrials and services sectors are found to be affected by the unanticipated news originating in the oil market. Additionally, by an inspection of the estimated coefficients in the conditional variance equations, we provide empirical evidence that sensitivity to oil price shocks and volatility is not uniform across the sectors in Turkey, which can be explained by the degree of oil consumption and differences in each market composition. More oil-dependent sectors such as industrials are captivated more by oil return volatility whereas less oil-dependent sectors such as banking are relatively less influenced by oil volatility. As a general implication, our findings reveal that Turkish companies in the sectors investigated, should implement more effective hedging strategies regarding oil price risk.

Table 3. Multivariate garch-bekk model results

	Banking		***C-P-P***		***Industrials***		***Services***		***BIST100***	
	Stock	***Oil***	***Stock***	***Oil***	***Stock***	***Oil***	***Stock***	***Oil***	***Stock***	***Oil***
A_{stock}	0.295[a]	-0.032	0.377[a]	-0.012	0.434[a]	-0.017	0.370[a]	0.015	0.319[a]	-0.039
	(0.000)	(0.273)	(0.000)	(0.586)	(0.000)	(0.314)	(0.000)	(0.372)	(0.000)	(0.123)
A_{oil}	-0.027[b]	0.130[a]	-0.012	0.141[a]	-0.038[b]	0.125[a]	-0.052[a]	0.138[a]	-0.018	0.127[a]
	(0.030)	(0.000)	(0.348)	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)	(0.194)	(0.000)
B_{stock}	0.940[a]	-0.003	0.902[a]	-0.010	0.884[a]	-0.008	0.912[a]	-0.008	0.933[a]	-0.002
	(0.000)	(0.573)	(0.000)	(0.070)	(0.000)	(0.120)	(0.000)	(0.101)	(0.000)	(0.629)
B_{oil}	0.020[a]	0.988[a]	0.020[a]	0.988[a]	0.032[a]	0.989[a]	0.029[a]	0.987[a]	0.019[a]	0.989[a]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LB(10)	27.275[a]	7.084	32.072[a]	7.720	42.375[a]	7.607	19458[a]	7.555	33.107[a]	6.188
$LB^2(10)$	6.923	7.865	7.342	5.359	10.638	7.644	12.280	6.336	7.398	7.043
ARCH(10)	0.750	0.727	0.780	0.504	0.612	0.592	1.299	0.601	0.989	0.789

Notes: Oil and stock are oil price returns and sector stock returns respectively. The superscripts (a), (b) and (c) indicate statistical significance at 1%, 5% and 10% respectively. LB(10) is the Ljung-Box test statistics for residual serial correlation at lag 10 and $LB^2(10)$ is the test statistics for squared residual serial correlation. JB is the Jarque-Bera's normality test statistics for the residuals. ARCH(10) refers to the test for conditional heteroscedasticity of order 10.

5. Conclusion

In this study we examine the volatility spillover between oil and five major sector indices in Turkey using daily data from January 4, 2005 to June 12, 2013, since sensitivity to oil price shocks and volatility is not uniform across sectors. We employ bivariate GARCH-BEKK model, which enables us to explore shock and volatility, to simultaneously estimate the mean and conditional variances. Overall our results suggest unidirectional volatility spillovers from the oil market to all of the examined sectors. For the banking, industrials and services sectors, we document significant shock transmissions from the oil market.

Our results are indicative for financial market participants while constructing their optimal portfolios, since "news" affecting global oil market may impact all the sectors through volatility transmission mechanisms. Moreover, our results provide important insights of volatility forecasting, risk management for portfolio managers and building more accurate asset pricing models.

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