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Sensitivity of Stock Market Indices to Oil Prices: Evidence from Manufacturing Sub-Sectors in Turkey

Summary: Crude oil price is a critical cost factor for manufacturing industries that are of vital importance for economic growth. This study examines the relationship between crude oil prices and the indices of seven Turkish manufacturing sub-sectors over the period 1997:01-2009:12. The error correction model results reveal the long term causality from crude oil prices to chemical-petroleum-plastic and basic metal sub-sectors indicating that these sub-sectors are highly sensitive to crude oil prices. We find no causal relationship for other sector indices for short or long time periods.

Key words: Crude oil prices, Manufacturing sub-sectors, VAR.

JEL: M21, O16, R11.

Following the collapse of the Bretton Woods system, oil price has become a critical factor for world economies. Since oil revenue is generally the biggest source of income for many oil exporting countries, high volatility in energy markets can cause economic imbalances in these countries. Same is also true for oil importers. Since many industries depend on oil as input, an increase in oil prices can create significant cost-push inflation and higher unemployment, and subsequently lead to economic crises.

Over the past decade, the price of oil at respective international exchanges has been rising and showing a volatile trend. For example, the oil pricing benchmark such as West Texas Intermediate hit an all-time high of $145 per barrel in June 2008, before falling to $30 per barrel in December 2008. Developing countries in particular are severely affected by these price movements as they are heavily dependent on foreign energy resources. Because of the critical role oil prices play in modern economy, wild price swings in energy markets have been an issue of concern to economists and policymakers. Accordingly, the recent public and academic attention not only to energy prices, but also to the volatility at the energy markets is not surprising.

The energy constitutes the most important and costly industrial input in developed and emerging economies. Furthermore, elasticity of substitution between energy and other inputs is close to zero. Oil accounts for more than 40% of the global energy consumption. Expensive oil would imply substantial increases in the price of energy sources, leading to a negative impact on competitiveness in today's highly globalized world. Although cost pressures are felt by all industries, the manufacturing industry is usually among the sectors that are hit most by oil price hikes. An increase in energy costs can significantly reduce the competitive advantage in manufacturing exports. The volatility in energy prices can also affect strategic investment decisions. Facing a greater energy input uncertainty investors, managers and policy makers can alter or postpone their investment decisions. At the macro level, increase in oil prices may lead to balance of payment deficits in countries that are highly dependent on oil imports. High and volatile energy prices can produce negative macroeconomic consequences including reduced output and employment, increased inflation, and in rare situations a full-blown economic crisis.

This paper attempts to investigate the impact of oil price changes on manufacturing sub-sectors in the context of an emerging market. We know that the growth capacity and performance of an industry is closely related to the input costs. Whether the observed increase in oil prices disparately affects different industries is the interest of our analysis. Crude oil can indirectly increase production costs in the form of higher energy costs even in industries where it is not used as a direct input. In this context, we attempt to determine whether changes in oil prices give rise to change in Food-Beverage, Basic Metal, Chemical-Petroleum-Plastic, Textile-Leather, Wood Paper Printing, Metal Products Machinery, Non-metal Mineral Products sub-sector performance at Istanbul Stock Exchange using co-integration and Granger causality test.

Our study differs from previous studies in several respects. First of all, earlier research primarily focuses on the impact of oil price on macroeconomic factors. The effect of energy prices on stock market is usually investigated for the overall market or in terms of stock market performance of individual oil companies. Further, most of the related studies examine the developed economies, only a few studies are concentrated on emerging markets. And the research on the impact of energy prices on Turkish market is relatively scant[1]. Finally, unlike most studies we use monthly data in our estimations which contain more information than quarterly and annual series. Our study contributes to the literature by furthering our understanding of the relationship between energy prices and manufacturing sector performance in emerging markets, namely in Turkey.

The rest of the study is organized as follows. Section 1 summarizes the previous studies. Section 2 presents our model, the testable hypotheses, and the data used. Section 3 discusses the empirical results while Section 4 presents the conclusions.

1. Literature

There is a considerable amount of literature on energy economics. In most of the related studies, the main theme is the effect of oil price on macroeconomic variables (see, among others, Rebeca Jimenez Rodriguez and Marcelo Sanchez 2004, 2009; Nung Bwo Huang, M. J. Hwang, and Hsiao Ping Peng 2005; Iaroslav Baclajanschi et al. 2006; Sandrine Lardic and Valérie Mignon 2008; Jan P. A. M. Jacobs, Gerard H.

[1] Two exceptions are Mehmet Eryigit (2009) who examines the impact of oil prices on financial, service, and industrial firms and Orhan Torul and Emre C. Alper (2010) who study the effects of domestic oil product price changes on manufacturing sub-sectors of Turkey.

Kuper, and Dean P. van Soest 2009; Yazid Dissou 2010). A growing body of academic literature suggests that oil price increases and volatility dampens macroeconomic growth by raising inflation and unemployment and by depressing the value of financial and other assets (Shimon Awerbuch and Sauter Raphael 2006).

Several other studies investigate oil price and stock market relationship. According to Syed A. Basher and Perry Sadorsky (2006), a rise in oil prices will act as inflation tax, which will (1) lead consumers to look for alternative energy sources and (2) increase risk and uncertainty which adversely affect stock prices and reduce wealth. Using an international multi-factor model that allows for both conditional and unconditional risk factors, the authors find strong evidence that oil price risk impacts stock price returns in emerging markets.

Using vector error correction model, Isaac J. Miller and Ronald A. Ratti (2009) examine the long-run relationship between the world price of crude oil and international stock markets over the period January 1971 to March 2008. They find a clear long-run relationship between oil price and real stock prices for six OECD countries. Intuitively, this means that stock market prices increase as the oil price decreases or decrease as the oil price increases, over the long-run.

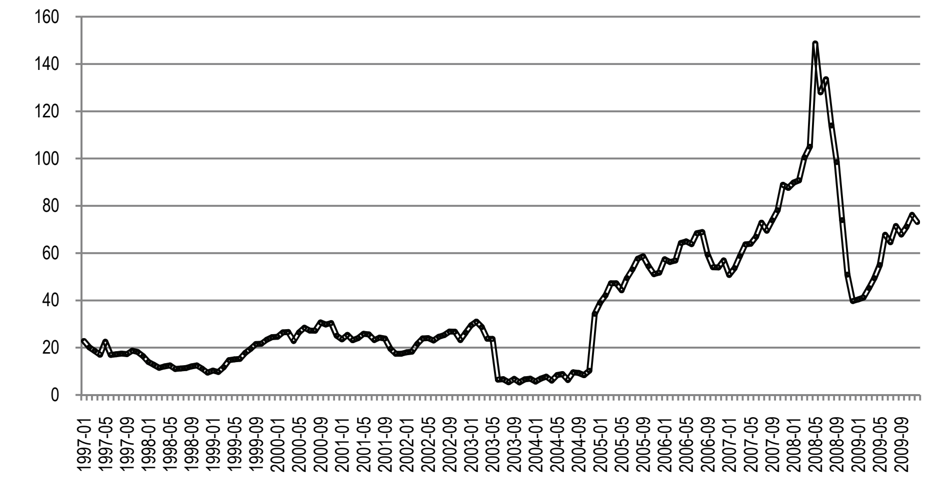
El I. Sharif et al. (2005) investigate the relationship between the price of crude oil and equity values in the oil and gas sector using data from the United Kingdom, the largest oil producer in the European Union. Their evidence indicates that the relationship is always positive, often highly significant and reflects the direct impact of volatility in the price of crude oil on share values within the sector.

Although the impact of oil prices has been extensively examined in the context of developed economies, studies covering emerging economies are relatively scant. Eryigit (2009) examines the effects of oil price changes on sector indices of Istanbul Stock Exchange and find that oil price (in TL) changes have positive effects on Electricity, Wholesale and Retail Trade, Insurance, Holding, Investment, Wood, Paper and Printing, Basic Metal, Metal Products and Machinery, and Non-metal and Mineral Products indices (significant at 5% level); on Tourism, Food, Beverages, Chemical, Petroleum and Plastics, Textile and Leather indices (significance at 10% level). He also finds that oil price (USD) changes have a significant positive effect on Wood, Paper & Printing, Insurance and Electricity sub-sector indices. On the other hand, oil price (both as TL and USD) changes do not have any significant effect on Transportation, Banks, Leasing and Factoring and Real Estate Investment Trust indices. In a related study Torul and Alper (2010) report that while oil price increases do not significantly affect the Turkish manufacturing sector in aggregate terms, they do impede the production growth of several manufacturing sub-sectors, including Wood and Wood Products, Furniture, Chemicals and Chemical Products, Electrical Machinery, Radio, TV and Communication Apparatus, and Rubber and Plastic Products.

2. Empirical Framework and Data

This study employs monthly time series over the period January 1997 and November 2008. Subsector index data are obtained from Istanbul Stock Exchange (ISE) while oil price data come from International Energy Agency (IEA). We use the classification of manufacturing sub-sectors by Istanbul Stock Exchange. Thus, seven sub-sectors including Food-Beverage (FB), Basic Metal (BM), Chemical-Petroleum-Plastic (CPC), Textile-Leather (TL), Wood-Paper-Printing (WPP), Metal Products-Machinery (MPM) and Non-metal Mineral products (NMP) were investigated.

The graphical representation of crude oil prices during our sample period is presented in Figure 1. As shown in the graph, the oil prices moved within a relatively stable range of $12 to $30 per barrel between 1997 and 2004, before taking an unprecedented ascent to all time high price of $145 by July 2008. The price has dip below $40 per barrel again before the end of 2008 and followed an upward trend since then.



Source: Prepared by authors using data obtained from IEA.

Figure 1 Monthly Average Oil Price Data (US Dollar)

Economic and financial time series are often subject to a recurring seasonal pattern that obscures their underlying behaviour and trends. These intra-year periodic variations make it difficult to analyze whether the changes in data for a specified period reflect increases or decreases in the level of the data, or otherwise due to recurring variation. Seasonal adjustment is the process of estimating and removing seasonal effects from a time series. In this study we employed Census X-12 ARIMA program developed by the U.S. Bureau of the Census for seasonal adjustment of time series.

2.1 Empirical Model and Testable Hypotheses

Considering the critical role energy prices play on the manufacturing firms, the goal of this study is to determine the relationship between oil prices and manufacturing sub-sector indexes using co-integration analyses. The hypothesis being tested is "*oil prices significantly affect manufacturing sector indexes*". Subsequent to establishing the relation between these variables, the hypothesis of "*the direction of causative* *relationship is from oil prices to sector indexes*" will be tested. This potential relationship can be denoted by the following equation:

$$LSI_{it} = \alpha + \beta lop_t + u_t, \quad (1)$$

where LSI is the logarithmic value of sector index *i* at month *t*; LOP is the logarithmic value of oil prices in US$, and *u* is the error term.

In order to conduct a co-integration analysis we need to test whether time series involved are unit root processes. The natural logarithms of the variables are taken to maintain stationary in time series. Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are used to test for the presence of unit roots in data. ADF and PP unit root test results reveal that the time series are not stationary. Following the unit-root test, VAR model is employed and optimal lag lengths are determined by Schwarz Criteria (SC). We employ Soren Johansen's (1988) co-integration procedure to examine the existence of a long-term relationship between the time-series. Finally, Granger causality test is performed to determine causality relation between manufacturing subsector indexes and oil price.

2.2 Unit Root Tests

Testing for a unit root is an essential part of any time series analysis. When a series has a unit root, it is non-stationary, indicating that the mean and variance are changing over time. In this paper we employed two most widely used unit root test, namely Augmented Dickey–Fuller (ADF) and Phillips and Peron (PP) tests. In Dickey-Fuller (ADF) test stationarity of the series was tested according to the following equation:

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \sum_{i=1}^{k} \beta_i \Delta Y_{t-i} + \varepsilon_t \quad (2)$$

where Y is the variable subject to statitonarity test, Δ is the first difference operator and ε is the error term. The null and alternative hypotheses are H_0: $\alpha_1 = 0$ and H_1: $\alpha_1 < 0$. If H_0 is rejected then Y is said to be stationary.

The Phillips–Perron (PP) test uses the following equation:

$$y_t = \phi + \beta(t - \frac{T}{2}) + \rho y_{t-1} + v_t, \quad (3)$$

where *T* is the number of observations, (*t-T/2*) is the time trend and v_t is the error term. The hypotheses tested are (H_0: $\rho=1$) and (H_1: $\rho<1$). If H_0 is rejected then *y* is stationary with a deterministic trend.

2.3 Cointegration Test

Cointegration refers to a long-run relationship between non-stationary series. Robert F. Engle and Clive W. J. Granger (1987) indicate that linear combinations of two or more nonstationary series may be stationary. The existence of a cointegration relationship in such linear combination suggests that these variables share a common trend and tend to move together in the long run. We used the vector autoregression model (VAR) proposed by Engle and Granger (1987) and Johansen (1988) to investigate such relationship. P^{th} order VAR model is represented by the following equation:

$$y_t = A_1 y_{t-1} + \ldots + A_p y_{t-p} + Bx_t + \varepsilon_t, \quad (4)$$

where y_t is a vector of non-stationary variables, x_t is a vector of deterministic variables and ε_t represents error terms. VAR model in matrix notation is given by:

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + Bx_t + \varepsilon_t . \quad (5)$$

In this equation, i_t is defined as:

$$\prod = \sum_{i=1}^{p} A_i - I \quad \text{and} \quad \Gamma_i = -\sum_{j=i+1}^{p} A_j \ . \quad (6)$$

The coefficient of Π shows that if the reduced rank (r) is smaller than the number of endogenous variables (if r < k), then Π=αβ' and β'y is I(0) and there exist kxr number of α and β matrices. r shows the number of cointegration relationship and each column of β is the cointegration vector. In our study, trace test statistic is used for testing the cointegration relationship in number r. In this test H_0 investigates r and H_1 investigates k number of cointegration relationship (k is the number of endogenous variables). Trace statistic is calculated as follows (Johansen and Juselius 1990, p. 170):

$$LR_{tr}(r/k) = -T\sum_{i=r+1}^{k} \log(1-\lambda_i), \quad (7)$$

where λ_i is the i^{th} eigen value of Π matrix.

2.4 Vector Error Correction Model

Once we determine the existence of a long-term relationship between two series, we can examine the direction of causality between them. Existence of a relationship between two variables in an econometric model does not necessarily mean a causative relation between the same variables. Although the literature offers several approaches to determine the direction of existent relationship, this study employs Granger causality test due to useful inferences from its results and ease of applicability. When time series are cointegrated, standard Granger causality test is not valid. In this case Vector Error Correction Model (VECM) instead of Vector Autoregressive Model (VAR) is used to examine the causality relationship (Granger 1988, pp. 199-211).

Error correction parameter in the model keeps the dynamics of the model in equilibrium and forces the variables closer to their long term equilibrium values. Statistically significant coefficient on the error-correction parameter is a sign of deviation from the equilibrium. The magnitude of the coefficient represents the speed of error correction mechanism. It is expected to be significantly negative. A larger value represents a faster convergence toward a long-term equilibrium in cases of short-run deviations from equilibrium. While a significant error correction term is a sign of long-term Granger causality, significant F-Wald test statistic shows the existence of a short-term causality.

Vector error correction mechanism (VECM) for causality analysis between x and y can be expressed as:

$$\Delta Y_t = \alpha_1 + \sum_{i=1}^{m} \beta_{1i}\Delta Y_{t-1} + \sum_{i=1}^{n} \gamma_{1i}\Delta X_{t-i} + \sum_{i=1}^{r} \delta_{1i} ECM_{r,t-1} + u_t \quad (8)$$

$$\Delta X_t = \alpha_2 + \sum_{i=1}^{m} \beta_{2i}\Delta X_{t-1} + \sum_{i=1}^{n} \gamma_{2i}\Delta Y_{t-i} + \sum_{i=1}^{r} \delta_{2i} ECM_{r,t-1} + u_t \quad (9)$$

The source of causality could be determined by applying the t-test to ECM.

2.5 Granger Causality

Granger causality test is one of the most widely used approaches to determine the direction of relationship between variables. This test can be represented by the following two equations:

$$Y_t = \alpha_0 + \sum_{i=1}^{p} \phi_i Y_{t-i} + \sum_{i=1}^{q} \delta_i X_{t-i} \varepsilon_i \quad (10)$$

$$X_t = \beta_0 + \sum_{i=1}^{p} \pi_i X_{t-i} + \sum_{i=1}^{q} \lambda_i Y_{t-1} + \mu_t \quad (11)$$

where α and β are constant terms, Φ, δ, π and λ are optimal lag lengths for series X and Y.

In these models we test ($\delta_1 = \delta_2 = \ldots = \delta_i = 0$; $\lambda_1 = \lambda_2 = \ldots = \lambda_1 = 0$). Rejection of this hypothesis in equation 10 by F-test means X Granger causes Y; rejection of the same hypothesis in equation 11 means Y Granger causes X. The definitions of the variables used in our model are summarized in Table 1.

Table 1 Notations Used in Analyses

LOP	ΔLOP	Oil Prices
LFB	ΔLFB	Food-Beverage
LBM	ΔLBM	Basic Metal
LCPP	ΔLCPP	Chemical-Petroleum-Plastic
LTL	ΔLTL	Textile-Leather
LWPP	ΔLWPP	Wood-Paper-Printing
LMPM	ΔLMPM	Metal Products-Machinery
LNMP	ΔLNMP	Non-Metal Mineral Products

Notes: Δ - First Log; L - Logaritmic Values.

Source: Authors.

3. Results of the Simulations

Table 2 presents the results of the unit root tests. Both ADF and PP test results indicate that all series of sample variables are no stationary in levels but stationary in first differences. Once we determine the series as I(1), we employ Johansen's cointegration procedure in order to gauge out the presence of cointegration vectors.

Consequently, VAR model is built and optimal lag lengths are determined by SC. According to test results, the lag number for Food-Beverage, Basic Metal, and Chemical-Petroleum-Plastic, Wood-Paper-Printing and Non-Metal Mineral Products Sectors is 1, and for Textile-Leather and Metal Products-Machinery industries are 2. The co-integration analysis was performed using these lag numbers.

Table 2 Results of Unit Root Test

PANEL A: ADF TEST

Variables		Level				1st Difference			
		1%	5%	10%	ADF Test	1%	5%	10%	ADF Test
OP	Intercept	-3.48	-2.88	-2.57	1.63	-3.48	-2.88	-2.57	-10.24*
	Trend and intercept	-4.03	-3.44	-3.14	-2.05	-4.03	-3.44	-3.14	-10.68*
FB	Intercept	-3.47	-2.88	-2.57	-1.75	-3.47	-2.88	-2.57	-13.26*
	Trend and intercept	-4.01	-3.43	-3.14	-2.18	-4.51	-3.43	-3.14	-13.32*
BM	Intercept	-3.47	-2.88	-2.57	-0.96	-3.47	-2.88	-2.57	-11.59*
	Trend and intercept	-4.01	-3.43	-3.14	-2.30	-4.01	-3.43	-3.14	-11.55*
CPP	Intercept	-3.47	-2.88	-2.57	-2.08	-3.47	-2.88	-2.57	-12.49*
	Trend and intercept	-4.01	-3.43	-3.14	-2.51	-4.01	-3.43	-3.14	-12.55*
TL	Intercept	-3.47	-2.88	-2.57	-1.71	-3.47	-2.88	-2.57	-10.71*
	Trend and intercept	-4.01	-3.43	-3.14	-2.25	-4.01	-3.43	-3.14	-10.68*
WPP	Intercept	-3.47	-2.88	-2.57	-1.26	-3.47	-2.88	-2.57	-13.19*
	Trend and intercept	-4.01	-3.43	-3.14	-1.85	-4.01	-3.43	-3.14	-13.16*
MPM	Intercept	-3.47	-2.88	-2.57	-2.00	-3.47	-2.88	-2.57	-11.52*
	Trend and intercept	-4.01	-3.43	-3.14	-1.90	-4.01	-3.43	-3.14	-11.58*
NMP	Intercept	-3.47	-2.88	-2.57	-1.79	-3.47	-2.88	-2.57	-10.69*
	Trend and intercept	-4.01	-3.43	-3.14	-1.61	-4.01	-3.43	-3.14	-10.70*

Panel B: PP TEST

Sector		Level				1st Difference			
		1%	5%	10%	PP Test	1%	5%	10%	PP Test
OP	Intercept	-3.48	-2.88	-2.57	1.33	-3.48	-2.88	-2.57	-12.31*
	Trend and intercept	-4.03	-3.44	-3.14	-2.05	-4.03	-3.44	-3.14	-12.83*
FB	Intercept	-3.43	-2.88	-2.57	-1.78	-3.47	-2.88	-2.57	-13.25*
	Trend and intercept	-4.01	-3.43	-3.14	-2.13	-4.01	-3.43	-3.14	-13.32*
BM	Intercept	-3.47	-2.88	-2.57	-1.05	-3.47	-2.88	-2.52	-11.68*
	Trend and intercept	-4.01	-3.43	-3.14	-2.78	-4.01	-3.43	-3.14	-11.65*
CPP	Intercept	-3.47	-2.88	-2.57	-2.05	-3.47	-2.88	-2.57	-12.49*
	Trend and intercept	-4.01	-3.43	-3.14	-2.58	-4.01	-3.43	-3.14	-12.45*
TL	Intercept	-3.47	-2.88	-2.57	-1.86	-3.47	-2.88	-2.57	-10.73*
	Trend and intercept	-4.01	-3.34	-3.14	-2.62	-4.01	-3.43	-3.14	-10.70*
WPP	Intercept	-3.47	-2.88	-2.57	-1.27	-3.47	-2.88	-2.57	-13.16*
	Trend and intercept	-4.01	-3.43	-3.14	-1.98	-4.01	-3.43	-3.14	-13.13*
MPM	Intercept	-3.47	-2.88	-2.57	-2.01	-3.47	-2.88	-2.57	-11.66*
	Trend and intercept	-4.01	-3.43	-3.14	-2.19	-4.01	-3.43	-3.14	-11.71*
NMP	Intercept	-3.47	-2.88	-2.57	-1.72	-3.47	-2.88	-2.57	-10.75*
	Trend and intercept	-4.01	-3.43	-3.14	-1.98	-4.01	-3.43	-3.14	-10.79*

Notes: * denotes significance at 1% critical level. Optimum lag lengths are set according to SC for ADF, Newey-West method for PP.

Source: Authors' estimations.

The results of cointegration tests in Table 3 reveal the existence of long term vector for Basic Metal, Chemical-Petroleum-Plastic and Non-Metal Mineral Products sub-sectors. The results can be interpreted as the long-term equilibrium relationship between oil prices and these three manufacturing subsectors for the period 1997-2009.

Table 3 Results of Cointegration Test

Sector	Sampling period: 1997:01–2009:11 Trend assumption: Deterministic linear trend						
	H_0	H_1	LAGS	Eigen value	Trace statistic	0.05 Critical value	Prob.
OP	R=0	R=1	1	0.070961	13.53258	15.49471	0.0967
	R≤1	R=2		0.014734	2.271090	3.841466	0.1318
FB	R=0	R=1	1	0.107625	18.31993	15.49471	0.0183**
	R≤1	R=2		0.005852	0.897967	3.841466	0.3433
BM	R=0	R=1	1	0.095267	17.55360	15.49471	0.0242**
	R≤1	R=2		0.014507	2.235900	3.841466	0.1348
CPP	R=0	R=1	2	0.056482	9.799188	15.49471	0.2965
	R≤1	R=2		0.006309	0.961987	3.841466	0.3267
TL	R=0	R=1	1	0.083337	15.10782	15.49471	0.0571
	R≤1	R=2		0.011660	1.794518	3.841466	0.1804
WPP	R=0	R=1	2	0.073987	14.18389	15.49471	0.0780
	R≤1	R=2		0.016313	2.500059	3.841466	0.1138
MPM	R=0	R=1	1	0.080708	15.56374	15.49471	0.0488**
	R≤1	R=2		0.017419	2.688535	3.841466	0.1011

Notes: Models were estimated according to SC. ** denotes rejection of the null hypothesis at the 5% level of significance.

Source: Authors' estimations.

Engle and Granger (1987) show that if two series are individually I(1) and cointegrated, then there would be a causal relationship at least in one direction. We can conveniently use the Granger causality test to detect the long-run causality among the variables. In the current study, the error terms for cointegration trend of the specific sectors are found to be in steady state. After this analysis, whether the VECM mechanism works for these sectors was tested. The results of VECM for the 3 sectors are given in the Table 4.

Table 4 The Results of VECM

	Dependent variable: ΔLBM			Causality results	
	Variable	**Prob.**	**Coefficient**	**Short term**	**Long term**
Basic Metal	**ECTt-1**	0.0311	-0.085165**	No	$\Delta LOP \rightarrow \Delta LBM$
	ΔLBM_{t-1}	0.2329	0.101918		
	ΔLBM_{t-2}	0.0398	0.175585		
	ΔLBM_{t-3}	0.3100	0.085566		
	ΔLOP_{t-1}	0.7659	-0.039617		
	ΔLOP_{t-2}	0.3895	0.110014		
	ΔLOP_{t-3}	0.2188	-0.154336		
	f-wald test	0.4041	0.979876		
	Dependent variable: $\Delta LCPP$			Causality results	
	Variable	**Prob.**	**Coefficient**	**Short term**	**Long term**
Chemical-Petroleum-Plastic	**ECTt-1**	0.0251	-0.072604**	No	$\Delta LOP \rightarrow \Delta LCPP$
	$\Delta LCPP_{t-1}$	0.5798	0.046838		
	$\Delta LCPP_{t-2}$	0.6925	0.033919		
	$\Delta LCPP_{t-3}$	0.2538	0.098037		
	$\Delta LCPP_{t-4}$	0.3720	0.076713		
	ΔLOP_{t-1}	0.4536	-0.084123		
	ΔLOP_{t-2}	0.4904	0.076544		
	ΔLOP_{t-3}	0.8051	-0.027183		
	ΔLOP_{t-4}	0.5269	0.068566		
	f-wald test	0.8461	0.346476		
	Dependent variable: $\Delta LNMP$			Causality results	
	Variable	**Prob.**	**Coefficient**	**Short term**	**Long term**
Non-metal Mineral Products	**ECTt-1**	0.3077	-0.024625	No	No
	$\Delta LNMP_{t-1}$	0.0183	0.202362		
	$\Delta LNMP_{t-2}$	0.6067	0.044504		
	$\Delta LNMP_{t-3}$	0.0576	0.165022		
	$\Delta LNMP_{t-4}$	0.6649	0.036723		
	ΔLOP_{t-1}	0.2767	-0.110935		
	ΔLOP_{t-2}	0.3807	0.089572		
	ΔLOP_{t-3}	0.1388	-0.151039		
	f-wald test	0.2461	1.397373		

Notes: Optimal lag number is determined according to the Schwarz (SC). ** denotes 5% significance level. Normality of the model used for VECM is tested with Jarque-Bera test; autocorrelation is tested with LM test.

Source: Authors' estimations.

For Non-Metal Mineral Products subsector, we cannot find the long term causality in the error correction model. On the other hand, the error correction mechanism can be applied for Chemical-Petroleum-Plastic and Basic Metal sub-sectors, and therefore, the long term relationship could be found. The F-Wald test measures the effect of the lags of independent variables on dependent variables and shows the short term causality. The test results exhibit no statistically significant relationship, indicating no short term causality between sector indexes and crude oil prices.

The standard Granger causality tests for Food–Beverage, Textile – Leather, Wood–Paper–Printing and Metal Products Machine sub-sectors do not yield significant results as shown in Table 5. Based on these results we conclude that crude oil prices do not have significant impact on these index values.

Table 5 The Results of Granger Causality Test

Null hypothesis	Prob.
Δ**LOP** does not Granger Cause ΔLFB	0.193
Δ**LOP** does not Granger Cause ΔLTL	0.424
Δ**LOP** does not Granger Cause ΔLWPP	0.240
Δ**LOP** does not Granger Cause ΔLMPM	0.281

Source: Authors' estimations.

4. Conclusion: Findings and Recommendations

The increased volatility in energy markets in general and crude oil prices in particular has raised the interest in this issue among academicians and policymakers because of its significant impact on different sectors. Since crude oil prices is a major cost factor in manufacturing sector, companies can be severely affected by volatile movements in energy-dependent emerging countries. This study examines the sensitivity of the stock market indexes of seven Turkish sub-manufacturing sectors on crude oil prices.

The error correction model results reveals the long term causality from crude oil prices to chemical-petroleum-plastic and basic metal sub-sectors indicating that these sub-sectors are highly sensitive to crude oil prices. This is not surprising since oil is a direct input in these sectors. There is no causal relationship for other sector indexes for short or long time periods.

Important conclusions arise from our analyses. To the extent that negative impact of oil prices can be mitigated, firms in these sectors can invest and grow, contributing to overall economic growth. Therefore availability and the use of alternative energy resources, especially for these two sub-sectors, should be facilitated. In addition investors in capital markets should carefully consider the long term relationship between oil prices and their interested sector before investment decisions.

The recent sharp increases in energy prices underline the importance of developing alternative energy resources for all countries. Lacking the nuclear power facilities and sufficient renewable energy infrastructure, Turkey has a competitive disadvantage in this area. Furthermore, Turkey is dependent on imported oil and gas to meet 97% of its energy needs. The need to finance large trade deficit caused mainly by oil imports makes Turkey dependent on often volatile, short-term foreign investment. This situation creates an unwarranted external financial and credit risk, leaving the economy vulnerable to destabilizing shifts in investor confidence. In light of continuing global economic turmoil, Turkey urgently needs to develop policies that address how to diversify its energy resources and increase the share of its renewable energy sources.

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