ANALYSIS OF OIL PRODUCT PRICES - SELECTED PRACTICAL ISSUES

E + M

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1. Introduction: Crude Oil and its Price

Crude oil is combustible liquid [1], exploited from the subterrestrial oil-fields and is one of the most significant energy sources. In the year 2006 crude oil represented about 36.4 % of the world energy consumption.

A great number of oil products are produced from crude oil, for example: gasoline, diesel fuel, jet kerosene, liquefied petroleum gases, lubricants, heavy and light fuel oils, bitumens etc.

Currently the world crude oil production amounts to about 78 million barrels per day. Since the year 1969, when the production reached the number of 41 million barrels per day, this figure has almost doubled. The annual growth of the daily consumption of crude oil amounting to 1.8 million barrels (2 %) in the period of 2006 - 2011 can be expected based on the assumption that the world economy rapidly grows.

The total daily demand should rise from 84.8 million to 93.7 million barrels in the year of 2011. The consumption of Asian countries should catch up with the consumption of the North America. This growing consumption is influenced by globalization of international trade and the economic growth of Asian countries. Multinational enterprises are moving their production plants owing to lower production costs in Asian countries and consequently the products are exported from Asia back to highly developed countries. The transportation increases the consumption of fuels.

The various types of crude oil are traded on the commodity exchange. The prices of a part of the types of crude oil are derived from the „main" types.

The main types of crude oil are:

1. Brent - comprising 15 types of crude oil from oil fields in the Brent and Ninian systems in the East Shetland Basin of the North Sea (during the period from 1976 to 1984 it was named „Forties");
2. WTI - West Texas Intermediate - North American crude oil;
3. Dubai - crude oil from the Persian Gulf (during the period from 1972 to 1986 it was named „Arabian Light");
4. Nigerian Light - Nigerian crude oil;
5. Tapis (crude oil from Malaysia, used as a reference to light Far East oil);
6. Minas (from Indonesia, used as a reference to heavy Far East oil);
7. The OPEC Reference Basket, a weighted average of crude oil blends from various members of OPEC (Organization of Petroleum Exporting Countries - a legal cartel).

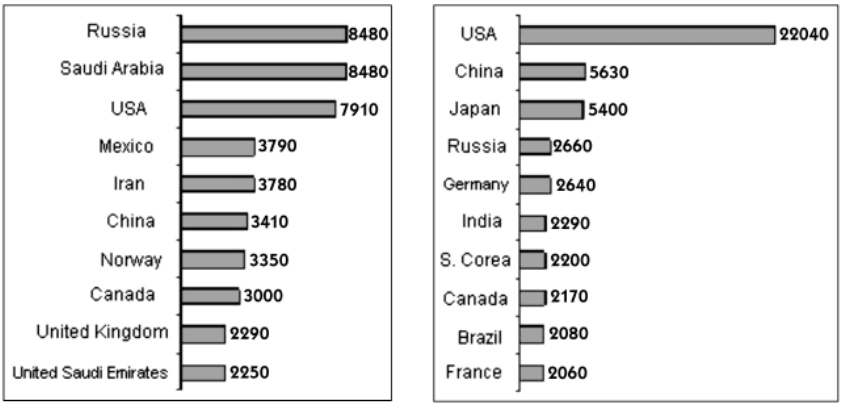
The great majority of crude oil is not traded on a stock exchange but on an over-the-counter basis (an over-the-counter contract is a bi-lateral contract in which two contracting parties agree with a particular trade or agreement that will be settled in the future), typically with reference to a marker crude oil grade that is quoted via pricing agencies such as Platts [6].

The REBCO (Russian Export Blend Crude Oil) is mostly processed in The Czech Republic. Its price is derived from the price of crude oil Brent.

The prices of different types of crude oil are derived from its characteristic features, especially its density, the sulphur content and the metals content (vanadium, nickel). In recent years the price of the crude oil (Brent) has oscilated from 45 to 75 USD/bbl. (barrel; 1 bbl = 158,987294928 liters) (See Fig. 2). Experts say that the „magical" price 100 USD/bbl. will be exceeded very soon. The trouble arises for crude oil processing enterprise when the prices of products do not follow the growing price of crude oil.

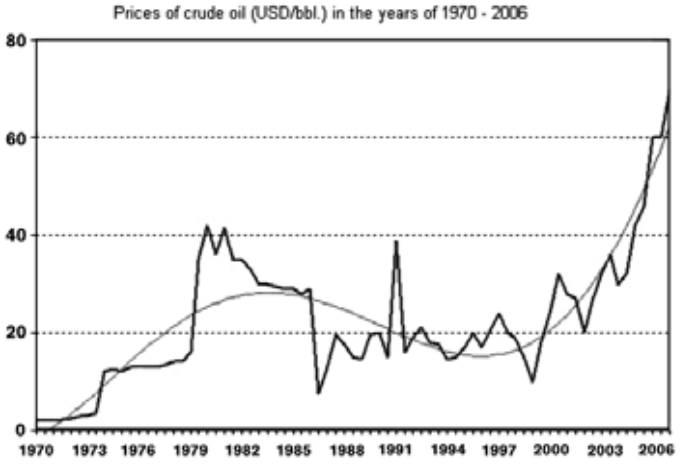
While the fuel (gasoline, diesel fuel) prices react based on the price fluctuation immediately, the prices of other products (e.g. bitumens, lubricants) react to the growth of crude oil prices with delay or do not react at all. This situation has a negative impact on the so-called refinery margin, it means that it decreases the profitability of refinery.

Fig. 1: The biggest producers (left table) and the biggest consumers (right table) of crude oil - daily production/consumption in thousands bbl. a day



Source: EIA

Fig. 2: The crude oil prices on the world markets



Source: EIA, WTRG

2. The Refinery Margin

The refinery margin could be approximately defined as a difference between the value of products (the outputs from the production) and the variable costs (crude oil costs, energy costs, other resources costs). The refinery margin indicates how the refinery is able to cover the fixed and variable costs. The refinery generates profit if the refinery margin reaches a certain positive figure. The refinery generates loss by a lower figure. However, the processing covers a part of the fixed costs, the more crude oil is processed, the lower is the loss.

During the decline in the refinery margin to the negative figures the refinery does not cover either the variable cost, such that the permanent loss owing to not covering of the fixed costs adds other loss relating to the variable costs. The more crude oil is processed, the higher is the loss. The refinery margin value around zero is the breaking point. On the basis of this breaking point we can claim that further refinery running makes no sense.

Each refinery has its own products configuration [2] [4], i.e. its own product portfolio. It

is evident that each refinery has also its own refinery margin. The so-called complex refineries gain higher yields of the so-called light products thanks to the deep crude oil processing.

The so-called notional refinery upgrade (the profitability of the hypothetic refinery, refinery margin, NRU) is the standard measure of value applied to the analysis of the actual level of profitability of the refinery business. Its value results from the assumption that we would run the refinery in Rotterdam where all the standard refinery products are quoted.

The NRU is based on the basis of the hypothetic yields vector of the particular configuration of a hypothetic refinery, the crude oil prices and quotation based prices of oil products.

We can distinguish between the average refinery margin (USD per barrel) and the gross refinery margin (GRM) that can be defined if we multiply the average refinery margin by the quantity of processed crude oil (in tons). If we deduct the sum of the fixed costs from the GRM, we can obtain the approximate operating income of the refinery.

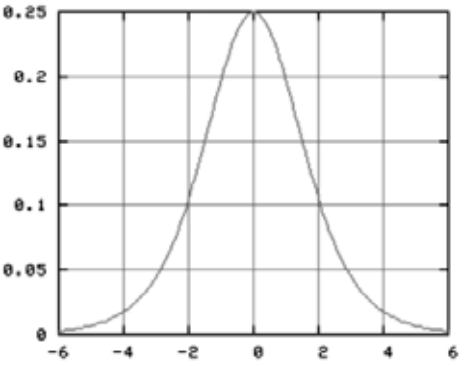
3. The Hubbert Peak Theory

The Hubbert peak theory [3] has to be mentioned in all articles concerning the oil market. The peak theory became very popular during the world oil crisis in 1973. This theory seeks the date when the world crude oil consumption starts to decrease. This theory says that any finite resource will have a beginning, middle, and end of production, and at some point it will reach a level of maximum output. In 1956 geologist Marion King Hubbert predicted the peaking of US Oil production, which occured in the late 1960's. Hubbert supposed that after fossil fuel reserves are discovered, production firstly increases approximately exponentially, as more extraction commences and more efficient facilities are installed. At some point, a peak output is reached, and production begins to decline until it approximates an exponential decline.

The Hubbert peak theory is presented in the Hubbert curve that is the derivative of the logistic function.

$$x = \frac{e^{-t}}{\left(1+e^{-t}\right)^2} = \frac{1}{2+2\cosh t} \qquad (1)$$

Fig. 3: The quotation based prices of the ULSD



Source: Wikipedia

Hubbert predicted that the world oil peak would happen in 2000. Some oil experts say that the world oil production peak has already taken place while other oil experts argue that it hasn't. The peak oil is a controversial issue.

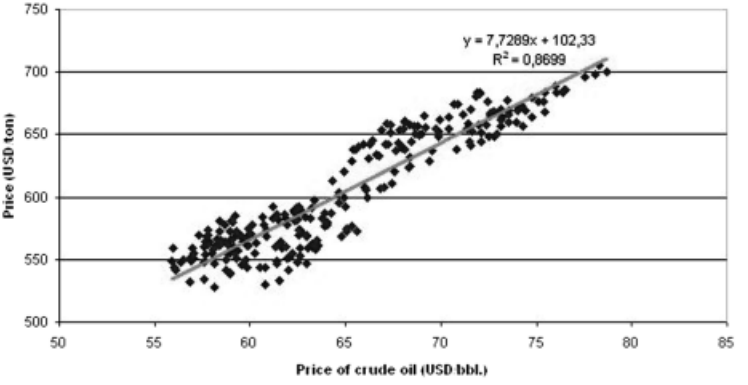
4. The Oil products and their Prices

It is usual in the Czech Republic that producers set the prices of motor fuels on Mondays, these prices are valid from Tuesday till the following Monday, including these days.

We can distinguish several variables that determine the prices of motor fuels:

1. The quotation based prices of the products - the average of quotations for each product on the basis of the FOB Barges Rotterdam from the previous calendar week (Monday - Friday) is used for setting prices.
2. Currency exchange rate CZK/USD - the average of the exchange rates (CZK/USD) of the previous week (Monday - Friday) is used from setting prices.
3. The referential density (it is mostly the invariable) - the referential density of diesel oil is 845 kg/m3, of the gasoline is 755 kg/m3.
4. The so-called inland premium (IP) - the fixed figure in USD that is added to (1), results from the business policy of the refinery.
5. The consumer tax - based on the valid legislation. Presently the consumer tax is 9.95 CZK/liter (diesel oil), 11.84 CZK/liter (gasoline) and 472 CZK/ton (heavy fuel oils).

Fig. 4: The quotation based prices of the ULSD



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Business customs allow a modification of these variables - for example the usage of the average of the quotations of the current calendar month.

The prices of other oil products (for example lubricants, bitumens, sulphur etc.) are set quarterly, half-yearly or yearly (a certain price of crude oil is expected for a certain period) or the prices are set for a particular business transaction. However, these product prices can be related to the quoted prices (for example the lubricants related to the prices of VGO).

5. The Analysis of the Quotation based Prices of the Selected Oil Products

As it was stated above, this article is focused on the analysis of the trend of the quoted prices of diesel oil (ULSD), gasoline „BA 95"(PREM UNL) and the heavy fuel oil with up to 3.5 % sulphur content (HSFO 3.5 % S). The daily averages of the „low" and „high" quotations of all products in the year of 2006 are used.

The prices of the North Sea crude oil Brent are used in this analysis (as stated above, the REBCO (Russian Export Blend Crude Oil) is mostly processed in the Czech Republic). The prices of REBCO depend on the prices of Brent. The prices of REBCO are reduced by the so-called discount that ranges from 2.5 to 5 USD/bbl. The prices are quoted in USD. The authors of this article suppose that the dependence of the prices of oil products on the price of crude oil is linear. When the prices of crude oil grows we can expect the growth of the prices of oil products.

a) Diesel fuel (ULSD)

It is evident from the empirical results that the prices of diesel fuel follow the price of crude oil very sharply and with high accuracy. The dependence of the prices of diesel oil (dependent variable) and the price of crude oil (independent variable) in the year of 2006 is demonstrated in this regressive function [5] (See Fig. 4):

$$y = 7{,}7289x + 102{,}33 \qquad (2)$$

The correlation coefficient is 0.9327 (very strong correlation), it means that the prices of diesel oil follow with 93% accuracy the prices of crude oil.

b) Gasoline „BA 95 Natural" (PREM UNL)

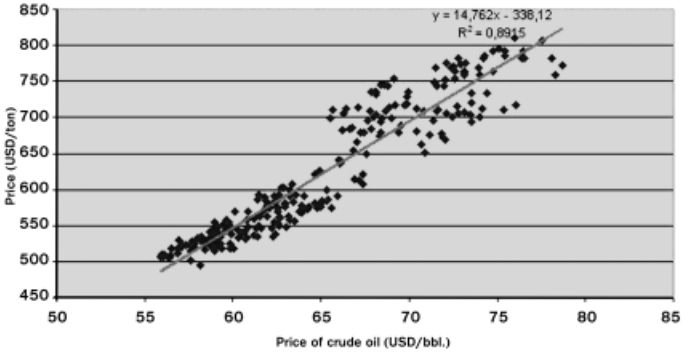
It is also evident from the empirical results that the prices of gasoline follow the price of crude oil very sharply and with high accuracy.

The dependence of the prices of gasoline (dependent variable) and the price of crude oil (independent variable) in the year of 2006 is demonstrated in this regression function (See Fig. 5):

$$y = 14{,}762x - 338{,}12 \qquad (3)$$

The correlation coefficient is 0.9442 (very strong correlation), it means that the prices of ga-

Fig. 5: The quotation based prices of the PREM UNL



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soline „BA 95 Natural" follow with 94 % accuracy the prices of crude oil.

c) The heavy fuel oil with up to 3.5 % sulphur content (HSFO 3.5 % S)

The prices of the heavy fuel oil with up to 3.5% sulphur content are supposed to follow the prices of crude oil with a certain accuracy but not with such a strong accuracy as we can see above [7].

The dependence of the prices of the heavy fuel oil with up to 3.5% sulphur content (dependent variable) and the price of crude oil (independent variable) in the year of 2006 is demonstrated in this regression function (See Fig. 6):

$$y = 3{,}3188x + 71{,}05 \qquad (4)$$

We can assume on the basis of this analysis that the correlation coefficient amounts to 0.8040 (strong correlation), it means that the price changes of the heavy fuel oil can possibly be explained by 80 % of the change of the price of the crude oil.

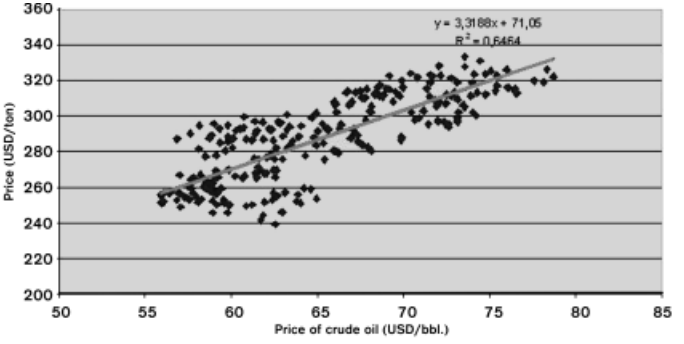
If we took a look at the dependence of the prices of other oil products that are not based on the quotation based prices (for example sulphur, bitumens, lubricants) and the prices of crude oil, we could come to a conclusion that the correlation between the prices of these products and prices of crude oil is not so significant.

In this case we can not use the prices stated in commodity exchange, we ought to bring the specific selling prices of a certain firm thereby we would break business secret.

6. Retail Prices

The retail prices are not the same as the quotation based prices. There are some differences

Fig. 6: The quotation based prices of the HSFO 3.5 % S



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caused by some factors that influence these prices. If we speak about the retail prices, we have to explain what the retail business is. It is all the retail customers that buy oil products. These customers are as follows:

- Petrol stations - petrol stations sell motor fuels (diesel oil, gasoline, LPG). The more significant petrol station chains have better purchase conditions than a single „no name" petrol station, especially the petrol station chains with an international brand. Some of them are specialized in the firm customers that prefer „all inclusive". It means that this sort of customers is willing to buy motor fuels for higher prices but they require better level of services (shop, restaurant, wash-stand, coffee bar etc.). Recently, the market share of supermarket petrol stations increases.
- Industrial firms - buy motor fuels, lubricants, industrial oil, greases, sulphur, fuel oils, petrochemical products, etc.
- Transport and construction firms - buy motor fuels, lubricants, industrial oil, greases, bitumens, bitumenous products. The season has a big influence on the demand.

These main factors determining the retail prices are:

- business policies of oil products producers and wholesalers;
- actual demand and supply at the decisive market;
- competition;
- illegal cartel agreements among traders;
- behavior of the price making leader(s);
- solvency of end-consumers;
- seasonal factors - farmers increase demand for motor fuels during the harvest period, construction firms during the construction season, winter time increase the consumption of heating oils etc.;
- the variability of the quotation based prices;
- demand shocks - rapid decreasing of demand (for example due to the break-down of refineries and supply failures).

7. Conclusion

The mathematic functions, mentioned above, could be used for „forecasting" (for more info please see [9]). the prices of oil products for the future period. We can forecast the prices by means of other method (for example Fourrier analysis).

This article emphasize the term „refinery margin" that should give the crude oil processors a guidance in running production. The refinery should try to maximize the total amount of its gross refinery margin. These efforts can be successful if the price makers know all the causalities, mentioned in this article, and prices correlations that can be formalized by the means of mathematic - statistical methods. Thanks to this approach the oil product businessmen (including the oil product producers included) can speculate in stock („bear" or „bull" speculations) for example by the means of financial derivates or on the market by the means of over-the-counter contracts.

Modern management of the refineries is based on the application of wide range of tested methods (for example PIMS, JUST-IN-TIME, ABC/M etc.). In connection with the changes on the oil market the crude oil processors ought to modify the product configuration by the means of sophisticated technologies (visbreaking, fluid catalytic cracker, hydro cracker etc.).

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ABSTRACT

THE ANALYSIS OF THE OIL PRODUCTS PRICES - SELECTED PRACTICAL ISSUES

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The introduction to the issues of the economics of the crude oil processing enterprises (refinery) and the analysis of the relationship between the crude oil price (the input of the refinery) and the prices of selected oil products (the output of the refinery) in the year of 2006 is the basic target of this paper.

The stock quotation prices of the selected oil products (ULSD - diesel fuel, PREM UNL - gasoline „BA 95 Natural" and HSFO 3.5 % S - heavy fuel oil with up to 3.5 % sulphur) on the basis of FOB Barges Rotterdam (traded on the commodity stock exchange in Rotterdam) and the prices of the North Sea crude oil Brent are used in this analysis. The prices are quoted in US dollar.

The prices are analyzed by the means of regression and correlation analysis. The term „refinery margin" and its application in practical use with reference to the production configuration of the crude oil processor are explained in this article. The regression functions can be used for prediction of the oil products prices trend. These functions could be essentially changed in future with reference to the relevant changes on the fuel products market (for example a strong shift to fuels with biological components) or due to the decrease of the importance of crude oil as a natural resource. Furthermore, the popular oil peak theory by geologist Hubbert is presented here. It is possible to say that it would be fine to think about other economic issues, concerning the crude oil industry economics - the negative externalities related to the crude oil processing and the fossil fuels consumption.

Key Words: *refinery margin, crude oil Brent, FOB Barges Rotterdam, platts, regression and correlation analysis.*

JEL Classification: *L72, M11*