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Determining the Functional Form of Relationships between Oil Prices and Macroeconomic Variables: The Case of Mexico, Indonesia, South Korea, Turkey Countries

Ebru Caglayan Akay[1], Sinem Guler Kangalli Uyar[2*]

[1]Department of Econometrics, Faculty of Economics, Marmara University, Goztepe Campus, Kadıkoy, İstanbul, Turkey,
[2]Department of Econometrics, Faculty of Economics and Administrative Sciences, Pamukkale University, Kınıklı Campus, Denizli, Turkey. *Email: skangalli@pau.edu.tr

ABSTRACT

The aim of this study is to investigate that how economic conditions change when crude oil shocks occured in 1980-2013 for Mexico, Indonesia, South Korea, Turkey (MIST) countries. Another objective of the study is to determine accurately the functional forms of the relationships between oil prices and macroeconomic variables. For this aim, the relationships between crude oil price and macroeconomic variables were estimated by using additive model being a non-parametric model. In order to make comparisons, estimation results of the ordinary least squares model being parametric were also given. The F-test statistics showed that relationships between crude oil price and macroeconomic variables were explained by non-parametric models better than parametric models. Teraesvirta et al. Neural Network test (1993) shows also that oil price shocks can cause to be symmetric effects on macroeconomic variables while asymmetric effects on some macroeconomic variables.

Keywords: Crude Oil Price, Macroeconomic Variables, Partial Response Functions
JEL Classifications: C53, C14, Q43, Q41

1. INTRODUCTION

Petroleum, as it was in the last century, is the most significant raw material in the twenty first century. The significance of petroleum does not only derive from the fact that it is an energy resource; petroleum is also an indispensable main input in the industry due to the widespread use of its derivatives. By-products of petroleum with fuel properties obtained as a result of refining process, as well as its by-products without fuel properties carry a great importance for the industries. One of the most significant results of globalization tendency in the world is the increasing need for transportation and logistic services. Furthermore, the increasing industrialization in China and the country's move to become the world's manufacturing center fueled the demand.

The first among the reasons that sets oil market from the other commodity markets is the fact that petroleum is a non-renewable resource. Known oil reserves indicate that the reserves could deplete by the end of the 21st century. Thus, every drilled barrel of petroleum means that the oil reserves decreased a little further. As the oil is drilled out of the soil, subterranean reserves decrease, which in turn creates a scarcity premium effect on crude oil prices.

Increasing oil demand requires supply. Otherwise, due to high demand, oil prices would increase. However, increasing oil production would result in the decrease of known underground oil reserves, which would mean in turn that oil would not be supplied sufficiently in the future. In other words, oil prices would increase today if the supply is low today, they would increase in the future if the supply is high today. Therefore, it could be argued that oil markets are not only defined by the supply and demand of today. Paradoxically, as the oil supply increases, the upward pressures on oil prices increase as well.

One of the main factors behind the increase in oil prices during the recent years is the fact that oil markets became vulnerable to speculations, parallel to the increasing demand after the introduction of new oil market mechanisms in 1986. In other words, although the physical supply figures did not change, oil prices could increase due to speculative reasons.

Increase in oil prices affect the global economy significantly. The biggest danger that increasing oil prices could create for the global economy is the cost-push inflation. With the cost-push inflation, growth rate of the global economy would fall, unemployment would increase, capacity utilization would decrease and inflation would rise. Under these circumstances, all economic balances would have to be redressed again and most probably in different forms (Yetkiner and Berk, 2008).

National economies, on the other hand, could be affected by the variations in crude oil prices through different channels. One of the initial effects is supply-side effect. Based on this, and especially for oil importing countries, an increase in oil prices would decrease the input amounts in manufacturing, which would cause a decrease in potential output amounts. As a result, the increase in production costs would slow the output growth and productivity down (Burbridge and Harrison, 1984; Abel and Bernanke, 2001; Cunado and Perez de Gracia, 2003).

Second, increase in oil prices could deteriorate commerce in countries that import oil, because an increase in prices would cause an income transfer from oil importing countries to the oil exporting countries and as a result of this income transfer, purchasing power of households and corporations in oil importing countries would decrease (Lescaroux and Mignon, 2008; Blanchard and Gali, 2010).

Third, the increase in oil prices could cause a real balance effect. According to this, an increase in oil prices would also cause an increase in money demand. And when the monetary policy makers could not balance the increase in money demand with an increase in money supply, interest rates would rise and economic growth would slow down (Brown and Yücel, 2002; Mork, 1994).

Fourth, the increase in oil prices could lead to inflation and indirectly could change price-wage cycles (Kahn and Hampton, 1990; Cunado and Pe´rez de Gracia, 2005; Farzanegan and Markwardt, 2009; Alvarez et al., 2011).

Fifth, the increase in oil prices could have negative effects on consumption, investments, and equity prices. Consumption would be affected by this increase in price, since it has a positive relationship with expendable income, investments would be affected from the increase in oil prices due to increasing corporate costs (Masih et al., 2011; Gomez-Loscos et al., 2012; Rafiq et al., 2009).

Finally, if the increase in oil prices is sustained, both the change in production structure and unemployment would increase (Mellquist and Femermo, 2007; Gunsel and Soytas, 2010). As a result, increase in oil prices would decrease the profitability in oil-intensive industries and the corporations would generate and adopt new production methods that utilize less oil input. In the long-term, this change would result in redistribution of labor and capital in industries that could affect the unemployment. As a result of these factors, changes in oil prices could have effects on economic activities. Thus, oil price is one of the important indicators of global and national economic performances and the higher and long standing the increase in oil prices, its effects are greater on macroeconomics (Lardic and Mignon, 2008).

There are several studies in the literature that analyzed the relationships between oil prices and macroeconomic variables. In the present study, the relationships between oil prices and various macroeconomic variables in Mexico, Indonesia, South Korea, Turkey (MIST) countries were scrutinized. MIST countries include oil importing countries of Indonesia, South Korea and Turkey and an oil exporting country, Mexico. The macroeconomic variables that were scrutinized in the study for their relationship with oil prices were gross domestic product (GDP), consumer price index (CPI), real interest rate and real exchange rate.

MIST are defined as countries that are expected to influence the world economy in the future, having markets with a new growth potential. MIST economies carry similar characteristics that could attract the attention of investors. Primarily, MIST economies contribute more than 1% to the nominal gross global product. These are fast-growth economies which have a relatively stable economic growth. Growing population and the purchasing power of the population create a significant potential for the domestic markets of these countries. Furthermore, since inflation is relatively under good control in these countries and they are G20 member countries, it is expected that they would exhibit a high growth rate in the next 20-30 years (Pao et al., 2014).

The objective of the present study is to examine how the economic conditions in these countries that could have a significant investment potential are affected by the shocks in oil prices for the 1980-2013 period. Another objective of the study is to determine accurately the relationship between oil prices and macroeconomic variables.

Assuming linearity when the relationship between X and Y is actually non-linear can cause to be misspecification problem. In this case, an analyst might conclude that there is no relationship between X and Y, when the two are strongly related. In the absence of strong theory for the functional form, the best way can be estimation of the functional form from data. The additive model does not make any apriori assumption about the functional form can be the solution.

Accordingly in case the relationships between macroeconomic variables and oil prices are assumed to be linear but non-linear in reality, results could reflect that there is no relationship between the variables. To obtain reliable results by identifying the functional form of the relationships between the variables, non-parametric predictions were included in addition to parametric predictions in the current study.

2. LITERATURE

Studies that scrutinize the relationships between crude oil prices and various macroeconomic variables using different methods occupy a significant place in the literature. The effects of the variations in oil prices on economic activities were examined for both developed country economies and emerging markets in the literature. As indicated by Lescaroux and Mignon (2008), Lardic and Mignon (2006), Jones et al. (2004) and Brown and Yücel (2002), variations in oil prices could have significant effects on national economic activities through various channels.

One of the fundamental studies that examined these effects empirically was the study by Hamilton (1983). Using quarterly data for the 1948-1980 period, Hamilton (1983) investigated the effect of oil prices on the US economy using the vector autoregression (VAR) model. Hamilton indicated that USA GDP decreased 4% between 1960 and 1972 before the first oil crisis and 2.4% in the 1973-1981 period, and concluded that the shock that occurred in oil prices especially before the first oil crisis affected GDP negatively with a delay of 3-4. Hamilton divided the 1948-1980 period into two sub-periods of 1984-1972 and 1973-1980 and found a negative and statistically significant relationship between oil prices and domestic income.

Burbridge and Harrison (1984) predicted the effects of oil prices on macroeconomic variables in five developed OECD countries using monthly data for 1973-1982 period and with multi-variable VAR model. Burbridge and Harrison found that variations in oil prices had a negative effect on domestic income for the USA, the UK, Canada and Germany, and stressed that this negative effect was higher in Japan when compared to the other countries in the study.

Hamilton (2003) defined the positive difference between oil price level and maximum oil price during the last three quarters as "net oil price increase," contributing to the literature. By inclusion of this definition in the VAR model set up for the USA economy, a strong relationship between the oil prices and real GDP was established.

Aslan et al. (2014) investigate the linkage between the banking development and energy consumption for a panel of seven Middle Eastern countries using panel cointegration and causality techniques over the period 1980-2011. Panel cointegration results show a long-run relationship between energy consumption, income, energy prices and banking sector development indicators. Fully modified ordinary least squares results reveal that all banking sector indicators affect energy demand positively in the long-run and the impact range falls between 0.169 and 0.396. In terms of causality, there is evidence of a one-way short-run relationship from banking expansion to energy consumption while long-run dynamics indicate a bi-directional feedback relationship.

Apergis et al. (2015) investigated the dynamic relationship between oil prices and growth across the US States using a panel data framework for 1973-2013 and 1948Q1-2013Q4 periods. They concluded that the long-run coefficients are found to be statistically significant across all empirical models, with positive oil prices reducing output, while negative oil prices increasing output by applying Hatemi-J cointegration test. Moreover, they found evidence of both short- and long-run bidirectional causality between aggregate oil prices and output. However, there is evidence of unidirectional causality both from positive and negative oil prices to output based on annual data. The quarterly data generated slightly different result, indicating both long- and short-run bidirectional causality between positive and negative oil prices and output.

A significant portion of conducted studies were based on the USA economy and only in the second half of 1990's, studies on other national economies demonstrated an increase.

Cunado and Pe´rez de Gracia (2003) investigated the effects of oil price shocks on GDP and CPI in Asian countries for 1975Q1-2002Q2 period using Granger causality analysis. Results demonstrated that oil prices had significant effects on GDP and CPI. Furthermore, it was found out that there was asymmetrical relationships between oil prices and GDP and CPI.

Lardic and Mignon (2006) examined long-term relationship between oil prices and GDP for the USA economy, G-7 countries, European and Eurozone economies in 1970Q1-2004Q3 period. They have utilized the asymmetric cointegration approach considering the asymmetrical relationship between the two variables. Results demonstrated that there was an asymmetric cointegration relationship between the oil prices and GDP.

Cologni and Manera (2005) investigated long-term and short-term relationships between oil prices and inflation, money demand, foreign exchange rates and interest rates for G-7 countries in the 1980Q1-2003Q4 period using structural cointegrated VAR model. The results of the study demonstrated that the oil price shocks were effective on inflation rate and an increase in oil prices increase the inflation rate for G-7 countries except Japan and the UK. Increases in the inflation rate cause an increase in interest rates. Furthermore, simulations showed that a significant part of the total effect of the 1990 oil price shock on the economy was caused by the monetary policy reaction function for the US economy.

Lescaroux and Mignon (2008) analyzed the relationship between oil prices and macroeconomic (GDP, CPI, unemployment rate) variables and financial rates (equity prices) for OPEC member countries, Eurozone members and 12 oil exporters and 8 oil importers in 1960-2005 period. They utilized Granger causality analysis and cointegration analysis to analyze short- and long-term relationships between the variables. Granger causality results showed that there was an effect from oil prices towards other variables. However, one of the most interesting results was the causality relationship from oil prices towards the equity prices, especially for oil exporting countries. In long-term analyses, it was observed that most of the long-term relationships were related to GDP, unemployment rate and equity prices and GDP and oil prices moved together in the long-term for 12 oil importing countries. In the long-term, the relationships between oil prices and unemployment reates and equity prices were obtained for non-OPEC member countries. As a result, a strong relationship between oil prices and equity prices was obtained, especially in the short-term, and it was also identified that there were significant relationships between oil prices and macroeconomic variables.

Tang et al. (2010) scrutinized the effects of oil price shocks on Chinese economy between June 1998 and August 2008 using structural VAR model. Results showed that increase in oil prices affected the output and investments negatively, on the other hand affected inflation and interest rates positively. Furthermore, it was expressed that its effects lasted longer on the real economy despite Chinese price control policies when compared to prices and monetary varaibles.

Zhang et al. (2015) proposed a novel hybrid method to forecast crude oil prices. Since the complexity of international crude oil price movement and the uncertainty of crude oil price forecasting results, they propose a new hybrid method for crude oil price forecasting, which considers both the non-linearity and time-varying dynamics of crude oil price movement. Consequently, they found out that the newly proposed hybrid method has excellent forecasting performance for crude oil prices, regardless of the influence of random sample selection, sample frequency or sample structural breaks, which fully verify its good robustness and reliability. Additionally, the comparison of the new method and previously popular forecasting methods shows that the new hybrid method proves superior in crude oil price forecasting.

Zhang and Zhang (2015) explored the price regimes of Brent and WTI after the financial crisis. Then they analyzed the causes of the abnormal spreads between the two benchmark crude oil prices based on the statistical observations of their typical regime differences. The results show that there are three main regimes in both Brent and WTI crude oil price returns, i.e. sharply downward, slightly downward and sharply upward regimes for Brent whilst sharply downward, relatively stable and sharply upward regimes for WTI. Meanwhile, the typical price regimes of Brent and WTI are the sharply upward and relatively stable regimes after the financial crisis, respectively. Besides, their different movement regimes in recent years are mainly attributed to their different market fundamental situations and the dynamics in crude oil markets, which also lead to the occurrence of their abnormal price spreads.

Zhang and Wang (2015) investigated the price bubbles and their evolving process by using Markov regime switching model. Empirical results indicate that the fundamental price of WTI crude oil appears relatively more stable than that of the market-trading price, which verifies the existence of oil price bubbles during the sample period. Besides, by allowing the WTI crude oil price bubble process to switch between two regimes according to a first-order Markov chain, they are able to statistically discriminate upheaval from stable states in the crude oil price bubble process; and in most of time, the stable state dominates the WTI crude oil price bubbles while the upheaval state usually proves short-lived and accompanies unexpected market events.

Rafiq et al. (2016) investigated the effects of oil price shocks on three measures of oil exporters' and oil importers' external balances: Total trade balance, oil trade balance and non-oil trade balance for 1981-2013 period. They employed three second-generation heterogeneous linear panel models and one recently developed non-linear panel estimation technique that allows for cross-sectional dependence. They found evidence of an increase in oil prices leads to an improved real oil trade balance, although it is detrimental to non-oil and total trade balances. A decline in oil prices has a negative impact on both total and real oil trade balances resulting from increased oil imports in emerging economies.

In addition to studies that demonstrated significant effects of oil price shocks on macroeconomic variables, certain researchers reported that variations in oil prices were not a major cause of economic fluctuations.

Blanchard and Gali (2010) stressed that oil prices were not a significant reason for economic fluctuations during the last decade. According to Blanchard and Gali (2010), the effects of oil price shocks on inflation and economic activities were reduced due to reasons such as good luck (negative shocks not occurring simultaneously), decrease in the production share of oil, more flexible labor markets and the developments in monetary policy administration.

On the other hand, Segal (2011) searched for an answer to the question why the global economy did not slow down during mid-2000's even though oil prices were quite high in his study. According to Segal (2011), oil prices were never as effective on the world economy as it was perceived. On the other hand, oil prices did not slow down growth, because crude oil prices never exceeded core inflation as a result of contractionary monetary policies against positive oil price shocks.

Certain studies that scrutinized the relationships between oil prices and macroeconomic variables found that there were asymmetrical relationships between oil prices and macroeconomic variables. Among these, the most impressive studies were those conducted by Mork (1989), Hamilton (1996) and Lee et al. (1995). Results of those studies demonstrated that the effect size of the increase in oil prices on macroeconomic variables was greater than the effect size of the increase in oil prices on the microeconomic variables.

Finally, Huang et al. (2005) investigated the effects of the change in oil prices on economic activities in 1970-2002 period for the economies of USA, Canada and Japan using multi-variable threshold model. The most significant finding of this study was, while in two-regime model the responses of economic activities to oil price shocks were limited in the first regime, in the second regime where oil price variations surpass the threshold level, these responses could be observed more clearly.

3. DATA AND METHODOLOGY

In this study, the effect of changes in crude oil prices on macroeconomic variables will be investigated for MIST countries in 1980-2013 period.

There are direct and indirect effects of the crude oil prices on any number of macroeconomic variables. However there is no consensus about which macroeconomic variables will be chosen. Among reasons of this situation, country-specific economic conditions (oil exporter or importer), viewpoints of researchers in their studies, sample choice and different methodologies can be shown. Gross domestic product (GDP), consumer price index (CPI), money supply (MONEY), real exchange rate (EXCHANGE.RATE), real interest rate (INTEREST.RATE) and unemployment rate (UNEMPLOYMENT) were determined as macroeconomic variables in the study. The data set belongs to countries' macroeconomic variables was obtained from World Bank and International Monetary Fund, the crude oil prices from Energy Information Agency.

3.1. Generalized Additive Model

In considerable part of the studies which were examined that relationships between oil price and macroeconomic variables, these relationships are not linear and there are asymmetric relationships. In other words when a positive shock occured in oil prices, their effect size on macroeconomic variables can be more different (higher or lower) than when a negative shock occured in oil prices. Furthermore when the change in the crude oil prices exceeded a particular threshold or did not exceed, the response magnitude of macroeconomic variables can be different. When this kind of asymmetric relationships exist, models do not make any assumption about the functional form of the relationships instead of models assuming linear relationships can be preferred. In order to examine non-linear relationships, generalized additive model which does not make assumption about the functional form can be used.

In the linear regression, dependent variable is modelled as a function of independent variables.

$$E(y|x_1, x_2,\ldots, x_k) = \alpha + \beta_1 x_1 + \beta_1 x_2 + \ldots + \beta_k x_k \quad (1)$$

The mean value of dependent variable is total of seperate terms for each independent variable in the additive model. However, it is assumed that these terms are mostly the smooth functions of x's.

$$E(y|x_1, x_2,\ldots, x_k) = \alpha + m_1(x_1) + m_2(x_2) + \ldots + m_k(x_k) \quad (2)$$

Since the additive model ignore the interactions between x's, it is more restricted than classic non-parametric regression model but more flexible than standard linear regression model. There can exist a relationship between explanatory variables, even that additive models ignore the relationships between explanatory variables. In this situation, this relationship should be considered in the model estimation. For this purpose, partial residuals can be utilized obtained from partial regressions (Fox, 2000).

If the function of only one explanatory variable is known and the others are not known, the known values are subtracted from the dependent variable and the effect of unknown function on the dependent variable is obtained. The function value of differenced dependent variable is smoothed to the function of unknown variable and thus the function of unknown variable is obtained.

$$y_i = \beta_0 + m_1(x_{i1}) + m_2(x_{i2}) + \ldots + m_k(x_{ik}) + \varepsilon_i \qquad i = 1,2,\ldots,n \quad (3)$$

x_i's are independent from the error terms for additive model established in Equation (3).

$E(\varepsilon) = 0$ and $\mathrm{Var}(\varepsilon) = \sigma^2$

If $m_1(x_{i1})$ is an unknown function of the independent variable x_{i1} and the others' functions are known, the known values are subtracted from the dependent variable and the effect of unknown function on the dependent variable is obtained such as Equation (4). As the result of smoothing of e_{i1} to x_{i1}, the estimation of $\beta_0 + m_1(x_{i1})$ is obtained. However, the estimation of intercept coefficient is not important because $m_1(x_{i1})$ includes the intercept coefficient.

$$e_{i1} = yi - m_2(x_{i2}) - \ldots - m_k(x_{ik}) = \beta_0 + m_1(x_{i1}) \quad (4)$$

The intercept equals to unconditional mean of the dependent variable under $\sum_{i=1}^{n} m_k(x_{ik}) = 0$ assumption, that is $\beta_0 = \bar{y}$.

However, the function of only one variable is unknown is not a realistic assumption in practice. Thus, it needs to be all operations provide all estimations of regression functions. Accordingly, the model established in Equation (5) is estimated by ordinary least square method and $\beta_0 = \bar{y}$ accepted as.

$$yi - \bar{y} = \hat{\beta}_1(x_{i1} - \bar{x}_1) + \hat{\beta}_2(x_{i2} - \bar{x}_2) + \ldots + \hat{\beta}_k(x_{ik} - \bar{x}_k) + \varepsilon_i \quad (5)$$

The first estimations of the regression function such as in Equation (6) are obtained by estimating $\hat{\beta}$'s in Equation (5).

$$\hat{m}_1^{(0)}(x_{i1}) = \beta_1(x_{i1} - \bar{x}_1)$$
$$\hat{m}_2^{(0)}(x_{i2}) = \beta_2(x_{i2} - \bar{x}_2)$$
$$\vdots$$
$$\hat{m}_k^{(0)}(x_{ik}) = \beta_k(x_{ik} - \bar{x}_k) \quad (6)$$

Here the superscripts for $m(.)$ functions are used to indicate the order of operations. The expression in Equation (7) is obtained for m_1 estimation if ε_i left alone in Equation (5).

$$\varepsilon_i = y_i - \bar{y} - \hat{\beta}_1(x_{i1} - \bar{x}_1) - \hat{\beta}_2(x_{i2} - \bar{x}_2) - \ldots - \hat{\beta}_k(x_{ik} - \bar{x}_k) \quad (7)$$

The operations in Equations (8) and (9) are applied to obtain m_1 estimation.

$$\varepsilon_i + \hat{\beta}_1(x_{i1} - \bar{x}_1) = yi - \bar{y} - \hat{\beta}_2(x_{i2} - \bar{x}_2) - \ldots - \hat{\beta}_k(x_{ik} - \bar{x}_k) = \varepsilon_{i1} \quad (8)$$

$$\varepsilon^{(1)}{}_{i1} = \varepsilon_i + \hat{\beta}_1(x_{i1} - \bar{x}_1) \quad (9)$$

The new estimation of m_1 which is $\hat{m}_1^{(1)}$ is obtained by smoothing of $\varepsilon^{(1)}{}_{i1}$ to x_1 in Equation (9). The same operations are repeated for $x_2,\ldots x_k$ and $\hat{m}_2^{(1)},\ldots,\hat{m}_k^{(1)}$ estimations are obtained. After this process was completed for all variables, second estimations of regression functions, $\hat{m}_2^{(2)},\ldots,\hat{m}_k^{(2)}$, are obtained by using partial residuals (Caglayan, 2012). This iterative process will be applied until partial regression functions stabilized is named as Backfitting

Algorithm (Fox, 2000). In other words, getting estimations of non-parametric functions by smoothing of partial residuals to variables in the model is called as backfitting algorithm. Spline or Loess smoothers can be used for smoothing operation. However, many softwares use splines in selection step of smoothing parameter of backfitting algorithm.

Accordingly, the solution of additive model based on spline adjustment in all function space, $m_j, j = 1,2,\ldots,p$, the minimization problem of generalized penalized sum square residuals in Equation (10) as considered:

$$\sum_{i=1}^{n}\left\{y_i - \sum_{j=1}^{p} m_j(x_{ij})\right\}^2 + \sum_{j=1}^{p}\lambda_j \int m_j''(x)^2\,dx \tag{10}$$

Each function in the second term of the expression established in Equation (10) is depend on selected smoothing parameter indicated as λ_j.

The generalized cross validated criterion (GCV) can be used in selection of optimal smoothing parameter. Optimal smoothing parameter is the smoothing parameter that minimize this criterion. The GCV criterion for additive model can be indicated as in Equation (11):

$$GCV(\lambda_1,\ldots,\lambda_p) = \frac{\sum_{i=1}^{n}\left\{y_i - \sum_{j=1}^{p}\hat{m}_{\lambda j}(x_{ij})\right\}^2}{n*\left(1 - trR(\lambda_1,\ldots\lambda_p)/n\right)^2} \tag{11}$$

Here $R(\lambda_1,\ldots \lambda p)$ indicates the matrix including smoothing parameters and $\hat{m}_{\lambda j}$ shows estimated partial regression functions.

3.2. Partial Response Functions

The additive models have many advantages that linear models have but additive models are more flexible. The one of the most important features of linear models is that regression coefficients can be interpreted directly. The estimation of regression coefficients will be sufficient if we know how the prediction will change when a change occured in any explanatory variable.

$$y = \alpha + \sum_{i=1}^{p} m_j(x_j) \tag{12}$$

The partial response functions, m_j, give information about that the prediction how will change when a change occured in any explanatory variable (Shalizi, 2013). m_j's are non-linear functions and $m_j(x_j)$ term corresponds to $\beta_j x_j$ in linear model. The partial response functions indicate that how the prediction will change as a change occured in the level of any explanatory variable.

4. FINDINGS

The relationships between crude oil prices and macoeconomic variables were estimated by parametric and non-parametric models to examine that how the MIST countries' economies will respond to positive shocks in crude oil prices for 1980-2013 period. Furthermore, non-linear relationships between crude oil prices and macroeconomic variables were observed by using partial response functions obtained from non-parametric model. When the crude oil prices increased, it was examined that how the macroeconomic variables respond to this. The relationships between each macroeconomic variable and crude oil prices were estimated seperately by using additive model. In each model, it was not made an apriori assumption related to functional forms and crude oil prices were added in non-parametric form into the model.

Table 2 includes parametric and non-parametric estimation results indicating the relationships between crude oil prices and macroeconomic variables for MIST countries in 1980-2013 period.

According to Table 2, parametric and non-parametric estimation results show that all variables are effected by the changes in crude oil prices except for GDP and INTEREST.RATE in Mexico. The F-test results indicate that whether there is a statistically significant difference or not between parametric model's and non-parametric model's residuals. Accordingly, the crude oil prices should be added non-parametrically into the model for the other variables apart from UNEMPLOYMENT variable.

For Indonesia, the parametric estimation results show that crude oil price shocks do not effect GDP, INTEREST.RATE and EXCHANGE.RATE variables but non-parametric estimation results show that only GDP variable were not effected by the changes in crude oil prices. The F-test results indicate that the crude

Table 1: Definition of variables

Variable name	Variable definition	Source
OIL	Crude oil price index (2005=100)	IMF (https://www.quandl.com/data/IMF/poılapsp_index)
GDP	Real gross domestic product	IMF (http://opendataforafrica.org/wiraszf/ imf-world-economic-outlook-weo-october-2015)
CPI	Consumer price index (2005=100)	World bank (https://www.quandl.com/collections/ economics/cpi-worldbank-by-country)
MONEY	Money supply (M1)	World Bank (https://www.quandl.com/collections/ economics/money-supply-bn-lcu-worldbank-by-country)
INTEREST.RATE	Real interest rate	World bank (https://www.quandl.com/collections/ economics/real-interest-rate-by-country)
UNEMPLOYMENT	Unemployment rate	World bank (http://opendataforafrica.org/wiraszf/ imf-world-economic-outlook-weo-october-2015)
EXCHANGE.RATE	Real exchange rate	IMF (http://opendataforafrica.org/wiraszf/ imf-world-economic-outlook-weo-october-2015)

IMF: International monetary fund, GDP: Gross domestic product, CPI: Consumer price index

Table 2: Parametric and non-parametric estimation results

Model	Mexico			Indonesia		
	Parametric (OLS)	Non-parametric (Additive)	F-test	Parametric (OLS)	Non-parametric (Additive)	F-test
Model 1: GDP = f(Oil)+ε	0.003	Figure 1, F-statistics: 0.067	-	0.012	Figure 1, F-statistics: 0.932	-
Model 2: CPI = f(Oil)+ε	0.541***	Figure 1, F-statistics: 41.67***	0.427***	0.574***	Figure 1, F-statistics: 89.83***	0.278***
Model 3: MONEY = f(Oil)+ε	1.26e+10***	Figure 1, F-statistics: 157***	1.558***	5.433e+12***	Figure 1, F- statistics: 89.96***	3.653*
Model 4: INTEREST. RATE = f(Oil)+ε	0.036	Figure 1, F-statistics: 0.638	-	−0.03371	Figure 1, F-statistics: 6.386***	8.392***
Model 5: UNEMPLOYMENT = f(Oil)+ε	0.008**	Figure 1, F-statistics: 3.804**	2.161	0.023***	Figure 1, F-statistics: 4.83***	4.883**
Model 6: EXCHANGE. RATE = f(Oil)+ε	0.0081***	Figure 1, F-statistics: 30.36***	1.164***	19.119	Figure 1, F-statistics: 98.61***	0.113***
	South Korea			Turkey		
Model 1: GDP = f(Oil)+ε	−0.027**	Figure 1, F-statistics: 2.999**	3.459***	0.006	Figure 1, F-statistics: 0.193	-
Model 2: CPI = f(Oil)+ε	−0.018	Figure 1, F-statistics: 1.799	-	0.695***	Figure 1, F-statistics: 143.4***	3.302***
Model 3: MONEY = f(Oil)+ε	2.75e+12***	Figure 1, F-statistics: 105.1***	5.185***	1.17e+09***	Figure 1, F-statistics: 65.77***	3.426**
Model 4: INTEREST. RATE = f(Oil)+ε	−0.021*	Figure 1, F-statistics: 3.478***	4.419***	0.085	Figure 1, F-statistics: 1.657	-
Model 5: UNEMPLOYMENT = f(Oil)+ε	−0.0003925	Figure 1, F-statistics: 0.012	-	0.014***	Figure 1, F-statistics: 5.28***	4.072***
Model 6: EXCHANGE. RATE = f(Oil)+ε	1.121	Figure 1, F-statistics: 6.966	-	0.006***	Figure 1, F-statistics: 32.8***	6.331***

*,**,*** Coefficient is statistically significant at the 1% level, 5% level and 10% level, respectively. The regression models which each macroeconomic variable is dependent variable and oil price is independent variable were estimated in parametric and nonparametric forms. Univariate parametric models were estimated by using OLS. Univarite nonparametric or additive models were estimated by using backfitting algorithm. OLS: Ordinary least square

oil prices should be added into the models as non-parametrically for all variables.

The parametric estimation results indicate that CPI, UNEMPLOYMENT and EXCHANGE.RATE are not effected by crude oil price shocks in South Korea. Furthermore, the crude oil prices should be added non-parametrically into the models for GDP, MONEY and INTEREST.RATE variables.

Both the parametric and non-parametric estimation results show that GDP and INTEREST.RATE variables are not effected by positive shocks in the crude oil prices in Turkey. The F test results indicate that the crude oil prices should be added non-parametrically into the models for CPI, MONEY, UNEMPLOYMENT and EXCHANGE.RATE variables.

The relationships between crude oil prices and subject variables can be observed by the graphs of partial response functions. The shaded regions in the graphs of partial response functions belong to additive model show that confidence levels for standard errors and dots show the actual partial residuals.

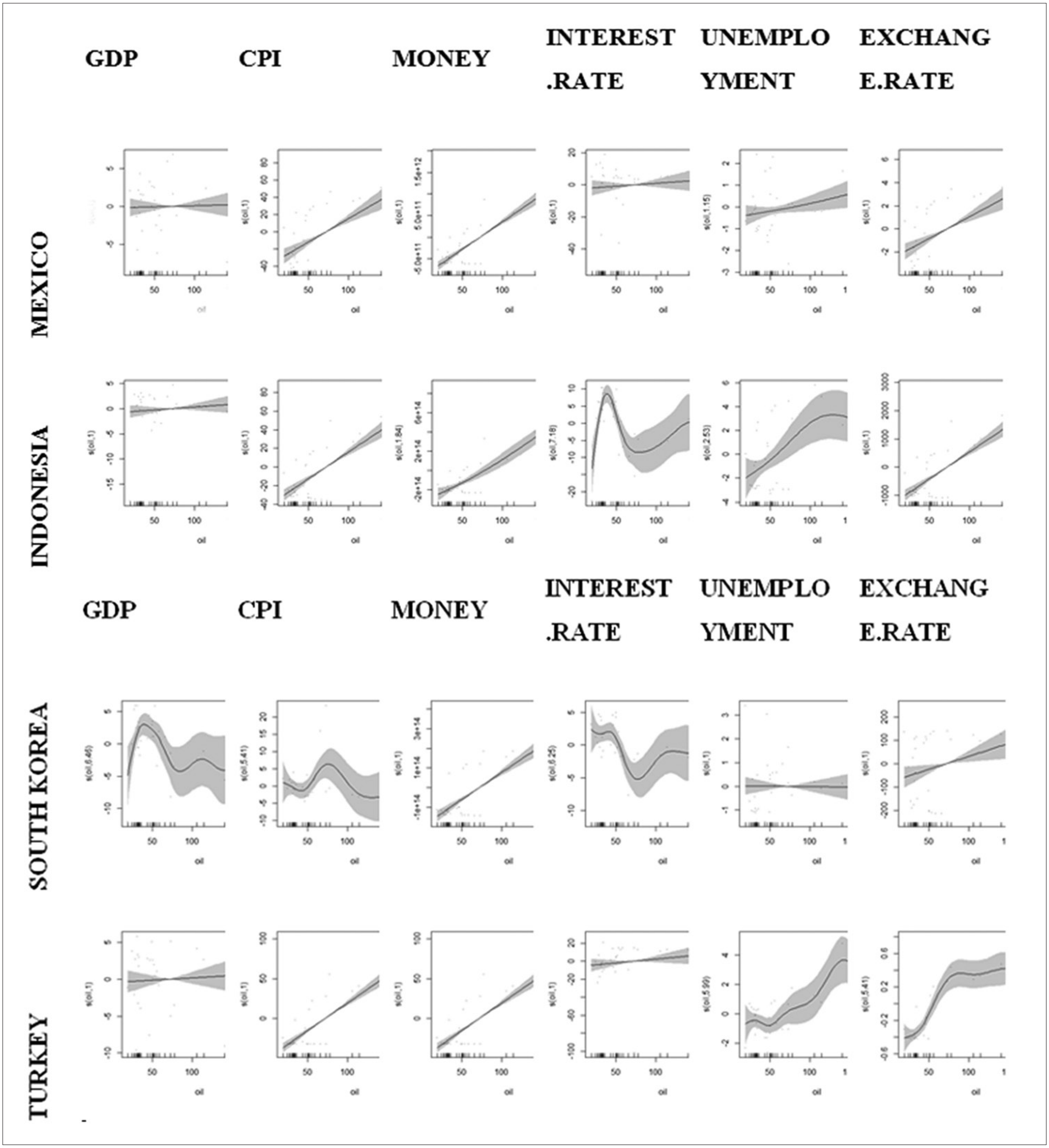
In additive model since each observation in the data set is determined as target observation in selection of smoothing parameter for non-parametric estimations, the number of models are estimated as much as number of observations in the data set. Consequently, 33 additive models were estimated and 33 estimated coefficients were obtained for each independent variable. Therefore, the estimated coefficients of the variables in additive model were demonstrated by figures in Figure 1.

The graphs of partial response functions in Figure 1 indicate that how the macroeconomic variables respond to crude oil price shocks in MIST countries.

Accordingly, GDP and INTEREST.RATE were not effected positive shocks in the crude oil prices for Mexican economy. Moreover, it was seen that there is a linear relationship between crude oil prices and CPI, MONEY, UNEMPLOYMENT and EXCHANGE.RATE variables and these variables move up quickly in response to positive shocks in crude oil prices. While GDP is not effected by crude oil price shocks, the others respond to shocks differently from each other for Mexican economy. It was observed that there are non-linear relationships between crude oil prices and INTEREST.RATE with together UNEMPLOYMENT while there are linear relationships between crude oil prices and CPI, MONEY and EXCHANGE.RATE.

For Indonesian economy, CPI, MONEY and EXCHANGE.RATE increase in response to positive shocks in crude oil prices. However

Figure 1: Partial response functions



the real interest rate achieved the maximum level which is about 9% when a positive shock occured in crude oil prices. After the increase in real interest rate achieved the maximum level, the real interest rate decreases rapidly when the crude oil price shocks continued. Afterwards, real interest rate increases while crude oil prices is increasing but the intensity of the response is not as high as at first. The unemployment increase rapidly in response to the increase in crude oil prices and then the unemployment achieves the maximum level when the crude oil prices per barrel achieved nearly 125$. After this level, the unemployment decreases when the crude oil prices continue increasing but the unemployment achieves a higher level with respect to old level. In other words, the increments in crude oil prices cause to be non-transitory increases on unemployment rate.

For South Korea, there is a non-linear relationship between crude oil prices and GDP. The GDP increases heavily in response to increase in the crude oil prices and achieve the maximum level when the crude oil price per barrel is about 50$. However, when GDP decreases rapidly as the crude oil prices continue to rise and then follows a fluctuating course. The MONEY increase linearly in response to positive shocks in the crude oil prices. It was observed that there is a non-linear relationship between crude oil prices and INTEREST.RATE. The real interest rate achieve the maximum level is about 4% as the crude oil price per barrel is nearly 50$ and real interest rate achieve the minimum level is nearly -5% by decreasing rapidly when the crude oil price per barrel is about 75$. When the crude oil price shocks go on increasing, real interest rate reach a plateau at a level of −1%.

For Turkey, GDP and INTEREST.RATE never response to increase in the crude oil prices and both of them reach a plateau around zero. Furthermore, these findings in Figure 1 correspond to the results in Table 2. There is a linear relationship between crude oil prices and CPI increase heavily when the crude oil prices go on increasing. Moreover it can be said that there is a relationship increasing exponentially between crude oil prices and MONEY. It can be observed that non-linear relationships between crude oil price and UNEMPLOYMENT together with EXCHANGE. RATE. The unemployment increase when the crude oil prices increase and achieve the maximum level as crude oil price per barrel is about 150$. After this level if crude oil prices go on increasing, unemployment decrease but continue at a higher level than the unemployment level at first. On the other words, positive shocks in the crude oil prices cause to be a persistent rise in the unemployment rate.

As a conclusion, it was observed that there are non-linear relationships between oil prices and some macroeconomic variables while there are linear relationships in MIST countries. To support this information obtained from partial response functions, Teraesvirta et al. Neural Network Test was applied also to investigate the stucture of relationships between oil prices and macroeconomic variables. Teraesvirta et al. Neural Network Test results was given in Table 3.

When the null hypothesis is rejected the model is said to suffer from neglected non-linearity, meaning that a non-linear model may provide better forecasts than those obtained with the linear model. According to test results, there are not any non-linear relationships between oil prices and macroeconomic variables for Mexico and this finding is consistent with the graphs of partial response functions. On the other hand, there is a non-linear relationship between oil prices and unemployment for Indonesia and the result supports the graph of partial response function. Moreover, there is a non-linear relationship between oil prices and real interest rate for South Korea. This finding provides some evidence for the graph of partial response function. Finally, there are non-linear relationships between oil prices and unemployment together with exchange rate for Turkey. These relationships were also observed as non-linear on the graphs of partial response functions. On Figure 1, the relationship between oil prices and interest rate for Indonesia seems to be non-linear but the non-linearity test does not support the graph of partial response function. The relationship between oil prices and GDP for South Korea seems also as non-linear on Figure 1 but the non-linearity test does not support this finding.

Table 3: Teraesvirta et al. Neural Network Test (1993)

Non-linearity test, Ki-kare values	Mexıco	Indonesıa	South Korea	Turkey
OIL and GDP	0.625	2.896	1.288	0.3156
OIL and MONEY	1.261	3.969	0.909	3.991
OIL and INTEREST.RATE	0.144	1.923	6.590**	0.144
OIL and UNEMPLOYMENT	1.380	7.241**	0.954	11.28***
OIL and EXCHANGE.RATE	1.408	0.862	1.933	7.748**
OIL and CPI	1.097	1.149	2.117	0.883

*,**,*** Coefficient is statistically significant at the 1% level, 5% level and 10% level, respectively., GDP: Gross domestic product, CPI: Consumer price index

To sum up, while some macroeconomic variables response to oil price shocks the others do not response to oil price shocks. The some macroeconomic variables affected by changes in oil prices are linearly related to oil prices. However, there are non-linear relationships between some macroeconomic variables and oil prices.

5. ROBUST ANALYSIS

The robust analysis can be utilized to compare between forecast performance of parametric and non-parametric model. There are many forecast criterions are used in order to make comparison between the forecast performance of different methods. The root mean squared error (RMSE) criterion is used most commonly among them. According to this approach, the forecast performance of the model having minimum RMSE criterion is higher relatively than the other model's forecast performance. However these results can be random so that it can be used modified Diebold-Mariano (M-DM) test[1] suggested by Harvey et al. (1997) to test whether there is a significant difference or not between RMSE values of two models. The null hypothesis of this test states that there is no statistically significant difference between the forecast performance of two models. The alternative hypothesis can be set as two-side and also one-side. The one-sided alternative hypothesis states that the forecast performance of parametric model is lower than non-parametric model's performance (Kanas et al., 2012).

The RMSE values and M-DM (1995) test results were given in Table 4 to make comparison about in-sample and out-of-sample forecast performance for parametric and non-parametric models. For in-sample and out-of-sample predictions, 1980-1999 period was determined in the estimation of parametric and non-parametric

1 The original DM statistic is defined as $DM = \bar{d}/\sqrt{\omega}$, where $\bar{d}$ is the average loss differential, $\bar{d} = (1/m)\sum_{j=1}^{m} d_j, d_j$ is the difference between the squared forecast errors of two competing models. For 1-step-ahead forecasts, ω is estimated using the variance of d_j. The DM statistic is asymptotically distributed as N(0,1). The modified DM statistic is defined as $M-DM = \left[\frac{T+1-2h+T^{-1}h(h-1)}{T}\right]^{1/2} * DM$ and follows the students t-distribution with (T−1) degrees of freedom.

Table 4: RMSE and DM (1995) test results

Countries	Mexico						Indonesia					
Variables	In-sample prediction			Out-of-sample prediction			In-sample prediction			Out-of-sample prediction		
	Parametric (RMSE)	Non-parametric (RMSE)	M-DM test	Parametric (RMSE)	Non-parametric (RMSE)	M-DM test	Parametric (RMSE)	Non-parametric (RMSE)	M-DM test	Parametric (RMSE)	Non-parametric (RMSE)	M-DM test
GDP	3.374	3.374	−0.722	2.646	2.646	−0.623	3.620	3.620	−0.735	0.520	0.223	−2.203**
CPI	25.396	25.396	−0.300	5.791	5.791	−0.021	18.345	18.345	−0.284	9.140	9.140	−0.005
MONEY	3057	3057	−0.948	2446	2431	−1.720	1.193e+14	1.139e+14	−1.266	1.215e+14	1.025e+14	1.784*
INTEREST.RATE	13.826	13.826	−0.292	0.829	0.512	−2.859**	7.024	4.049	−2.047**	2.684	1.053	−2.745**
UNEMPLOYMENT	1.182	1.176	−1.326	0.551	0.551	−0.341	2.543	2.279	−1.742*	1.452	0.989	−2.098*
EXCHANGE. RATE	2.049	2.049	−0.355	0.317	0.317	−1.427	583.470	583.470	−0.029	336.886	336.886	−0.006
	South Korea						Turkey					
GDP	3.664	2.800	−1.371	1.930	1.930	−1.218	4.301	4.301	−0.172	4.611	2.670	−1.797*
CPI	5.297	4.355	−1.044	0.792	0.792	−0.029	17.601	17.601	−0.751	12.639	10.680	−1.538
MONEY	8.135 +13	8.135e+13	−0.600	5.849e +13	5.849 +13	−0.004	2162	1829	−1.895*	2163	2514	−1.349
INTEREST.RATE	3.179	2.326	−1.529	1.271	1.271	−0.643	20.070	20.070	−0.365	6.034	6.034	−0.231
UNEMPLOYMENT	1.079	1.079	−1.150	0.295	0.295	−0.751	1.192	0.901	−1.518	1.489	1.137	−1.721
EXCHANGE. RATE	128.722	128.722	−0.688	15.657	15.657	−1.055	0.178	0.114	−2.325**	0.087	0.111	−1.793*

*,**,*** Coefficient is statistically significant at the 1% level, 5% level and 10% level, respectively. DM: Diebold-Mariano, GDP: Gross domestic product, CPI: Consumer price index, RMSE: Root mean squared error

models. On the basis of the estimated models over that period, the 1-step ahead out-of-sample forecasts were calculated from each model for 2000-2013.

Table 4 includes M-DM test results and RMSE values obtained from parametric and non-parametric models specified for MIST countries.

For Mexico, M-DM test results indicate that there is any difference in terms of forecast performance of parametric and non-parametric models apart from the models including interest rate variable. The forecast performance of non-parametric model including interest rate variable is better than parametric model's.

For Indonesia, M-DM test results show that the forecast performance of non-parametric models including interest rate and unemployment variables is higher for in-sample predictions. The forecast performance of non-parametric models including interest rate, unemployment and GDP is higher than the parametric model's. There are any differences between the forecast performance of parametric and non-parametric models for other variables.

For South Korea, M-DM test results show that there is any difference between the forecast performance of parametric and non-parametric models in terms of both in-sample and out-of-sample predictions.

Finally, M-DM test results for Turkey show that the forecast performance of non-parametric models including money supply and exchange rate variables is higher for in-sample predictions. The forecast performance of non-parametric models including GDP and exchange rate is higher than the parametric model's. There are any differences between the forecast performance of parametric and non-parametric models for other variables.

6. CONCLUSION

The oil is one of the most important energy sources as well as the fluctuations in the oil prices are considerable risky in terms of country economies. These fluctuations effect the country economies both importing and exporting oil. The oil price fluctuations have especially an important effect on macroeconomic variables such as CPI, GDP, unemployment, interest rate and real exchange rate. Moreover, unrestrainable increments in the oil prices can cause to be recession for countries importing oil by causing increase in consumer prices and cost inflation. On the other hand, there is an upside influence on the oil prices because of some reasons. If it is mentioned about these reasons, it can be said that oil is a non-renewable enegry source and its price is open to speculations. In addition to these reasons, it can be also said that increasing oil demand as the result of rising industrialization and being struggle for in the centre of world production in China causes upside effects on the oil prices.

In consideration of the oil fluctutaions' negative effects on country economies, the increments in the oil prices entail a risk in terms of both world and country economies.

Increasing in the oil prices can effect differently and directly or indirectly macroeconomic variables. There are many studies related to this issue in the literature and some of these studies indicate that oil prices effect considerably country economies and another group of these studies demonstrate that oil prices effect slightly or do not effect country economies. Furthermore, some of these studies show that there are non-linear or asymmetric relationships between oil prices and macroeconomic variables.

The asymmetric relationships between oil prices and macroeconomic variables express that oil prices in the event that whether excessing a threshold value or not can effect the macroeconomic variables differently. While the econometric methodology is very important in case of these non-linear relationships, implementing policies are quite important in terms of economic. In case of non-linear relationships, models assuming linear relationships can cause to be biased and inconsistent estimation results. On the other hand, obtaining information about that how oil prices effect macroeconomic variables before and after the threshold level is important in terms of policies to be implemented on the national economy. Although oil prices uncontrollable because of speculations in the oil prices, getting information about that oil prices effect mostly or less macroeconomic variables at which level can provide important policy implications in the sense of non-oil producing countries.

When the results obtained from study were evaluated, both parametric and non-parametric estimation results show that GDP and real interest rate are not effected by positive shocks in the oil prices for Mexico. It was observed that there are linear relationships between oil prices and other variables.

The parametric estimation results obtained for Indonesia indicate that gross domestice product, real interest rate and real exchange rate were not effected by increments in the oil prices but non-parametric estimation results show that the other variables were effected by increments in the oil prices except for GDP. The partial response functions obtained from non-parametric model indicate that GDP never effected by increasing in the oil prices and this increment causes that CPI, money supply and real exchange rate increase linearly but asymmetric effects on the unemployment and real interest rates. Another important result obtained from this study is that although parametric models show that some variables are not effected by oil price shocks, non-parametric models show that these variables are effected indeed by increasing in the oil prices. However these kind of effects can not be considered by parametric models because of non-linear relationships. To make a wrong assumption related to the functional forms of the relationships between variables can cause to be a misspecification error.

When the results were considered for South Korea, both parametric and non-parametric estimations demonstrate that CPI, unemployment and real exchange rate are not effected by increasing in the oil prices. In addition to this, the partial response functions indicate that there is a linear relationship between oil prices and money supply but asymmetric relationships between oil prices and GDP, real interest rate.

According to parametric and non-parametric relationships for Turkey, GDP and real interest rate are not influenced by positive oil price shocks. It is observed that while there are non-linear relationships between oil prices and money supply, unemployment and real exchange rate, a linear relationship between oil prices and CPI.

As a conclusion, some variables are related linearly and the others are related non-linearly in non-parametric analysis' for MIST countries. In this case, semiparametric or additive models including both of parametric and non-parametric variables can be used instead of parametric models having just parametric variables. Otherwise, the misspecification error can arise from the assumption of wrong functional form.

On the other hand, increasing in the oil prices is effective on macroeconomic variables in each country and functional forms between same variables differ greatly by country. Moreover, these results reveal that country specific dynamics make different the effects of positive oil shocks on macroeconomic variables even MIST countries resemble each other with regard to growth rates.

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