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Reaction of Stock Market Index to Oil Price Shocks

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Abstract

This study examines how oil price shocks interact with the stock market index within a nonlinear autoregressive distributed lag model in Iran. Based on quarterly data for the period from 1991 to 2017, the findings revealed statistically significant evidence of short-run and long-run asymmetric behavior of stock market index in response to the positive and negative shocks occurring in oil price, industrial production and lending rate. In particular, Unanticipated short-run and long-run positive (negative) oil price shocks trigger an addition (reduction) in the stock market index. Moreover, both short-run and long-run results present that the stock market index is more affected by positive changes in oil prices than the negative ones. Furthermore, the cumulative dynamic multipliers point out a significant asymmetric reaction of the stock market index to oil price shocks and other macroeconomic determinants. The aforementioned multipliers also show that the speed of response and time required to reach a new equilibrium state are sensitive to the direction of changes in the macroeconomic fundamentals. Consequently, the results prescribe that financial participants, energy policymakers and the government should adjust their respective strategies to changes in oil prices and consider the asymmetry when forecasting and managing the negative impacts of unexpected events.

Keywords: Oil Price Shocks, Stock Market Index, Nonlinear Autoregressive Distributed Lag Model, Dynamic Multiplier.
JEL Classification: E32, G17, Q43.

1. Introduction

From a financial perspective, changes in crude oil prices may lead to economic depression, which could weaken asset prices. Thus, it is crucial to study the possible effects of crude oil price shocks on the stock market index. These findings can help government authorities to

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reduce the instability in financial markets caused by oil price shocks. Furthermore, an empirical analysis of the impact of oil price shocks on the stock market index will help financial market participants in adjusting their decisions and revising their coverage of energy policies, which is substantially affected by the turbulence and uncertainty in the crude oil market (Arouri et al., 2011; Awartani and Maghyereh, 2013).

According to the above mentioned, financial participants are expected to respond more when there are large positive oil price shocks. Thus, it might be inappropriate to gage such reactions in a linear setting. Further, this sample is marked by oil price shocks and financial crises, which may have induced nonlinearity and asymmetry into the financial and economic time series. Various studies have found evidence of possible nonlinearity in financial and macroeconomic data (Aloui et al., 2013; Reboredo and Rivera-Castro, 2013; Jammazi et al., 2014, among others). The possible nonlinearity is driven, according to Jammazi et al. (2014), "by successive episodes of the economic and financial crisis, black swan events, geopolitical tensions, structural changes in the business cycle, and heterogeneous economic agents." The authors also added, "the asymmetries can arise from the differences in the fundamental factors that determine the dynamics of markets under consideration". Accordingly, considering these vital externalities, We investigate the instantaneous long run and short-run asymmetric impacts of positive and negative oil price shocks on the stock market index in Iran, using the Nonlinear Autoregressive Distributed Lag (NARDL) model proposed by Shin et al. (2014).

The remainder of this paper proceeds as follows. In Section II, We provide an overview of the related literature. Section III describes the model, data and methodology. In Section IV, we present the key empirical findings with a discussion, and finally, Section V concludes.

2. Literature Review

From an economic perspective, a number of studies have focused on the linkages between changes in oil prices and economic recessions. In a seminal study, Hamilton (1983) linked the US economic recessions to rises in oil prices. He argued that seven of the eight US post-war economic recessions were preceded by an increase in oil prices (Hamilton, 2011). Moreover, the negative impact of oil price shocks has been empirically established by Hamilton (1983, 1996, 2003, 2011) for the US, Cũnado and Perez de Gracia (2003) for European countries, Cũnado and Perez de Gracia (2005) for Asian economies, and Engemann et al. (2011) for other economies. Empirical evidence regarding the impact of oil price changes on stock markets is mixed and inconclusive. For example, Jones and Kaul (1996), Sadorsky (1999), and Cũnado and Perez de Gracia (2014) have confirmed that an increase in oil prices has a significant but negative impact on the stock market index. In contrast, several studies (Faff and Brailsford, 1999; Sadorsky, 2001; El-Sharif et al., 2005) have found a positive and significant relation between oil prices and stock market index. An insignificant effect of oil prices on the stock market index has also been empirically confirmed by Chen et al. (1986) and Huang et al. (1996). Narayan and Sharma (2011) argued that oil prices may have different impacts on stock market prices, depending on the industries, and further reported that stock market prices are sensitive to lagged oil prices. Degiannakis et al. (2003), Kilian and Park (2009), Filis et al. (2011), Cũnado and Perez de Gracia (2014), and Dhaoui and Saidi (2015) noted that the effect of oil price shocks on stock prices depends on the nature of the shocks, namely, whether they are demand or supply-side shocks. More obviously, the relation between oil price shocks and stock market prices depends on whether a country is a net importer or net exporter of oil (Degiannakis et al. 2003, Filis et al. 2011, Dhaoui and Saidi 2015). Dhaoui et al. (2018) show an asymmetric long-run relation between stock return, oil price shocks and other macroeconomic fundamentals within a nonlinear autoregressive distributed lag framework. They also show that changes in oil prices and real industrial production do not have a significant impact or a delayed time horizon impact on stock return. Golkhandaan (2016) shows that the Iran stock index is more influenced by the short-run and long-run negative oil price changes than the positive ones. Moreover, he also shows that there are a direct short-run and long-run relationship between stock index and GDP but indirect for the exchange rate. A negative relation between oil price changes and stock market prices is empirically, but strongly, confirmed in the US market, European countries, and other economies (Hamilton, 1983; 1996; 2003; 2011, Jones and Kaul, 1996, Sadorsky, 1999, Cũnado and Perez de Gracia, 2003; Cũnado and Perez de Gracia, 2005, Engemann et al., 2011; Cũnado and Perez de Gracia, 2014). A positive but significant impact of oil price changes on stock market prices has been reported by Faff and Brailsford (1999), Sadorsky (2001), and El-Sharif et al. (2005), among others, but an insignificant relation between these variables has also been exposed by Chen et al. (1986) and Huang et al. (1996). A number of transmission channels have also been identified, such as those by Bernanke et al. (1997), Lee and Ni (2002), Edelstein and Kilian (2007), Blanchard and Gali (2009), Kilian and Park (2009), Lee et al. (2011), and Serletis and Elder (2011). Stakeholders in oil markets are generally interested in how the volatility and oil price shocks are transmitted to stock market prices. Uncertainty is presented as an essential channel through which changes in oil prices can be transmitted to the key sectors of an economy, including the real sector and the financial sector (Başkaya et al., 2013; Aye, 2015; Caporale et al., 2015; and Cũnado et al., 2015). In this vein, the stock market prices depend on the expected cash flows discounted by the required rate of returns (Williams, 1938), which are substantially sensitive to any factor that could alter the expected cash flows or the required rate of returns (Filis et al., 2011). Moreover, a rise in oil prices can directly increase the cost of production and, consequently, lower the value of the cash flows that are considered in stock assessment models (Jones et al., 2004). These effects can also be extended to sectors other than the manufacturing industry. Indeed, due to a reduction in discretionary income or an increase in precautionary saving, an increase in oil prices may lead consumers to cut their spending that is not directly related to the oil industry (Gogineni, 2010). However, oil price fluctuations can affect macroeconomic variables, including GDP growth, inflation, and the currency exchange rate (Hamilton and Herrara, 2004; Hamilton, 2005). Thus, oil price fluctuations lead to an increase in equity risk premiums, which can, in turn, affect the discount rates applied to cash flows in stock assessment models. With the same alignment, policymakers and central banks consider the increase in oil prices to be inflationary. Therefore, central banks react by increasing interest rates, particularly short-term interest rates, affecting the discount rate used in stock market price assessment models (Basher et al. 2012). Investors may also require an increase in the risk premium on the assets that they hold and experience greater exposure because of oil price fluctuations. Thus, an increase in the required risk premium on the volatility of oil prices leads to significant response inequities. In this vein, French et al. (1987) found that the expected market risk premium and the predictable volatility of stock returns are positively related. Faff and Brailsford (1999) and Jalil et al. (2009), have claimed that oil prices affect both consumers and producers. Faff and Brailsford (1999) documented that an increase in oil prices induces an increase in the prices of goods and services for consumers. In contrast, a decline in the demand for goods and services due to the inflationary effect driven by an increase in oil prices reduces the profits and lowers the magnitude of operations of producers. Jalil et al. (2009) argued that on the producer’s side, “a higher oil price is associated with higher input price.” They added that an increase in production costs “will not only cause a reduction in the quantity of output produced but also push the price of output sold in the market to be higher.” In fact, an increase in the cost of production and distribution due to a higher oil price will lead to a lower real income for producers. To protect their real income, producers will consequently pass on the cost to consumers. As a result, the general price level in an economy seems to increase in a similar manner.

Specifically, signs of nonlinearity have been reported and the responses are likely to be raised asymmetrically (Hamilton 2003, Lardic and Mignon, 2006, 2008; Zhang, 2008; Cologni and Manera, 2009). Other types of interactions are empirically reported drivers, despite the importance of the studies, with mixed and inconclusive results obtained for the types of actions taken in response to the upheavals in oil prices. Different reasons exist for these mixed results. First, the samples covering periods and countries were not equivalent. Second, the econometric analysis methods varied. Furthermore, the specification of oil price shocks faces several difficulties, and distinguishing between net oil-importing and net oil-exporting countries is not easy. It is a subject of confusion in that the needs and reserves of oil vary according to the country over time, as do the rate of consumption, the stability of producer countries, and the pressures of supply and global demand. Various empirical studies have found that the stock market index is asymmetrically affected by different exogenous regressors, such as financial news (Antoniou et al., 1998), stock market indices of foreign countries (Bahng and Shin 2003), and monetary policies (Tsai, 2013). In particular, Tsai (2013) examined "whether a high oil price event that worsens the quality of a firm's balance sheet, in turn, provides an additional transmission channel to the stock market, which then affects stock returns." This author examined the asymmetric impacts of monetary shocks on stock returns across high oil price events and non-high oil price events over the period from 1995 to 2008. The "findings suggest that more energy-intensive industries and durable-goods industries react more significantly to monetary shocks based on high oil price events than on those based on non-high oil price events." The possible nonlinearity is driven, according to Jammazi et al. (2014), "by successive episodes of the economic and financial crisis, black swan events, geopolitical tensions, structural changes in the business cycle, and heterogeneous economic agents." The authors also added, "the asymmetries can arise from the differences in the fundamental factors that determine the dynamics of markets under consideration". Hence, according to Cũnado and Perez de Gracia (2014), oil price, lending rate, and industrial production are possible candidates for causing asymmetric impacts on the stock market index. Keeping the possible asymmetry in the reaction of the stock market index, investigating stock market index's reactions to oil price shocks, lending rate (credit rate on sectors), and industrial production can provide a better understanding of their relation. In particular, the NARDL approach adopted in this study allows the possible asymmetry in both long-run and short-run effects to be considered. To the best of our knowledge, most of the existing empirical literature in the case of Iran lacks evidence on the nonlinear relation between stock market index and oil price shocks through direct and indirect transmission channels. So, this study fills the gap by investigating the relation between oil price shocks and stock market index in the case of Iran.

3. Model, Data and Method

3.1 Theoretical Framework

In this paper, and following the idea that “not all oil price shocks are alike” (Kilian, 2009), we propose an alternative oil price shock specification to disentangle positive and negative shocks. Our proposed oil price shocks are related to the studies by Rapaport (2013) and Cũnado and Perez de Gracia (2014), identifying oil price shocks based on the sign and size of the correlation between oil price changes and stock market returns. In our case, we are going to indicate the short-run and long-run asymmetric relationship between the stock market index and positive and negative changes in oil price based on the direct and indirect transmission channels. In particular, the oil price allows us to supervise the direct transmission channel of oil price shocks to the stock market index, while lending rate and industrial production are used to control for the indirect macroeconomic channels through which oil price changes are transmitted to the stock market index. In other words, lending rate and industrial production are presented as essential channels through which changes in oil prices can be transmitted to the key sectors of an economy, including the real sector and the financial sector.

3.2 Data Description

This study utilizes the quarterly data of the Iran economy spanning from 1991 to 2017 including stock market index, exchange rate, consumer price index, industrial production, lending rate (rate of the loanable fund) and oil price. The data for the considered variables are available from the Iran Central Bank database and IMF. Moreover, according to Cũnado and Perez de Gracia (2014), the empirical model includes the stock market index (RET) as the endogenous variable, and numerous exogenous variables, specifically industrial production (IP), lending rate or credit rate on sectors (IR), and the oil price (OP). Furthermore, the Iranian nominal crude oil price is used as a proxy for nominal oil price and notably, all aforementioned variables are captured in their real terms and logarithmic values.

3.3 Estimation Model

In the previous literature, the relation between oil price shocks and stock market index have been examined using various time series techniques, such as Autoregressive Conditionally Heteroskedastic (ARCH) and Generalized Autoregressive Conditionally Heteroscedastic (GARCH) model, cointegration and the Vector Error Correction Model (VECM), the Vector Autoregression (VAR) model, and the Markov switching model. The major disadvantages of these techniques include the presumptions of a symmetric relation between oil price and stock market index, the linearity of the relation, and the time-varying independence of the relation. New research in this field has attached greater importance to the nonlinear and asymmetric relation between the variables. In particular, Shin et al. (2014) developed an extension to the well known Autoregressive Distributed Lag (ARDL) approach initiated by Pesaran and Shin (1999) and Pesaran et al. (2001), namely the Nonlinear Autoregressive Distributed Lag (NARDL). This technique also allows the investigation of the asymmetric linkages between Stock Market Index (RET) as an endogenous variable and each of Lending Rate (IR), Oil Price (OP), and Industrial Production (IP) as exogenous variables. Moreover, this framework helps us to estimate the size, speed of response and time required to reach a new equilibrium state of the oil price shocks transmission among the system variables. The asymmetry in the relation between the dependent variable and each of the independent variables refers to the asymmetry in the impact of negative and positive changes of 1% in each of the independent variable on the stock market index as the dependent variable in both signs and magnitude. Further, it allows both long run and short run asymmetries to be captured in the predictor. The asymmetric long run specification of oil price and stock market index are specified as shown in Equation (1).

$$\begin{aligned}\mathrm{RET_t} = {} & \alpha_0 + \alpha_1 \mathrm{OP_t^+} + \alpha_2 \mathrm{OP_t^-} + \alpha_3 \mathrm{IP_t^+} + \alpha_4 \mathrm{IP_t^-} + \alpha_5 \mathrm{IR_t^+} \\ & + \alpha_6 \mathrm{IR_t^-} + \varepsilon_t \end{aligned} \tag{1}$$

where RET is the stock market index, IP and IR capture the industrial production and lending rate channels through which oil price changes are transmitted to the stock market index, and OP is the oil price. $\alpha = (\alpha_0 + \alpha_1 + \cdots + \alpha_6)$ represents a vector of the long-run parameters to be estimated. For each independent variable $\mathrm{iv_{it}}$, increases $(\mathrm{iv_{it}^+})$ and decreases $(\mathrm{iv_{it}^-})$ are specified as follows:

$$iv_{it}^{+} = \begin{cases} \Delta iv_{it} & \text{if } \Delta iv_{it} > 0 \\ 0 & \text{otherwise} \end{cases} \tag{2}$$

And

$$iv_{it}^{-} = \begin{cases} \Delta iv_{it} & \text{if } \Delta iv_{it} < 0 \\ 0 & \text{otherwise} \end{cases} \tag{3}$$

Where each independent variable is decomposed into iv_{it}^{+} and iv_{it}^{-} around a threshold of zero, thereby distinguishing between positive and negative changes in the rate of growth of each independent variable. Based on Equation (1), α_1, α_3 and α_5 capture the long run link between stock market index and increases in oil price, industrial production and lending rate, respectively, and α_2, α_4 and α_6 capture the long run relation between such dependent variable and decreases in oil price, industrial production and lending rate, respectively. In accordance with Faff and Brailsford (1999), Jalil et al. (2009), Cũnado and Perez de Gracia (2014), and Dhaoui and Saidi (2015), α_1 and α_3 are assumed to be positive, whereas α_2 and α_4 are expected to be negative for net oil exporting countries and of course the opposite around for net oil importing countries. It is also expected that for both net oil importing and exporting countries, α_5 and α_6 will be negative and positive respectively. Because financial participants are more sensitive to increases in production costs than they are to decreases, the impacts of oil price increases on long run changes in stock market index seem to be greater than the impacts of the same magnitude of oil price decreases. Accordingly α_1, α_3 and α_5 seem to be greater thanα_2, α_4 and α_6, reflecting the asymmetric long run relation between the stock market index and the selected variables. Furthermore, the ARDL setting of Equation (1) is as follows:

$$\begin{aligned} \Delta RET_t = {} & \alpha + \beta_0 RET_{t-1} + \beta_1 OP_{t-1}^{+} + \beta_2 OP_{t-1}^{-} + \beta_3 IP_{t-1}^{+} + \beta_4 IP_{t-1}^{-} \\ & + \beta_5 IR_{t-1}^{+} + \\ & \beta_6 IR_{t-1}^{-} + \sum_{i=1}^{m} \lambda_i \Delta RET_{t-i} + \sum_{i=0}^{n} (\gamma_i^{+} \Delta OP_{t-i}^{+} + \gamma_i^{-} \Delta OP_{t-i}^{-}) + \\ & \sum_{i=0}^{p} (\theta_i^{+} \Delta IP_{t-i}^{+} + \theta_i^{-} \Delta IP_{t-i}^{-}) + \sum_{i=0}^{q} (\delta_i^{+} \Delta IR_{t-i}^{+} + \delta_i^{-} \Delta IR_{t-i}^{-}) + U_t \end{aligned} \tag{4}$$

In Equation (4), all the variables are defined as in Equation (1), and m, n, p, and q represent the lag orders. $\alpha_1 = \frac{\beta_1}{\beta_0}$, $\alpha_3 = \frac{\beta_3}{\beta_0}$ and $\alpha_5 = \frac{\beta_5}{\beta_0}$ capture respectively, the aforementioned long-run impacts of increases in oil price, industrial production and lending rate on the stock market index. In the same way, $\alpha_2 = \frac{\beta_2}{\beta_0}$, $\alpha_4 = \frac{\beta_4}{\beta_0}$ and $\alpha_6 = \frac{\beta_6}{\beta_0}$ capture respectively, the long-run impacts of the decreases in oil price, industrial production and lending rate on the stock market index. So, $\sum_{i=1}^{n} \gamma_i^+$, $\sum_{i=1}^{p} \theta_i^+$ and $\sum_{i=1}^{q} \delta_i^+$ capture respectively, the short-run impacts on the stock market index of the increases in the following variables: oil price, industrial production, and lending rate. Similarly, $\sum_{i=1}^{n} \gamma_i^-$, $\sum_{i=1}^{p} \theta_i^-$ and $\sum_{i=1}^{q} \delta_i^-$ capture respectively, the short-run impacts on the stock market index of the decreases in the following variables: oil price, industrial production, and lending rate. Moreover, ε_t is an iid process with zero mean and constant variance. In addition to the asymmetric long-run relation captured in Equation (1), Equation (4) allows the asymmetric impacts of changes to be captured in the selected explanatory variables on the stock market index. However, the nonlinear ARDL model can be applied regardless of whether the variables are I(0) or I(1). The presence of an I(2) variable can affect the estimated output significantly and “renders the computed F-statistics for testing cointegration invalid” (Ibrahim 2015). As a consequence, We conduct ADF, PP and Perron unit root tests to establish the order of integration of the variables. In the second step, Equation (4) is estimated. We proceed following Katrakilidis and Trachanas (2012) and Ibrahim (2015) to determine the final specification of the NARDL model. The general to specific procedure involves running the basic model and trimming the insignificant lags after each estimation until significant results are obtained for all the regressors. Once the objective at the second step has been achieved, the third step is to test for the presence of cointegration among the variables. The bounds testing approach of Pesaran et al. (2001) and Shin et al. (2014) is used. This approach is to apply a Wald F-test to verify whether the null hypothesis $\beta_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$ can be rejected. Moreover, the dynamic error correction representation associated with the asymmetric long-run cointegrating regression, resulting in the NARDL model. Once a cointegration relation has been identified, the next step is to examine the long run and short run asymmetries in the relation between the stock market index and the variable of interest. Furthermore, the asymmetric cumulative dynamic multiplier impacts of a 1% positive change in each regressor can be derived as

$$m_{in}^{+} = \sum_{i=o}^{n} \frac{\partial y_{t+i}}{\partial iv_{it-1}^{+}} \quad (n = 0, 1, 2, \dots) \tag{5}$$

At the same time, the asymmetric cumulative dynamic multiplier impacts of a 1% negative change in each regressor can be derived as

$$m_{in}^{-} = \sum_{i=o}^{n} \frac{\partial y_{t+i}}{\partial iv_{it-1}^{-}} \quad (n = 0, 1, 2, \dots) \tag{6}$$

For relations Equation (5) and Equation (6), We note that,

as $n \to \infty$ then $m_n^{+} \to \alpha_n^{+}$ and $m_n^{-} \to \alpha_n^{-}$ (Ibrahim (2015)).

However, the NARDL model, in fact, admits three general forms of asymmetry: (i) long run or reaction asymmetry; (ii) impact asymmetry, associated with the inequality of the coefficients on the contemporaneous first differences of independent variables; (iii) adjustment asymmetry, captured by the patterns of adjustment from initial equilibrium to the new equilibrium following an economic perturbation (i.e. the dynamic multipliers). Adjustment asymmetry derives from the interaction of impact and reaction asymmetries in conjunction with the error correction coefficient (Shin et al. (2014)).

4. Empirical Results

4.1 Descriptive Statistics

Table 1 presents the descriptive statistics and the stochastic properties of the quarterly data of the stock market index, oil price, industrial production, and lending rate, alongside the results of the normality. However, the results of oil price and industrial production display positive skewness, whereas the stock market index and lending rate follow negative skewness. These results imply that the probability of an increase in oil price and industrial production is higher than the probability of a decrease and of course, the opposite around for stock market index and lending rate. At the same time, the p-value of the Jarque-Bera test statistics shows the normal distribution for all considered variables.

Table 1: Descriptive Statistics

Variable	Mean	Median	Maximum	Minimum	Std.Dev	Skewness	Kurtosis	Jarque-Bera (P)
RET	7.25	8.21	13.77	0.048	4.87	-0.32	1.62	2.30 (0.34)
OP	9.24	9.21	9.98	8.58	0.36	0.19	1.90	2.25 (0.38)
IP	10.73	10.64	11.91	9.49	0.62	0.26	2.28	1.31 (0.51)
IR	2.66	2.67	3.09	2.3	0.23	-0.007	1.79	2.43 (0.29)

4.2 Unit Root Test

The bounds testing approach requires that no I(2) variables are involved. Hence, We perform the unit root tests on the time series including both constant and trend terms and employ the Akaike Information Criterion (AIC) to select the optimal lag order in the ADF unit root test. As Perron (1989) structural change and unit-roots are closely related. It is found that the conventional unit root test gives biased results indicating a false unit root when data are trend stationery with structural breaks. Therefore, we also carried out unit root tests with structural breaks as Perron (1989). The outcomes of the ADF, Phillips-Perron, and Perron unit root tests on the level of and for the first difference of the variables are presented in Tables 2 and 3. The various unit root tests indicate, that the different series are integrated with an order of 0 or 1, no series is I(2). Hence, We can proceed to implement the bounds testing approach. We estimate Equation (4) by applying the general to the specific procedure to reach the final model specification.

4.3 Cointegration Tests

The asymptotic distributions of Pesaran, Shin, and Smith (2001), estimated error correction coefficient (β_0) and Banerjee et al. (1998) test statistics for the existence of an asymmetric long-run relationship (asymmetric cointegration) that are nonstandard under their respective null hypotheses. In addition, their exact asymptotic distributions are

Table 2: ADF and PP Unit Root Tests

At Level	ADF	PP
RET	-3.21*	-3.49*
IP	-2.02	-0.7
OP	-2.04	-2.04
IR	-1.38	-1.42
At First Difference	ADF	PP
RET	-7.55***	-7.55***
IP	-3.93***	-5.43***
OP	-2.8**	-2.89**
IR	-6.1***	-6.1***

Table 3: Perron (1989) Breakpoint Unit Root Test

Variable	At Level	At First Difference
RET	-7.57***	-8.3***
IP	-3.56	-7.01***
OP	-3.14	-6.99***
IR	-2.44	-7.26***

Note: ADF denotes Augmented Dickey-Fuller unit root tests; PP refers to Phillips-Perron unit root tests. *, ** and *** denote rejection of the null hypothesis at 10%, 5% and 1% levels of significance, respectively. The lag length in all the tests has been selected according to Akaike Information Criteria (AIC).

generally complicated to derive due to the complex dependence structure between iv_{it}^{+} and iv_{it}^{-}, especially when the means of ΔY_t and ΔX_t are non-zero (Shin et al. (2014)). In light of these difficulties, we use the pragmatic `bounds-testing' approach advanced by Pesaran et al. (2001) and Shin et al. (2014). Table 4 presents the result of the estimated NARDL cointegration F-statistics of the proposed model. Moreover, the results of the Wald test for cointegration advanced by Pesaran et al. (2001) and Shin et al. (2014) are reported in table 5. In fact, we show F-statistics and Chi-Square statistics, which are significant at the 1% level. Based on the results, the four variables, stock market index, oil price, industrial production, and lending rate, move together in the end. Consequently, we can determine the effect of the stock market index dynamics and their relation to positive and negative changes in oil price, industrial production and lending rate.

Table 4: Nonlinear ARDL Cointegration Result

F – Statistics	Cointegration
5.38***	Yes

Table 5: Wald Test for Cointegration

F- Statistic	Value: 3.45** Prob: (0.02)
Chi-Square	Value: 24.15*** Prob: (0.0011)

Note: ***, **, and *, denote significance level at 1%, 5% and 10%.

4.4 Diagnostic Tests

Before investigating the long run and short-run relations between the stock market index and the explanatory variables, we judge the adequacy of the dynamic specification based on various diagnostic statistics, including the serial correlation LM test, the White test of heteroskedasticity, normality test and the Ramsey Regression Equation Specification Error Test (RESET) for the stability test. In accordance with the results of suggested tests presented at tables 6 to 9, we can conclude that the proposed model passes all the diagnostic tests, including the absence of autocorrelation. For the stability test diagnostic, the results of the RESET test suggest that we cannot reject the null hypothesis that the model has no omitted variables. Moreover, the result for Durbin–Watson statistics indicates the absence of autocorrelation for the model.

Table 6: Ramsey RESET Test

F- Statistic	Value: 0.0045 Prob: (0.94)
t-Statictic	Value: 0.067 Prob: (0.94)

Table 7: Heteroskedasticity Test

F- Statistic **Breusch-Pagan-Godfrey**	Value: 1.3 Prob: (0.31)
F- Statistic **White**	Value: 1.92 Prob: (0.11)

Table 8: Normality Test

Jarque – Bera	Value: 0.329
Prob	Prob: (0.848)

Table 9: Breusch-Godfrey Serial Correlation LM Test

F- Statistic	Value: 0.75
White	Prob: (0.49)
Obs*R-square	Value: 4.32
Prob	Prob: (0.11)

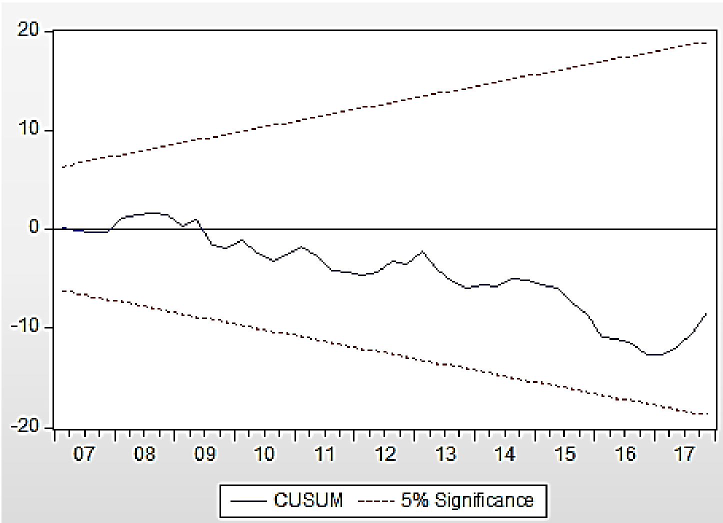

Figure 1: CUSUM Stability Test

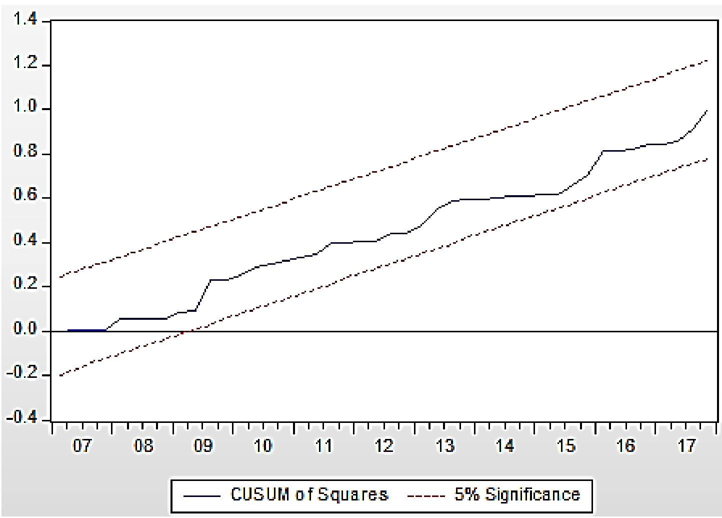

Figure 2: CUSUM Squares Stability Test

Furthermore, the stability of the model is tested by conducting CUSUM and CUSUM Squares tests as shown in figures 1 and 2. Both tests reveal the stability of the model coefficients since the estimated model lies within the 5% significance line for CUSUM and CUSUM Squares tests.

Table 10: The NARDL Estimation Results of Stock Market Index Equation

Dynamic Nonlinear Estimation			**Long Run Coefficients**		
Variable	**Coefficient**	**Prob**	**Variable**	**Coefficient**	**Prob**
C	0.17	0.79	C	0.16	0.79
RET(-1)	-1.05***	0.000	OP_POS	3.25***	0.01
OP_POS(-1)	3.42**	0.011	OP_NEG	-2.25***	0.005
OP_NEG(-1)	-2.37**	0.02	IR_POS	-5.16***	0.000
IR_POS(-1)	-5.4***	0.00	IR_NEG	2.4**	0.02
IR_NEG(-1)	2.53*	0.09	IP_POS	-0.45	0.7
IP_POS(-1)	-0.47	0.71	IP_NEG	-7.95***	0.000
IP_NEG(-1)	-8.38***	0.002	Specification and Diagnostic Tests		
D(OP_POS)	-2.12***	0.003			
D(OP_POS(-1))	-2.53***	0.01	Test		Statistics
D(OP_POS(-2))	-5.01***	0.000	R_Squared		0.99
D(OP_NEG)	0.51	0.21	Adjusted R-Squared		0.99
D(OP_NEG(-1))	3.23***	0.000	S.E. of Regression		0.38
D(OP_NEG(-2))	2.13***	0.002	Sum Squared Resid		1.90
D(IR_POS)	-3.28***	0.000	D-W Statistics		2.03
D(IR_NEG)	1.86	0.25	Log Likelihood		1.78
D(IR_NEG(-1))	0.24	0.91	Mean Dependent		7.97
D(IR_NEG(-2))	6.45**	0.013	S.D. Dependent		4.58
D(IP_POS)	-0.94	0.17	Akaike Criterion		1.17
D(IP_NEG)	-5.09***	0.01	Schwarz Criterion		2.19
D(IP_POS(-1))	1.8**	0.02	Han-Qui Criterion		1.53
D(IP_POS(-2))	1.7**	0.03	F- Stat		226.9 (0.000)
D(RET(-1))	0.2*	0.07	CointEq(-1)		-0.22 (0.000)

Note: This table reports the results of the estimation of the best-fitted NARDL model for the adjustment of the stock market index. The superscripts *, ** and *** indicate 10%, 5% and 1% levels of significance, respectively.

4.4.1NARDL Model Coefficients Estimation

In accordance with equation 4, the estimation results of the proposed NARDL model are presented in table 10.

Based on the dynamic nonlinear estimated parameters provided at table 10, with the exception of (IP_POS(-1)), D(IR_NEG), D(IR_NEG(-1)), D(OP_NEG) and D(IP_POS), the other estimated coefficients of independent variables are highly significant at 1% and 5% significant levels. In particular, (OP_POS(-1)) and (OP_NEG(-1)) present positive and negative coefficients respectively, whereas we see the opposite results for the lending rate. Moreover, the results indicate the existence of a positive and negative relationship between D(OP_NEG), D(OP_POS) and stock market index, respectively. The findings also show the impact of asymmetry for both positive and negative changes in D(IR) and D(IP). Furthermore, based on the AIC information criterion and Wald symmetry tests, We selected the NARDL lag specification with short-run asymmetry for the specified model. To sum up, it can be detected mixed short-run effects of independent variables on the stock market index.

In accordance with the long run estimation results reported in table 10, with the exception of positive changes in industrial production, the estimated long-run coefficients related to other independent variables are statistically significant at the 1% significance levels. Specifically, the positive and negative oil price shocks present positive and negative long-run coefficients respectively, that are compatible with Faff and Brailsford (1999) and Jalil et al. (2009). Moreover, consistent with Cũnado and Perez de Gracia (2014), and Dhaoui and Saidi (2015), the long-run coefficient sign of positive and negative changes in lending rate are significantly negative and positive respectively, while both positive and negative changes in industrial production present negative long-run coefficients. In the long-run and among the mentioned variables, negative and positive changes in industrial production have the highest and the lowest effect on the stock market index respectively, which may be one of the main characteristics of the stock market in Iran. The results also show that the positive changes in the lending rate have a higher effect on the stock market index than the positive changes in oil prices. Furthermore, the stock market index responds negatively and positively to the long-run negative changes in oil price and lending rate with the same magnitude, respectively. Additionally, the statistically significant negative coefficient of the error correction term indicates the existence of asymmetric cointegration for the proposed model. To sum up, financial participants in many net oil-exporting countries experience more sensitivity to positive oil price shocks than the negative ones caused by the greater impact of positive changes in oil price on the stock market index than the same magnitude of the negative ones, and the importance of future expectations on their economies as well.

4.4.2 Wald Test for Short Run and Long Run Asymmetry

Table 11 summarizes the Wald test results of long-run asymmetry (reaction asymmetry) and short-run asymmetry (impact asymmetry). The null hypothesis of symmetry in the long run against the alternative of asymmetry is tested using the Wald statistic, including: $H_{LR,OP}$: $\alpha_1 = \alpha_2$ (i.e.,. $\frac{\beta_1}{\beta_0} = \frac{\beta_2}{\beta_0}$), $H_{LR,IP}$: $\alpha_3 = \alpha_4$ (i.e.,. $\frac{\beta_3}{\beta_0} = \frac{\beta_4}{\beta_0}$) and $H_{LR,IR}$: $\alpha_5 = \alpha_6$ (i.e.,. $\frac{\beta_5}{\beta_0} = \frac{\beta_6}{\beta_0}$). Regarding asymmetry in the short run, We analyze the null hypothesis of symmetry against the alternative of asymmetry based on the Wald statistic, including:

$$H_{SR,OP:} \sum_{i=0}^{n} \gamma_i^+ = \sum_{i=0}^{n} \gamma_i^- \ , H_{SR,IP:} \sum_{i=0}^{p} \theta_i^+ = \sum_{i=0}^{p} \theta_i^-,$$

$$\text{and } H_{SR,IR:} \ \sum_{i=0}^{q} \delta_i^+ = \sum_{i=0}^{q} \delta_i^-$$

Based on table 11, the results of the Wald test show the rejection of the null hypothesis of significant short run and long run symmetry for the positive and negative changes in all independent variables. Consequently, the findings of the proposed model confirm the presence of significantly asymmetric responses of a stock market index to both positive and negative changes in all explanatory variables, which may be also verified by the plots of the cumulative dynamic multipliers.

Table 11: Long Run and Short Run Asymmetry Wald Tests

Wald Test	**Long Run Asymmetry**			**Short Run Asymmetry**		
Test Statistic	Wald(OP)	Wald(IP)	Wald(IR)	Wald(OP)	Wald(IP)	Wald(IR)
T	3.46***	3.33***	-4.15***	3.68***	-3.44***	2.36**
Statistic	(0.004)	(0.005)	(0.001)	(0.002)	(0.003)	(0.03)
F	13.13***	11.1***	17.24***	13.54***	-6.09**	5.59**
Statistics	(0.003)	(0.005)	(0.001)	(0.002)	(0.03)	(0.03)
Chi	13.13***	11.1***	17.24***	13.54***	6.09**	5.59**
Square	(0.000)	(0.000)	(0.000)	(0.002)	(0.015)	(0.018)

Note: This table reports the results of the long run and short run symmetry tests for the effect of each explanatory variable (industrial production, lending rate, and oil price) on the stock market index. The Wald test statistic for the long run symmetry, which tests the null hypothesis of $\boldsymbol{\theta}^{+} = \boldsymbol{\theta}^{-}$ for each explanatory variable in equation (4), the Wald test statistic for the short run asymmetry, which tests the null hypothesis that $\boldsymbol{\pi}^{+} = \boldsymbol{\pi}^{-}$ for each explanatory variable in Equation (4). The numbers in brackets are the associated p-values. *,**and *** indicate rejection of the null hypothesis of symmetry at 10%, 5%, and 1% levels, respectively.

5. Cumulative Dynamic Multipliers

Figures 3, 4 and 5 present NARDL cumulative dynamic multipliers of the proposed model. These plots display the dynamic effects of positive and negative changes in oil price, industrial production and lending rate, respectively. Based on the Figures, an asymmetric response of the stock market index to positive and negative changes in oil price, industrial production and lending rate is detected. It is also provided a particularly significant reaction of the dependent variable in response to both positive and negative changes in all independent variables with a time deferred impact.

According to figure 3, through the direct transmission channel of oil price shocks to stock market, it can be recognized an asymmetric response of stock market index to both positive and negative changes in oil price. As one of the implications of nonlinearity, the asymmetric reactions of stock market index to positive and negative oil price shocks appear in the 2th quarter of 2005 and the 3th quarter of 2006 respectively, and then reach to their new equilibrium levels of 3.25 and 2.25 in the last quarter of 2011 and the first quarter of 2012 respectively. As mentioned before, adjustment asymmetry derives from the interaction of impact and reaction asymmetries in conjunction with the error correction coefficient. It is notable that due to the mentioned reasons of asymmetry, the stock market index experiences a mixed nonlinear response to both positive and negative oil price shocks in short run and long run. In other words, the figure shows that the stock market index is more sensitive to positive changes in oil price than the negative ones. Furthermore, the size of asymmetry increases from short run to long run and then takes its new equilibrium level in the last quarter of 2012. To sum up, the significant long run asymmetry (reaction asymmetry) and short run asymmetry (impact asymmetry) of oil price shocks to stock market index for the proposed model are recognized.

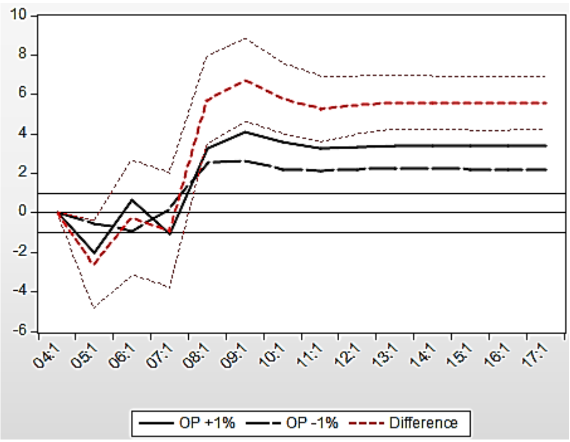

Figure 3: NARDL Multiplier Graph of Positive & Negative Changes in Oil Price

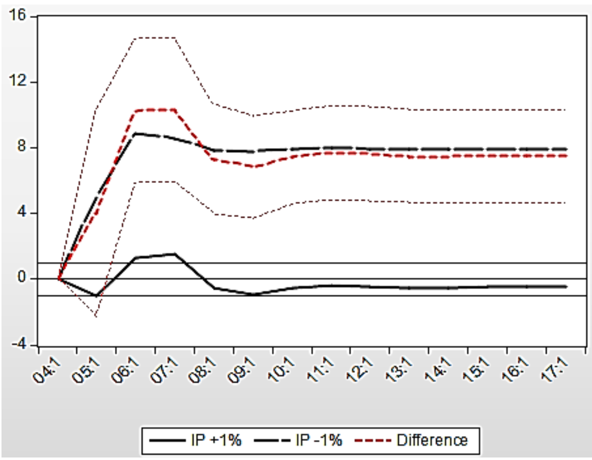

Figure 4: NARDL Multiplier Graph of Positive & Negative Changes in Industrial Production)

Based on figure 4, through one of the indirect transmission channels of oil price shocks to stock market, We detect an asymmetric response of stock market index to positive and negative changes in industrial production. Clearly, the asymmetric reaction of stock market index to positive and negative changes in industrial production takes place in the 2th quarter of 2005 and the 3th quarter of 2006, respectively. The asymmetric responses take their new equilibrium levels for the positive changes in industrial production in the 3th quarter of 2011 with the multiplier 0.45, while We detect the first quarter of 2012 for the negative changes in suggested variable with the multiplier 7.95, that is another implication for the existence of asymmetry between dependent and independent variables. The results also show that the responses to both increases and decreases of industrial production experience mixed nonlinear pattern with notable negatively response of the stock market index to both positive and negative shocks of industrial production in the long run. Moreover, the reaction of stock market index is more sensitive to the negative changes in industrial production than the positive ones. We can also detect that the size of asymmetry increases and then reaches to its new equilibrium level in the last quarter of 2012. To sum up, the significant long run and short run asymmetry among mentioned variables are recognized.

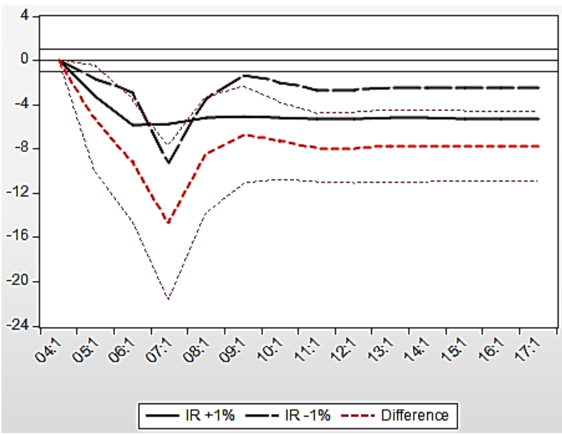

Figure 5: NARDL Multiplier Graph of Positive & Negative Changes in Lending Rate

Figure 5 indicates the dynamic effects for the second indirect transmission channel of oil price shock to stock market. In accordance with figure 5, the asymmetric responses of stock market index to both positive and negative changes in lending rate happen in the third quarter of 2005. It is notable that the reaction of stock market index to the positive changes in lending rate is absorbed in the first quarter of 2012 with the multiplier 5.16 to reach an equilibrium state, whereas it takes place in the last quarter of 2012 for the negative ones with the multiplier 2.4. We also recognize that the size of suggested asymmetry rises, and then falls to be at its new equilibrium level in the last quarter of 2013. Moreover, the stock market index is more sensitive to the negative changes in lending rate for the most length of the period. To sum up, the significant short run and long run asymmetric response of stock market index to both increases and decreases of lending rate can be recognized.

The empirical results discussed above have significant implications for financial participants, economic and financial analysts, political decision-makers and the government as well. In the first place, We note that the stock market index is highly sensitive to positive and negative shocks occurring in the oil price, industrial production and lending rate. It is apparent that the stock market index reacts to changes in the lending rate. However, Iran as one of the main net oil-exporting countries in the world is significantly dependent on its oil revenues and has a high (Oil Revenue)/(GNP) ratio leading to significant impacts of oil price shocks on the stock market index. Because the abrupt changes in the oil price are transmitted to the stock market through industrial production and lending rate as indirect transmission channels, this country adjusts the policy on oil reserves to smoothen the impact on the stock market index. The adjustment process also involves the central bank adjusting its policies to address the inflation rate induced by oil prices because oil price acts as an inflationary factor. Moreover, the positive and negative shocks in the oil price effect become absorbed and recompensed by the loss and gain induced by this adjustment of the rate of lending and borrowing with all economic agents. Furthermore, the impact of changes in oil prices on industrial production is neutralized by the effect of adjustment of the lending rate. In addition, the asymmetric response of the stock market index to direct and indirect transmission channels of oil price shocks takes place approximately from the 6th quarter of the period for some considered shocks to the 11th quarter for the others and follows a gradual stabilization process. Finally, the short-run and long-run coefficient sign of explanatory variables may reflect the nature and characteristics of the stock market in Iran.

6. Conclusions

This paper investigates the dynamic asymmetric response of the stock market index to the oil price, industrial production and lending rate in Iran. The short-run and long-run asymmetries in the relation are estimated using the NARDL model with quarterly data from 1991 to 2017. The results indicate an asymmetric short-run and long-run impact of oil price, industrial production and lending rate on the stock market index. Overall, the findings serve as confirmation that the stock market index is significantly related in a nonlinear way to macroeconomic fundamentals, such as oil price, industrial production, and lending rate. Specifically, the stock market index in both the short-run and long-run is more sensitive to positive changes in oil prices than the negative ones. The results also show that the stock market index reacts positively (negatively) in response to increasing (decreasing) short-run and long-run oil price shocks. Moreover, in both short-run and long-run, the positive changes in lending rate are more effective on the stock market index than the negative ones within indirect and direct relationship respectively, whereas the negative shocks of industrial production through indirect relationship have a greater impact on the stock market index than the positive ones. Furthermore, the response of the stock market index is highly sensitive to whether the changes in macroeconomic variables would be positive or negative due to economic and financial crises, geopolitical tensions and structural changes in the business cycle. In particular, the speed of response and the time required to reach a new equilibrium state are sensitive to the direction of changes in the macroeconomic fundamentals. Consequently, the findings substantially help financial participants, energy policy-makers and the government to adjust their respective strategies and adopt policies that are more efficient in order to smooth the negative impacts of unexpected events.

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