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IMPACT OF CHANGING COMMERCIAL, STRATEGIC OIL RESERVES ON PRICES BY USING FUSSY LOGIC: (2002_2007)

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ABSTRACT

When oil crisis occurred in the world in 1973 and the occurrence of Islamic Revolution of Iran in 1979 thus because of the lack of the capability for the potential production it was a great shock for the oil market. In addition to the excess of the production capacities of the producer countries, the consumer countries considered that determining security is a vital factor for oil consumer countries to be used in crisis situations. Security list can be obtained from reserve operations and the investments of oil producer countries. One of the ways to obtain security list is the creation of crude oil reserves and their products. There is empirical and theoretical evidence that commercial and strategic oil reserves may be affected the oil prices. Nowadays, Soft computing (computational intelligence) models as intelligent approach can be used to predict price. Fuzzy logic, Genetic Algorithm, Artificial Neural Network and ANFIS are some kind of computational intelligence.

Keywords: *Strategic, Commercial, Oil, Reserves, Prices, Fussy Logic.*

INTRODUCTION

According to American Petroleum Institute (API) (API, 2008), the oil and natural gas industry's segments include steps in finding, producing, processing, transporting, and marketing oil and natural gas. API breaks the oil and natural gas industry down into five major sectors, including the Service and Supply sector, the Marine sector, the Pipeline sector, the Refining and Marketing (downstream) sector, and the Exploration and Production (upstream) sector (Vital, 2006). The upstream segment makes up the crude petroleum and natural gas extraction industry. The upstream segment deals with the exploration and production of oil and natural gas using tools ranging from cutting-edge geology to high-tech offshore drilling platforms (API, 2008). One of the main benefits that technology has been applied to the upstream sector is the elimination of poor prospects which substantially reduces costs involved with drilling a dry hole. Technology also improves the recovery processes allowing more petroleum and natural gas to be extracted, but the most impressive is the ability to produce from reservoirs that were never reachable or known about. The greatest benefit that technology provides the oil industry is to make processes safer. Any technology that can prevent explosions like the BP refinery in Texas during 2005 is needed (Ende and Wei, 2007).

The importance of oil and the oscillations together made the consumer countries especially the industrial countries attempt to save their economics from the impacts of the oil market oscillations. Thus energy security became meaningful for the consumer countries. One of the ways to obtain security list is the creation of crude oil reserves and their products. The fact that

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has been less considered is why there should be increase in the oil prices as opposed to other changes in the oil market in different periods of time. Thus it is a one-way process of increase in oil prices. During these six years from 2002 onwards. The study of oil prices and oil reserves show that the oil market does not allows the oil consumers to interfere, which results in higher prices. This compelled the consumers to take active part in their price decisions. From the start of creating the strategic and commercial oil reserves, these reservoirs were known as the effective factors for the oil market situation and changes in reserves result in different supply and demands in the markets (Kretzmann, 2006; Swafford, 2006; Abbasi, 2001; Details and current levels of SPR).

In this study, Back-Propagation Neural Network (BPNN) approach used to design and trained Artificial Neural Network (ANN) capability of predicting price for field data in case based on inputs that selected to construct networks and results show good accuracy of these modeling for the case according to error analysis.

Key words: strategic, commercial, Artificial Neural Network.

Statement of the Problem

The crude oil price increase during 2002 to 2007 caused the oil consumers to confront many difficulties. Different factors were responsible for the increase in oil prices such as the Third Persian Gulf War, the American war against Iraq, Iran Nuclear Energy problems, increasing world population, decreasing OPEC production, the decrease of American oil strategic reserves, Katrina events and also the lack of capacity for refining oil in America. The fact that has been less considered is why they should be increase in the oil prices as opposed to other changes in the oil market in different periods of time. Thus it is one-way process of increase in prices. During these 6 years from 2002 onwards these events have lead to stability and increase in oil prices. The oil market could thus witness stable prices.

These reservoirs cover the differences of supply and demand. In different situations, the impacts of changes in supply and demand have increased. It is hereby seen that strategic reserves and commercial oil have great impacts on the worldwide oil prices. They have the potentially to decrease or increase the oil prices.

Strategic Petroleum Reserves (SPR):

Which are restored for providing the strategic purposes and saving the economics from certain affective factors? Countries are less willing to restore them (Due to government regulations they are being controlled) (Abbasi, 2001).

Commercial Petroleum Reserves:

Are restored for commercial purposes and they often follows two goals of selling with the higher rate or avoid from buying the when rates of oil are high.

History of the World Strategic (Oil) Petroleum Reserves (SPR):

From the mid-1970s until 2006, world markets have had to absorb roughly five significant spikes in the price of crude oil and petroleum products. Whether driven by disruptions in the physical supply of crude or refined fuels, or by uncertainties owing to international conflicts and instabilities, these price increases can have consequences for the United States balance of trade and, owing to the relative inelasticity of demand for gasoline at prices up to $3.00 per gallon, siphon away disposable income that might be spent to support other economic activity or savings.

The origin of the U.S. Strategic Petroleum Reserve (SPR) stems from the 1973 Arab-Israeli War. In response to the United States support for Israel, the Organization of Arab Exporting Countries (OAPEC) imposed reduced production. While some Arab crude did reach the United States, the price of imported crude oil rose from roughly $4/barrel (bbl.) during the last quarter of 1973 to an average price of $12.50/bbl. in 1974. While no amount of strategic stocks can insulate any oil- consuming nation from paying the market price for oil in a supply emergency, the availability of strategic stocks can help blunt the magnitude of the market's reaction to a crisis. More importantly, one of the original perceptions of the value of a strategic stockpile was that its very existence would discourage the use of oil as a political weapon. The embargo imposed by the Arab producers was a stark, politically motivated event intended to create a very discernible physical disruption. This probably explains, in part, why the genesis of the SPR was focused especially on deliberate and dramatic physical disruptions of oil flow.

In response to the experience of the embargo, US Congress authorized the Strategic Petroleum Reserve **(SPR) in the Energy Policy and Conservation**

Act (EPCA, P.L. 94-163) to help prevent a repetition of the economic dislocation caused by the Arab oil embargo. The program is managed by the Department of Energy (DOE) (Details and current levels of SPR).

Physically, the SPR comprises five underground storage facilities, hollowed out from naturally occurring salt domes, located in Texas and Louisiana. The caverns were finished by injecting water and removing the brine. Similarly, oil is removed by displacing it with water injection. For this reason, crude stored in the SPR remains undisturbed, except in the event of a sale or exchange. Multiple injections of water, over time, will compromise the structural integrity of the caverns. By 2005, the capacity of the SPR reached 727 million barrels.

Stored at one SPR site, Weeks Island, was transferred after problems with the structural integrity of the cavern unrelated to drawdown activity were discovered in the mid1990s. It held virtually 700 million barrels before Hurricanes Katrina and Rita in 2005. Following the storms, some crude was loaned or sold, leaving the Reserve with 685 million barrels in mid-March 2006.

As already noted, it was hoped that the creation of a significant operational reserve of crude oil would discourage the use of oil as a weapon. In the event of an interruption, introduction into the market of oil from the Reserve was expected to help calm markets, mitigate sharp price spikes, and reduce the economic dislocation that had accompanied the 1973 disruption. In so doing, the Reserve would also buy time — time for the crisis to sort itself out or for diplomacy to seek some resolution before a potentially severe oil shortage escalated the crisis beyond diplomacy. The SPR was to contain enough crude oil to replace imports for 90 days, with a goal initially of 500 million barrels in storage. In May1978, plans for a 750-million- barrel Reserve were implemented. SPR oil is sold by competitive sale (Fruhling & Sian, 2007; J. WeI, 2009).

A notice of Sale is issued, including the volume, characteristics, and location of the petroleum for sale; delivery dates and procedures for submitting offers; as well as measures for assuring performance and financial responsibility. Bids are reviewed by DOE and awards offered. The Department of Energy estimates that oil could enter the market roughly two weeks after the appearance of a notice of sale (U.S. Federal Register, 2005). The International Energy Agency (IEA) to develop plans and measures for emergency responses to energy crises. Strategic stocks are one of the policies included in the agency International Energy Program (IEP). Signatories to the IEA are committed to maintaining emergency reserves, developing programs for demand restraint in the event of emergencies, and agreeing to participate in allocation of oil deliveries among the signatory nations to balance the shortage among IEA members. While the U.S. SPR holds government held crude oil stocks, some IEA nations require a level of stocks to be held by the private sector or by both the public and private sectors. Including the US SPR, roughly two-thirds of IEA stocks are held by the oil industry, whereas one-third is held by governments and supervisory agencies (Brown & Lockett, 2004).

History of the world Commercial oil reserve

Established in 1975 in the aftermath of the OPEC oil embargo, the commercial petroleum reserve was originally intended to hold at least 750 million barrels of crude oil as an insurance policy against future supply cutoffs (the maximum size was later reduced when a geologically unstable storage site was decommissioned). The original intent was to fill the commercial oil reserves primarily by purchasing crude oil on the open market. Concern over the vulnerability of the United States to additional oil cutoffs prompted the federal government to purchase most of the oil for the commercial oil reserves in the late 1970s and early 1980s when world oil prices often exceeded $30 per barrel. Since that time, world oil prices have fluctuated from the mid-teens to the current oil in the commercial oil reserves reflects the value of the crude oil at the time it was acquired.

During the 30 years that the commercial petroleum reserve has existed, crude oil has been acquired from 25 countries. The oil is categorized as either "sweet" (with a sulfur content not exceeding 0.5 percent by weight) or "sour" (with sulfur content greater than 0.5 percent but less than 0.2 percent). The commercial oil reserve accepts only crude oil that meets its quality specifications and it is co-mingled in caverns designated as either sweet or sour. Salt formations offer the lowest cost, most environmentally secure way to store crude oil for long periods of time. Stockpiling oil in artificially-created caverns deep within the rock-hard salt costs historically about $3.50 per barrel in capital costs. Storing oil in above-ground tanks, by comparison, can cost $15 to $18 per barrel – or at least five times the expense. Also, because the salt caverns are 2,000-4,000 feet below the surface, geologic pressures will seal any crack that develops in the salt formation, assuring that no crude oil leaks from the cavern. An added benefit is the natural temperature difference between the top of the caverns and the bottom- a distance of around 2,000 feet: the temperature differential keeps the crude oil continuously circulating in the caverns, giving the oil a consistent quality.

History of Oil Prices

Crude oil prices behave much as any other commodity with wide price swings in times of shortage or oversupply. The crude oil price cycle may extend over several years responding to changes in demand as well as OPEC and non-OPEC supply. The U.S. petroleum industry's price has been heavily regulated through production or price controls throughout much of the twentieth century. In the post world War II era U.S. oil prices at the wellhead averaged $24.20 per barrel adjusted for inflation to 2006 dollars. In the absence of price controls, the U.S. price would have tracked the world price averaging $26.16. Over the same post war period the median for the domestic and the adjusted world price of crude oil was $18.53 in 2006 prices. That means that only fifty percent of the time from 1947 to 2006 have oil prices exceeded $18.53 per barrel.

Until the March 28, 2000 adoption of the $22-$28 price band for the OPEC basket of crude, oil prices only exceeded $24.00 per barrel in response to war or conflict in the Middle East. With limited spare production capacity OPEC abandoned its price band in 2005 and was powerless to stem a surge in oil prices which was reminiscent of the late 1970s.

Post World War II

Pre Embargo Period

Crude Oil prices ranged between $2.50 and $3.00 from 1948 through the end of the 1960s. The price oil rose from $2.50 in 1948 to about $3.00 in 1957. When viewed in 2006 dollars an entirely different story emerges with crude oil prices fluctuating between $17 - $18 during the same period. The apparent 20% price increase just kept up with inflation.

From 1958 to 1970 prices were stable at about $3.00 per barrel, but in real terms the price of crude oil declined from above $17 to below $14 per barrel. The decline in the price of crude when adjusted for inflation was amplified for the international producer in 1971 and 1972 by the weakness of the US dollar.

OPEC was formed in 1960 with five founding members Iran, Iraq, Kuwait, Saudi Arabia and Venezuela. Two of the representatives at the initial meetings had studied the Texas Railroad Commission's methods of influencing price through limitations on production. By the end of 1971 six other nations had joined the group: Qatar, Indonesia, Libya, United Arab Emirates, Algeria and Nigeria. From the foundation of the Organization of Petroleum Exporting Countries through 1972 member countries experienced steady decline in the purchasing power of a barrel of oil. Throughout the post war period exporting countries found increasing demand for their crude oil but a 40% decline in the purchasing power of a barrel of oil. In March 1971, the balance of power shifted. That month the Texas Railroad Commission set proration at 100 percent for the first time. This meant that Texas producers were no longer limited in the amount of oil that they could produce. More importantly, it meant that the power to control crude oil prices shifted from the United States (Texas, Oklahoma and Louisiana) to OPEC. Another way to say it is that there was no more spare capacity and therefore no tool to put an upper limit on prices. A little over two years later OPEC would, through the unintended consequence of war, get a glimpse at the extent of its power to influence prices.

Middle East Supply Interruptions

Yom Kippur War - Arab Oil Embargo

In 1972 the price of crude oil was about $3.00 per barrel and by the end of 1974 the price of oil had quadrupled to over $12.00. The Yom Kippur War started with an attack on Israel by Syria and Egypt on October 5, 1973. The United States and many countries in the western world showed support for Israel. As a result of this support several Arab exporting nations imposed an embargo on the countries supporting Israel. While Arab nations curtailed production by 5 million barrels per day (MMBPD) about 1 MMBPD was made up by increased production in other countries. The net loss of 4 MMBPD extended through March of 1974 and represented 7 percent of the free world production. If there was any doubt that the ability to control crude oil prices had passed from the United States to OPEC it was removed during the Arab Oil Embargo. The extreme sensitivity of prices to supply shortages became all too apparent when prices increased 400 percent in six short months. From 1974 to 1978 world crude oil prices were relatively flat ranging from $12.21 per barrel to $13.55 per barrel. When adjusted for inflation the price over that period of time world oil prices were in a period of moderate decline.

Crises in Iran and Iraq

Events in Iran and Iraq led to another round of crude oil price increases in 1979 and 1980. The Iranian revolution resulted in the loss of 2 to 2.5 million barrels per day of oil production between November, 1978 and June, 1979. At one-point production almost halted.

While the Iranian revolution was the proximate cause of what would be the highest prices in post-WWII history, its impact on prices would have been limited and of relatively short duration had it not been for subsequent events. Shortly after the revolution production was up to 4 million barrels per day.

Iran weakened by the revolution was invaded by Iraq in September, 1980. By November the combined production of both countries was only a million barrels per day and 6.5 million barrels per day less than a year before. As a consequence, worldwide crude oil production was 10 percent lower than in 1979.

The combination of the Iranian revolution and the Iraq-Iran War cause crude oil prices to more than double increasing from $14 in 1978 to $35 per barrel in 1981. Twenty-six years later Iran's production is only two-thirds of the level reached under the government of Reza Pahlavi, the former Shah of Iran. Iraq's production remains about 1.5 million barrels below its peak before the Iraq-Iran War.

OPEC's Failure to Control Crude Oil Prices

OPEC continued to have mixed success in controlling prices. There were mistakes in timing of quota changes as well as the usual problems in maintaining production discipline among its member countries.

The price increases came to a rapid end in 1997 and 1998 when the impact of the economic crisis in Asia was either ignored or severely underestimated by OPEC. In December, 1997 OPEC increased its quota by 2.5 million barrels per day (10 percent) to 27.5 MMBPD effective January 1, 1998. The rapid growth in Asian economies had come to a halt. In 1998 Asian Pacific oil consumption declined for the first time since 1982. The combination of lower consumption and higher OPEC production sent prices into a downward spiral. In response, OPEC cut quotas by 1.25 million b/d in April and another 1.335 million in July. Price continued down through December 1998.

Prices began to recover in early 1999 and OPEC reduced production another 1.719 million barrels in April. As usual not all of the quotas were observed but between early 1998 and the middle of 1999 OPEC production dropped by about 3 million barrels per day and was sufficient to move prices above $25 per barrel.

With minimal Y2K problems and growing US and world economies the price continued to rise throughout 2000 to a post 1981 high. Between April and October, 2000 three successive OPEC quota increases totaling 3.2 million barrels per day were not able to stem the price increases. Prices finally started down following another quota increase of 500,000 effective November 1, 2000.

Russian production increases dominated non-OPEC production growth from 2000 forward and was responsible for most of the non-OPEC increase since the turn of the century.

Once again it appeared that OPEC overshot the mark. In 2001, a weakened US economy and increases in non-OPEC production put downward pressure on prices. In response OPEC once again entered into a series of reductions in member quotas cutting 3.5 million barrels by September 1, 2001. In the absence of the September 11, 2001 terrorist attack this would have been sufficient to moderate or even reverse the trend.

In the wake of the attack crude oil prices plummeted. Spot prices for the U.S. benchmark West Texas Intermediate were down 35 percent by the middle of November. Under normal circumstances a drop in price of this magnitude would have resulted an another round of quota reductions but given the political climate OPEC delayed additional cuts until January 2002. It then reduced its quota by 1.5 million barrels per day and was joined by several non-OPEC producers including Russia who promised combined production cuts of an additional 462,500 barrels. This had the desired effect with oil prices moving into the $25 range by March, 2002. By mid-year the non-OPEC members were restoring their production cuts but prices continued to rise and U.S. inventories reached a 20-year low later in the year.

By year end oversupply was not a problem. Problems in Venezuela led to a strike at PDVSA causing Venezuelan production to plummet. In the wake of the strike Venezuela was never able to restore capacity to its previous level and is still about 900,000 barrels per day below its peak capacity of 3.5 million barrels per day. OPEC increased quotas by 2.8 million barrels per day in January and February, 2003. On March 19, 2003, just as some Venezuelan production was beginning to return, military action commenced in Iraq. Meanwhile, inventories remained low in the U.S. and other OECD countries. With an improving economy U.S. demand was increasing and Asian demand for crude oil was growing at a rapid pace.

The loss of production capacity in Iraq and Venezuela combined with increased OPEC production to meet growing international demand led to the erosion of excess oil production capacity. In mid 2002, there was over 6 million barrels per day of excess production capacity and by mid-2003 the excess was below 2 million. During much of 2004 and 2005 the spare capacity to produce oil was under a million barrels per day. A million barrels per day is not enough spare capacity to cover an interruption of supply from most OPEC producers.

In a world that consumes over 80 million barrels per day of petroleum products that added a significant risk premium to crude oil price and are largely responsible for prices in excess of $40-$50 per barrel.

Other major factors contributing to the current level of prices include a weak dollar and the continued rapid growth in Asian economies and their petroleum consumption. The 2005 hurricanes and U.S. refinery problems associated with the conversion from MTBE as an additive to ethanol have contributed to higher prices.

One of the most important factors supporting a high price is the level of petroleum inventories in the U.S. and other consuming countries. Until spare capacity became an issue inventory levels provided an excellent tool for short-term price forecasts. Although not well publicized OPEC has for several years depended on a policy that amounts to world inventory management. Its primary reason for cutting back on production in November, 2006 and again in February, 2007 was concern about growing OECD inventories. Their focus is on total petroleum inventories including crude oil and petroleum products, which are a better indicator of prices that oil inventories alone (Petroleum Review, 2008).

Changing Trends of OPEC Basket Crude and Oil Product Prices between 2002-2007

Because of the influential nature of the OPEC Basket Oil Prices on the International Oil Prices we study this trend as bellow.

Crude Oil Prices in the 2002-2003

The weekly price of the OPEC basket of crudes continued to rise for the greater part of October 2002 exceeding, for several days, OPEC's price band ($22-28/bbl) . However, this trend did not continue for the 20-day period required to activate the Organization's price mechanism. The average for the third week stood at $29.7/bbl. The average price of the OPEC basket for the October2003 stood at $28.1/bbl. up by $1 .7/bbl. from the previous month and about $0.8/bbl. more than in October 2002 (Table 1).

The rise in oil prices was precipitated by several factors, namely, the closure of a refinery in the US and forecasts of increasingly colder weather. Prices were also pressured by reports of an explosion at a Venezuelan refinery, which sparked fears of gasoline supply disruption to the US market since that country is the primary source of imported gasoline in the US.

Table 1: Change in the price of the OPEC Basket of Crudes, 2002-2003($/bbl)

	Nov-2002	Dec	Jan-2003	Feb	Mar	April	May	June	July	Aug	Sept	Oct
Monthly Change	-3.1	4.1	1.9	1.2	-1.7	-4.4	0.3	1.2	0.7	1.2	-2.2	1.7
Month-on-Month From The Previous Year	6.5	10.6	12.0	12.5	7.2	0.6	0.8	3.0	2.2	2.7	-1.0	0.8

The daily price of the OPEC basket of crudes exceeded the upper limit of OPEC's price band ($22-2SIbbl) for the most part of December2002 with the average for the third week peaking at $30.5/bbl. The hike in prices coincided with a set of bearish oil stocks data inferring to a decline in US crude inventory. Weekly prices shown in the figure below fluctuated between $28.6/bbl. and $ 30.5/bbl.

The average price of the OPEC basket for the month stood at $29.6lbbl up by $1. 1/bbl. from the previous month and about $1.2/bbl. more than the corresponding month of December2002.

The rise in oil prices was precipitated by the following factors:

- Fears of supply shortages emanating from the Middle East which remains engulfed by a high degree of political uncertainty.
- Acts of sabotage hampering the shipment -of Iraqi crude oil.

Table 2 shows the change in the price of the OPEC basket of crudes as well as month-on-month price comparisons to levels prevailing in

Table 2: Change in the price of the OPEC Basket of Crudes, 2003

	Jan-2003	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Monthly Change	1.9	1.2	-1.7	-4.4	0.3	1.2	0.7	1.2	-2.2	1.7	0.4	1.1
Month-on-Month From The Previous Year	12.0	12.5	7.2	0.6	0.8	3.0	2.2	2.7	-1.0	0.8	4.2	1.2

Crude Oil Prices in the 2003-2005.

The price of the OPEC basket of crudes remained above the $5Oibbl level for the fifth consecutive month (since June 2005). Weekly prices of the OPEC basket in October- shown in the figure below - fluctuated between $53.6/bbl and $55.7/bbl. The monthly average price of the OPEC basket in October fell by 6.0% or $3.5/bbl.

From the previous month to $54.4/bbl. This level was 19.8% or $9.0/bbl. higher than a year ago when the OPEC basket was still comprised of seven crudes.

Due to the recent slow down in demand, particularly in the USA, the crude oil market has lost part of its strength. However, prices of oil remained at high levels primarily due to insecurity about future supply and a tight products market. Table 3 show the change in the price of the OPEC basket of crudes as well as month-on-month price comparisons to levels prevailing in 2004-2005.

Table 3: Change in the price of the OPEC Basket of Crudes, 2004-2005

	Oct 2004	Nov	Dec	Jan-2005	Feb	March	April	May	June	July	Aug	Sept	Oct
Monthly Change	5.0	-6.4	-3.3	4.5	1.5	7.4	0.4	-3.0	4.0	2.2	6.3	-0.2	-3.5
Month-on Month From The Previous Year	17.3	10.5	6.1	9.9	12.1	17.0	17.1	10.3	16.3	16.8	19.1	17.2	9.0

Crude Oil Prices in the 2003-2006

The price of the OPEC basket of crudes remained above the $50/bbl. level for the eleventh consecutive month, i.e., since June 2005, with weekly prices in April - shown in the figure below - fluctuating between $61.6/bbl and $66.4/bbl (Table 4). The 134th (Extraordinary) Meeting of the Conference of OPEC held on January 30, 2005, suspended the Price Band mechanism, pending completion of further studies on the subject.
The monthly average price of the OPEC basket in April rose by 11.2% or $6.5/bbl. from the prey 5 worth to S6t4? bbt This level was 29.8% or $14.8/bbl. higher than a year ago when the OPEC basket was still comprised of seven crudes.
Oil prices rose due to tensions caused by the ongoing debate over Iran's (OPEC's second largest producer) nuclear program, despite its assurances that it had no plans to reduce its output. Fears regarding the reliability of Nigerian supplies also contributed to market sentiment.

Table 4: Change in the price of the OPEC Basket of Crudes, 2005-2006

	April-2005	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan-2006	Feb	March	April
Monthly Change	0.4	-3.0	4.0	2.2	6.3	-2.0	-3.5	-3.5	1.4	5.7	-1.9	1.3	6.5
Month-on-Month From The Previous Year	17.1	10.3	16.3	16.8	19.1	17.2	9.0	12.1	16.9	18.1	14.9	8.8	14.8

Crude Oil Prices in the 2004-2007

The price of the OPEC basket of crudes remained above the $50/bbl. level for the twenty-seventh consecutive month, i.e., since June 2005, with weekly prices in August 2007 shown in the figure below - fluctuating between $67.2/bbl. and $68.6 /bbl. The monthly average price of the OPEC basket in August declined by 4.5% or $3.2/bbl. from the previous month to $68.6Ibbl. This level was 0.3% or $0.2/bbl. lower than a year ago when the OPEC basket was still comprised of seven crudes.
Monthly oil price decline is attributed mainly to several factors including:

- Prediction indicating that hurricane Dean will not hit main oil and gas facilities in Gulf of Mexico.
- Resumption of some US refineries to operate in full capacity after a three-week stoppage, especially that end of US summer holidays was at sight.

- Announcements made prior to OPEC ordinary meeting convened in September 11, 2007 indicating a probable increase in production.

The Table 5 shows the change in the price of the OPEC basket of crudes as well as month-on-month price comparisons to levels prevailing in

Table 5: Change in the price of the OPEC Basket of Crudes, 2006-2007

	Aug 2006	Sept	Oct	Nov	Dec	Jan-2007	Feb	March	April	May	June	July	Aug
Monthly Change	0.6	-9.5	-4.3	0.4	2.5	-7.2	3.8	4.0	4.9	1.0	2.4	5.0	-3.2
Month-on-Month From The Previous Year	11.7	1.4	0.4	4.1	5.3	-7.8	-2.1	0.6	-1.0	-0.7	2.2	2.9	-0.2

Crude Oil Prices in the 2005-2007

The price of the OPEC basket of crudes remained above the $50/bbl level for the thirtieth consecutive month, i.e., since June 2005, with weekly prices in November - shown in the figure below - fluctuating between $87.4/bbl and $90.7 /bbl.

The monthly average price of the OPEC basket in November rose by 12.1% or $9.6/bbl from the previous month to $89.0/bbl. This level was 60.6% or $33.6/bbl higher than a year ago when the OPEC basket was still comprised of seven crudes.

The continued oil price is attributed to several factors including:

- Fears of potential winter supply shortage in the north hemisphere where demand reaches its peak.
- Closure of four pipelines near kilbreck pump station in Minnesota, carrying more than 2.0 mnb/d of Canadian crude during last week of November due to five accidents.
- Decline of US crude oil inventories by 8 million barrels during the last week of November 2007 compared to similar period last month to 305 million barrels.

The Table 6 shows the change in the price of the OPEC basket of crudes as well as month-on-month price comparisons to levels prevailing.

Table 6: Change in the price of the OPEC Basket of Crudes, 2006-2007

	Nov 2006	Dec	Jan-2007	Feb	March	Apr	May	June	July	Aug	Sep	Oct	Nov
Monthly Change	0.4	2.5	-7.2	3.8	4.0	4.9	1.0	2.4	5.0	-3.2	5.5	5.1	9.6
Month-on-Month From The Previous Year	4.1	5.3	-7.8	-2.1	0.6	-1.0	-0.7	2.2	2.9	-0.2	14.9	24.3	33.6

Soft computing (SC)

Soft computing (SC), an innovative approach to constructing computationally intelligent systems, has just come into the limelight. It is now realized that complex real-world problems require intelligent systems that combine knowledge, techniques, and methodologies from various sources. These intelligent systems are supposed to possess humanlike expertise within a specific domain, adapt themselves and learn to do better in changing environments, and explain how they make decisions or take actions. In confronting real-world computing problems, it is frequently advantageous to use several computing techniques synergistically rather than exclusively, resulting in construction of complementary hybrid intelligent systems. The quintessence of designing intelligent systems of this kind is neuro-fuzzy computing: neural networks that recognize patterns and adapt themselves to cope with changing environments; fuzzy inference systems that incorporate human knowledge and perform inference and decision making. The integration of these two complementary approaches, together with certain derivative-free optimization techniques, results in a novel discipline called Neuro-fuzzy and soft computing. As a prelude, we shall provide a bird's-eye view of relevant intelligent system approaches, along with bits of their history, and discuss the features of Neuro-fuzzy and soft computing (Jyh-Shing, 1997).

Soft computing is an emerging approach to computing which parallels the remarkable ability of the human mind to reason and learn in an environment of uncertainty and imprecision (LotfiZadeh, 1992).

Artificial Neural Network (ANN)

Neural networks are adaptive networks which are composed of simple elements operating in parallel. These elements are inspired by biological nervous systems. As in nature, the network function is determined largely by the connections between elements. Commonly, neural networks are adjusted or trained so that a particular input leads to specific target output (Figure 1).

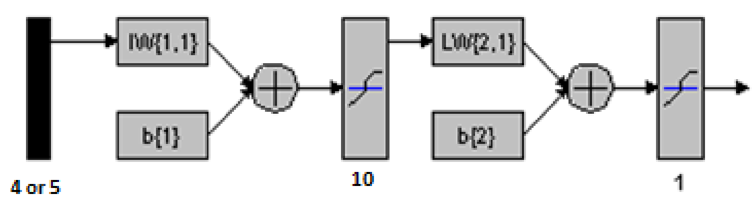


Figure 1: Neural Network Structure for Price Prediction in Four Cases

Neural networks have been trained to perform complex functions in various fields of applications including pattern recognition, identification, classification, speech and vision and control systems. When the inputs of the network and target outputs are given, back-propagation gradient descent method is used. Because there is no initial knowledge about connection weights and biases, these parameters should be determined by minimization of error method to feed-forward networks. After their determination, errors are distributed between layers towards backward direction (J Rene et al., 2009). There are a lot of methods of back- propagation, some of them work slowly, but some new methods are faster than the gradient descent method (Zurada, 1992; Demuth and Beale, 1998).

Advantage of Artificial Neural Network

ANN is a powerful tool in the hand of petroleum engineers for proper and professional management of hydrocarbon assets due to its following capabilities:

a) ANNs are data-driven models that do not require a priori knowledge of data to which it will be applied.
b) ANN is able to recognize hidden and unknown non-linear relationship that exists among input-output data. This is particularly suitable for heterogeneous situations, which are commonly encountered in oil and gas reservoir.
c) ANNs are able to process data fast and also provide easy means of applying an already built model to a new system (Zargari et al., 2010).

Disadvantage of Artificial Neural Network

Without a complete understanding of the way of neural networks function, they are often thought of as "black box" approach instead of a useful method to generate reproducible models. Ignorance is the primary problem for this belief and with a better knowledge of neural network behind and architecture the "black box" label should disappear.
Another problem with neural networks is that they are prone to "over fitting". Like neural networks, polynomial curve fitting has much the same problem and will be used to demonstrate this concept. Polynomial shape is determined by the other, that is, the larger the number of orders the more oscillatory the shape. Given a set of data, a polynomial curve may be used to fit the data (i.e. model). Assuming that data are replete with extraneous information, the best fit curve or surface may not necessarily pass through all data points. A low order polynomial may not fit; whereas a high order polynomial may fit the data exactly by adopting a highly oscillatory shape that is unrelated to the underlying function (Zargari et al., 2010).

POPULATION

The study covers all strategic and commercial oil Reserves in major consumption areas and countries which are included in oil Merchant Exchange and countries.

COLLECTION OF DATA

The study has been based on secondary data, mostly in the form of published annual reports of companies. All the information published in business reports include:

1. Balance sheets and supply and demand of production of crude oil.
2. Schedules related to production of crude oil.
3. Volume of products of refineries.
4. Stocks of (Strategic Petroleum Reserves).
5. Crude Oil Stocks.
6. Stocks of (Commercial Petroleum Reserves).
7. Oil price specially (Brent, West Texas Intermediate, OPEC basket, Saudi Arabia Light spot).
8. Consumption of crude oil worldwide.
9. Consumption of oil products worldwide.
10. Consumption of OECD crude oil.
11. Consumption of OECD oil products.
12. Consumption of OPEC crude oil.
13. Consumption of the U.S crude oil.
14. Consumption of the U.S oil products.
15. Consumption of the European Countries crude oil.
16. Production of the oil products of the U.S.
17. Production of the oil products of the OECD.

These have been taken into consideration while doing the research. Since the periods of study include Annual Reports of 2002 till 2007 it was not possible to collect all data at once and at one place only. Some parts of data have been collected from OPEC, OAPEC and Institute of Iranian Energy studying bulletin.

Some old annual reports have been collected from the libraries of the N.I.O.C (National Iranian Oil Company), EIA (Energy Information Administration), B P (British petroleum).

To collect the data from remaining strategic and commercial OIL RESERVES, the researcher addressed direct letters to Institute of Iranian Energy studies (I I ES) to supply the annual reports in order to collect latest annual reports of a few SPR& CPR. Also, I have been requested the libraries of (N.I.O.C) and institute of energy studies, the researcher has visited OPEC affairs office in Tehran. Whatever latest Annual reports still remained to be collected was obtained from related sites such as BP. Com OPEC.com, EIA.com GasDefrance. com, Rohr Gas.com, Iea.com, Platts.com.

However, all data needed for the study were collected for SPR& CPR after hard trying for one and a half years.

In order to recognize population under study in all reports, historical data of SPR& CPR have been collected from all the above mentioned sources apart from NYMEX, IPE Singapora Stock Exchang, OPEC and OAPEC reports.

Price Prediction Based on Artificial Neural Network

One case considered to predict price as output according to inputs that are available. Input set used to model this case that considered, include:

- Supply
- ZSPR
- ZCPR (-1)
- LD
- ZCMR(-1)

The purpose of this section is to develop a neural network model that can be used to predict price values for the case. Since these inputs are available in the field, idea of finding relation between price and input data passes the mind.

In this study, it should be noted that data file for case include 72 data that divided into three subsets randomly; 80% was used for training (58 data), 10% for validation (7 data) and 10% for testing (7 data).

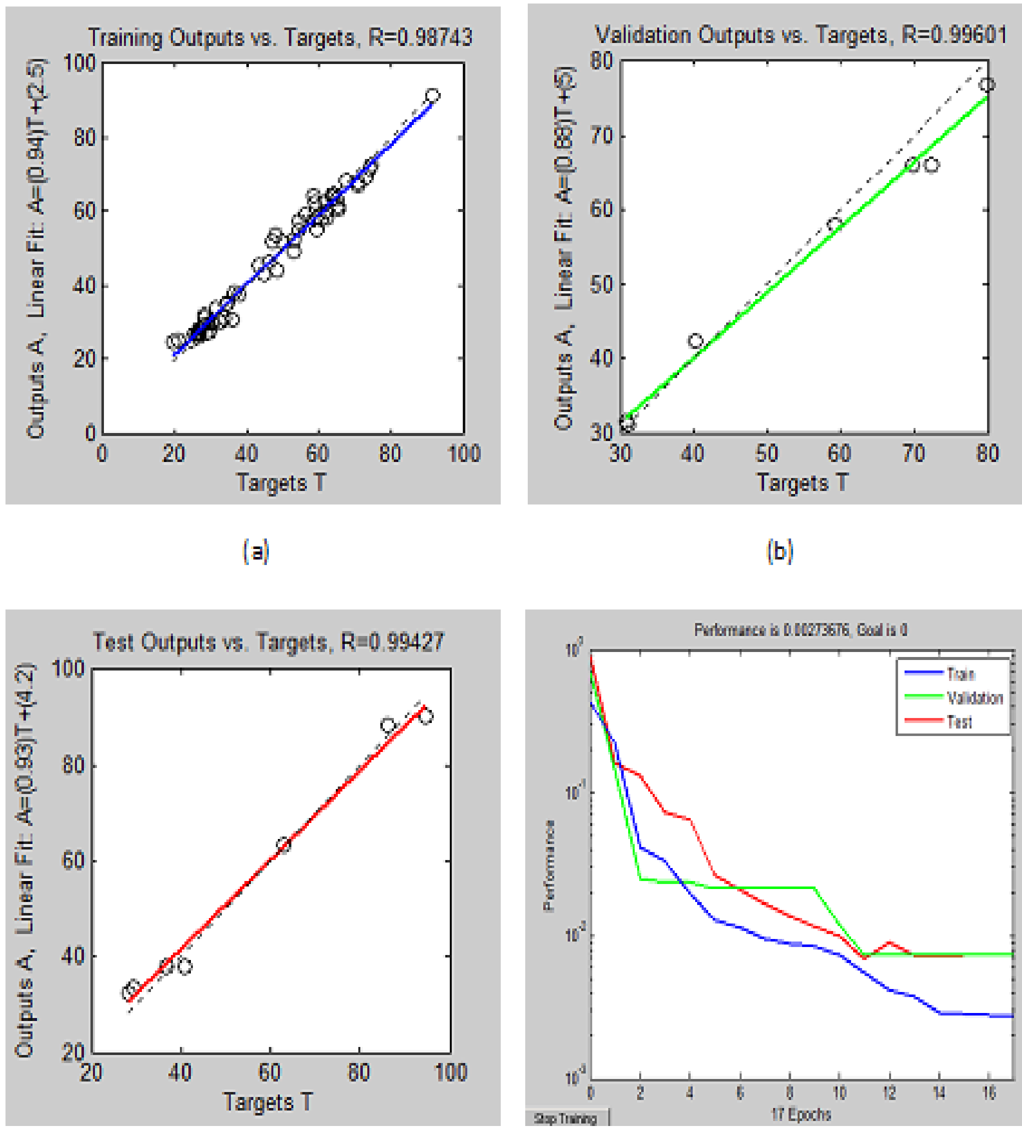
Network Design

The appropriate architecture for building the network among the available networks is usually chosen based on the type of the data and the problem. A back-propagation network has been chosen because of its high capabilities to generalize well in problems plagued with significant heterogeneity and nonlinearity. The features of the network presented in Table7.

Table 7: Network Design for Price Prediction

Training Algorithm	Back-Propagation, Levenberg-Marquardt (TRAINLM)
Performance Function	MSE
Number of Layers	2
Neurons for Input Layer	10
Activation Function	TANSIG (Tan-sigmoid)

According to two parameters of error analysis as correlation coefficient (R value) and mean square error (MSE as Performance), the results of models are expressed in the Table 8 and the black row is selected as the best network. R value for training, validate and test data and performance (MSE) for this black row shown in Figure 2. As seen in Table 8 and Figure 2, network modeled price with good accuracy respect to R value and mean squared error.



(c) (d)

Figure 2: Neural Network Structure for Price Prediction in Four Cases

Table 8: Results of Networks for Cases in Price Prediction

	Train		Validation		Test	
	MSE	R	MSE	R	MSE	R
Case-1	0.003	0.99	0.007	0.99	0.007	0.99

CONCLUSIONS

Based on the results of this paper, the following conclusions were obtained:

1- Soft Computing models, which result in the lowest error and based on actual field data, is strongly proposed to solve intricate industrial problems instead of empirical correlations and mechanistic models.
2- Generally soft computing methods model price with good accuracy.

3- Application of genetic algorithm in conjunction with Artificial Neural Network may cause to have better results.
4- More Field data can be used to model in applicability of Soft Computing models.
5- New input data without error can improve the price prediction significantly.
6- Model summery table reports the strength of the relationship between the oil price (as a dependent variable) and Supply of worldwide Crude Oil , ZSPR (worldwide Strategic Petroleum Reserves), ZCPR(-1), Previous Period of Commercial Petroleum Reserves, LD (The value of demand for Light distillates) and ZCMR(-1) (worldwide previous period of Commercial petroleum products Reserves) as the independents variables ; According to two parameters of error analysis as correlation coefficient (R value) and mean square error (MSE as performance), the result of model is expressed in the table 2 and R value for training ,validate and test data and performance 0.99 for train 0.99 for validation (MSE) for case are shown in figure 2. AS Seen in table2 and figure2 network modeled to predict price with good accuracy respect and R 0.99 for test indicate the strong and significant relationship between the oil prices and input data passes the mind.

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