A New Pricing Model for Crude Oil Pre-Sale Units

via SPFO (Standard Parallel Forward with Options) in Iran

Ghasem Nikjou[1], Hamed Najafi[2] & Kamran Salmani[3]

[1] Faculty of Economics, Allameh Tabataba'i University, Iran

[2] Faculty of Economics, Payame Noor University, Iran

[3] Financial Mathematics, Allameh Tabataba'i University, Iran

Correspondence: Hamed Najafi, Faculty of Economics, Payame Noor University, Iran

Abstract

Nowadays energy has an important role as a driving sector of economy. Forecasting 150 billion dollars investment in energy sector during the fifth development program in Iran, the banking and financial system require a dynamic and modern economy and financial instruments. Obviously, this approach needs to remove legal barriers and modification of contracts. Financing in the oil industry has faced with serious challenges in recent years. In addition, investing in common offshore oil and gas resources is indispensable. Accordingly we are going to design a new contract which is called Oil SPFO (Standard Parallel Forward security with two Options under betting condition), in order to raise funds needed. In this article we would investigate the SPFO for Iran Ministry of Petroleum (MOP)'s finance and present a model for pricing the oil SPFO based on Black and Scholes option pricing model. Finally, we have some recommendations to develop the oil SPFO and suggest that other researchers work on pricing the oil parallel forward securities according to this model.

Keywords: SPFO (oil standard parallel forward with options), black and scholes, call option, put option, pricing, finance

1. Introduction

According to positive relation between financial market development and economic growth, financial market efficiently helps to conduct the flow of savings and investment in ways that facilitate the accumulation of capital and production of goods and services. Nowadays new financial instruments are inseparable part of advanced financial markets. Each instrument has its special charm. In this regard, SPFO contract is a kind of financial innovations which using the proper and scientific design, can turn into an effective financial instrument for financing the large national projects.

In fact SPFO securities are a combination of a security with call and put option. But the important question about this type of securities is that how the exercise price of call option which the buyer sells to issuer (ministry of oil) and the exercise price of put option which the buyer purchases from the ministry of oil should be determined? How will the secondary price of these securities be determined in secondary market?

This research is theoretical and exploratory; therefore, its hypotheses are presented as a theoretical model for answering research questions. The aim of this paper is providing a model in order to optimal and suitable pricing for standard parallel forward securities based on the principles of economics and efficient designing. Furthermore we hope that it would be able to attract domestic and foreign investors to provide the optimal financial support for the National Iranian Oil Company (NIOC) and other companies. A scientific and suitable model will be presented and also we express the importance of research, and reviewing literature of the subject as follow.

2. Literature Review

Economy policymakers generally pursue oil-fewer programs in long-term horizons, instead in the short and medium term the impact of oil is quite evident in domestic economy and international relations. Since its inception in 1951 as the second largest oil company in the world, and the main member of OPEC, the NIOC has always tried to develop exploration, drilling and oil production in the world's regional and global partnerships in the Middle East. (NIOC,

2017) But procrastination in exploiting of common offshore oil and gas resources is along with the loss of national wealth. Therefor investment is necessary for this sector and it is clear that investment requires the capital formation and applying the financial instruments.

This is true that the oil industry has human resources, equipment, technical and engineering services, despite this one of the biggest challenges in this regard is financing. Furthermore this industry is suffering from lack of modern methods and non-use of the principles of financial economy which make the problems worse. (DIFC, 2009) It appears that financing of Iranian Oil Ministry's projects through this attractive financial instrument can be convenient for investors. The most important issue about publishing of these securities is the accurate pricing based on accepted theories of the financial economy.

Before the 1980s, fixed income markets were composed primarily by vanilla bonds and simple structured financial instruments. Thus, their valuations were easy and direct done frequently via closed-form mathematical formula then forth, markets have become sophisticated as more complex products aiming to reduce or share risks appear, complicating the pricing and hedging engines. The fast growth of financial market instruments over recent decades has spawned many challenging mathematical problems to be solved, from the underlying stochastic modeling to solutions through computational methods. (F. Black, 1976)

Fixed income derivatives are contracts which have payoff, contingent on the evolution of interest rates. They are traded in the equity, commodity, currency and credit markets along with hybrid derivatives engineered over the counter .The valuation of interest rate derivative contracts is a very important subject in modern financial theory and practice. The financial health of banks, governments and industrial companies are very sensitive to changes in the term structure of the interest rates. It has become mandatory nowadays to quantify and control the risk exposure to prices of interest rate associated contracts. (J. F. Marshall, V. K. Bansal, 1991)

The literature in the area of options is relatively recent. The foundation of the literature comes from financial option pricing theory, which started with pioneering work of Black and Scholes (1973), Merton (1973), Cox and Ross (1976), and Cox, Ross, and Rubinstein (1979). As financial option pricing theory became more widely accepted and understood, real options literature began in its own right.

However, is to use the real options framework in valuing investment opportunities? On the work of Brennan and Schwartz (1985), one of the most often cited papers in the area of real options. It has been credited as the first theoretical paper to pioneer the use of options methodology in valuing physical assets.

Options on government bonds are traded at several exchanges and also on the OTC-markets (OTC: Over-the-counter). In addition, many bonds are issued with "embedded" options. For example, many mortgage-backed bonds and corporate bonds are callable, in the sense that the issuer has the right to buy back the bond at a pre-specified price. (Claus Munk, 2003)

Because of the newness of this method and the innovative approach of these fixed income securities, there is no special study about this issue in the world. Accordingly the only case is the study of Nikjou (2012) in a paper titled "Survey of Oil Parallel Forward contract and Providing Three Offers" classified securities into two categories: (a) Financing (b): Speculating. He claims that Rial speculationary securities can be useful for financial market and applying of Dollar speculationary securities (Note 1) should be avoided. The reason is increase in Dollar speculative demand leads to Dollarization intensification. Research results showed that Oil Parallel Forward contract issuance could be useful to circulate people's in-hand Dollars purchased in order to speculation.

In setting prices and determination of interest rates, we should attend to the opportunity cost of foreign currency and keeping the securities. Two important problems addressed about the Dollar oil forward contract and it resulted that this instrument will be changed to a Dollar speculative security due to the volatility of oil price and exercising of call and put options. Finally, three important recommendations rose for correct issuance of these securities:

1.   Bank interest rates on dollar deposits must be ordained between the minimum interest rate and maximum of these securities. Otherwise, the National Oil Company will bear additional costs for financing.

2.   Type of secondary transactions settlement for these securities must be made in Rial and based on the market exchange rate.

3.   It is recommended that the parallel forward contract be issued along with exchange participation papers issuance. It causes both risk-taker and risk-averse investors be interested in these securities and increases the liquidity of them.

Farahani Fard (2010) in a research titled "Salam Sukuk, an appropriate instrument for financing and hedging" using the experience of Bahrain tried to introduce this instrument to Iran capital market. The research shows that there is no problem with initial public offering for forward contracts but according to Islamic economic rules, there are some problems in the secondary market.

Moosavian (2011) in a research titled "Salam sukuk, an instrument for financing the upstream projects of oil industry" showed that combining Standard Parallel Forward and drafts, we can make a legal and controlled risk instrument (so called forward contract). It might have many applications such as financing upstream projects. The different aspects of research are:

- It provides a better solution to address the problem of secondary market of forward contract

- Using call and put option contracts it controls fluctuations in prices at maturity

- Given the current economic situation in Iran, it suggests suitable methods for pricing of forward contract.

2.1 Definition

A derivative is a financial contract which derives its value from the performance of another entity such as an asset, index, or interest rate, called the "underlying". Derivative is one of the three main categories of financial instruments, the other two being equities (i.e. stocks) and debt (i.e. bonds and mortgages). It includes a variety of financial contracts, including futures, forwards, swaps, options, and variations of these. A forward contract or simply a forward is a non-standardized contract between two parties to buy or to sell an asset at a specified future time at a price agreed upon today, making it a type of derivative instrument. (Hull, 2006) The time line of a forward contract is as follow:

2.2 Features of Forward Contracts

- The price fixed now for future exchange is the forward price.

- The buyer obtains a "long position" in the asset/commodity.

- Traded over the counter (not on exchanges)

- Custom tailored

- No money changes hands until maturity

- Non-trivial counter-party risk

In fact forward securities are designed based on forward contracts. Participation papers are financial project-based securities and their proceeds should be consumed exclusively in a particular project but forward proceeds can be owned by security publisher. (Ross et al, 2002) Consequently, it allows NIOC to finance the projects, short-term investments and to provide working capital, through the pre-sale of future products. We should consider that if the forward securities publish inside the country, earnings will also assign to domestic investors without losing the national wealth.

Oil sector investment importance caused we propose oil SPFO contract. This proposal has special features that distinguish it from commonly used forward securities in some Islamic countries. SPFO refers to a sale in which payment is made in advance by the buyer, and the delivery of the asset is deferred by the seller. Total payment shall be made upon making the transaction.

2.3 Experiences in Forward Contract

- Bahrain: Forward contract has been issued by the CBB at three monthly intervals since 2002 as part of the short-term financing facilities arranged on behalf of the Government of Bahrain.

- Yemen: The Central Bank of Yemen issued some Forward contracts worth 50 billion Yemeni riyals ($234 million) in April 2012. The first forward security devoted to the purchase and sale of petroleum products.

- Gambia: The Central Bank of Gambia has issued many Forward contracts which are on similar terms and conditions as the conventional T-Bills. The volume of Gambian Forward contract has increased from $215.14 million in 2010 to $345.56 million in 2011.

- Iran Mercantile Exchange (IME): Various commodities are traded periodically in the form of structured Forward contracts by the foundation of IME in 2007. These contracts are in various maturities according to decision of the producer and their sales policies.(Naserpoor, 2015)

Table 1. The Amount Of Financing By Forward Contracts In IME (Billion Rial)

Commodity Group	2011	2012	2013
Agricultural	1,512	373	0
Industrial and mineral	69,622	140,809	164,907
Petrochemical and oil products	22,603	37,002	37,957
Total	93,737	178,184	202,864

2.4 SPFO Contract

Let's start with some questions: what is a SPFO contract and why we have called Standard Parallel Forward with Option? Actually, because of standardized specified underlying asset and standardized specifications such as contract size and maturity it is called Standard. Since an individual who buys a product through a forward contract can sell part of the product to a new buyer with a parallel independent forward contract thus this contract is called parallel forward. Also due to hedging with two options under betting condition, we finally name it SPFO.

According to the SPFO modeling: the forward is an instrument which buyer of forward contract can sell a specified amount of asset before maturity through another independent forward contract but for delivery of an asset in the maturity, refers the new buyer to the first forward security issuer by draft contract. This is initially because of a strong assurance by the government provided for investors due to the developing countries conditions. Accordingly secondary forward contract is called Standard Parallel Forward with Option (SPFO) and process can be continued this way and the buyer of an asset in the SPFO can sell it to another's. There are some preconditions and features for SPFO which is pointed out as follow:

- The sold good do not need to exist at the time of contracting.
- The sale price should be paid immediately upon making transaction
- The byer cannot sell the object of transaction prior to taking delivery unless under SPFO condition.
- The underlying asset must be described in enough detail, for the seller to deliver the required asset.
- The date and the location of delivery should be determined exactly and clearly

And about the SPFO pillars we have:

- Participants: real producers of commodities can sell their product

- Counterparty risk: is covered with the required guaranties based on the IME (Iran Mercantile Exchange)'s Clearing house. Most of companies are guaranteed by governmental institutions.

- Maturity date: There is no time limitation for SPFO contracts maturity date and it depends on market demand.(up to 6 month)

- Price: Commodities would be sold at a discount rather than the cash price
- Delivery: All deals lead to physical delivery
- Secondary Market: We have planning a SPFO secondary market for these contracts

3. A Proposal for MOP: Oil SPFO Contract

Defining under SPFO contract increases the liquidity of these securities (in compare with other ordinary domestic financial instruments) and attracts investors. A new SPFO contract will be defined after each transfer and a seller referrals new buyer to the first seller (MOP). Our plan for MOP is a new contract considering some changes and small size of contract scale. In this plan, NIOC will sell its four-year maturity oil SPFO contracts to applicants by agent bank in order to finance its investment plans. For funds received from buyers, a standard bill of exchange will be given to the buyers, which show the right of visit and receive the crude oil or cash settlement with NIGC. Each pre-sold oil SPFO security contains 10 barrels of crude oil on day price (for example, $ 100). The supplied crude oil under oil SPFO contract is "Iran heavy export crude oil". The base price is fixed and will be calculated based on Oman & Dubai Indices on the last trading day before the start of the supply period. Of course, given the oil market

oscillating conditions, there are two general risks for this contract: first, risk of non-rising oil price to favorable level (on the side of buyers) and the second, risk of excessive increase in oil price, (on the side of seller (MOP)).

It seems important to explain about options here. An option is a contract giving its owner the right to buy or sell an asset at a fixed price on or before a given date. For example, an option on a building might give the buyer the right to buy the building for $1 million on or any time before the Saturday prior to the third Wednesday in January 2010. Options are a unique type of financial contracts because they give buyers the right, but not the obligation, to do something. . (Ross et al, 2002) The buyer uses the option only if it is advantageous to do so; otherwise the option can be thrown away. There is also a special vocabulary associated with options. Here are some important definitions:

1.   Exercising the Option. The act of buying or selling the underlying asset via the option contract is referred to as exercising the option.

2.   Striking or Exercise Price. The fixed price in the option contract at which the holder can buy or sell the underlying asset is called the striking price or exercise price.

3.   Expiration Date. The maturity date of the option is referred to as the expiration date. After this date, the option is dead.

4.   American and European Options. An American option may be exercised anytime up to the expiration date. A European option differs from an American option in that it can be exercised only on the expiration date. (Ross et al, 2002)

In order to control these two types of risk, two options under betting condition is added to model. In addition, buyer (investor) purchases a put option for $ 140 (under betting condition) while he buys SPFO contract. With these explanations on one hand, if the price of per barrel be lower than $140, at maturity date, holder will have the right of selling security (put option) to NIOC for $ 140.

On the other hand, security buyer sells a call option to NIOC and if the price of per barrel rises to more than $160, at the maturity date, NIOC will have the right of purchasing security (call option) from security holder for $160. Thus, the swing range that buyer will be faced with is $140 to $160. In fact, if per barrel price is between $140 and $160, buyers can fulfill a cash settlements or physical agreement under NIOC conditions.
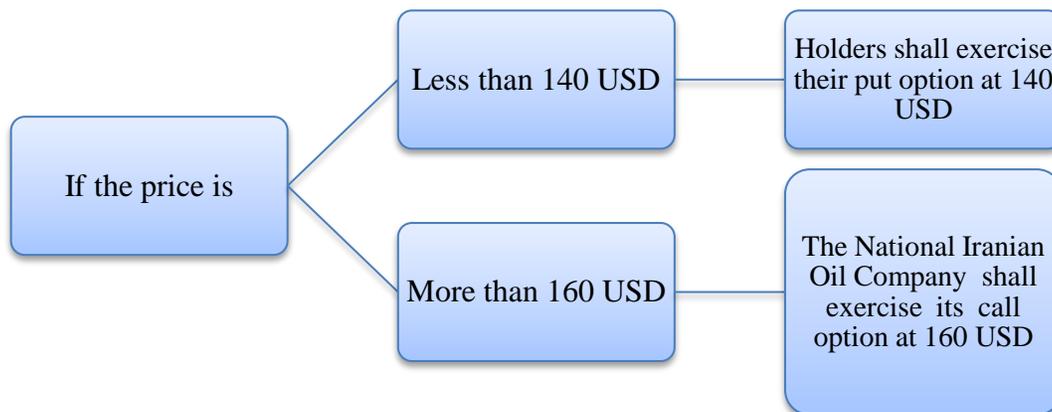

Figure 1. Use of SPFO contract; scenarios at maturity

Initially, three methods (in a three-symbol stock) were proposed to the MOP so that individuals could buy these securities with: Dollar, Rial based on Dollar and Rial. Therefore, the stock symbol should be opened for these items. Bondholders can choose physical delivery or cash settlement at maturity, under the price between $ 140 and $ 160. If they choose physical delivery option, buyer must accept the delivery terms of securities issued by the Ministry of Oil at the time of issuance. (Nikjou, 2012)

According to the latest available information, the minimum physical delivery value for shipments is one million barrels. In fact, buyers who own 100,000 contracts can request physical delivery. Furthermore, the conditions for physical extraction of crude oil in SPFO contract are so that bondholders shall announce their request to NIOC till three months before the maturity.

Accordingly all investors (domestic and foreign) have the opportunity to take part in this market and buy these securities, but in the case of physical delivery of crude oil, buyers should have special conditions of NIOC.

A question raised is: How exactly do following prices get determined?

1. The exercise price of call option that byer sells to the Ministry of Oil

2. The exercise price of put option that byer purchases from the Ministry of Oil

3. The secondary price of oil forward contract in secondary market

In this regard we apply research hypotheses as a theoretical model to answer research questions. The purpose of this research is providing a model for proper pricing of oil SPFO contract or in other words pricing the crude oil pre-sale units which is based on efficient economic principles so that finances NIOC's projects.

4. Methodology

Actually the holder of a forward contract is obliged to trade at maturity, unless the position is closed before maturity the holder must take possession of the asset, regardless of whether the underlying asset has risen or fallen in price. Wouldn't it be nice if we only had to take possession of the asset if it had risen? In order to address this problem, derivatives known as options are applied. The two most famous ones are call options and put options as follow:

• A call option gives the investor the right (not the obligation) to buy an underlying asset at an agreed-upon-price (the strike price) at a date in the future (the expiration date T)

• A Put Option gives the holder the right (but not the obligation) to sell an underlying asset at an agreed-upon-price (the strike price) at a date in the future (the expiration date T).

As already mentioned, SPFO securities have two options for dealing at maturity. Although buyer or seller does not pay for this put and call option directly, however they implicitly pay this option cost to each other. Therefore, the difference of upper limit price at maturity (X_{max}) from oil expected price at maturity (X_e) would be considered as call option price (C_c) and accordingly the difference of down limit price at maturity (X_{min}) from oil expected price at maturity (X_e) would be considered as put option price (C_p). Now we have:

$$C_c = X_{max} - X_e \tag{1}$$

$$C_p = X_e - X_{min} \tag{2}$$

X_{max}: The maximum agreed crude oil price at maturity

X_e: The expected price of crude oil at maturity

C_c: Call option price

X_{min}: The minimum agreed crude oil price at maturity

C_p: Put option price

The oil SPFO should be profitable as a kind of financial security. Therefore, the expected price of crude oil at maturity should be determined so that provides profitability for holders of these securities. But the important point to keep in mind is that since these securities have an asset risk because of the volatility in their base assets (crude oil); the expected return of investor should be adjusted to its risk degree. One of the most significant models for determining the expected return on risk assets is Capital Asset Pricing Model (CAPM).

For the first time, CAPM was developed by Sharp (1964),)Lintener (1965), Treynor (1961) in the 1960s. In their proposed model, they tried to create an implicit equilibrium between risk and return on securities.

In this way, the return on a capital asset can be attributed to the return on the stock market by following equations (Perord, 2004):

$$R = R_f + \beta(R_m - R_f) \tag{3}$$

$$\beta = \frac{cov(R_i, R_m)}{var(R_m)} \tag{4}$$

R_f: Interest rate on bank dollar deposits (risk-free rate)

R: Expected rate of dollar return on risky asset (crude oil)

R_m: The average of dollar return on other assets (market rate)

β: Systematic investment risk criterion

In addition, in this research X_e is calculated by the following formula:

$$X_e = (1 + R)*S \tag{5}$$

S: Crude oil price at the beginning of period

As when as the expected return rate of risk asset (crude oil) is determined until maturity, using formula 5, we can calculate the expected price of risk asset at maturity.

In this paper, a template is presented based on the pricing of a dollar-based oil SPFO security. In order to calculate X_{min} and X_{max} in oil SPFO contract, the call and put option price of these securities should be determined; accordingly the Black-Scholes pricing model is implied for this purpose.

The Black-Scholes formula (also called Black-Scholes-Merton) was the first widely used model for option pricing. It is used to calculate the theoretical value of European-style options using current stock prices, expected dividends, the option's strike price, expected interest rates, time to expiration and expected volatility. The formula, developed by three economists – Fischer Black, Myron Scholes and Robert Merton (1973) – is perhaps the world's most well-known options pricing model. (Folger, 2015)

It takes into account that you have the option of investing in an asset earning the risk-free interest rate. It acknowledges that the option price is purely a function of the volatility of the stock's price (the higher the volatility the higher the premium on the option). Black-Scholes treats a call option as a forward contract to deliver stock at a contractual price, which is, of course, the strike price.

It was designed based on binominal option pricing (Note 2). The reason of using this model is that oil SPFO contract has no dividing and earning.   Also, since these options will be applied at maturity, and in this regard, it is a kind of European-style option; consequently Black-Scholes model is the best choice. (Black and Scholes, 1973)

In the main pattern of this method, the underlying asset had no dividing and earning, which has been modified in subsequent patterns by Robert Merton (1970s). In this method, the return on the underlying asset (stock) is considered as a variable with normal probability distribution. Using this model, the underlying asset price (stock) itself will have a normal logarithmic distribution.

4.1 The Black-Scholes Model Assumptions

For extracting the Black-Scholes formula, the following assumptions are considered:

- The option is European and can only be exercised at expiration.

- No dividends are paid out during the life of the option.

- Markets are efficient (i.e., market movements cannot be predicted).

- There are no transaction costs in buying the option.

- The risk-free rate and volatility of the underlying are known and constant.

- The returns on the underlying are normally distributed.

- Lending and borrowing are not restricted at risk-free rate.

- There is a feasibility for short-selling

- Transactions are ongoing, over the time

- Stock price changes are continuous and there is no price jump; therefore, stock prices follow a normal logarithmic distribution

Almost all of above assumptions can be applied with a little simplification to the SPFO securities. The option to deal these securities is only applicable at maturity, thus it is a European option. No dividends or cash flows shall be paid until maturity. Market-related of these financial securities are often efficient markets, and there is no reason to be non-efficient.

Due to the standardization and existence of secondary market, transaction costs of these securities are very low and negligible. The fifth hypothesis and subsequent assumptions, though they don't appear to happen in financial markets, are important so that all other pricing models would utilize them; therefore we follow them in the same way.

4.2 Black-Scholes Pricing Formula

Black-Scholes pricing formula has six parameters: Cash price of underlying asset (S), Contractual price at maturity (k), Maturity date (t), Volatility of underlying asset (δ), Risk-free rate (r), Expected earnings of underlying asset (y)

The formula for pricing European call option contracts is as follows:

$$C = SN(d_1) - ke^{-rT}N(d_2) \tag{6}$$

Also the formula for pricing European put option contracts is as follows:

$$P = ke^{-rT}N(-d_2) - SN(-d_1) \tag{7}$$

Where:

$$d_1 = \frac{\ln\left(\frac{S}{k}\right) + \left(r + \frac{\delta^2}{2}\right)(T)}{\delta\sqrt{T}} \tag{8}$$

And:

$$d_2 = \frac{\ln\left(\frac{S}{k}\right) + \left(r - \frac{\delta^2}{2}\right)(T)}{\delta\sqrt{T}} = d_1 - \delta\sqrt{T} \tag{9}$$

Considering $N(x)$ is equal to standard normal cumulative distribution function.

4.3 Crude Oil Pricing Model

Now we present a model for pricing of SPF. As it has explained:

$$c = X_{max} - X_e$$
$$P = X_e - X_{min}$$
$$X_e = (1 + R)*S$$

From these equations, we can extract the following formulas:

$$X_{max} = X_e + c \tag{10}$$
$$X_{min} = X_e - p$$

According to the Black-Scholes formula:

$$C = SN(d_1) - ke^{-rT}N(d_2)$$
$$P = ke^{-rT}N(-d_2) - SN(-d_1)$$

Now, by inserting these formulas, we will present a model for the pricing the SPFO:

$$X_{min} = X_e - ke^{-rT}N(-d_2) + X_eN(-d_1)$$
$$X_{min} = X_e[1 + N(-d_1)] - ke^{-rT}N(-d_2) \tag{11}$$
$$X_{max} = X_eN(d_1) - ke^{-rT}N(d_2) + X_e$$
$$X_{max} = X_e[1 + N(d_1)] - ke^{-rT}N(d_2) \tag{12}$$

Since, in the SPFO, the agreed-price for put option (k) is X_{min} and the agreed-price for call option is X_{max}, , placing in equations (11) and (12), we find the final equations (13) and (14) which are the main equations for determining the up and down prices of oil standard forward bonds at maturity:

$$X_{min} = \frac{X_e[1+N(-d_1)]}{1 + ke^{-rT}N(-d_2)} \tag{13}$$

$$X_{max} = \frac{X_e[1 + N(d_1)]}{1 + ke^{-rT}N(d_2)} \tag{14}$$

As we mentioned, in lower prices than X_{min} the buyer is allowed to sell his shares to issuer therefor the exercise price at maturity of call option would be:

$$X_{min} = k \tag{15}$$

And accordingly:

$$X_{max} = k \qquad (16)$$

Placing equations 15 and 16 in equations 13 and 14 we meet some integral equations with unknown boundaries. Since these equations are unsolvable we will not achieve a specific answer so that:

$$X_{min} + \frac{e^{-rT}}{\sqrt{2\pi}} X_{min}^2 \int_{-\infty}^{-\frac{\ln\left(\frac{S}{X_{min}}\right)+\left(r-\frac{\delta^2}{2}\right)(T)}{\delta\sqrt{T}}} e^{-\frac{Z^2}{2}} dz - X_e (1 + \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{-\frac{\ln\left(\frac{S}{X_{min}}\right)+\left(r+\frac{\delta^2}{2}\right)(T)}{\delta\sqrt{T}}} e^{-\frac{Z^2}{2}} dz) = 0 \quad (17)$$

And

$$X_{max} + \frac{e^{-rT}}{\sqrt{2\pi}} X_{max}^2 \int_{-\infty}^{-\frac{\ln\left(\frac{S}{X_{max}}\right)+\left(r-\frac{\delta^2}{2}\right)(T)}{\delta\sqrt{T}}} e^{-\frac{Z^2}{2}} dz - X_e (1 + \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{-\frac{\ln\left(\frac{S}{X_{max}}\right)+\left(r+\frac{\delta^2}{2}\right)(T)}{\delta\sqrt{T}}} e^{-\frac{Z^2}{2}} dz) = 0$$

$$(18)$$

Mathematically, in order to solve these kinds of equations we should apply numeral methods because it estimates almost as same as origin answer. In this regard, there are several numeral methods but in this article we employed the Newton–Raphson method. Since the solutions for equations 13 and 14 are the same we just investigate the 14. The Newton–Raphson method is so that to solve $f(y) = 0$ we use the following repetitive formula:

$$y_{i+1} = y_i - \frac{f(y_i)}{f'(y_i)} \qquad (19)$$

And: $\quad i = 0,1,2,\dots,n$

It is noticeable that in this method we utilize a primary guess y_0 to solve the equation and it is selected according to the condition. Placing the X_0 in Newton–Raphson formula the amount of y_1 is achieved and it is similar to principle answer. Actually we can improve the initial answer through calculating the repetitive amounts of y_2 and y_3 and minimize the estimation error. Therefore we solve the equation 14 using Newton–Raphson method as follow:

$$g = X_{min} + \frac{e^{-rT}}{\sqrt{2\pi}} X_{min}^2 \int_{-\infty}^{-\frac{\ln\left(\frac{S}{X_{min}}\right)+\left(r-\frac{\delta^2}{2}\right)(T)}{\delta\sqrt{T}}} e^{-\frac{Z^2}{2}} dz - X_e (1 + \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{-\frac{\ln\left(\frac{S}{X_{min}}\right)+\left(r+\frac{\delta^2}{2}\right)(T)}{\delta\sqrt{T}}} e^{-\frac{Z^2}{2}} dz)$$

$$(20)$$

$$f = X_{max} + \frac{e^{-rT}}{\sqrt{2\pi}} X_{max}^2 \int_{-\infty}^{-\frac{\ln\left(\frac{S}{X_{max}}\right)+\left(r-\frac{\delta^2}{2}\right)(T)}{\delta\sqrt{T}}} e^{-\frac{Z^2}{2}} dz - X_e (1 + \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{-\frac{\ln\left(\frac{S}{X_{max}}\right)+\left(r+\frac{\delta^2}{2}\right)(T)}{\delta\sqrt{T}}} e^{-\frac{Z^2}{2}} dz)$$

$$(21)$$

Also we can employ primary guess $X_{max} = X_e$ to solve the equation and consider it as primary amount y_0. Now placing the other parameters we can calculate the amount of X_{max}.

Let's illustrate with an example:

Assume that $X_0 = 60$ \$, risk free rate $R_f = r = 5\%$, standard deviation $(\delta) = 20\%$, remained time to maturity $(T) = 1$ year, (β) for crude oil $= 1.1$ and market return rate $(R_m) = 7\%$. In this condition using the Newton–Raphson method we can calculate the X_{max} and X_{min} as follow:

First of all we calculate Xe from equations 3 and 5:

$$R = R_f + \beta(R_m - R_f) = 0.05 + 1.1(0.07 - 0.05) = 0.072$$

$$X_e = (1 + R)X_0 = 64.32$$

Accordingly we employ primary guess $X_{max} = X_e = 64.32$ and put it in repetitive Newton–Raphson formula as y_0. Placing the amount of $y_0 = 64.32$ in equation 17 the amount of y_1 is calculated as follow:

$$y_1 = y_0 - \frac{f(y_0)}{f'(y_0)} = 64.32 - \frac{f(64.32)}{f'(64.32)} = 65.12$$

Now using the amount of y_1, second-order answer of y_2 is calculated as follow:

$$y_2 = y_1 - \frac{f(y_1)}{f'(y_1)} = 65.12 - \frac{f(65.12)}{f'(65.12)} = 66.27$$

Therefore we can consider the amount of $y_2 = 66.27$ as an approximation for X_{max}. It is noticeable that in order to get the answer more exactly we should repeat the process till higher orders. Similarly for X_{min} we can apply Newton–Raphson formula with two repetitions as follows:

$$y_1 = y_0 - \frac{g(y_0)}{g'(y_0)} = 64.32 - \frac{g(64.32)}{g'(64.32)} = 63.08$$

Now again using the amount of y_1, second-order answer of y_2 is calculated as follow:

$$y_2 = y_1 - \frac{g(y_1)}{g'(y_1)} = 63.08 - \frac{g(63.08)}{g'(63.08)} = 62.16$$

Consequently the amount of $y_2 = 62.16$ is an approximation for X_{min} and in order to get the answer more exactly we should repeat the process till higher orders.

5. Conclusions and Recommendations

Economic growth and sustainable development of economy depends on macroeconomic, national, targeted, and precise investment in the country. The oil industry is one of the most important economic sectors in Iran that finances other sectors of economy. Considering energy as a pioneer of Iran's economy, it has a definite investment position and deeply needs to be equipped.

The way we suggested in this regard to finance the projects of oil industry is SPFO oil contract. Due to its different nature with the conventional financing instruments, it should be investigated. Actually the most important aspect of this security is the pricing which discussed in this research. Finally, using the well-known model of Black-Scholes option pricing, we tried to illustrate the appropriate mathematical model. We have some considerations in this regard:

- The maturity of oil parallel forward contract is usually as short as can be considered as an alternative for a conventional T-bill.

- In most of the case forward contract has been issued as monitory policy instrument, SPFO oil contracts also can be used for this target.

- Despite a wide acceptance of some forward contracts, they have a very little amount of global issuance. We suggest the promotion of SPFO oil contracts by policy-makers.

- Lack of secondary market for forward contract results liquidity risk that using these model would address this problem.

- Because of counterparty risk, entities rarely enter into a contract if there is no third-party guarantee that using this model individuals can trust to the contracts.

- Financing with less expenses

- No limitations regarding funds for financing

- Providing adequate price hedging for both side of transaction

Finally, we suggest that empirical and statistical research can be carried out on the basis of this model to estimate the marginal prices of these securities. There are some suggestions for future studies:

- The presented pricing model is about domestic investment while the type of currency for buying and returns of this security is the same. Otherwise if we look as a foreign investor then the type of currency and returns would be different and the exchange rate is entered. Therefore the pricing model should be different and in this regard we offer to consider this important matter in next studies.

- Because of tricky numeral calculations we can apply MATLAB application and analyze the impact of each factor and provide two and three-dimensional graphs.

- The risk free interest rate and crude oil price are random variables and because of this, changing the presented model assumptions and employing Brownian motion and Itos Lemma we can make a new model to evaluate these kinds of securities.

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Notes

Note 1. It means that settlement should be fulfilled with Dollar.

Note 2. Binomial option pricing is a simple but powerful technique that can be used to solve many complex option-pricing problems. In contrast to the Black-Scholes and other complex option-pricing models that require solutions to stochastic differential equations, the binomial option-pricing model (two state option-pricing models) is mathematically simple. It is based on the assumption of no arbitrage.