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# FACTORS AFFECTING OIL PRICES (1985-2014)

Issa S. Al Azri
issa.alazri@siu.edu

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(1985-2014)

by
Issa Al Azri

B.S., Sultan Qaboos University, 2013

A Research Paper
Submitted in Partial Fulfillment of the Requirements for the
Master of Science

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RESEARCH PAPER APPROVAL

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Approved by:

Dr. ZSolt Becsi

Graduate School
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AN ABSTRACT OF THE RESEARCH PAPER OF

ISSA AL AZRI, for the Master of Science degree in ECONOMICS, presented on JULY 27, 2016, at Southern Illinois University Carbondale.

TITLE: FACTORS AFFECTING OIL PRICES (1985-2014)

MAJOR PROFESSOR: Dr. ZSolt Becsi

This research paper examines the factors that affect crude oil prices from 1985 to 2014. These factors include: the demand and supply relationship, the critical political events by governments, oil inventories that are controlled by OPEC, emergency events, natural climate changes, alternative energy sources improvements, the exploration investments, the wars in Gulf countries area, the everyday change of dollar index, the oil procuration level, the world economy growth rate, crises and recessions, the developments in world economy, oil production, gas prices and gas production. There are three different models tested in this research paper, each one with different variables. We find that the most two factors, the oil production and the gas prices are significantly related to oil prices over the time frame examined.

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# CHAPTER 1

# INTRODUCTION

Crude oil is a natural resource that is considered the main energy resource for most countries in the world. It contains many different classes of chemical components which may or may not be related in their uses, structure and features. The daily usage of oil explains the importance of it as the revenue segment of exporting countries and the cost segment of importing countries. Also, it is considered the primary revenue for many exporting countries like KSA, Kuwait, Iraq, Oman and Iran. It forms the highest revenue for my home country's budget - Oman- each year.

The decline of oil prices since 2014 has affected the economy of exporting countries negatively creating more burdens on the financial earning to cover the cost of the budget. In March2015, my home country has approached these changes by deducting the salaries and the allowances of employees, pausing many projects, increasing the fuel prices and increasing the rate of unemployment. From that point, I have focused my research to be about the factors that lead to the changing of oil prices and how countries can anticipate the fluctuation before it takes place.

Oil prices is a topic that leads the everyday economic news. It is an updated topic which can influence governments in general and individuals specifically. I have chosen this topic among other topics for two main reasons. Firstly, it helps me prepare myself for my graduate studies dealing with financial and international economics and changes in crude oil prices, which is considered one of the most critical topics within international economics. Secondly, I have experienced the effect of changing crude oil prices since last year between two different countries which are my home country, Oman (exporting country), and my current resident country, the United States (importing country). This research paper will examine which are the factors that have affected crude oil prices during the last 30 years, specifically from 1985 to 2014. Many studies have been conducted on this topic in the last four decades.

Jian Chai (2011) defines the core factors that cause oil prices to fluctuate from one time to another. Oil prices are sensitive to the supply-demand relationships on the global market. There is a positive correlation between the market demand and oil prices and there is a negative correlation between the market supply and oil prices. The author starts his article by explaining the most important factors that cause oil prices to fluctuate.

According to the US Energy Information Administration’s data base, the first usage of the term “oil prices” occurred in the 19th century, to determine the first purchase price by the United States. The term did not change over time and it remains the same when referring to crude oil. The controversy about the changing of oil prices started recently due to the negative effects of these changes on the economies of exporting and importing countries. It also started due to the effect on the economies of developed countries and their people financials positions. The instability of oil prices has led many companies to see their projects to incur losses, and to shut down their operations.

Hossein Kavand (2011) defines the influence of changing in oil prices from year to year, “As Auty and Gelb (1986), and Conway and Gelb (1988) state, one could argue that there is a close relationship between oil price fluctuations and total productivity (TP) fluctuations in an oil-exporting country. As these scholars claim, most oil exporting countries experience expansion in their domestic investment, consumption and subsidies during periods of oil windfalls. A positive oil price change can substantially affect government oil revenues in an oil exporting and developing country, and because of the large public sector in these countries, government could encourage and subsidies the education sector. Especially over the short run, public sectors improve the productivity of their employees by investing in education and training".

There are other indicators that affect oil supply, such as world crude oil reserves, outputs, the oil system's decisions taken by the Organization of Petroleum Exporting Countries (OPEC), the costs of oil production, and the exploration investments in the exporting countries. All of these factors play important roles in determining oil prices on the market. The exploration investments in new fields in Oman two years ago have reduced the international oil prices for a while, because it increased the supply of oil on the market. Fluctuations can influence the expenditures of people and governments significantly in importing countries like the United States. Historically, the value of money – one million US dollars of today has not the same value as one million US dollars in the future – and the depreciation of the US dollar index have important effects on fluctuations in oil prices (Jian Chai, 2011).

Lingyu Yan (2012) discusses the factors that lead to oil price fluctuations, and the influence of these changes on most top countries in the world. In the article, the author presents oil price fluctuations in different historical periods, analyzes all the factors, and proposes some solutions in response to future changes. There are many factors behind oil price changes such as the imbalance between the supply and demand of international oil, the change of oil inventories, emergency events, and the instability of oil production in exporting countries.

# CHAPTER 2

# LITERATURE REVIEW

Zeybel Abidin, (2014), in “Are there really bubbles in oil prices?”, which is clarifying the bubbles and crashes periods for oil prices. There are four different periods. Two of the periods are before 2000 and the other two are after 2000. The focus of the article is most likely on the last two periods because the information is more helpful and updated to the reader. The article explains the varying reasons that lead to the bubbles and crashes in oil prices history, which can support the answers for my primary question, “Factors affecting oil prices”.

It explains the factors behind the bubbles that happened in the years 2008 and 2011. In general, the reasons behind these two bubbles are the high volume demands of oil, the changes in market of US housing and the changes in mortgages rates. At the same time, it introduces a new methodology and a formula to calculate these crashes and changes of oil prices in the previous mentioned years, and then shows the data analysis and the empirical results.

The second article is written by Jian Chai, (2011), in “Exploring the core factors and its dynamic effects on oil price: An application on path analysis and BVAR-TVP model”, defines the core factors that influence oil prices to fluctuate up or down from a time to other. Oil prices are more sensitive to the demand-supply relationships on the global market. There is a direct correlation relationship between the market demand and oil prices, but there is a reverse relationship between the market supply and oil prices.

There are many indicators that affect the demand of oil, such as the status of global economic development - more than unexpected growth can increase the prices, the change of economic structure in some developed countries and the improving of alternative energy sources.

Changing of global economic structure in 2008 financial crisis 'Great Recession', has led to impact and decrease the oil prices sharply.

The article suggests three models that can be used to evaluate the factors affecting the price of oil. The first model is called "Path-Analysis", based on a simple correlation analysis and the mechanism of it is depending on 21 variables factors, some of them are; the growth of world economy, the geopolitics, the exchange rate, the change of the seasonal climate, the alternative energy prices, inventory, the production cost, the OPEC oil production, the US dollar index, the net of oil imports to US and Euro zone, the oil consumption in the world, and other factors that could influence in direct or indirect on the oil price. The dependent variable is the oil prices.

The second model is called "Vector Auto Regression" (VAR) model, and it is almost similar to the first model except that, it can be used with some variables and there is no need to use all of them. In the same time, this model has many deficient, such as it does not consider the theory of economic and does not interpret that based on structure. Also, there are many important parameters need to be estimated.

The third article is written by Lingyu Yan (2012), in "Analysis of the International Oil Price Fluctuations and Its Influencing Factors", explains the factors that lead oil price fluctuations and how the changes on oil prices can influence the economic discussion in each country. In the article, the author presented many factors behind oil price changes such as the imbalance between the supply and demand of international oil, the change of oil inventories, emergencies events and instability of oil production be exporting countries. Also, he introduced one interesting factor which is about the critical political decisions and geopolitical instability in the world and how these reflect on the changes of international oil prices. The author explained all of these factors in detail and provided many different examples from the real situations.

In addition, he mentioned some general factors such as wars, political disturbances, terrorist attack incidents and natural climates. The method to find this article was by online searching from many different available articles and reading them in detail, then selecting the one with new factors. The writer of article did secondary research and he used more than 12 academic resources to support his information. In addition, the author believes that the prediction of oil prices may become more difficult and inaccurate, because of the diversity of the factors that cause the influence in oil prices. At the same time, he suggested that, countries should find other energy resources than oil as this considers finite resource in the land.

The fourth article written by is Franz Wirl (2007), in “Why do oil prices jump or fall?”, explains the theories of the zigzags in oil prices and how these prices react with competitive market conditions. The changes in market can be dynamic in every second, uncertainty about the consequences of facts and political decisions that influence the media. The writer focuses on the previous oil price fluctuations and the recent one after the 2000. Also, he mentions that the oil prices are in updated reaction about the capacity utilization of oil. He confirms that the increase in oil prices is created because the demand shock and demand uncertainty in the market.

On the other hand, he argues about politics motives and there is no clear or explanatory power. He explains all the factors behind the fluctuations in oil prices in detail and the consequences for these changes. Also, he uses different models and equations to explore the growth of demand and supply in historical manner. The author concludes that most significant of previous changes in oil prices are linked to political decisions in the world, but the recent one did not get influenced by that as the oil prices had already adapted their levels from previous experiences. He enforces that economic considerations are the primary reason for the recent oil changes.

Another source used for my research is written by James D. Hamilton (2011), which has clarified the historical oil events by stating that, “World oil consumption grew by more than 2% per year between 1994 and 1997. Moreover, if oil producers correctly anticipated the growth in petroleum demand from the newly industrialized countries, it would have paid them to hold off some production in 1995 in anticipation of higher prices to come. By this mechanism, the perceived future growth rate can affect the current price”. (James D. Hamilton, 2011)

Lutz Kilian (2011) explains how the current changes in oil prices are linked to the overall world economy. His research was between 2003 and 2008. He attributes the changes of oil prices in the period to the change in trading in oil markets, reduction of oil supplies and strong growth in the global economy. In the most part of the article, he explains these three factors in more detail and the competing interchangeable relationship between all of them. Also, he suggests that the United States oil production will decrease the effect of prices changes over the world because as it is increasing the production that will lead to reduce the demand of the global oil and therefore reducing oil prices fluctuations. (Lutz Kilian, 2011).

# CHAPTER 3

# DATA

Table (1) First Model Data

| Year | Oil Prices (USD/Barrels) | Oil production (Barrels per year) | Gas price (USD/Thousand Cubic Feet) | Gas production (Thousand Cubic feet per year) | Oil Proved Reserves (Barrels per year) | World Economy Annual Growth Rate of GDP |
|---|---|---|---|---|---|---|
| Yr | Oprice (Y) | Oprod | Gprice | Gprod | Oreserv | Wgrate |
| 1985 | 27.56 | 19,697,320,630 | 2.28 | 8,039,052,000 | 699,000,000,000 | 3.76 |
| 1986 | 14.43 | 20,558,848,380 | 1.76 | 8,509,172,000 | 700,000,000,000 | 3.24 |
| 1987 | 18.44 | 20,677,274,353 | 1.7 | 8,758,540,000 | 889,000,000,000 | 3.58 |
| 1988 | 16.23 | 21,424,352,075 | 1.89 | 9,195,956,000 | 907,000,000,000 | 4.48 |
| 1989 | 21.05 | 21,827,668,680 | 1.92 | 9,224,572,000 | 1,002,000,000,000 | 3.57 |
| 1990 | 28.35 | 22,081,313,750 | 2.04 | 9,494,380,000 | 1,000,000,000,000 | 2.83 |
| 1991 | 17.75 | 21,946,584,220 | 2.00 | 9,847,992,000 | 991,000,000,000 | 1.22 |
| 1992 | 17.85 | 21,937,487,690 | 2.07 | 9,911,356,000 | 997,000,000,000 | 1.68 |
| 1993 | 13.18 | 21,963,124,801 | 2.15 | 10,346,728,000 | 1,000,000,000,000 | 1.62 |
| 1994 | 16.23 | 22,328,316,236 | 1.88 | 10,988,544,000 | 1,000,000,000,000 | 3.04 |
| 1995 | 18.65 | 22,788,291,401 | 1.84 | 11,391,212,000 | 1,009,000,000,000 | 3.01 |
| 1996 | 23.90 | 23,293,652,698 | 3.26 | 11,661,020,000 | 1,020,000,000,000 | 3.33 |
| 1997 | 15.86 | 24,019,173,352 | 2.28 | 11,945,136,000 | 1,021,000,000,000 | 3.74 |
| 1998 | 10.54 | 24,466,594,948 | 1.95 | 12,272,176,000 | 1,034,000,000,000 | 2.44 |
| 1999 | 24.93 | 24,078,098,372 | 2.24 | 12,633,964,000 | 1,018,000,000,000 | 3.30 |
| 2000 | 22.58 | 25,012,228,845 | 5.77 | 13,032,544,000 | 1,030,000,000,000 | 4.33 |
| 2001 | 19.35 | 24,868,147,533 | 3.42 | 13,680,492,000 | 1,033,000,000,000 | 1.92 |
| 2002 | 30.12 | 24,560,913,174 | 3.96 | 13,917,596,000 | 1,214,000,000,000 | 2.17 |
| 2003 | 30.30 | 25,352,989,235 | 4.76 | 14,426,552,000 | 1,266,000,000,000 | 2.92 |
| 2004 | 40.38 | 26,497,241,134 | 6.01 | 15,389,276,000 | 1,278,000,000,000 | 4.46 |
| 2005 | 58.34 | 26,960,453,517 | 9.08 | 16,192,568,000 | 1,294,000,000,000 | 3.82 |
| 2006 | 58.96 | 26,819,324,803 | 6.76 | 16,664,732,000 | 1,318,000,000,000 | 4.38 |
| 2007 | 93.68 | 26,704,852,218 | 6.87 | 17,059,224,000 | 1,334,000,000,000 | 4.29 |
| 2008 | 35.82 | 27,032,644,914 | 5.94 | 17,306,548,000 | 1,341,000,000,000 | 1.84 |
| 2009 | 77.91 | 26,597,795,017 | 4.66 | 17,588,620,000 | 1,357,000,000,000 | -1.69 |
| 2010 | 93.23 | 27,248,509,206 | 4.68 | 18,118,016,000 | 1,476,000,000,000 | 4.33 |
| 2011 | 108.09 | 27,277,730,610 | 3.14 | 18,532,948,000 | 1,528,000,000,000 | 3.09 |
| 2012 | 110.80 | 27,798,288,971 | 3.35 | 19,295,360,000 | 1,649,000,000,000 | 2.45 |
| 2013 | 109.95 | 27,830,372,774 | 3.49 | 19,573,344,000 | 1,656,000,000,000 | 2.56 |
| 2014 | 55.27 | 28,408,989,042 | 3.68 | 20,711,852,000 | 1,740,000,000,000 | 2.57 |

The research paper will examine the relationship between oil prices from 1985 to 2014 and other factors. There are five independent factors that will be tested in this paper. The first variable is oil production ($x_1$), which will be stated as (Oprod) in STATA. The volume of oil production has an important role on prices as it determines the main concepts of supply and demand, and how these were able to influence oil prices in the past. The Second variable is gas price ($x_2$), which will be referred to as (Gprice) in STATA. It explains how the changes in gas prices influence the demand and supply of oil, especially in the industrial sector. The third variable is gas production ($x_3$), later referred to as (Gprod) in STATA, which explains how the shifting from oil-based technology to gas-based technology has lately reduced the demand for oil, and has subsequently decreased the overall oil prices. The fourth variable is the oil proved reserves ($x_4$), which will be stated as (Oreserv) in STATA, explains the quantity of oil reserves per country all over the world. It assumes that as the reserves go up, the demand will decrease, and accordingly will affect oil prices. The last variable that will be discussed in the project is the world economic growth rate ($x_5$), which will be stated as (Wgrate) in STATA. This variable studies how the change of overall world economy can influence oil prices.

There are many useful sources that are used to gather some of the information in the proposal. For instance, six articles are considered, written by Jian Chai (2011), Zeybel Abidin (2014), and Lingyu Yan (2012), Hossein Kavand and Asghar Shahmoradi (2011), Franz Wirl (2007), Lutz Kilian (2011), World Development Indicators and Financial Statistics Datasets, Federal Reserve Bank of Saint Louis, the World Bank and CIA Fact book.

# CHAPTER 4

# METHODS

Table (2) First Model Multiple Linear Regression

| $Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \varepsilon$ | | |
|---|---|---|
| Variables | | Stata & Eviews |
| Y | The world oil prices | Oprice |
| $x_1$ | The oil production per year | Oprod |
| $x_2$ | The gas prices | Gprice |
| $x_3$ | The gas production per year | Gprod |
| $x_4$ | The oil proved reserves per year | Oreserv |
| $x_5$ | The world economy annual growth rate of GDP | Wgrate |
| The hypothesis:<br>$H_0$: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$<br>$H_A$: At least one of them $\neq 0$ | | |

The multiple linear regression is: $Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \varepsilon$

The model explains the relationship between the dependent variable Y – the world oil prices – and the independent variable factors that can change them over the time. Also, it includes multiple explanatory variables donating by $x_1$ for oil barrels production per year -in million-, $x_2$ for the gas prices in USD per thousand cubic feet, $x_3$ for the thousand cubic feet gas production per year -in millions-, $x_4$ for the oil barrels proved reserves per year -in millions-, and $x_5$ for the world economy annual growth rate of gross domestic products. The intercept parameter is donating by $\beta_0$, and with slope parameters $\beta_1$, $\beta_2$, $\beta_3$, $\beta_4$ and $\beta_5$.

The hypothesis of this model can be expressed as a two-sided test, as maybe not all of the variables can work in the same way for the dependent oil prices;

$H_0$: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$

$H_A$: At least one of them $\neq 0$

# CHAPTER 5

# EMPIRICAL RESULTS (1)

Table (3) Empirical Results 1

. regress Oprice Oprod Gprice Gprod Oreserv Wgrate

| Source | SS | df | MS |
|---|---|---|---|
| Model | 23774.1657 | 5 | 4754.83314 |
| Residual | 6754.64499 | 24 | 281.443541 |
| Total | 30528.8107 | 29 | 1052.71761 |

| | |
|---|---|
| Number of obs = | 30 |
| F( 5, 24) = | 16.89 |
| Prob > F = | 0.0000 |
| R-squared = | 0.7787 |
| Adj R-squared = | 0.7327 |
| Root MSE = | 16.776 |

| Oprice | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| Oprod | -.0195016 | .0071006 | -2.75 | 0.011 | -.0341565 | -.0048467 |
| Gprice | 1.828829 | 2.692756 | 0.68 | 0.504 | -3.728746 | 7.386404 |
| Gprod | .0161211 | .0056404 | 2.86 | 0.009 | .0044799 | .0277622 |
| Oreserv | .0000486 | .0000462 | 1.05 | 0.304 | -.0000468 | .0001441 |
| Wgrate | 3.329964 | 2.635076 | 1.26 | 0.218 | -2.108566 | 8.768495 |
| _cons | 226.1524 | 111.3333 | 2.03 | 0.053 | -3.628277 | 455.9331 |

The regression model implies that the dependent Y, which refers to the oil prices, is getting influenced by independent variables, which are oil production, gas prices, gas production, oil proved reserves, and world economy annual growth rate of GDP. All the coefficients are indications of a clear positive relationship between oil prices and all the variables, except for the oil production. For example, as the gas prices increase by $1, the oil prices increase by $1.828829. In reality, the negative relationship between oil prices and oil production is an application of the economics concept of supply-demand relationship: as the oil production (supply) increases, the market demand for oil will decrease, which will lead to a decrease of oil prices.

**Analysis of Variance (ANOVA)**

The regression model seems to fit well, as the standard error does not represent a big amount of the total amount. Also, the R-square ($R^2$) is fitting well in the model, which indicates that the oil price changes can be interpreted by 78% of the listed five variables. The $R^2$ can be computed manually in the model as follows;

$R^2 = 1 - \frac{RSS}{\text{TSS}} = 1 - \frac{6{,}754.64499}{30{,}528.8107} = 0.7787$

**T-Test, P-Test and F-Test**

To test how the independent variables are related or significant to the dependent variable, either one or all of t-test, p-test, and f-test may be used. Let us examine how the oil production is significant to oil prices. The null and alternative hypothesis of this test uses a 5 percent significant level as follows;

$H_0\colon\ \beta_1 = 0$

$H_A\colon\ \beta_1 \neq 0$

It is a two-trail hypothesis, with 30 observations. Using the t-distribution critical values table, the t-critical value is 2.064. From the previous regression result, the t-absolute value for oil production is 2.75, which is bigger than the t-critical value. In this case, we reject the null hypothesis and accept the alternative one, which means that there, the oil prices changes depended on oil production. Another quicker way to test this hypothesis is by using the p-test. The p-value for the oil production is 0.011, which is below the 5 percent significant level. Therefore, we can conclude that, the relationship between the oil price and oil production is significant, and that the null hypothesis must be rejected.

In addition, as there is more than one variable in the model, the f-test can also be a useful tool to consider. Based on the same data as in the previous example, the f-value from the overall regression model is 16.89, which is greater that the f-critical value (2.62), that is indicates insignificant relationship here. The null hypothesis is rejected and the previous results from the t-test and p-test are confirmed.

**Non-linearity**

This operation consists in testing the relationship between the dependent and independent variables in order to observe whether they are linearly related or not. One way to check whether non-linearity exists between the dependent and independent variables is to create quadratic independent variables from the primary ones.

Table (4) Empirical Results 1 of Non-linearity

```
. regress Oprice Oprod Gprice Gprod Oreserv Wgrate Oprod2 Gprice2 Gprod2 Oreserv2 Wgrate2
```

| Source | SS | df | MS |
|---|---|---|---|
| Model | 24854.0595 | 10 | 2485.40595 |
| Residual | 5674.75116 | 19 | 298.671114 |
| Total | 30528.8107 | 29 | 1052.71761 |

| | |
|---|---|
| Number of obs | = 30 |
| F( 10, 19) | = 8.32 |
| Prob > F | = 0.0000 |
| R-squared | = 0.8141 |
| Adj R-squared | = 0.7163 |
| Root MSE | = 17.282 |

| Oprice | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| Oprod | -.0718275 | .1236088 | -0.58 | 0.568 | -.3305437 | .1868886 |
| Gprice | -10.07882 | 11.38624 | -0.89 | 0.387 | -33.9105 | 13.75285 |
| Gprod | .023069 | .0343293 | 0.67 | 0.510 | -.0487831 | .094921 |
| Oreserv | .0001529 | .0002741 | 0.56 | 0.584 | -.0004209 | .0007266 |
| Wgrate | -4.694057 | 6.681114 | -0.70 | 0.491 | -18.67779 | 9.289675 |
| Oprod2 | 1.15e-06 | 2.67e-06 | 0.43 | 0.672 | -4.45e-06 | 6.75e-06 |
| Gprice2 | .8320574 | 1.03908 | 0.80 | 0.433 | -1.342762 | 3.006877 |
| Gprod2 | -3.07e-07 | 1.35e-06 | -0.23 | 0.823 | -3.14e-06 | 2.52e-06 |
| Oreserv2 | -3.90e-11 | 1.32e-10 | -0.30 | 0.770 | -3.15e-10 | 2.37e-10 |
| Wgrate2 | 2.111397 | 1.439002 | 1.47 | 0.159 | -.9004685 | 5.123262 |
| _cons | 742.3511 | 1257.237 | 0.59 | 0.562 | -1889.077 | 3373.779 |

Then, we regress all the primary independent variables and the new created independent variables with the dependent variable. Lastly, we use the t-test or f-test to test the null and alternative hypothesis.

$H_0$: $\beta_6 = \beta_7 = \beta_8 = \beta_9 = \beta_{10} = 0$

$H_A$: At least one of them $\neq 0$

With 30 observations and a 5% significant level, the t-critical value is 2.093, and all the t-absolute values are below the t-critical value. The conclusion is that we fail to reject the null hypothesis, which indicates a linearity here. All the independent variables are in a linear relationship with the dependent variable. According to the p-test, we can observe that all X's p-values are greater than the 5% significant level, which confirms the linearity between the dependent and independent variables. Another way to test the non-linearity is to scatter plots of Y on each X from the model. Here, we examine the non-linearity between oil prices and gas production.

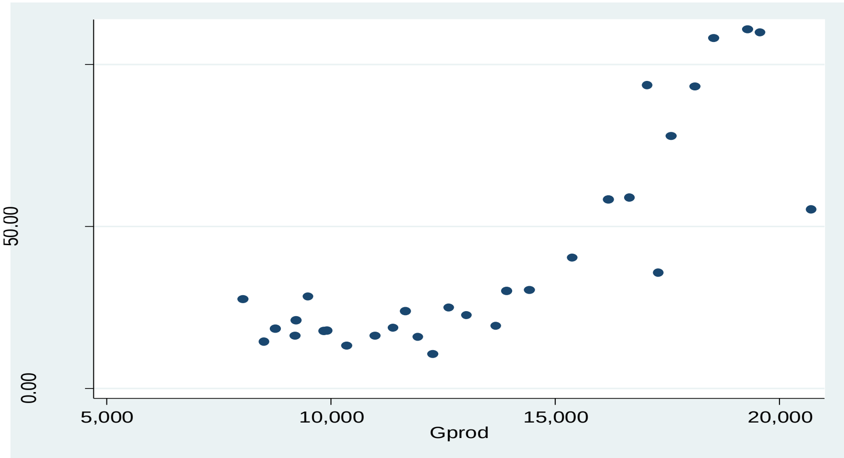


Figure (1) Empirical Results 1 of Non-Linearity -A-

The graph above confirms the conclusion drawn from both the t-test and p-test previously. Indeed, there is a positive relationship between both axes. The scatter plots test for the Y with other X's are as follow;

- ✓ Oil prices and gas prices

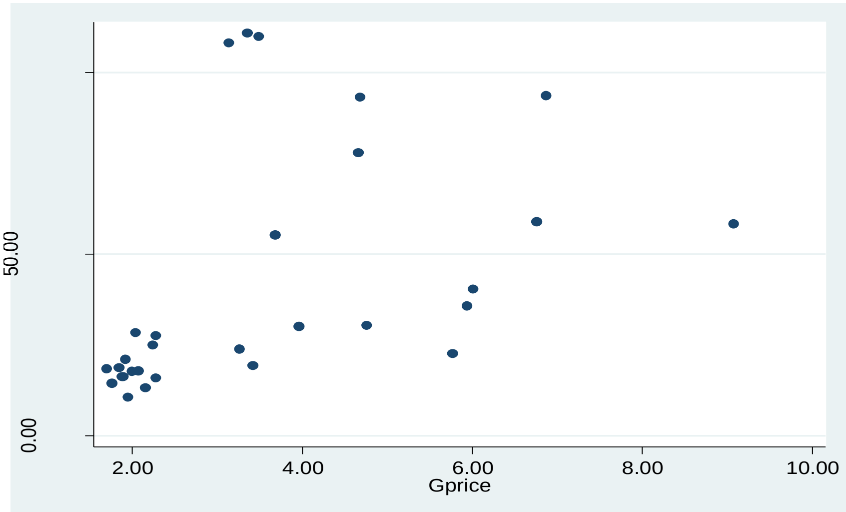


Figure (2) Empirical Results 1 of Non-Linearity -B-

✓ Oil prices and oil production

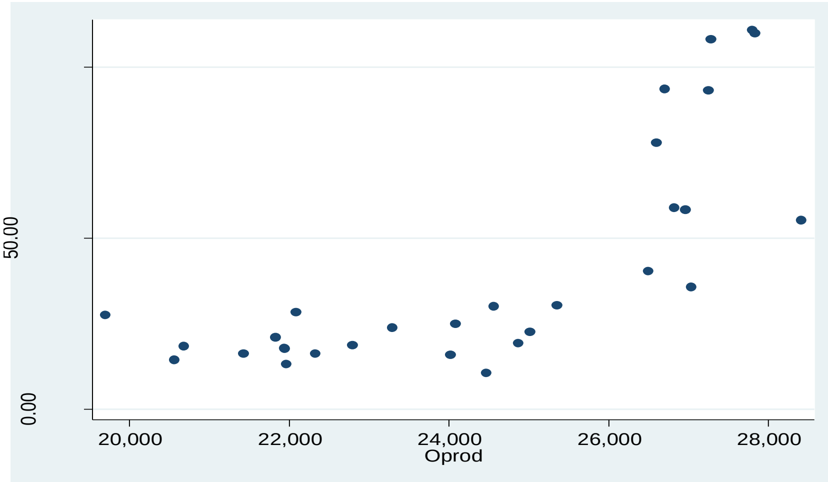


Figure (3) Empirical Results 1 of Non-Linearity -C-

✓ Oil prices and oil reserve

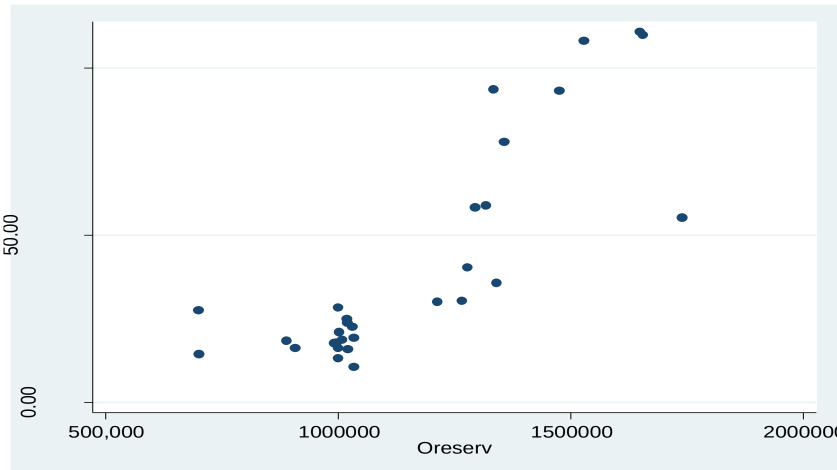


Figure (4) Empirical Results 1 of Non-Linearity -D-

✓ Oil prices and world growth rate of GDP

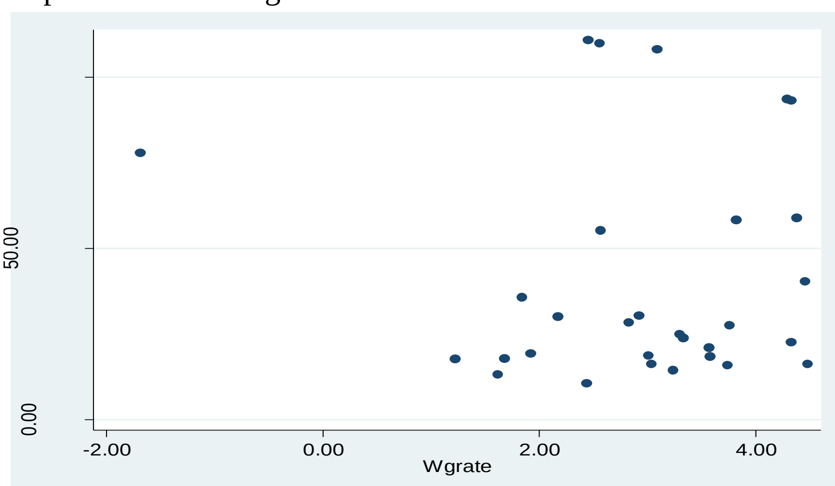


Figure (5) Empirical Results 1 of Non-Linearity -E-

One more test that can be used to check the non-linearity is from getting the residuals from the model and plot them against the independent variables. For example, plotting the residuals against the gas prices provides us with the results below.

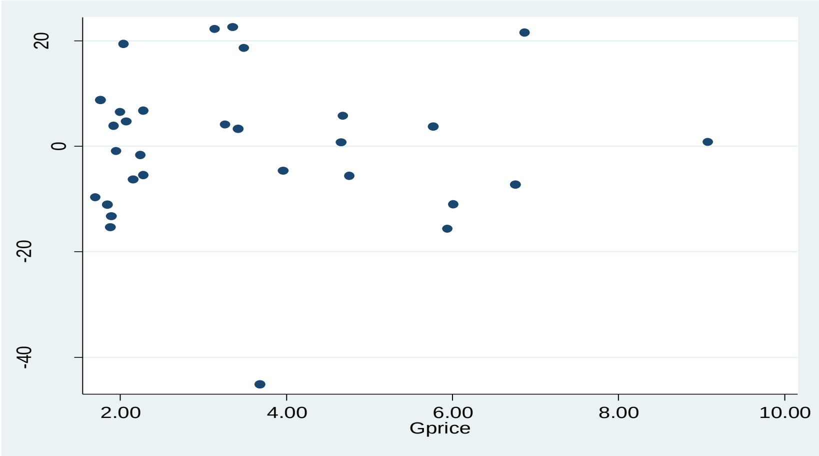


Figure (6) Empirical Results 1 of Non-linearity -F-

The graph shows a non-systematic relationship between the residuals and the gas prices, which confirms the linear relationship in the model.

**Dummy Variable Regression**

The dummy variable is used to distinguish between the influence of such quantitative and qualitative information on the dependent variable. Oil prices fluctuates highly during periods of instable security in the Gulf countries, which are considered the main exporters of oil in the world. The primary three events were Iraq versus Iran war (1980-1988), Iraq versus Kuwait war (1990-1991), and the United States versus Iraq war (2003-2011).

The influence of such qualitative information on the oil prices changes during those specific times can be transcribed by adding the dummy variable for these three wars to the previous model. War years are represented by D=1, and no-war years are represented by D=0. The new dummy variable is called “DV01”.

Table (5) Empirical Results 1 of Dummy Variable

```
. regress Oprice Oprod Gprice Gprod Oreser Wgrate DV01
```

| Source | SS | df | MS |
|---|---|---|---|
| Model | 24449.9436 | 6 | 4074.9906 |
| Residual | 6078.86709 | 23 | 264.298569 |
| Total | 30528.8107 | 29 | 1052.71761 |

| | |
|---|---|
| Number of obs | = 30 |
| F( 6, 23) | = 15.42 |
| Prob > F | = 0.0000 |
| R-squared | = 0.8009 |
| Adj R-squared | = 0.7489 |
| Root MSE | = 16.257 |

| Oprice | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| Oprod | -.0147355 | .0074988 | -1.97 | 0.062 | -.0302479 | .0007769 |
| Gprice | -.6565427 | 3.037284 | -0.22 | 0.831 | -6.939643 | 5.626557 |
| Gprod | .0138388 | .0056492 | 2.45 | 0.022 | .0021526 | .0255249 |
| Oreserv | .0000465 | .0000448 | 1.04 | 0.310 | -.0000462 | .0001393 |
| Wgrate | 3.154537 | 2.555909 | 1.23 | 0.230 | -2.132765 | 8.441838 |
| DV01 | 11.44186 | 7.155534 | 1.60 | 0.123 | -3.36049 | 26.24421 |
| _cons | 146.753 | 118.7672 | 1.24 | 0.229 | -98.93561 | 392.4416 |

The above regression model suggests that there is a positive relationship between the dummy variable (DV01) and oil prices between 1985 and 2014, but insignificant relationship with the oil prices. As wars occur, oil prices rise. In more details, in war years, oil prices increase by $ 11.44.

**Multicollinearity**

Multicollinearity exists whenever two or more of the independent variables in a multiple regression are correlated. The issue can occur whenever we derive $x_2$ (the new variable) from $x_1$ (the current variable), and then regress all the independent variables with the dependent one. This phenomenon can be explored using many different tests, for instance by comparing all the independent variables with each other, and checking the R-square, tolerance and Variance Inflation Factor (VIF). All these tests will provide the same result for each comparison.

Using STATA, the $R^2$ conclusion of the regressions between each two independent variables can be summarized as in the following table.

Table (6) Empirical Results 1 of Multicollinearity -A-

| | Gprice | Gprod | Oreserv | Wgrate |
|---|---|---|---|---|
| Oprod | 0.48 | 0.96 | 0.86 | 0.003 |
| Gprice | | 0.38 | 0.25 | 0.04 |
| Gprod | | | 0.92 | 0.01 |
| Oreserv | | | | 0.02 |

We can see the evidence of multicollinearity between oil proved reserves and oil production (86%), oil proved reserves and gas production (92%), and between gas production and oil production (96%). As a matter of fact, $R^2 \geq 0.8$, which indicates the evidence of collinearity and shows that not all independent variables are distinct. The following two summary tables of tolerance and VIF are included for further verification;

Table (7) Empirical Results 1 of Multicollinearity -B-
Tolerance = 1 - $R_k^2$ , if tolerance is ≤ 0.2, indicates a possible collinearity

| | Gprice | Gprod | Oreserv | Wgrate |
|---|---|---|---|---|
| Oprod | 0.52 | 0.04 | 0.14 | 0.997 |
| Gprice | | 0.62 | 0.75 | 0.96 |
| Gprod | | | 0.08 | 0.99 |
| Oreserv | | | | 0.98 |

Table (8): Empirical Results 1 of Multicollinearity -C-
$VIF_k = \frac{1}{tolerance_k}$ , if $VIF \geq 5$, indicates a possible collinearity

| | Gprice | Gprod | Oreserv | Wgrate |
|---|---|---|---|---|
| Oprod | 1.92 | 25.00 | 7.14 | 1.00 |
| Gprice | | 1.61 | 1.33 | 1.04 |
| Gprod | | | 12.5 | 1.01 |
| Oreserv | | | | 1.02 |

To alleviate the multicollinearity consequences between the independent variables, we need to omit the oil proved reserves as one of the independent variables from here on, as its changes were slight from a year to another. Most countries have a certain level of oil proved reserve each year, and they try to maintain it at such fixed point, keeping the changes as small as possible. Another reason to remove the oil proved reserves as an independent variable is that, from the first regression in the project, as oil proved reserves increase by one unit (barrel), the oil price increases by $0.0000486 only. Therefore, the influence of the variable is insignificant, and the oil proved reserves will be omitted on forward.

Regarding the collinearity problem between gas production and oil production (96%), creating a new variable called “GGprod” will allow us to fix the issue. The new variable depends on the growth rate of the gas production ($\frac{Gprod_t - Gprod_{t-1}}{Gprod_{t-1}}$), instead of taking gas production as a volume. The new regression between GGprod and Oprod operates as follows;

Table (9) Empirical Results 1 of Multicollinearity -D-

```
. regress GGprod Oprod

      Source |       SS       df       MS              Number of obs =      29
-------------+------------------------------           F(  1,    27) =    0.08
       Model |  .000024537     1  .000024537           Prob > F      =  0.7809
    Residual |  .008396152    27  .000310969           R-squared     =  0.0029
-------------+------------------------------           Adj R-squared = -0.0340
       Total |   .00842069    28  .000300739           Root MSE      =  .01763
```

The number of observations becomes 29, going one observation down because of the growth rate. The R-square is getting better here and the collinearity does not exist anymore. The new updated regression model is as follows;

Table (10) Empirical Results 1 of Multicollinearity -E-

```
. regress Oprice Oprod Gprice GGprod Wgrate

      Source |       SS       df       MS              Number of obs =      29
-------------+------------------------------           F(  4,    24) =   11.28
       Model |  19804.0221     4  4951.00553           Prob > F      =  0.0000
    Residual |  10538.1766    24   439.09069           R-squared     =  0.6527
-------------+------------------------------           Adj R-squared =  0.5948
       Total |  30342.1987    28  1083.64995           Root MSE      =  20.954

------------------------------------------------------------------------------
      Oprice |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       Oprod |   .0122977   .0023224     5.30   0.000     .0075045    .0170909
      Gprice |  -3.346089   2.977363    -1.12   0.272    -9.491064    2.798886
      GGprod |  -290.5092   233.3073    -1.25   0.225    -772.0318    191.0134
      Wgrate |   1.638377   3.272002     0.50   0.621    -5.114704    8.391458
       _cons |  -243.7229   53.44277    -4.56   0.000    -354.0234   -133.4225
------------------------------------------------------------------------------
```

The fact that R-square is getting better as 65% of oil prices changes can be interpreted by the four independent variables.

**Heteroskedasticity**

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \varepsilon$$

Heteroskedasticity is used in order to check whether the variance of the error ε depends on Xs (independent variables) or not. If the variance of error ε depends on any Xs, hetroskedasticity occurs. Otherwise, it is considered a homoskedasticity. There are many common tests for hetroskedasticity, such as using the t-test or f-test and then observing if the conclusion is significant or not. Also, this can be tested by scattering plots for the residuals against the independent variables and checking if there is a systematic relationship between them or not. The last test is called the white test. In case of heteroscedasticity, we can "robust" the regression to get a better result. The result of regressing the residual with the independent variables and their quadratic counterparts operates as follows;

Table (11) Empirical Results 1 of Heteroskedasticity

```
. regress resid2 Oprod Gprice GGprod Wgrate Oprod2 Gprice2 GGprod2 Wgrate2
```

| Source | SS | df | MS |
|---|---|---|---|
| Model | 1348396.91 | 8 | 168549.614 |
| Residual | 2476430.04 | 20 | 123821.502 |
| Total | 3824826.95 | 28 | 136600.962 |

| | |
|---|---|
| Number of obs | 29 |
| F( 8, 20) | 1.36 |
| Prob > F | 0.2719 |
| R-squared | 0.3525 |
| Adj R-squared | 0.0936 |
| Root MSE | 351.88 |

| resid2 | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| Oprod | -.1490192 | .8083775 | -0.18 | 0.856 | -1.835265 | 1.537227 |
| Gprice | -136.1887 | 233.4512 | -0.58 | 0.566 | -623.1595 | 350.782 |
| GGprod | 5376.408 | 14641.43 | 0.37 | 0.717 | -25165.08 | 35917.9 |
| Wgrate | 63.6648 | 108.1613 | 0.59 | 0.563 | -161.9557 | 289.2853 |
| Oprod2 | 5.45e-06 | .0000162 | 0.34 | 0.740 | -.0000283 | .0000392 |
| Gprice2 | 6.65221 | 21.22365 | 0.31 | 0.757 | -37.61955 | 50.92397 |
| GGprod2 | -124167.9 | 202217.7 | -0.61 | 0.546 | -545986.5 | 297650.7 |
| Wgrate2 | -12.67053 | 25.15851 | -0.50 | 0.620 | -65.15026 | 39.8092 |
| _cons | 1020.861 | 9813.169 | 0.10 | 0.918 | -19449.05 | 21490.77 |

$H_0: \beta_6 = \beta_7 = \beta_8 = \beta_9 = \beta_{10} = 0$ (homoskedasticity)

$H_A: \beta_6 \neq \beta_7 \neq \beta_8 \neq \beta_9 \neq \beta_{10} \neq 0$ (hetroskedasticity)

The regression stated that the f-value is 1.36. Comparing it to the f-critical value (2.45), we fail to reject the null hypothesis, as the f-value is lower than the f-critical value. That indicates the absence of hetroskedasticity problem here.

**Autocorrelation / Serial Correlation**

Having error autocorrelation (serial correlation) means that successive values of errors are correlated with each other, which is relevant as the regression model may have errors $\varepsilon_i$ that are also serially correlated. It violates the assumption of the classical model, which states that errors $\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_t$ are independent and identically distributed. We can check if the autocorrelation issue occurs or not by regressing the residuals and plot them over time to see how the shape of the graph moves.

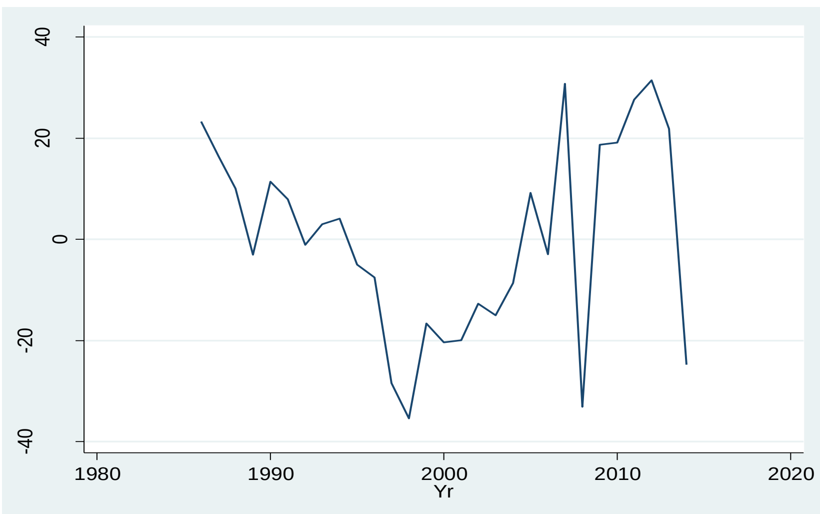


Figure (7) Empirical Results 1 of Autocorrelation -A-

There is a serial correlation in the residuals, because there is a pattern or a systematic relationship of predictability in the residuals over the time from 1985 to 2014. Another test that can be used to test for autocorrelation consists in plotting the residuals on their first lagged values by using “scatter resid L.resid” in STATA as follows;

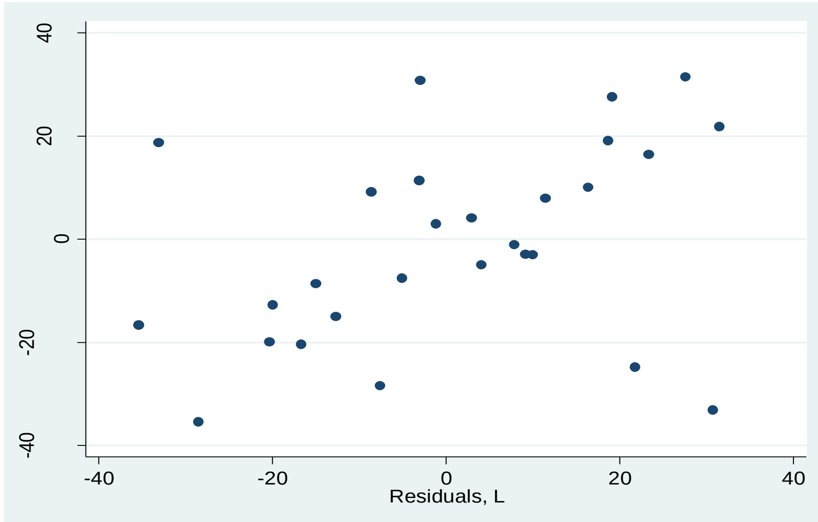


Figure (8) Empirical Results 1 of Autocorrelation -B-

There is a positive relationship between the residuals and their first lagged, which confirms the presence of an autocorrelation problem here. Another way to test and to confirm the previous results is to regress the residuals on their lagged values by running a p-test in order to check if their relation is significant or not;

Table (12) Empirical Results 1 of Autocorrelation -A-

```
. predict resid, residual
(1 missing value generated)

. tsset Yr
        time variable:  Yr, 1985 to 2014
                delta:  1 unit

. regress resid L.resid
```

| Source | SS | df | MS |
|---|---|---|---|
| Model | 1461.13293 | 1 | 1461.13293 |
| Residual | 8513.02251 | 26 | 327.423943 |
| Total | 9974.15545 | 27 | 369.413165 |

| | | |
|---|---|---|
| Number of obs | = | 28 |
| F( 1, 26) | = | 4.46 |
| Prob > F | = | 0.0444 |
| R-squared | = | 0.1465 |
| Adj R-squared | = | 0.1137 |
| Root MSE | = | 18.095 |

| resid | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| resid | | | | | | |
| L1. | .3841892 | .1818676 | 2.11 | 0.044 | .0103548 | .7580235 |
| _cons | -1.174242 | 3.423411 | -0.34 | 0.734 | -8.211164 | 5.862679 |

$H_0: \alpha_1 = 0$ Non-autocorrelation

$H_A: \alpha_1 \neq 0$ Autocorrrelation

The p-value stated a very weak autocorrelation problem here, as it is almost 0.044, which is very close 5% and appears to be insignificant. In this case, we reject the null hypothesis and accept the alternative hypothesis at 5% significant level, but it we accept the null hypothesis and reject the alternative hypothesis at 10% significant level.

The last test to check for serial correlation or autocorrelation consists in using Durbin-Watson d-statistic;

Table (13) Empirical Results 1 of Autocorrelation -B-

```
. estat dwatson

Durbin-Watson d-statistic(  2,    28) =  2.130433
```

The result confirms a small negative autocorrelation, as it is > 2.

We can modify such standard errors via the Newey-West method, which corrects serial correlation and heteroscedasticity at the same time. In STATA we can accomplish this by using the “newey” command instead of the regress command;

Table (14) Empirical Results 1 of Autocorrelation -C-

```
. newey Oprice Oprod Gprice GGprod Wgrate, lag(1)

Regression with Newey-West standard errors          Number of obs  =        29
maximum lag: 1                                      F(  4,    24)  =      9.90
                                                    Prob > F       =    0.0001
```

| Oprice | Coef. | Newey-West Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| Oprod | .0122977 | .0032464 | 3.79 | 0.001 | .0055974 | .018998 |
| Gprice | -3.346089 | 3.531197 | -0.95 | 0.353 | -10.63412 | 3.941944 |
| GGprod | -290.5092 | 201.2631 | -1.44 | 0.162 | -705.8959 | 124.8775 |
| Wgrate | 1.638377 | 2.682273 | 0.61 | 0.547 | -3.897562 | 7.174316 |
| _cons | -243.7229 | 68.12162 | -3.58 | 0.002 | -384.319 | -103.1268 |

**Autoregressive Time Series Models**

This model is characterized by the fact that it has a dependent variable and an independent variable, which represents the same outcome, but observed at a different time. For example, an autoregressive model analyzing oil prices relates the rate observed in one period to the rate observed in the previous period. Oil prices are one of the most sensitive and non-stationary events in the current world, as they are getting influenced by any unusual event. The tracking of the historical data shows that oil prices fell down reach around $10 per barrel (the peak), and high to $ 140 per barrel between 1985 and 2014.

To illustrate the relationship between Y (oil prices) and $Y_{t-1}$ (its lagged), using the EViews, we consider the following results;

Table (15) Empirical Results 1 of Autoregressive Time Series Models -A-

Dependent Variable: OPRICE
Method: Least Squares
Date: 04/29/16 Time: 10:44
Sample (adjusted): 1986 2014
Included observations: 29 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 8.323028 | 5.742618 | 1.449344 | 0.1588 |
| OPRICE(-1) | 0.818080 | 0.110813 | 7.382528 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.668719 | Mean dependent var | 41.45414 |
| Adjusted R-squared | 0.656449 | S.D. dependent var | 32.91884 |
| S.E. of regression | 19.29479 | Akaike info criterion | 8.824020 |
| Sum squared resid | 10051.81 | Schwarz criterion | 8.918316 |
| Log likelihood | -125.9483 | Hannan-Quinn criter. | 8.853552 |
| F-statistic | 54.50172 | Durbin-Watson stat | 2.196512 |
| Prob(F-statistic) | 0.000000 | | |

The results are highly correlated as the P-vale was 0.000, which indicates that oil prices movements depend on the previous oil prices changes. In addition, there are many tests that can be used to test for data stationarity versus data non-stationarity. Some of these tests are Dickey

Fuller test, Phillips Perron test, and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test. These tests can be run through STATA or Eview. As an example here, we use the Dickey Fuller test;

Table (16) Empirical Results 1 of Autoregressive Time Series -B-

Null Hypothesis: OPRICE has a unit root
Exogenous: Constant
Lag Length: 0 (Fixed)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -1.641685 | 0.4492 |
| Test critical values: | 1% level | -3.679322 | |
| | 5% level | -2.967767 | |
| | 10% level | -2.622989 | |

*MacKinnon (1996) one-sided p-values.

Table (17) Empirical Results 1 of Autoregressive Time Series Models -C-

```
. tsset Yr
        time variable:  Yr, 1985 to 2014
                delta:  1 unit

. regress Oprice L.Oprice

      Source |       SS       df       MS              Number of obs =      29
-------------+------------------------------           F(  1,    27) =   54.50
       Model |  20290.3935     1  20290.3935           Prob > F      =  0.0000
    Residual |   10051.805    27  372.289074           R-squared     =  0.6687
-------------+------------------------------           Adj R-squared =  0.6564
       Total |  30342.1985    28  1083.64995           Root MSE      =  19.295

------------------------------------------------------------------------------
      Oprice |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      Oprice |
         L1. |   .8180799    .110813     7.38   0.000     .5907105    1.045449
             |
       _cons |   8.323028   5.742618     1.45   0.159     -3.45985    20.10591
------------------------------------------------------------------------------

. dfuller Oprice, lag(0)

Dickey-Fuller test for unit root                   Number of obs   =        29

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -1.642            -3.723            -2.989            -2.625
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.4614
```

$H_0: \beta_1 = 1$ Non-stationarity

$H_A: -1 < \beta_1 < 1$ Stationarity

The p-value is insignificant, as 0.4492 is greater than the 1%, 5%, and 10% significant levels. We fail to reject the null hypothesis, which indicates non-stationarity here.

# CHAPTER 6

# GROWTH RATE MODEL

In this model, we are going to revised all the previous variables values by taking the growth rate of each independent variable individually from the previous year to simple the way that dealing with autocorrelation. The new dependent and independent variables will be stated in STATA as follow; the dependent variable (Y), which indicates the growth rate of oil prices in yearly bases from 1985 to 2014 and it will be stated as (OOprice) in STATA. The first independent variable is the growth rate of oil production ($x_1$), which will be stated as (OOprod) in STATA. The volume growth rate of oil production has an important role on prices as it determines the main concepts of supply and demand, and how these were able to influence oil prices in the past. The Second variable is the growth rate of gas price ($x_2$), which will be referred to as (GGprice) in STATA. It explains how the change in gas prices influence the demand and supply of oil, especially in the industrial sector. The third variable is the growth rate of gas production ($x_3$), later referred to as (GGprod) in STATA, which explains how the shifting from oil-based technology to gas-based technology has lately reduced the demand for oil, and has subsequently decreased the overall oil prices. The fourth variable is the growth rate of oil proved reserves ($x_4$), which will be stated as (OOreserv) in STATA, explains the change in quantity of oil reserves per country all over the world. It assumes that as the reserves go up, the demand will decrease, and accordingly will affect oil prices. The last variable that will be discussed in the growth rate model is the change in world economic annual growth rate ($x_5$), which will be stated as (WWgrate) in STATA. This variable studies how the change of overall world economy can influence oil prices.

## Empirical Results (2)

Table (18) Second Model Data

| Year | Growth Rate of Oil Prices (USD/Barrels) | Growth Rate of Oil Production (Barrels per year) | Growth Rate of Gas Price (USD/Thousand Cubic Feet) | Growth Rate of Gas Production (Thousand Cubic feet per year) | Growth Rate of Oil Proved Reserves (Barrels per year) | Change of World Economy Annual Growth Rate of GDP |
|---|---|---|---|---|---|---|
| Yr | OOprice | OOprod | GGprice | GGprod | OOreserv | WWgrate |
| 1985 | | | | | | |
| 1986 | -0.48 | 0.04 | -0.23 | 0.06 | 0.00 | -0.14 |
| 1987 | 0.28 | 0.01 | -0.03 | 0.03 | 0.27 | 0.10 |
| 1988 | -0.12 | 0.04 | 0.11 | 0.05 | 0.02 | 0.25 |
| 1989 | 0.30 | 0.02 | 0.02 | 0.00 | 0.10 | -0.20 |
| 1990 | 0.35 | 0.01 | 0.06 | 0.03 | 0.00 | -0.21 |
| 1991 | -0.37 | -0.01 | -0.02 | 0.04 | -0.01 | -0.57 |
| 1992 | 0.01 | 0.00 | 0.03 | 0.01 | 0.01 | 0.38 |
| 1993 | -0.26 | 0.00 | 0.04 | 0.04 | 0.00 | -0.04 |
| 1994 | 0.23 | 0.02 | -0.13 | 0.06 | 0.00 | 0.88 |
| 1995 | 0.15 | 0.02 | -0.02 | 0.04 | 0.01 | -0.01 |
| 1996 | 0.28 | 0.02 | 0.77 | 0.02 | 0.01 | 0.11 |
| 1997 | -0.34 | 0.03 | -0.30 | 0.02 | 0.00 | 0.12 |
| 1998 | -0.34 | 0.02 | -0.14 | 0.03 | 0.01 | -0.35 |
| 1999 | 1.37 | -0.02 | 0.15 | 0.03 | -0.02 | 0.35 |
| 2000 | -0.09 | 0.04 | 1.58 | 0.03 | 0.01 | 0.31 |
| 2001 | -0.14 | -0.01 | -0.41 | 0.05 | 0.00 | -0.56 |
| 2002 | 0.56 | -0.01 | 0.16 | 0.02 | 0.18 | 0.13 |
| 2003 | 0.01 | 0.03 | 0.20 | 0.04 | 0.04 | 0.35 |
| 2004 | 0.33 | 0.05 | 0.26 | 0.07 | 0.01 | 0.53 |
| 2005 | 0.44 | 0.02 | 0.51 | 0.05 | 0.01 | -0.14 |
| 2006 | 0.01 | -0.01 | -0.26 | 0.03 | 0.02 | 0.15 |
| 2007 | 0.59 | 0.00 | 0.02 | 0.02 | 0.01 | -0.02 |
| 2008 | -0.62 | 0.01 | -0.14 | 0.01 | 0.01 | -0.57 |
| 2009 | 1.18 | -0.02 | -0.22 | 0.02 | 0.01 | -1.92 |
| 2010 | 0.20 | 0.02 | 0.00 | 0.03 | 0.09 | -3.56 |
| 2011 | 0.16 | 0.00 | -0.33 | 0.02 | 0.04 | -0.29 |
| 2012 | 0.03 | 0.02 | 0.07 | 0.04 | 0.08 | -0.21 |
| 2013 | -0.01 | 0.00 | 0.04 | 0.01 | 0.00 | 0.04 |
| 2014 | -0.50 | 0.02 | 0.05 | 0.06 | 0.05 | 0.00 |

The regression of these data using STATA is as follow;

Table (19) Second Model Multiple Linear Regression

```
. regress OOprice OOprod GGprice GGprod OOreserv WWgrate
```

| Source | SS | df | MS |
|---|---|---|---|
| Model | 1.53184222 | 5 | .306368444 |
| Residual | 4.20054387 | 23 | .182632342 |
| Total | 5.73238609 | 28 | .204728075 |

| | | |
|---|---|---|
| Number of obs | = | 29 |
| F( 5, 23) | = | 1.68 |
| Prob > F | = | 0.1801 |
| R-squared | = | 0.2672 |
| Adj R-squared | = | 0.1079 |
| Root MSE | = | .42736 |

| OOprice | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| OOprod | -13.38927 | 5.27555 | -2.54 | 0.018 | -24.30257 | -2.475959 |
| GGprice | .3930573 | .237697 | 1.65 | 0.112 | -.0986564 | .884771 |
| GGprod | 2.039154 | 5.377386 | 0.38 | 0.708 | -9.084817 | 13.16313 |
| OOreserv | .9252353 | 1.340407 | 0.69 | 0.497 | -1.847607 | 3.698078 |
| WWgrate | -.029757 | .1040174 | -0.29 | 0.777 | -.2449333 | .1854193 |
| _cons | .148608 | .1947282 | 0.76 | 0.453 | -.254218 | .5514341 |

The regression model implies that the dependent Y, which refers to the change in oil prices, is getting influenced by independent variables, which are the growth rate of oil production, the growth rate of gas prices, the growth rate of gas production, the growth rate of oil proved reserves, and the change in world economy annual growth rate of GDP. All the coefficients are indications of a clear positive relationship between growth rate of oil prices and all the independent variables, except for the growth rate of oil production and the change in world economy annual growth rate of GDP. For example, as the growth rate of gas prices increase by $1, the oil prices increase by $0.3930573. In reality, the negative relationship between oil prices and oil production is an application of the economics concept of supply-demand relationship: as the oil production (supply) increases, the market demand for oil will decrease, which will lead to a decrease of oil prices.

The new regression model does not seem fit well, as the standard error represents a big amount of the total amount. The R-square ($R^2$) is not fitting well too in the new model, as growth rate of the oil price changes can be interpreted by 27% only of the listed five growth rates variables. Using the P values of the independent variables to test how these variables are significant or insignificant on the growth rate of oil prices, we observe that all of them are higher than 5% significant level, except for the growth rate of oil production. Therefore, we can conclude that, the relationship between the growth rate of oil price and the other four independent variables is insignificant.

To test the linearity of the new model, we regress all the primary independent variables and their new created quadratic independent variables with the dependent variable. Then, we use the P values to test the null and alternative hypothesis;

$H_0$: $\beta_6 = \beta_7 = \beta_8 = \beta_9 = \beta_{10} = 0$

$H_A$: At least one of them $\neq 0$

Table (20) Empirical Results 2 of Non-linearity

```
. regress OOprice OOprod GGprice GGprod OOreserv WWgrate OOprod2 GGprice2 GGprod2 OOreserv2 WWgrate2
```

| Source | SS | df | MS |
|---|---|---|---|
| Model | 3.14866365 | 10 | .314866365 |
| Residual | 2.58372244 | 18 | .143540136 |
| Total | 5.73238609 | 28 | .204728075 |

| | |
|---|---|
| Number of obs | 29 |
| F( 10, 18) | 2.19 |
| Prob > F | 0.0706 |
| R-squared | 0.5493 |
| Adj R-squared | 0.2989 |
| Root MSE | .37887 |

| OOprice | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| OOprod | -24.94617 | 6.766194 | -3.69 | 0.002 | -39.16142 | -10.73093 |
| GGprice | .802993 | .3727121 | 2.15 | 0.045 | .0199539 | 1.586032 |
| GGprod | -.1535392 | 17.25406 | -0.01 | 0.993 | -36.40297 | 36.09589 |
| OOreserv | .5011448 | 3.941267 | 0.13 | 0.900 | -7.779149 | 8.781439 |
| WWgrate | .215971 | .2225954 | 0.97 | 0.345 | -.2516847 | .6836266 |
| OOprod2 | 543.921 | 225.8889 | 2.41 | 0.027 | 69.34605 | 1018.496 |
| GGprice2 | -.5669232 | .2998352 | -1.89 | 0.075 | -1.196854 | .0630072 |
| GGprod2 | -67.163 | 257.9677 | -0.26 | 0.798 | -609.133 | 474.807 |
| OOreserv2 | 1.403614 | 16.32142 | 0.09 | 0.932 | -32.88642 | 35.69365 |
| WWgrate2 | .0926427 | .0708331 | 1.31 | 0.207 | -.0561721 | .2414575 |
| _cons | .2346792 | .2899146 | 0.81 | 0.429 | -.3744088 | .8437672 |

With 29 observations and a 5% significant level, all the independents variables are insignificant, except for the growth rate of oil production because it is less than 5% significant level. This is concluding that all the independent variables, except the growth rate of the oil production are in a linear relationship with the dependent variable.

To test the multicollinearity, we compare all the independent variables with each other, and checking the R-square ($R^2$), tolerance and Variance Inflation Factor (VIF). All these tests will provide the same result for each comparison. Using STATA, the $R^2$ conclusion of the regressions between each two independent variables can be summarized as in the following table;

Table (21) Empirical Results 2 of Multicollinearity -A-

| | GGprice | GGprod | OOreserv | WWgrate |
|---|---|---|---|---|
| OOprod | 0.02 | 0.46 | -0.01 | 0.01 |
| GGprice | | 0.25 | -0.14 | 0.1 |
| GGprod | | | -0.05 | 0.03 |
| OOreserv | | | | -0.01 |

All the values are less than 80%, which indicates that multicollineariy does not exist here and shows that all independent variables are distinct. We can apply the other two tests as follow;

Table (22) Empirical Results 2 of Multicollinearity -B-
Tolerance = 1 - $R_k^2$ , if tolerance is ≤ 0.2, indicates a possible collinearity

| | GGprice | GGprod | OOreserv | WWgrate |
|---|---|---|---|---|
| OOprod | 0.98 | 0.54 | 1.01 | 0.99 |
| GGprice | | 0.62 | 1.14 | 0.90 |
| GGprod | | | 1.05 | 0.97 |
| OOreserv | | | | 1.01 |

Table (23) Empirical Results 2 of Multicollinearity -C-
$VIF_k = \frac{1}{tolerance_k}$ , if $VIF \geq 5$, indicates a possible collinearity

| | GGprice | GGprod | OOreserv | WWgrate |
|---|---|---|---|---|
| OOprod | 1.02 | 1.85 | 0.99 | 1.01 |
| GGprice | | 1.61 | 0.88 | 1.11 |
| GGprod | | | 0.95 | 1.03 |
| OOreserv | | | | 0.99 |

We can check for the hetroskedasticity by regressing all the primary independent variables and their new created quadratic independent variables with the dependent variable;

$H_0$: $\beta_6 = \beta_7 = \beta_8 = \beta_9 = \beta_{10} = 0$ (homoskedasticity)

$H_A$: $\beta_6 \neq \beta_7 \neq \beta_8 \neq \beta_9 \neq \beta_{10} \neq 0$ (hetroskedasticity)

As per the regression result in the following page, the P values for the new created quadratic independent variables are higher than 5% significant level, except for the growth rate of oil production. That indicates the absence of hetroskedasticity problem here, except for the growth rate of oil production.

Table (24) Empirical Results 2 of Hetroskedasticity

```
. regress OOprice OOprod GGprice GGprod OOreserv WWgrate OOprod2 GGprice2 GGprod2 OOreserv2 WWgrate2
```

| Source | SS | df | MS |
|---|---|---|---|
| Model | 3.14866365 | 10 | .314866365 |
| Residual | 2.58372244 | 18 | .143540136 |
| Total | 5.73238609 | 28 | .204728075 |

| | |
|---|---|
| Number of obs | = 29 |
| F( 10, 18) | = 2.19 |
| Prob > F | = 0.0706 |
| R-squared | = 0.5493 |
| Adj R-squared | = 0.2989 |
| Root MSE | = .37887 |

| OOprice | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| OOprod | -24.94617 | 6.766194 | -3.69 | 0.002 | -39.16142 | -10.73093 |
| GGprice | .802993 | .3727121 | 2.15 | 0.045 | .0199539 | 1.586032 |
| GGprod | -.1535392 | 17.25406 | -0.01 | 0.993 | -36.40297 | 36.09589 |
| OOreserv | .5011448 | 3.941267 | 0.13 | 0.900 | -7.779149 | 8.781439 |
| WWgrate | .215971 | .2225954 | 0.97 | 0.345 | -.2516847 | .6836266 |
| OOprod2 | 543.921 | 225.8889 | 2.41 | 0.027 | 69.34605 | 1018.496 |
| GGprice2 | -.5669232 | .2998352 | -1.89 | 0.075 | -1.196854 | .0630072 |
| GGprod2 | -67.163 | 257.9677 | -0.26 | 0.798 | -609.133 | 474.807 |
| OOreserv2 | 1.403614 | 16.32142 | 0.09 | 0.932 | -32.88642 | 35.69365 |
| WWgrate2 | .0926427 | .0708331 | 1.31 | 0.207 | -.0561721 | .2414575 |
| _cons | .2346792 | .2899146 | 0.81 | 0.429 | -.3744088 | .8437672 |

We can test if the autocorrelation issue occurs or not by regressing the residuals and plot them over time to see how the shape of the graph moves.

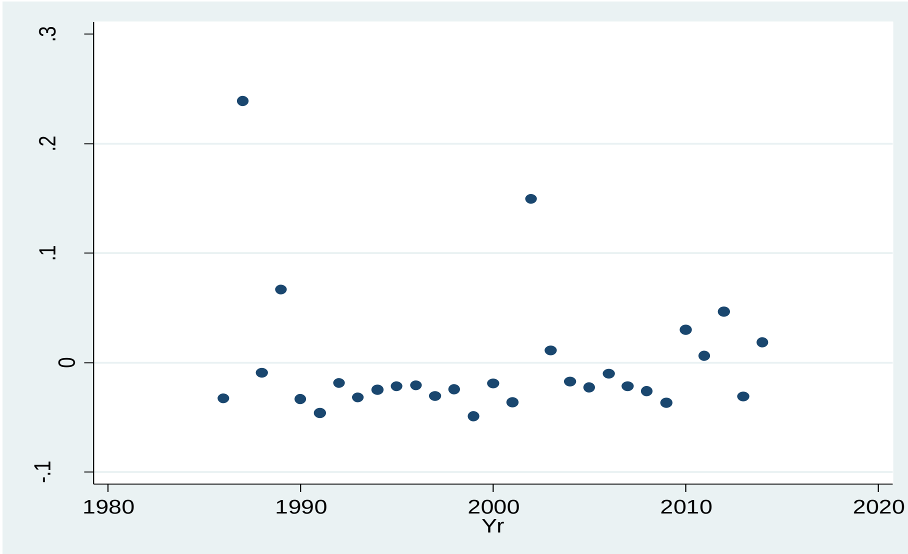


Figure (9) Empirical Results 2 of Autocorrelation

There is no serial correlation in the residuals, because there is no a pattern and no a systematic relationship of predictability in the residuals over the time from 1985 to 2014. Another test that can be used to test for autocorrelation consists in plotting the residuals on their first lagged values in STATA as follows;

Table (25) Empirical Results 2 of Autocorrelation

```
. regress resid L.resid

      Source |       SS           df       MS      Number of obs   =        28
-------------+----------------------------------   F(  1,     26)  =      0.16
       Model |  .000646896         1  .000646896   Prob > F        =    0.6896
    Residual |   .10310489        26  .003965573   R-squared       =    0.0062
-------------+----------------------------------   Adj R-squared   =   -0.0320
       Total |  .103751786        27  .003842659   Root MSE        =    .06297

------------------------------------------------------------------------------
       resid |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       resid |
         L1. |   -.078671   .1947827    -0.40   0.690    -.4790525    .3217106
             |
       _cons |   .0011209   .0119014     0.09   0.926    -.0233428    .0255846
------------------------------------------------------------------------------
```

$H_0: \alpha_1 = 0$ Non-autocorrelation

$H_A: \alpha_1 \neq 0$ Autocorrrelation

The P value stated no autocorrelation problem here, as it is 0.690, which is higher than 5% and appears to be insignificant. In this case, we fail to reject the null hypothesis.

# CHAPTER 7

# NEW VARIABLES MODEL

In addition to the previous five independent variables, we are adding two more variables in this model. The sixth independent variable is the growth rate of trade weighted U.S. dollar index ($x_6$) and the seventh independent variable is the growth rate of copper prices ($x_7$).

Table (26) Third Model Data

| Year | Growth Rate of Oil Prices (USD/Barrels) | Growth Rate of Oil Production (Barrels per year) | Growth Rate of Gas Price (USD/Thousand Cubic Feet) | Growth Rate of Gas Production (Thousand Cubic feet per year) | Growth Rate of Oil Proved Reserves (Barrels per year) | Change of World Economy Annual Growth Rate of GDP | Growth Rate of Trade Weighted U.S. Dollar Index | Growth Rate of Copper Prices |
|---|---|---|---|---|---|---|---|---|
| Yr | OOprice | OOprod | GGprice | GGprod | OOreserv | WWgrate | DoIndex | CCprice |
| 1985 | | | | | | | | |
| 1986 | -0.48 | 0.04 | -0.23 | 0.06 | 0.00 | -0.14 | -0.13 | -0.03 |
| 1987 | 0.28 | 0.01 | -0.03 | 0.03 | 0.27 | 0.10 | -0.17 | 0.30 |
| 1988 | -0.12 | 0.04 | 0.11 | 0.05 | 0.02 | 0.25 | 0.03 | 0.46 |
| 1989 | 0.30 | 0.02 | 0.02 | 0.00 | 0.10 | -0.20 | 0.04 | 0.10 |
| 1990 | 0.35 | 0.01 | 0.06 | 0.03 | 0.00 | -0.21 | -0.07 | -0.07 |
| 1991 | -0.37 | -0.01 | -0.02 | 0.04 | -0.01 | -0.57 | -0.01 | -0.12 |
| 1992 | 0.01 | 0.00 | 0.03 | 0.01 | 0.01 | 0.38 | 0.09 | -0.02 |
| 1993 | -0.26 | 0.00 | 0.04 | 0.04 | 0.00 | -0.04 | 0.01 | -0.16 |
| 1994 | 0.23 | 0.02 | -0.13 | 0.06 | 0.00 | 0.88 | -0.06 | 0.20 |
| 1995 | 0.15 | 0.02 | -0.02 | 0.04 | 0.01 | -0.01 | -0.02 | 0.27 |
| 1996 | 0.28 | 0.02 | 0.77 | 0.02 | 0.01 | 0.11 | 0.04 | -0.22 |
| 1997 | -0.34 | 0.03 | -0.30 | 0.02 | 0.00 | 0.12 | 0.11 | -0.01 |
| 1998 | -0.34 | 0.02 | -0.14 | 0.03 | 0.01 | -0.35 | -0.03 | -0.27 |
| 1999 | 1.37 | -0.02 | 0.15 | 0.03 | -0.02 | 0.35 | 0.01 | -0.05 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2000 | -0.09 | 0.04 | 1.58 | 0.03 | 0.01 | 0.31 | 0.07 | 0.15 |
| 2001 | -0.14 | -0.01 | -0.41 | 0.05 | 0.00 | -0.56 | 0.07 | -0.13 |
| 2002 | 0.56 | -0.01 | 0.16 | 0.02 | 0.18 | 0.13 | -0.09 | -0.01 |
| 2003 | 0.01 | 0.03 | 0.20 | 0.04 | 0.04 | 0.35 | -0.15 | 0.14 |
| 2004 | 0.33 | 0.05 | 0.26 | 0.07 | 0.01 | 0.53 | -0.06 | 0.61 |
| 2005 | 0.44 | 0.02 | 0.51 | 0.05 | 0.01 | -0.14 | 0.08 | 0.28 |
| 2006 | 0.01 | -0.01 | -0.26 | 0.03 | 0.02 | 0.15 | -0.05 | 0.83 |
| 2007 | 0.59 | 0.00 | 0.02 | 0.02 | 0.01 | -0.02 | -0.10 | 0.06 |
| 2008 | -0.62 | 0.01 | -0.14 | 0.01 | 0.01 | -0.57 | 0.08 | -0.02 |
| 2009 | 1.18 | -0.02 | -0.22 | 0.02 | 0.01 | -1.92 | -0.07 | -0.26 |
| 2010 | 0.20 | 0.02 | 0.00 | 0.03 | 0.09 | -3.56 | -0.01 | 0.46 |
| 2011 | 0.16 | 0.00 | -0.33 | 0.02 | 0.04 | -0.29 | 0.00 | 0.17 |
| 2012 | 0.03 | 0.02 | 0.07 | 0.04 | 0.08 | -0.21 | 0.00 | -0.10 |
| 2013 | -0.01 | 0.00 | 0.04 | 0.01 | 0.00 | 0.04 | 0.04 | -0.08 |
| 2014 | -0.50 | 0.02 | 0.05 | 0.06 | 0.05 | 0.00 | 0.12 | -0.06 |

The empirical result of the new variables' model as follow;

Table (27) Third Model Multiple Linear Regression -A-

```
. regress OOprice OOprod GGprice GGprod OOreserv WWgrate DoIndex CCprice

      Source |       SS       df       MS              Number of obs =      29
-------------+------------------------------           F(  7,    21) =    2.00
       Model |  2.29486427     7  .327837752           Prob > F      =  0.1031
    Residual |  3.43752182    21  .163691515           R-squared     =  0.4003
-------------+------------------------------           Adj R-squared =  0.2004
       Total |  5.73238609    28  .204728075           Root MSE      =  .40459

------------------------------------------------------------------------------
     OOprice |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      OOprod |  -13.68445   5.146515    -2.66   0.015    -24.38721   -2.981683
     GGprice |   .4711742   .2280525     2.07   0.051    -.0030869    .9454354
      GGprod |  -1.408142   5.341876    -0.26   0.795    -12.51718    9.700897
    OOreserv |  -.5113399   1.432895    -0.36   0.725    -3.491209    2.468529
     WWgrate |  -.0394746   .0986378    -0.40   0.693    -.2446032     .165654
     DoIndex |  -2.137268    1.13211    -1.89   0.073    -4.491619    .2170837
     CCprice |   .2891596   .3227482     0.90   0.380     -.382032    .9603512
       _cons |   .2662027   .1922874     1.38   0.181    -.1336807    .6660862
------------------------------------------------------------------------------
```

The coefficients are indications of a mix relationship with the oil prices and in this model. For example, as the growth rate of copper prices increase by $1, the growth rate of oil prices increase by $0.2891596. In reality, the negative relationship between gas production and oil prices is indicates that as the demand of gas production increase, that lead to decrease oil prices, which is the opposite to the previous models' results.

Regressing all the primary independent variables and their new created quadratic independent variables with the dependent variable (regressing the following; OOprice, OOprod, GGprice, GGprod, OOreserv, WWgrate, DoIndex, CCprice, OOprod2, GGprice2, GGprod2, OOreserv2, WWgrate2, DoIndex2 and CCprice2), will result as follow

Table (28) Third Model Multiple Linear Regression -B-

| Source | SS | df | MS | | |
|---|---|---|---|---|---|
| | | | | Number of obs | = 29 |
| | | | | F( 14, 14) | = 1.71 |
| Model | 3.62054806 | 14 | .258610576 | Prob > F | = 0.1623 |
| Residual | 2.11183803 | 14 | .150845574 | R-squared | = 0.6316 |
| | | | | Adj R-squared | = 0.2632 |
| Total | 5.73238609 | 28 | .204728075 | Root MSE | = .38839 |

| OOprice | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| OOprod | -24.98321 | 7.696949 | -3.25 | 0.006 | -41.49153 | -8.4749 |
| GGprice | .7727981 | .3967791 | 1.95 | 0.072 | -.0782084 | 1.623805 |
| GGprod | -5.800121 | 18.97218 | -0.31 | 0.764 | -46.4914 | 34.89115 |
| OOreserv | -.0725663 | 4.164046 | -0.02 | 0.986 | -9.003557 | 8.858424 |
| WWgrate | .1177302 | .2613717 | 0.45 | 0.659 | -.4428564 | .6783167 |
| DoIndex | -1.720624 | 1.262407 | -1.36 | 0.194 | -4.428218 | .9869688 |
| CCprice | .6027976 | .6189288 | 0.97 | 0.347 | -.7246726 | 1.930268 |
| OOprod2 | 496.7726 | 259.4042 | 1.92 | 0.076 | -59.59404 | 1053.139 |
| GGprice2 | -.4803147 | .3189881 | -1.51 | 0.154 | -1.164476 | .2038466 |
| GGprod2 | 15.25345 | 281.6778 | 0.05 | 0.958 | -588.8853 | 619.3922 |
| OOreserv2 | 1.020818 | 18.05777 | 0.06 | 0.956 | -37.70925 | 39.75088 |
| WWgrate2 | .0595544 | .0841191 | 0.71 | 0.491 | -.1208631 | .2399719 |
| DoIndex2 | -10.22927 | 14.86283 | -0.69 | 0.503 | -42.10688 | 21.64834 |
| CCprice2 | -1.24266 | 1.015411 | -1.22 | 0.241 | -3.4205 | .9351797 |
| _cons | .4334298 | .3264033 | 1.33 | 0.205 | -.2666357 | 1.133495 |

Regressing the dependent variable and the independents variables using the "robust", leads to the following result;

Table (29) Third Model Multiple Linear Regression -C-

```
. regress OOprice OOprod GGprice GGprod OOreserv WWgrate DoIndex CCprice, robust
```

Linear regression

| | |
|---|---|
| Number of obs = | 29 |
| F( 7, 21) = | 3.64 |
| Prob > F = | 0.0099 |
| R-squared = | 0.4003 |
| Root MSE = | .40459 |

| OOprice | Coef. | Robust Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| OOprod | -13.68445 | 7.226287 | -1.89 | 0.072 | -28.71233 | 1.343439 |
| GGprice | .4711742 | .234476 | 2.01 | 0.058 | -.0164453 | .9587937 |
| GGprod | -1.408142 | 4.868577 | -0.29 | 0.775 | -11.5329 | 8.716617 |
| OOreserv | -.5113399 | .9761129 | -0.52 | 0.606 | -2.541278 | 1.518598 |
| WWgrate | -.0394746 | .0832123 | -0.47 | 0.640 | -.2125241 | .1335749 |
| DoIndex | -2.137268 | .8347306 | -2.56 | 0.018 | -3.873185 | -.4013502 |
| CCprice | .2891596 | .3998304 | 0.72 | 0.478 | -.5423332 | 1.120652 |
| _cons | .2662027 | .175348 | 1.52 | 0.144 | -.0984535 | .6308589 |

Adding the growth rate of interest rate as a new independent variable does not change a lot. The R-square still below 50%.

Table (30) Third Model Multiple Linear Regression -D-

```
. regress OOprice OOprod GGprice GGprod OOreserv WWgrate DoIndex CCprice IIntRate
```

| Source | SS | df | MS |
|---|---|---|---|
| Model | 2.4322792 | 8 | .3040349 |
| Residual | 3.30010689 | 20 | .165005345 |
| Total | 5.73238609 | 28 | .204728075 |

| | |
|---|---|
| Number of obs = | 29 |
| F( 8, 20) = | 1.84 |
| Prob > F = | 0.1278 |
| R-squared = | 0.4243 |
| Adj R-squared = | 0.1940 |
| Root MSE = | .40621 |

| OOprice | Coef. | Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| OOprod | -14.07783 | 5.185077 | -2.72 | 0.013 | -24.89371 | -3.261946 |
| GGprice | .4204563 | .2356144 | 1.78 | 0.090 | -.0710267 | .9119394 |
| GGprod | -2.477902 | 5.489884 | -0.45 | 0.657 | -13.9296 | 8.973796 |
| OOreserv | -.5004253 | 1.438684 | -0.35 | 0.732 | -3.501467 | 2.500617 |
| WWgrate | -.0500342 | .0997066 | -0.50 | 0.621 | -.2580185 | .1579501 |
| DoIndex | -2.392071 | 1.170436 | -2.04 | 0.054 | -4.833558 | .0494155 |
| CCprice | .1151132 | .3760009 | 0.31 | 0.763 | -.669211 | .8994374 |
| IIntRate | .2207794 | .2419305 | 0.91 | 0.372 | -.2838788 | .7254376 |
| _cons | .3264762 | .2040429 | 1.60 | 0.125 | -.0991498 | .7521023 |

# CHAPTER 8

# CONCLUSION

Oil prices changes is one of the most sensitive topics in modern economics. Multiple events can influence the oil prices fluctuations. Compared to the independent variables that are mentioned earlier in the empirical results (1), the results provided here have updated the considerations regarding which independent variables are significant and which ones are insignificant. Including the war periods as a dummy variable showed an evidence about how oil prices were influenced by it, even the relationship between oil prices and wars as dummy variables was insignificant, and this led to the model results getting better. There is no non-linearity issue in the first model. However, there was multicollinearity between some of the independent variables. To solve that issue, the oil proved reserves has been dropped in the first empirical results, as it is an almost fixed amount every year which only shows very slight changes from one year to the next.

The results of testing hetroskedasticity has confirmed that there was no such issue in the model. Although autocorrelation occurred, it was very weak and almost insignificant at 5% level significant, but it was significant at 5%. The autoregressive time series model has confirmed how oil prices were non-stationary during that period, and the fluctuations of oil prices were very high in certain periods. The most significant variables that mainly influence oil prices are the oil production, growth rate of gas prices, gas production, and world economy annual growth rate of GDP.

Adding the second model, which is includes the same variables but calculated with the growth rate of each variable provides a weak model. The R-square of the regression dependent variable on the independent variables was very weak and most of the P values were insignificant at 5% significant level. The second model was better in the testing of linearity, multicollinearity, hetroskedasticity and autocorrelation. The third model has included two more independent variables, which are the growth rate of trade weighted U.S. dollar index and the growth rate of copper prices. The model in general was insignificant as the oil prices changes was explaining by 40% only of the independent variables.

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# VITA

Graduate School

Southern Illinois University

Issa Al Azri

issa_azri@hotmail.com

Sultan Qaboos University, Muscat, Oman

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