

# OIL PRICES AND ITS DEPENDENCE ON OIL RESERVES

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***Abstract:** Oil is a strategic raw material with many uses, mainly as a source of energy. As such energy source nowadays it cannot be replaced efficiently. More often oil is a reason for wars and disputes. It is exhaustible source of energy, with reduction in time. Lower supply and growing price are thus interconnected. Article is trying to find dependence of oil price on its reserves and predict the possible price development in the future, based on historical data about reserves and average oil prices. First, an oil production sector is analyzed, using SWOT analysis and analysis of offer and demand. On the side of offers there are countries named with biggest oil fields and than world supply as a whole. On the side of demand biggest oil users are defined and development of world needs for this raw material. Next, using Pearson correlation and Spearman ranks correlation coefficient a research was performed on dependence of two values (average oil price and oil supply during each year since 1980). Using polynomials a chart is build regarding future oil pricing, calculated from past development of quantities mentioned.*

***Keywords:** Oil, Supply, Price, Economic, Consumption.*

***JEL Classification:** G10, G17.*

## Introduction

Oil is becoming more and more a topic of many discussions. It is a strategic material of highest importance for energy, but as commodity for day-traders. Many times it was a cause of war conflicts. Thanks to its significant function it made some people rich and some countries strategic ally. Today's world relies on oil, bringing thus many risks, mainly because of shorter oil reserves. Diminishing oil reserves will influence all sectors of economy.

All sectors of course will be influenced by oil price. It is influenced by many factors. On one hand volume used mainly by fast developing economies is still growing, on the other hand the supply of easily extracted oil is reduced. Unrest in Middle East and Northern Africa are influencing the oil supply, since there are the biggest oil fields. Significant for oil prices formation are catastrophes such Exxon Valdez in March 1989, hurricane-Katrina in August 2005 or oil rig Deepwater Horizon British Petroleum disaster in April 2010. It is a fact, that there is less and less oil and most of known and available quantities are own by OPEC countries, it is nearly 80%. Reduced oil supply is going to influence all sectors of economy. In this article we shall concentrate on a key factor influencing oil price and that is oil reserves. The aim is to determine a level of oil price dependence just on such reserves, diminishing in the course of time.

# **1 Oil as a precious, non-renewable, resource of energy**

Oil is for this civilization the main resource of energy, it is one of most importance raw material for chemistry. For 95% of all goods oil is needed during their production, 95% oil derivatives is used in transportation. Oil importance is growing, since it is non-renewable, exhaustible energy resource.

Consumption is growing around the world. In 2010 daily use of oil grow by 3%, during last decade this was more than 12%. From year 2000 till today world oil reserves increased by only 25%, but during last year only by 0.5%. Growth of oil reserves was made possible by use of modern technologies which can extract oil not on reach 10 years ago. Such growth of oil reserves is smaller recently, confirming Huber Curve, resulting in statement that oil resources are non-renewable and exhausted; oil extraction is reaching its peak and than a decline is imminent. According to actual estimates, keeping level of consumption as of today, oil is going to be here for another 40 years.

## **1.1 Sector characteristics**

Oil during time became a vital raw material, since it is easy to transport, and concentrated source of energy, running all kinds of transportation vehicles. It is valuable and indispensable material for production of plastics, used for many goods production, from furniture to electronics, medicament's, pesticides and fertilizers...

Oil is classified according to its origin (WTI, Brent) and its density (light, medium-light and heavy). Used there are other names as well: sweet, containing less sulfur, or sour, with more than 0.5% sulfur, requiring elaborate processing. Other than those conventional types of oil there are large reserves of unconventional oil, mainly in Venezuela and Canada. Its share on world production is only 5%, since a big energy use for its extraction.

Originally extracted oil was transported in barrels, steel drums, and quantity of delivered oil was specified in such units. (bbl.) This production quantity and consumption is used today as well. Price is paid in US dollars (USD), and this is presented as USD/bbl. One metric ton of oil means according to the oil density 7 to 8 barrels (1 barrel volume is 0.158987 cubic meter.) Oil price is fluctuation on supply and demand, it is influence by political and other affairs, such as crisis. On commodities exchange mostly following types are quoted: Brent, WTI, Dubai, OPEC basket, and other prices of oil are directly tied to those named. It is needed to say, that price are quoted as spot price, FOB (Free On Board) or CIF (Cost, Insurance, Freight.) Price level can change if it is a long-term delivery contract, or spot purchase, coming from instant urgent need. It is influenced by US inflation rate as well, since the payment currency is mostly US dollar.

Oil price mostly means WTI variety quoted on NYME, New York Mercantile Exchange, or Brent oil, quoted on ICE, International Oil Exchange in London. It is derived from oil origin and quality.

Today oil is produced mainly by state-owned corporations in developing countries. The biggest ones are Saudi-Arabian ARAMCO, Russian GAZPROM, Chinese CNPC, Iranian NIOC, Venezuela PDVSA, Brazilian PETROBRAS and Malaysian PETRONAS. Those corporations are handling 1/3 of world oil and gas production and

influencing world price of those commodities. Crisis influenced this sector of economy as well, emerging in oil price fluctuation and fast destruction of oil demand.

## 2 Methods used

Oil production will be first analyzed by SWOT analysis. Strong and weak points will be formulated, sector opportunities and threats. Then we shall concentrate on oil value. It is formed by the price and US dollar exchange rate. Price is defined by offer and demand. On either side the oil reserves are playing important role, influencing both offer and demand. Aim of this study is to define oil price reliance on volume of proven reserves. Theory is formulated that  $H_0 =$  reliance of oil price and oil reserves is statistically of no importance ( $H_0: \rho_x = 0$ ). This theory will be analyzed using correlation analysis. Data about average WTO oil price and proven reserves since 1980 will be lined up.

Correlation coefficient can vary on type of statistical data variables researched. When random variables A and B are quantitative random variables with common two-dimensional normal distribution, for specific values  $(x_1, y_1), (x_2, y_2), \dots (x_n, y_n)$  a selective correlation coefficient defined by Pearson Correlation as

$$r = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2 \sum_{i=1}^n (y_i - \bar{y})^2}} \quad (1)$$

Sum of squares in denominator is n-1 multiple of selective spread. This is a reason, why more often we can see simple Pearson Correlation as

$$r = \frac{s_{xy}}{s_x s_y} \quad (2)$$

where  $s_x$  is determinant deviation of X, and  $s_y$  is determinant deviation of Y,  $s_{xy}$  is a co variation of X and Y variables.

$$r_{xy} = \frac{1}{n-1} \sum (x_i - \bar{x})(y_i - \bar{y}) \quad (3)$$

A correct interpretation of Pearson Correlation is assuming that both variables are random values with common two-dimensional normal distribution. Than Pearson Correlation with zero value means that variables are independent on each other. If the assumption of two-dimensional normal distribution is not met, from zero value of Pearson Correlation cannot be concluded nothing more that variables are not correlated. [4]

When by test of normality it is discovered that it is not a normal distribution of one of the variables, to measure the X and Y correlation a Spearman rank correlation can be used.

Using polynomials, an effort to determine possible future development of oil price, based on its reserves, is performed. We will than use the same data as with Pearson Correlation, proven reserves value and WTI average price since 1980.

### 3 Oil industry sectors analysis

Comparing strong and weak sides of this industry, one can see that oil is as of now irreplaceable energy source, basic raw material for energy production with widespread utilization possibilities. On the weak side there are high cost of scientific and technological development, protection of environment, and high cost of oil deposits and drilling research.

Among others, opportunities on new oil deposits research and China dependence and other developing countries on energy resources are included. On the dangers side it is oil exhaustion, natural disasters and political disputes, influencing oil production.

**Fig. 1: SWOT analysis of oil production and oil processing sectors**

<b>Strengths</b>	<b>Weaknesses</b>
Use for energy production, chemical industry and other sectors. Basic energy commodity (price fluctuation). Higher caloric index than coal. High mobility and transport property. Wide utilization. Non-renewable source of energy as of now (not counting water, wind, solar, biomass, geothermal sources) It is a motor of world economy since 10 <sup>th</sup> century. Unpredictable geo-strategic weapon and specific commodity (oil embargo 1973...). Main factor of international relations.	High investment and financial resources requirements of oil resources research and production costs. Cost of scientific and technological development. Cost of ecology protection and environmental protection. Negative influence on environment such as greenhouse gas, oil catastrophes and disasters. Source of global, regional conflicts and wars, Kuwait, Iraq, Iran etc....
<b>Opportunities</b>	<b>Threats</b>
New deposits research. Developed countries ability to influence energy needs. Developing countries (China, India etc) dependence on energy resources growth. Adjustment of EU energy policy (prices, electric power consumption, environmental protection, lack of electricity resources etc...) Fuel consumption growth in road and air transportation sectors.	Estimate of world oil reserves is about 12.5 billion barrels. Future decrease of oil output. Natural disasters (hurricanes...). Social and political instability (terrorism...). Prognosis of oil prices increase exists up to 300 US dollars (barrel causing a domino effect with other energy products and resources. Replacing oil products by alternative products.

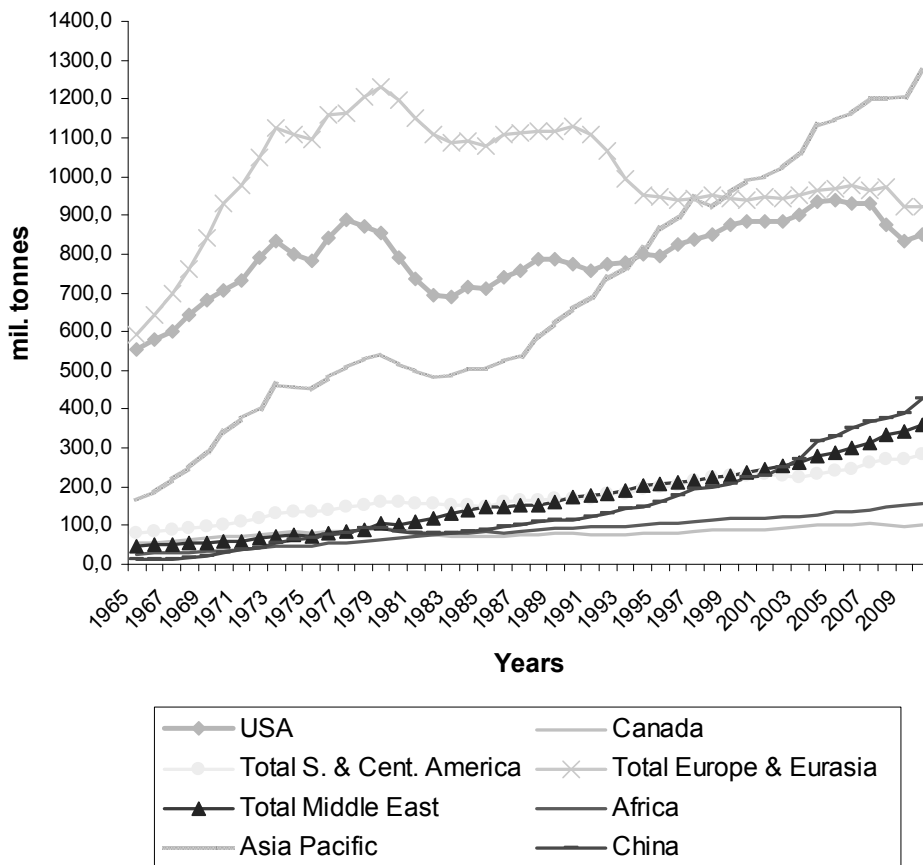
*Source of data: Authors*

#### 3.1 Demand for oil and oil consumption

Oil price is influenced by offer and demand. On the side of demand are practically all Earth inhabitants. With the civilization development there is growing need for

energy. Need for heat, electricity to make home appliances work and need to run growing number of automobiles. There is industry as well, consuming the main part of oil resources. All those factors are influencing oil consumption.

**Fig. 2: Oil Consumption**



Source of data: Authors

Analyzing oil consumption by territory (see Fig 2.) biggest single consumer is US. Its needs are during the last 10 years lower by nearly 4%, but are still ¼ of total world consumption. Second it is China, where contrary to the US trend consumption during last 10 years was growing by more than 90%, using during 2010 unbelievable 428 million tons (about 3.2 billion barrels). China, together with other Asian nations (mainly Japan, South Korea, and India) are forming group of states (in Fig 2 as Asia Pacific) with the greatest use of oil in the world. Total oil consumption growth during last 10 years was more than 12%, since 1967 this is 160%.

### 3.2 Oil supply and reserves

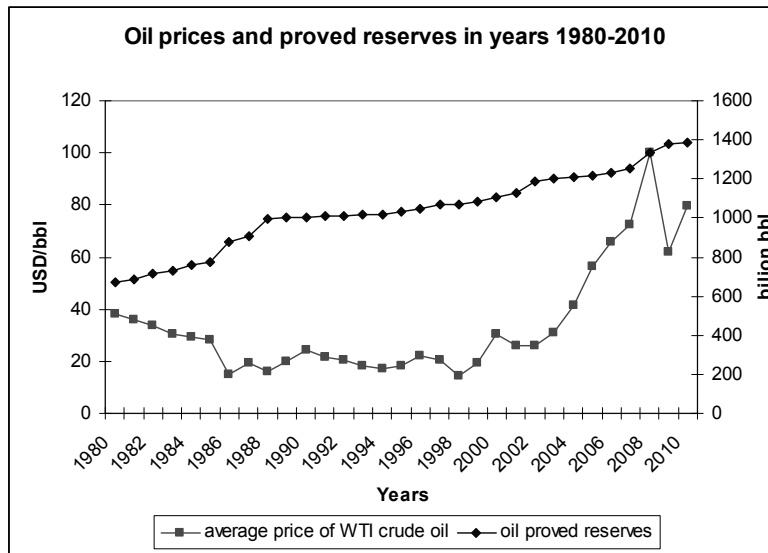
Oil supply is influenced mainly by the size of world reserves, drilling quotas from OPEC side, political tensions and other supply shocks. It is therefore valid that many oil fields are drying out and many of them are found in countries with unstable political regimes. Even that many efforts are made to find new deposits, no significant ones were found.

Biggest oil reserves are in Saudi Arabia, 20% of world volume. Other big reserves are in Venezuela, 15%, Iran with 10%, Iraq 8%, and United Arab Emirates, 7%. OPEC countries are controlling nearly 80% of all oil reserves in the world.

Based on territorial analysis we can state that 55% of oil fields are in Middle East, 17% in South America, 10% in Europe and Eurasia (Russia has only 5% of world reserves), 10% in Africa, where Libya and Nigeria alone are supervising 60% of all African reserves and rest of the volume is in North America and Asia.

Oil price and reserves development can be seen on Fig.3. Reserves are growing since 2008, during the last 3 years only by 3%. Those reserves are growing thanks to new mining technologies, allowing to produce oil where few years back it was not possible. Price is fluctuation during the time, growth can be observed since 2003, where WTI oil price inflated from 30 US dollars/barrel to more than 100 US dollars/barrel. As of now, it is around 90 USD/barrel.

**Fig. 3: Oil prices and proved reserves in years 1980-2010**



Source of data: Authors, [ 1]

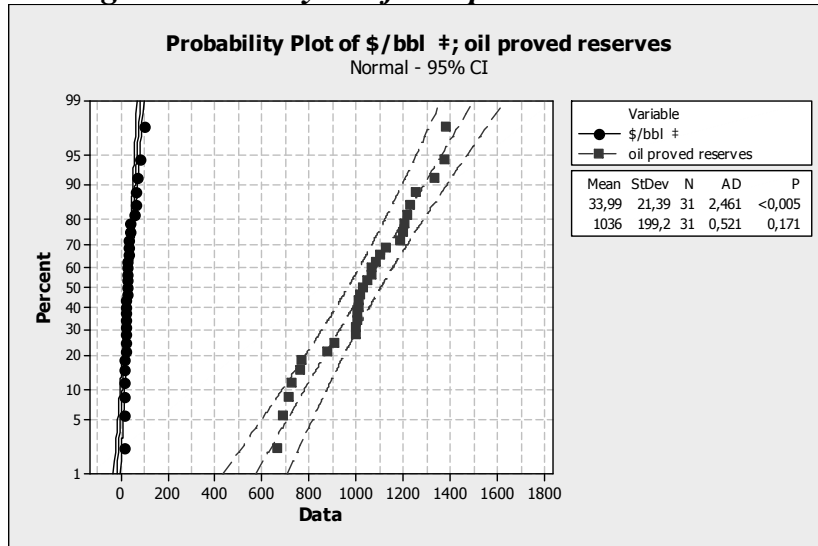
### 3.3 Influence of oil reserves on oil price

To express the level of dependence of those two variables first a Pearson Correlation is used:

Pearson correlation of \$/bbl and oil = 0.548

P-Value = 0.001

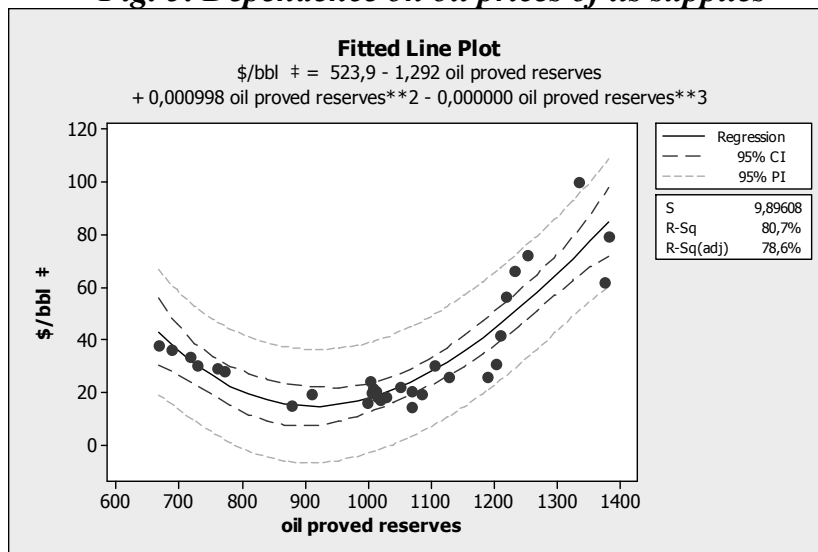
**Fig. 4: Normality test for 2 quantitative variables**



Source of data: Authors, Matlab

One of the variables is not from normal setting, than we will use Spearman rank correlation.

**Fig. 5: Dependence on oil prices of its supplies**



Source of data: Authors, Matlab

P-value with asymptotic and exact test is  $\leq \alpha (0.05) \Rightarrow$ , hypothesis  $H_0: \rho_x = 0$  is than rejected. Correlation between two quantitative variables is of statistical importance, positive one and of medium strength (0.4153).

## 4 Discussion

Based on correlation analysis presented in this article, dependence of oil price on size of oil reserves is statistically significant. Medium-strength dependence exists between those quantitative values. Since the size of oil reserves is one of the key factors influencing its price, we will rat to predict a future possible development of such price, comparing historical reserves and historical average prices.

To predict a WTI oil price development during coming years, we did test first to fourth order polynomials the results as follows:

Linear model Poly4:

$$f(x) = p1*x^4 + p2*x^3 + p3*x^2 + p4*x + p5 \quad (4)$$

Coefficients (with 95% confidence bounds):

$$p1 = -2.673e-009 \quad (-5.115e-009, -2.303e-010)$$

$$p2 = 1.089e-005 \quad (7.328e-007, 2.105e-005)$$

$$p3 = -0.01599 \quad (-0.03158, -0.0003931)$$

$$p4 = 10.04 \quad (-0.4256, 20.5)$$

$$p5 = -2250 \quad (-4832, 332.2)$$

Goodness of fit:

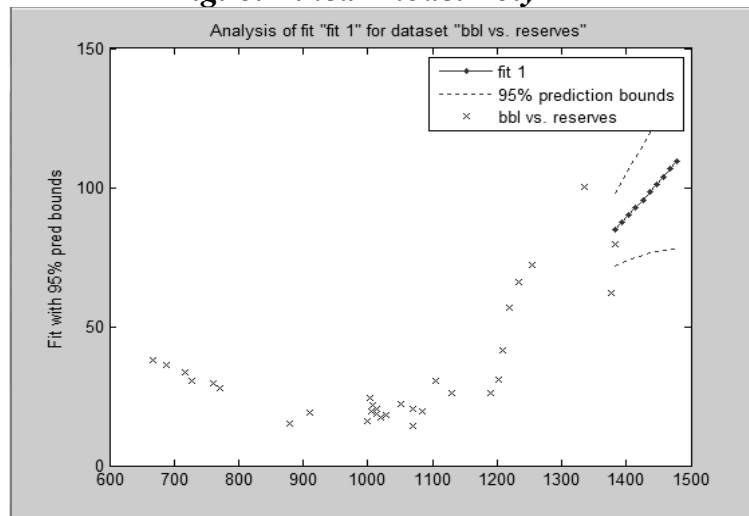
SSE: 2213

R-square: 0.8387

Adjusted R-square: 0.8139

RMSE: 9.226

**Fig. 6: Linear model Poly4**



Source of data: Authors, Matlab

Statistically most precise is a fourth-order polynomial. Its parameters are according to interval estimates statistically significant and determinative coefficient value is indicating that model explains 83.87% variability in data. As of oil price prediction in connection of oil reserves, previous Fig.4 shows with dashed line prediction boundaries including the curve of estimated probable development. This curve is closer to the upper boundaries of prediction, which means, that during the coming years small growth in oil reserves with average oil price growth, up to the 100 US dollars/barrel level, as it was during 2008.



## Conclusion

Aim of this article was to discover level of oil price dependence on its actual proven reserves. First the oil industry SWOT analysis was performed, specifying strong and weak points, occasions and dangers. As of strong points there is a widespread use of oil, its uniqueness, and the fact that it is irreplaceable as a source of energy. Weak points are: High costs of scientific and technological development and cost of environmental protection connected with oil production. As a chance there is a search and development of new oil reserves, and China and other developing countries reliance on energy resources. On the other hand, oil industry dangers are in decreasing oil production, oil reserves depletion, political instability and natural disasters.

Offer and demand for oil was than analyzed, the most important determinants of oil price. US are the greatest consumer of oil, consumption there means  $\frac{1}{4}$  of world oil needs. On the other hand in the US are only 2% of world oil reserves. Biggest oil reserves can be found in Saudi Arabia, where 20% of world oil reserves can be found. On the side of offers the biggest block of oil producers is OPEC, controlling nearly 80% of world reserves. Actual proven reserves of this commodity are around 1.5 billion barrels, which with current level of consumption could last for another 40 years.

Analyzing dependence using Spearman rank correlation there was discovered a significant statistical relation between size of oil reserves and oil price. It is positive and medium dependence. Theory about insignificance of dependence among oil price and its reserves was rejected.

Using polynomials future possible development of oil prices was predicted. Statistically most significant was polynomial of 4<sup>th</sup> order, explain g 83.87% variability in data figures. According to such polynomial the average price during the incoming years shall be on 100 US dollars/barrel barrier again as in year 2008.

OPEC predicts oil prices in the next decade between 85-95 USD/barrel. In the next years, the oil price forecast to grow above \$ 100 per barrel. The volume of oil would be in the next two to three years to grow enough to meet demand growth. OPEC also pointed to the possibility of higher prices due to unrest in North Africa and the Middle East.

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