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The uncertainty of oil price forecasts

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The Annual Energy Administration publication "Annual Energy Outlook" provides long-term oil price forecasts, which generally deny previous oil price forecasts. The purpose of this work was to assess the adequacy of oil price forecasts. A number of models used in oil price forecasts to assess and determine the indicators influencing the oil price change have been reviewed. In assessing long-term forecasts of oil prices, two different models were considered: multi-regressive and artificial neural networks. The resulting predicted oil prices were compared with the International Energy Agency oil price predictions.

Key words: oil price forecasts, artificial neural networks, multiple regression

1. INTRODUCTION

At the end of each year, the U. S. Department of Energy together with the Energy Information Administration releases an Annual Energy Outlook [1]. This review provides forecast data for various types of fuel prices and consumption levels in the world, with respect to varying global factors: gross domestic product, population number, resources and the changes of reserves. In the existing energy resources projections (IEA, etc.), the annual global oil consumption is projected to grow by 1.6 to 1.9% and in 2030 to reach 120 million barrels per day (bbl/d). These projections state that oil prices would be within reasonable limits to ensure the satisfaction of demand. In addition, global oil resources, the maximum amount of oil production, oil distribution to consumers, optimal investment and refinery capacities have been assessed. This publication contains projections of fuel prices for 25 years and their comparison with the forecasts of others institutions. The predicted differences of oil prices are slight. However, when the actual oil prices and the projected ones are compared, a mismatch is visible [2]. While trying to explain the saltatory evolution of prices due to oil supply and consumption imbalances, external reasons are mentioned [3]. In this case, oil price uncertainty factors can be divided into the following groups:

– oil stock levels,
– excess production capacity,
– the amount of investment,
– the rate of inflation,
– trade structure,
– geo-political factors,
– strategic oil reserves.

However, wars, natural disasters, oil production and consumption imbalances are the phenomena that have their beginning and end, and the price of oil stabilizes at a certain level.

Having in mind that these factors are repetitive and are reflected in price changes, several groups of methodologies of assessing oil price forecasts for a certain period have been created. There are three oil-price prediction models based on regression equations [4], time series [5, 7] and the recently popular of artificial neural networks and their various modifications [8–10].

Long-term oil price forecasts have a large dispersion of the results [2], which mainly reflects the present situation. If oil production is not insufficient, oil prices are evaluated with the help of alternative ways through the price of petroleum products [12].

2. INDICATORS THAT DICTATE OIL PRICE

Short-term and long-term oil price fluctuations are closely linked to economic cycles [9]. The cyclical nature of these economic fluctuations is not predictable. Four phases of a cycle can be pointed out, wich are recession, recovery, prosperity and depression. The chronology of these business cycles is different in different countries and is determined by a number of cyclically recurring economic indicators [13]. Although economic cycles in different countries occur at different periods, the greatest importance of oil price fluctuations is attributed to the economic cycles of Economic Cooperation and Development (OECD) countries because the maximum amount of oil is imported by the United States and the European Union – the OECD member countries.

The functional dependence for oil demand of the gross domestic product (GDP) growth in OECD countries can be expressed by a regression equation:

$$Y = -0.04717 + 2.074X. \qquad (1)$$

This regression relationship is shown in Fig. 1, based on the annual data of 1965 to 2007 [14, 15]. The equation correlation coefficient $|R| = 0.83$ shows that the GDP growth rate is closely related to the change in oil demand in OECD countries.

A correlation between the maximum economic cycles in OECD countries [15] and the maximum of oil prices [14] from 1986 to 2008 shows a strong mutual bond (correlation coefficient $R = 0.75$). A comparison of oil prices and the prices of non-ferrous metals (Fig. 2) shows that in the context of global economy and business cycle dynamics, regardless of the amount of resources and places of extraction, the trends

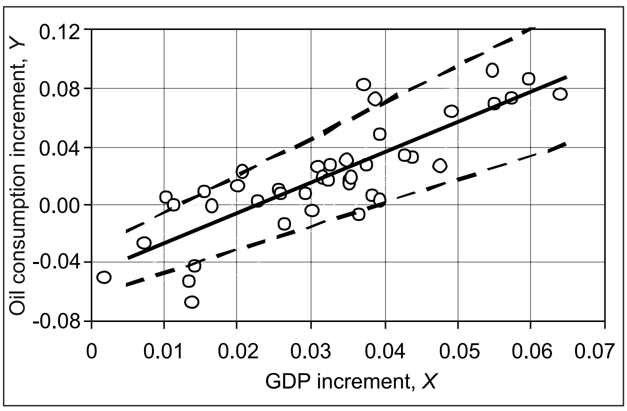

Fig. 1. Crude oil consumption increment in OECD countries from GDP growth. Solid line – regression equation (1), dotted line – confidence interval ± 95%

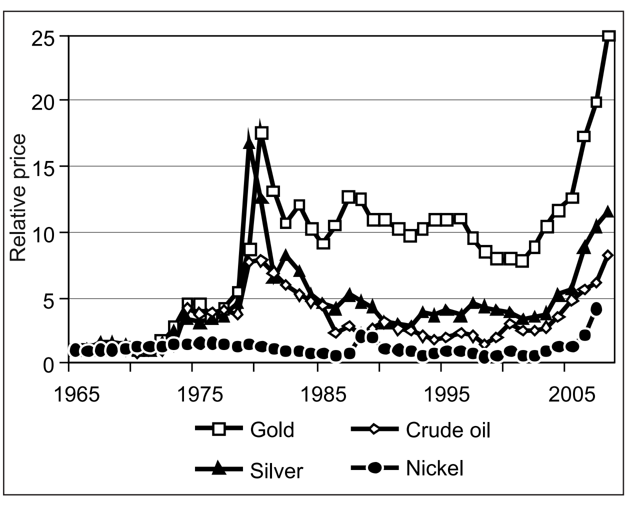

Fig. 2. Comparison of prices of different commodities [14, 16]. The relative price of commodities in 1965 is equal to 1

Table 1. **Coefficients of correlation among separate commodities**

	Oil	Gold	Silver	Nickel
Oil	1	0.92	0.88	0.71
Gold		1	0.93	0.87
Silver			1	0.82
Nickel				1

for oil and metal prices are the same. Their price correlation coefficients are presented in Table 1.

In this way, oil is not an exceptional product, and the dynamics of its price is similar to that of any other product. Consequently, during the period of the economic cycle, in accordance with the theory of storage, depending on stock levels, the future price can be predicted. There was a study assessing the changes of pricing of various goods (metals, petroleum, natural gas) during an economic cycle [9, 17, 18]. Studies assessing the price change of oil [9] and natural gas [18] are based on [17].

During a business cycle recovery phase, resource demand increases and the goods are stored expecting to obtain additional revenue by selling them later (the sign on the left side of equation (2) is positive), i. e. the storage of goods is going on. At the start of an economic cycle of decline; the demand of resources for production also declines, and there is a tendency to get rid of excess products as to store the goods is not beneficial.

Taking into account that F_t is the price of the product at time t in the future and the present product price is S_0, according to theory of storage, the income from purchasing the goods at time $T = 0$ and saling them at time $T = t$, the price difference F_t–S_0 is equal to the profit obtained during the storage period S_0–R_t plus storage service costs W_t and minus costs of services C_t:

$$F_t - S_0 = S_0 \times R_t + W_t - C_t. \qquad (2)$$

Transportation reimburse is included into the costs of services. Expecting to obtain profit during storage, the price of the future cost must not exceed its purchase price and to be sufficient to cover the costs of storing and R (interest rate). The equation of product storage describes the difference between the product price and interest rates:

$$\frac{F_t - S_0}{S_0} - R_t = \frac{W_t - C_t}{S_t}. \qquad (3)$$

On the left side, the values of F_t, S_0, R_t fluctuations can be observed. The negative sign obtained on the left side of the parity shows a low amount of stored goods, or vice versa. Studies have shown that a small quantity of goods in storage causes significant deviations between the current and future prices [17], increasing the price fluctuation decline of the stored commodities, and the price is getting closer to prices in the future.

An attempt to evaluate the projected oil prices in time t with the help of the regression equation for New York Mercantile Exchange as processed oil in the U. S. and future levels of oil consumption in OECD countries and on the existing amount of stored oil is described in the following regression equation (4):

$$P_t = \alpha + \beta_1 D_t + \beta_2 C_t + \beta_3 C_t^2 + \beta_4 C_t^3 + \beta_5 R_t^3 + \\ + \beta_6 (N4_t - N1_t) + \mu_t, \quad (4)$$

where P is the FOB price of oil imports to the U. S. (2000 U. S. \$), D is relative future oil consumption from oil reserves, calculated as the ratio of reserves and consumption, C is a relative oil amount, calculated as the ratio of the difference between the amount of extracted oil in OECD countries and OECD oil content quota extracted in the world, R is the U. S. ratio of using oil processing plants, N4, N1 – West Texas (WTI) oil prices of the fourth and next months, μ is the error correction member.

To evaluate cyclically volatile price fluctuation in the near future, the conditional Auto Regressive Conditional Heteroscedasticity (ARCH) model or its modification were used [5–7]. Although ARCH models are applied in many areas, they have some limitations. These models are parametric, designed to predict the values changing over time when market conditions are relatively stable and reliable results are obtained when the data change is stable. However, when significant random discrepancies of model amounts or unforeseen events appear, this model may provide results with significant errors. Therefore, most of financial decisions based solely on this model are rarely used.

When there is a nonlinear relationship between oil demand and production levels, prices vary drastically, but this is only a consequence of imbalances of production capacity, refinery sectors and consumption. Decreased production causes an increase of oil prices, while a decline of refinery production or an increase of oil demand trigger an increase of oil prices. These processes are clearly nonlinear. In addition, in many cases there is no clear functional dependence among these values. Therefore, in order to simulate various processes, including the price of oil, artificial neural network models (ANN) are also used [19].

3. THE UNCERTAINTY OF OIL PRODUCTION FORECAST

The size of global oil resources is finite, but according to the individual scenarios, the [20] extracted oil stock, depending on the optimistic or pessimistic scenario, is estimated differently (Fig. 3). The maximum oil extraction and the oil production peak are projected from conventional oil resources. Dr. M. King Hubert proposed a logical equation (5) for long-term forecasts of oil extraction volumes [21–23]:

$$Q = U / (1 + \exp(b(t - tm))), \quad (5)$$

where t is the year in question, Q is the total production of year t, U is the maximum extraction, tm is the curve breaking point time, and b is the factor describing the slope of the curve.

Depending on the time of prognosis (since 1956 until now), the forecast of maximum oil production extraction date U changed from 1995 to 2022 by assessing more or less optimistic quantities of oil resources and the assimilation of new oil extraction technologies. At present, it is believed that the peak of oil production in traditional ways was reached in 2005, and the total (traditional and non-traditional – heavy oil from deep waters of the polar and gas condensate) peak oil production volume was achieved in 2007 [24, 25]. In order to satisfy the demand of oil products, while the conventional ways of extracting oil are declining, non-traditional ways from other resources are expected to meet these needs (Fig. 6). It is believed that petroleum products obtained by non-traditional methods will determine the level of oil prices [26]. Unlike work [24], the IEA predicts [1] that oil demand will be met by undiscovered reserves (Fig. 4), and oil production in the near future will fully satisfy the needs.

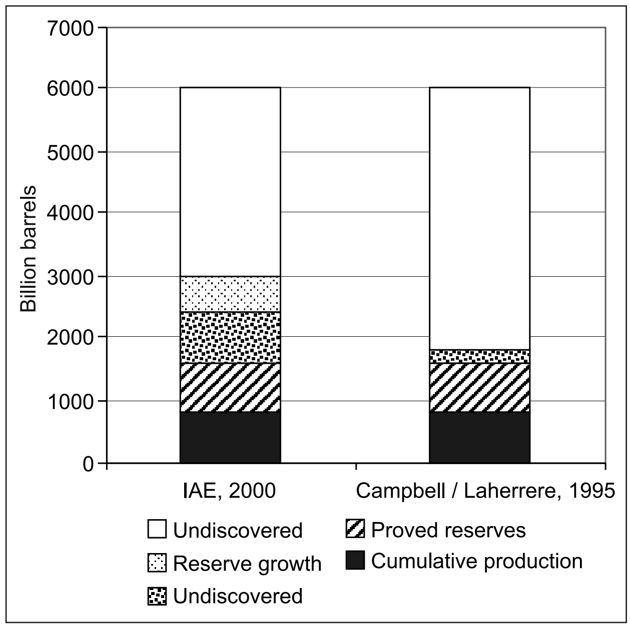

Fig. 3. Different interpretations of the world oil resource base [24]

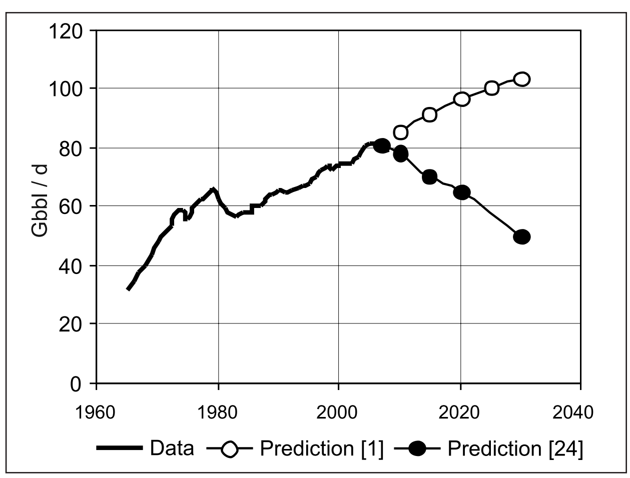

Fig. 4. World crude oil production and predictions

4. OIL PRICE PREDICTION MODELS

The database was mainly used for a comparison of oil price prediction models [14]. There was also an attempt to link oil price fluctuations with solar activity cycles. It was thought that in the periods of active sun, there emerge spots on the solar disk, and when the sun temperature decreases, the temperature of the earth goes down and causes an increase in fuel consumption. However, there is evidence both proving and disproving this hypothesis [27, 28]. When selecting characteristic data, it is accepted that the oil price depends on a quantified number of variables (Table 2).

The annual rates of changes:

$X_{9+j,\,i} = (X_{1+j,\,i+1} - X_{1+j,\,i}) / X_{1+j,\,i}$,

$j = 0,1,..., 6$;

$i = 1966, 1967,..., 2007$.

Table 2. **Analysis of data on prices**

Year	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8
1966	11.53	7.28	34.6	11.45	15.85	18.72	33.6	25.0	47.0
1967	11.23	7.57	37.1	12.24	16.88	20.24	36.1	26.8	93.8
1968	10.78	8.02	40.4	12.76	18.84	21.59	39.0	29.1	105.9
1969	10.23	8.45	43.6	13.14	20.88	22.75	42.5	31.8	105.5
1970	9.65	8.77	48.1	13.92	23.61	24.45	46.1	34.4	104.5
1971	11.53	9.11	50.8	14.01	25.59	25.26	48.6	36.1	66.6
1972	12.36	9.61	53.7	14.34	27.40	26.27	52.1	38.6	68.9
1973	15.42	10.23	58.5	14.50	31.06	27.40	56.3	41.5	38.0
1974	48.92	10.37	58.6	14.02	30.87	27.75	55.5	39.8	34.5
1975	44.64	10.45	55.8	13.67	27.33	28.50	55.0	38.7	15.5
1976	46.84	10.96	60.4	13.66	30.91	29.51	58.4	41.2	12.6
1977	47.83	11.37	62.7	14.56	31.48	31.23	60.6	42.3	27.5
1978	44.77	11.87	63.3	15.60	30.11	33.22	63.2	43.7	92.5
1979	90.68	12.33	66.1	16.52	31.38	34.67	64.4	44.0	155.4
1980	93.08	12.49	62.9	17.14	27.40	35.55	61.8	41.1	154.6
1981	82.25	12.66	59.5	17.59	23.28	36.25	59.9	38.9	140.4
1982	71.08	12.68	57.3	18.40	19.88	37.42	58.2	37.0	115.9
1983	61.73	13.02	56.6	18.88	18.12	38.48	57.9	36.5	66.6
1984	56.14	13.64	57.7	19.73	17.78	39.91	59.1	37.5	45.9
1985	53.21	14.14	57.5	20.06	16.93	40.55	59.4	37.2	17.9
1986	27.22	14.63	60.5	19.60	19.65	40.82	61.1	38.4	13.4
1987	33.64	15.14	60.8	19.68	19.60	41.19	62.4	39.0	29.4
1988	26.24	15.79	63.2	19.52	21.74	41.42	64.2	40.3	100.2
1989	30.47	16.35	64.1	18.77	23.37	40.68	65.6	40.9	157.6
1990	37.82	16.76	65.5	18.84	25.10	40.37	66.9	41.4	142.6
1991	30.57	16.93	65.3	19.41	25.27	40.03	66.9	41.6	145.7
1992	28.65	17.28	65.8	19.58	26.68	39.12	67.5	42.5	94.3
1993	24.52	17.55	66.1	19.68	27.42	38.64	67.4	42.9	54.6
1994	22.37	18.12	67.1	20.53	27.98	39.15	68.7	44.1	29.9
1995	23.40	18.65	68.1	20.74	28.30	39.83	69.8	44.5	17.5
1996	27.54	19.22	69.9	21.36	29.19	40.75	71.5	45.6	8.6
1997	24.97	19.90	72.2	21.67	30.67	41.56	73.6	46.5	21.5
1998	16.69	20.36	73.6	21.50	31.89	41.70	73.9	46.6	64.3
1999	22.74	21.00	72.4	21.10	30.67	41.71	75.6	47.5	93.3
2000	34.92	21.83	74.9	21.52	32.16	42.76	76.3	47.7	119.6
2001	29.03	22.07	74.8	21.30	31.50	43.35	76.9	47.7	111.0
2002	29.06	22.43	74.5	21.43	29.92	44.56	77.8	47.7	104.0
2003	32.51	22.88	77.0	21.17	31.71	45.32	79.3	48.3	63.7
2004	42.02	23.62	80.3	20.77	34.18	46.14	82.1	49.1	40.4
2005	57.90	24.23	81.3	19.86	35.32	45.93	83.3	49.5	29.8
2006	67.03	24.96	81.7	19.46	35.56	46.10	84.2	49.3	15.2
2007	72.39	25.30	81.5	19.17	35.20	46.33	85.2	48.9	7.5

Y – the price of oil [14], \$ 2007/bbl, X_1 – gross domestic product in OECD countries [15], billion \$ 1990, X_2 – oil production from the total [14] billion, bbl/d,
X_3 – oil production in OECD countries [14], billion bbl/d, X_4 – oil production in OPEC countries [14], billion, bbl/d,
X_5 – oil production outside OPEC countries [14], billion, bbl/d, X_6 – total Oil consumption [14] billion, bbl/d,
X_7 – oil consumption in OECD countries [14], billion, bbl/d, X_8 – sunspot number in the year [29].

Table 3. **Statistical significance of regression equation variables**

Coefficients	Value	P value	Standard error	Coefficients of ± –95% confidential interval		t statistics	VIF
b_0	53.42	1.374e–05	10.62	31.88	74.96	5.029	
b_1	–583.73	1.887e–10	66.64	–718.88	–448.58	–8.760	3.641
b_2	557.58	0.00111	157.30	238.57	876.59	3.545	3.298
b_3	–0.01078	1.439e–09	0.00134	–0.01349	–0.00806	–8.053	10.33
b_4	0.00458	3.643e–09	0.000593	0.00338	0.00579	7.736	12.79
b_5	265.72	9.544e–06	51.61	161.04	370.40	5.148	1.486

Table 4. **ANN model variables and their significance**

Variable	X_3	X_5	X_{11}	X_{15}
Significance, %	52.3	30.26	12.5	4.9

In order to identify more precisely the variables having the greatest impact on the price of oil, a multiregressive model was used [32]. In general, this function of choosing variables according to their significance results in a multiple regression equation. The goal of the selection of variables was to classify them in accordance with the significance and to eliminate insignificant variables, leaving a minimum number of significant variables in the equation. Regression analysis has shown that many variables are not significant. A regression equation characterizing oil price was obtained:

$$Y = b_0 + b_1X_{15} + b_2X_9 + b_3X_3 + b_4X_5 + b_5X_{11}. \quad (6)$$

The b_i values of the regression model (6) are given in Table 3. The resulting p values, close to zero, show that the zero hypotheses are rejected and the differences between the variables are obvious. The dispersion decreasing multiplier (variance inflation factor, VIF) shows that the chosen variables X_{15}, X_9, X_{11} are not multi-collinear (VIF < 4) and the variables X_3, X_5 are on average multi-collinear (10 < VIF < 30), but elimination from the regression equation of at least one of them significantly reduces the relationship between the predicted and the actual oil prices. Thus, the obtained regression equation may adequately reflect the price of oil (Table 4).

To describe oil prices with the help of the ANN model according to the importance of variables and to minimize the numbers of variables, the variables that allowed evaluating oil prices were chosen. The significance of these variables in describing oil prices is given in Table 4, and both models are compared in Table 5 and Fig. 5. A comparison of the two models in compliance with the actual oil prices, the artificial neutral network model with a correlation coefficient is slightly better (Fig. 5) than the multi-regression model (|R| = 0.94).

These models have been used to estimate long-term oil-price forecasts and to compare them with the IEA oil price predictions. In the dynamics of oil prices and production (Fig. 6), several characteristic time zones can be relatively identified:

until 1973 – oil prices were decided upon according to long-term contracts: we can see small price fluctuations;

1973–1986 – trouble in the Middle East (Yom Kippur War, Oil Embargo, the Iranian revolution, Iran–Iraq war): a drastic long-lasting increase of prices;

1986–2004 – world trade globalization: the impact of global economics on oil prices;

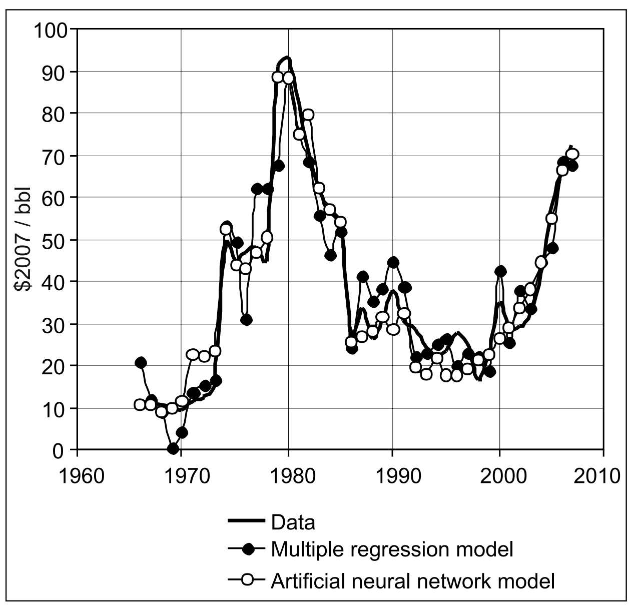

Fig. 5. Comparison of two oil price models

Table 5. **Oil price forecasts**

Variable	[1]					[30]				
	2010	2015	2020	2025	2030	2010	2015	2020	2025	2030
X15	–0.013	–0.014	–0.003	0.005	0.001	–0.024	–0.036	–0.044	–0.061	–0.089
X9	0.034	0.025	0.023	0.022	0.022	0.020	0.018	0.016	0.016	0.014
X3	18.8	17.5	17.3	17.7	17.8	18.0	15.0	12.0	8.8	5.5
X5	47.76	47.09	48.56	49.27	50.62	45.9	39.9	33.8	28.2	22.6
X11	–0.013	–0.014	–0.003	0.005	0.001	–0.024	–0.036	–0.044	–0.061	–0.089

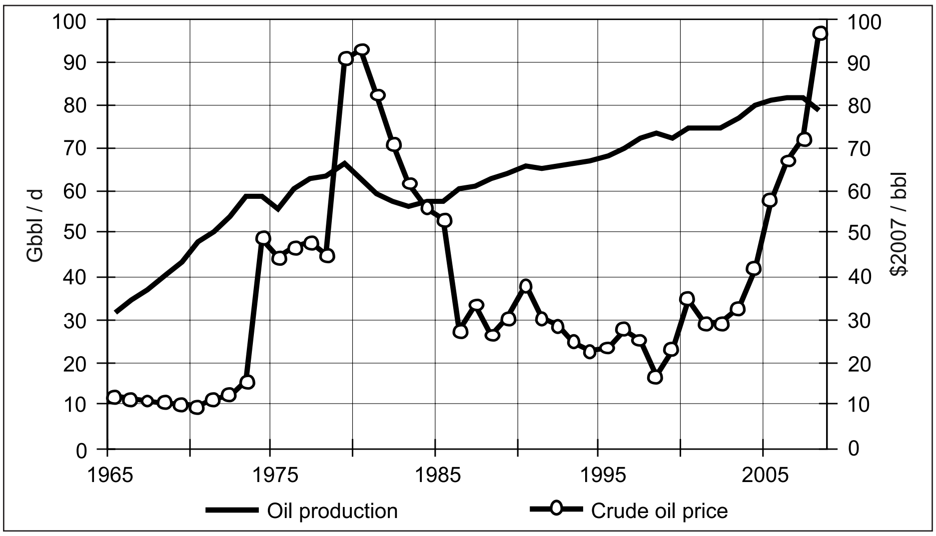

Fig. 6. Dynamics of oil prices and production

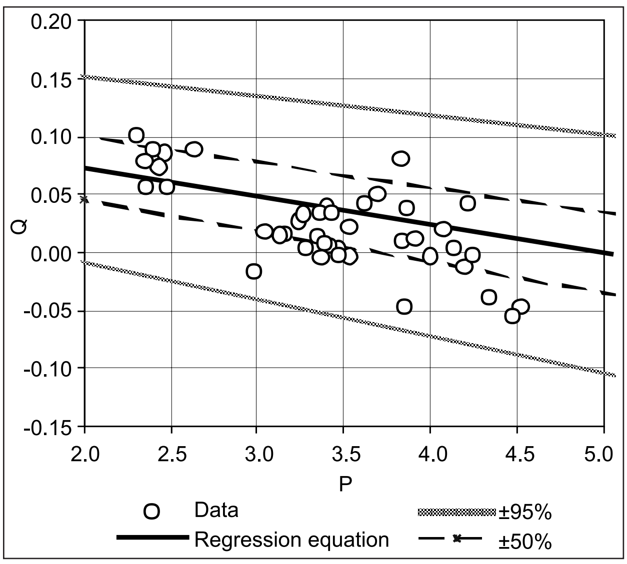

Fig. 7. Dependence of oil prices on world's oil production increment. Solid line – regression equation (7), dotted line – limits of confidence interval ± 50%, continuous toneless line – limits of confidence interval ± 95%

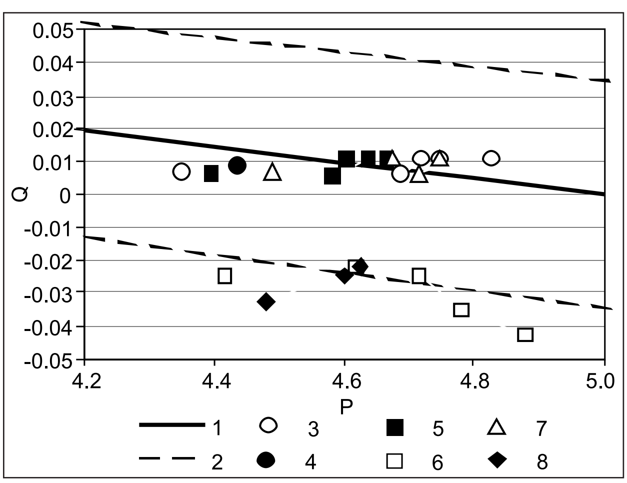

Fig. 8. Comparison of projected average oil price, labeling: *1* – equation (7), *2* – limits of confidence interval ±50%. Other markings as in Table 6

since 2004 until now – the inability oil-exporting countries to extract sufficient quantities of oil by traditional methods to supply the growing needs of the globe.

Each time zone is characterized by a different oil price and oil production dynamics. Using this dependence observation, we obtained the regression equation of oil production growth (7) (Fig. 7):

$$P = -0.0439Q + 0.174, \quad (7)$$

here $P_i = Ln(\frac{Y_i + Y_{i+1}}{2})$ is the logarithm of the price of oil and $Q_i = (X_{2,i+1} / X_{2,i})^{1/(M_{i+1} - M_i)} - 1$ is the world's annual oil production increase.

To evaluate the forecasts of oil price fluctuations, we will rely on different sources of oil production forecast data (Table 5). Using the data of Table 5, the obtained oil prices are compared with the IEA projections [1, 31] (Fig. 8). Figure 8 depicts also a set of oil price projections derived from the regression equation (6) and the artificial neural network model [32]. Unlike in the projected oil price regression equation (6), using [1, 30] data all projected oil prices are fixed at ± 95% confidence interval or close to it (Fig. 8).

Comparing various methods of oil price forecast, a fairly good coincidence was obtained regardless of the forecasting methodology. However, the worse oil price forecast estimate was obtained (Fig. 8) with [30] data. Thus, the comparison of oil price forecasts relies on the work of the IEA [1, 34, 35] (Fig. 9).

In Fig. 9 we see that IEA 1996 oil price projection data at the given level [34] and the estimated oil price by equation (6) projections coincide, but these estimates do not reflect the real price of oil. In this case, the crude oil production forecast is poorly assessed. Oil price projections by the IEA in 2004 [35] and the calculated ones do not match, but the estimated costs (equation (6)) much better reflect the actual data. According to the projections of oil production volume, in this case it was possible to predict the future oil price

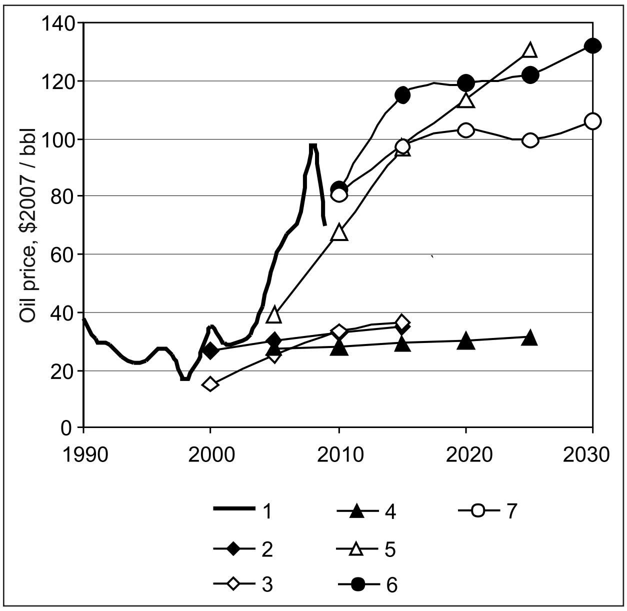

Fig. 9. Comparison of oil price projections: *1* – data of [14], *2* – forecast data [34], *3* – forecast of equation (6), data of [34], *4* – forecast data of [35], *5* – forecast of equation (6), data of [35], *6* – forecast data of [1], *7* – forecast of equation (6), data of [31]

growth (Table 6). In the last IEA report [1], the 2010 oil price forecasts coincide with the ones presented here, but further forecasts differ by 20%, although the oil price curve shapes are similar.

Various independent parameters are used to assess their influence on the so-called Tornado chart. The Tornado diagram shows the influence of the parameters on the outcome of the solution, when one of the variables has the minimum or maximum value and other variables stay at the basic values. The Tornado chart is calculated for 2010 [1] data. The minimum and maximum values were calculated by assessing the 1966–2007 (Table 2) deviations from the average of variable sizes. In this chart, the parameter with the greatest impact on the result goes to the front of the chart. Parameters with less influence are reorganized in descending order on the vertical y-axis (Fig. 10). For each parameter on the y-axis, Figures show the minimum and maximum limits and the minimum and maximum values of the analyzed parameters.

Even through the predicted oil prices are high, the objective reasons for a decrease of prices may be related with the discovery of new oilfields, which is unlikely, or substituting alternative energy sources for oil.

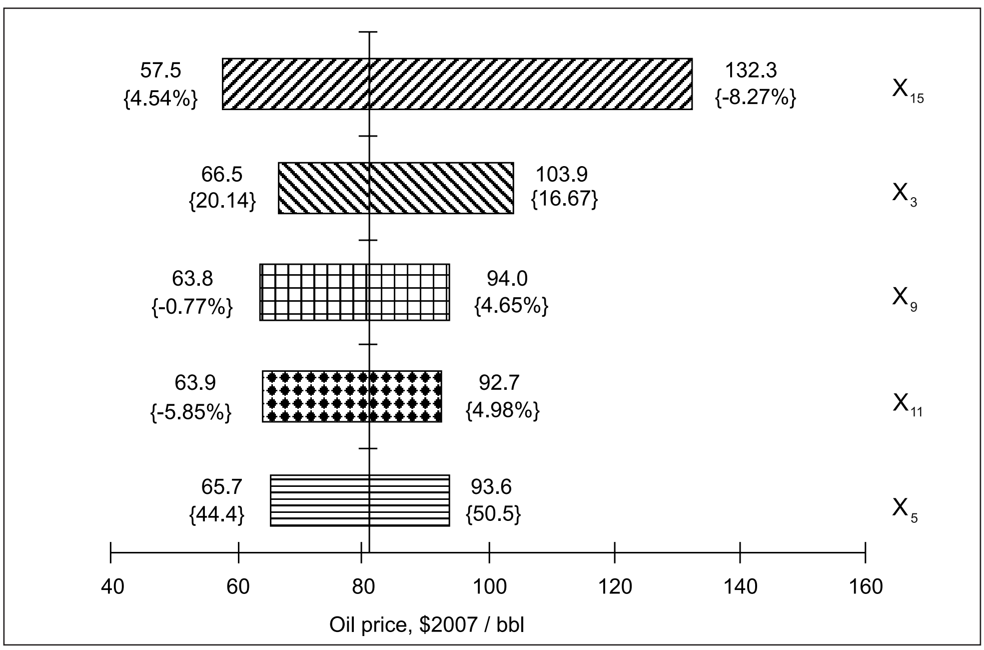

Fig. 10. Oil price 2010 sensitivity to different variables

Table 6. **Projected average oil price, $ 2000/bbl**

Marking (as in Fig. 8).	**3**	**4**	**5**	**6**	**7**	**8**
Forecast method	[1]	[30]	Equation (6)	Equation (6)	ANN	ANN
The data (Table 5)	[1]	[30]	[1]	[30]	[1]	[30]
2010	82.36	84.39	80.90	82.93	94.44	93.62
2015	115.24		97.50	101.19	118.72	108.28
2020	118.99		103.03	111.62	122.25	105.75
2025	122.47		99.58	119.14	113.97	
2030	132.32		106.11	131.40		

Local oil price change could be significant because, determined by a number of variables, it is as follows: X_{15} – OECD countries' oil consumption annual rate of change, X_3 – oil production in OECD countries, X_9 – annual rate of GDP change in OECD countries, X_{11} – the annual rate of change of oil extraction in OECD countries, X_5 – oil extraction outside the OPEC countries.

Whatever the scenario, oil production in OECD countries continues to decrease [1, 30], which will increase the dependence on OPEC countries' purchasing oil prices, and oil prices will rise. The OECD economics develops cyclically, and a potential significant price fluctuation is obvious as the economic cycles and oil consumption are interrelated.

5. CONCLUSIONS

1. The variables that influence oil price changes were identified. The models of multiregression and artificial neural networks, suitable for predicting long-term price of oil, are described. A comparison of the selected models with the actual oil prices has shown that the artificial neutral network model with the correlation coefficient $|R| = 0.98$ is better than the multi regression model ($|R| = 0.94$).

2. The regression model and ANN model variables were found to be identical. The level of oil prices is mainly dependent on the values of the OECD countries: their oil consumption or production alteration, the GDP variation, and global oil production without the OPEC.

3. The estimated average price of oil, regardless of the selected model, differs slightly and is within the 50% confidence interval limits. Since the oil-ANN describes oil prices more accurately than does the regression model, it should be given a priority in predicting oil prices.

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Algirdas Kuprys

NAFTOS KAINŲ PROGNOZIŲ NEAPIBRĖŽTUMAS

S a n t r a u k a

Kasmetiniame Energetikos administracijos leidinyje „Pasaulinė energetikos apžvalga“ pateikiamos ilgalaikės naftos kainų prognozės, kurios dažniausiai viena kitą paneigia. Šio darbo tikslas – įvertinti naftos kainų prognozių adekvatumą. Apžvelgta keletas modelių, naudojamų naftos kainų prognozėms įvertinti, ir nustatyti veiksniai, turintys įtakos naftos kainos kaitai. Vertinant naftos kainų ilgalaikes prognozes apsistota ties dviem skirtingais modeliais: daugiafaktoriniu regresiniu ir dirbtinių neuronų tinklų. Gautos prognozinės naftos kainos palygintos su tarptautinės energetikos agentūros prognozuojamomis naftos kainomis.

Raktažodžiai: naftos kainos, prognozės, dirbtiniai neuronų tinklai, daugiafaktorinė regresija

Альгирдас Куприс

НЕОПРЕДЕЛЕННОСТЬ ПРОГНОЗОВ ЦЕНЫ НА НЕФТЬ

Р е з ю м е

В ежегодном издании Международного энергетического агентства “World Energy Outlook” представлен долгосрочный прогноз цен на нефть, которые, как правило, являются взаимоисключающими. Цель данной работы – оценить адекватность прогноза цены на нефть. Рассмотрен ряд моделей, используемых для прогноза цены на нефть, оценены и определены факторы, влияющие на изменение цен на нефть. При оценке долгосрочных прогнозов цен на нефть использовались две различные модели: мультифакторная регрессия и искусственных нейронных сетей. В результате расследования полученные прогнозы цены на нефть сравнены с данными Международного энергетического агентства.

Ключевые слова: прогноз цены на нефть, искусственные нейронные сети, мультифакторная регрессия