

Modelling “*Bai Al Arboun*” Using Binomial Model

Siham Omrana^a, Rajae Aboulaich^b, Ali Alami Idrissi^c

^a *Corresponding Author, Islamic Financial Engineering Laboratory,
Laboratory of Study and Research in Applied Mathematics
Mohammadia School of Engineering,
Mohammed V University, Rabat Morocco
siham2005emi@gmail.com*

^b *Islamic Financial Engineering Laboratory,
Laboratory of Study and Research in Applied Mathematics
Mohammadia School of Engineering,
Mohammed V University, Rabat Morocco
aboulaich@emi.ac.ma*

^c *Optima Finance Consulting
alami@optima-finance.ma*

ABSTRACT

Bai Al Arboun, down payment sale, is characterized by many similarities with a call option in the sense that both could be employed as strategies of hedging risks and a method by which stakeholders have more flexibility prior to executing their contracts. From a theoretical perspective *Bai Al Arboun* would appear to be suitable for replicating the conventional call option in a manner that complies with Shariah.

This paper examines *Bai Al Arboun* as a Shariah compliant alternative to Call Option. The challenge is to find instruments that allow the management of production risks without prejudice of speculation. We studied the possibility of modeling *Bai Al Arboun* using the Binomial Model. This model, widely used for pricing options, will be adapted to Shariah rules and conditions for pricing *Al Arboun* deposit.

JEL Classifications: G12, C5, C6, C87

Keywords: Islamic finance; derivatives; Shariah compliance; Islamic risk management; call options; *Bai Al Arboun*; financial engineering; binomial model; Cox, Ross, & Rubenstein model; fixed point method

We would like to express our deep gratitude to Dr. Sami Ibrahim Suwailem for long discussions we had and his fruitful suggestions and our thanks to the IDB for the financial support.

I. INTRODUCTION

Islamic finance is experiencing a significant development in the world. It occupies an increasing importance with more than 500 Islamic financial institutions (Baker, 2014). It represented approximately 1% of the total world assets on 2014 (Naveed, 2014). The Islamic financial assets reached around US \$2.1 trillion in 2014 (Al Huda Centre of Islamic Banking and Economics (CIBE)).

According to Ernst and Young, Islamic Banking has been growing faster than banking assets as a whole, growing at an annual rate of 17.6% between 2009 and 2013, and will grow by an average of 19.7% a year to 2018 (World Islamic Banking Competitiveness Report, 2014), depending on the sector of activity, which is higher than the traditional financial activities.

With the advent of the financial derivatives markets in the 1970s, risk management was promoted as the use of derivatives to hedge market risk exposures. Derivatives, the most common hedging financial risk products have known exponential use. Derivatives did not help to stabilize the markets and mitigate the financial crisis. This is not difficult to explain since derivatives are the main instruments of speculation. More than 97% of derivatives are used for speculation, while less than 3% are used for hedging (Suwailem, 2006).

Until the present stage of its development, Islamic Financial institutions have been without the ability to profit from falling markets or even to protect stock market investments from downward trends. It is widely acknowledged in Shariah finance circles that the conventional methods for hedging, and the short sale in particular, are simply considered contrary to Shariah principles and precepts. However, for the past several years scholars and experts have indicated a growing consensus that allow, at least in theory, to use classical transactional models like *Bai Arboun* to provide investment managers with effective tools for hedging and managing risk, including the ability to take profit when the price of shares declines (Shaykh and Talal, 2008).

Islamic Financial institutions have to manage a number of pressing risks by enhancing the development and implementation of innovative instruments and formulation of creative solutions to issues in finance using Islamic financial engineering.

Bai Al Arboun is an alternative transaction, which replicates the economic results of a conventional Call Option. It refers to a sale in which an amount is given by the buyer to the seller with the understanding that this amount becomes a part of the price in case the sale is approved, but it will be up to the seller in case the buyer is unable to fulfill its original agreement.

Bai Al Arboun has the effect of generating a net economic benefit arising from a fall in the price of the shares in the way that the seller takes an earnest money deposit from the buyer with the understanding that the deposit will be credited toward the price if the sale is concluded, and forfeited if it is not.

This Paper outlines the development of *Bai Al Arboun* as a practical solution providing investment managers with an effective way to benefit from stock market investments regardless of market trends.

After having explored the possibility of modeling *Bai Al Arboun* using the Black and Scholes (1973) model for pricing the deposit amount (Omrana and Aboulaich, 2013), we propose in this paper, the modeling of *Bai Al Arboun* using the Binomial

Model, widely used for pricing options, and adapting it on the basis of the Shariah rules to price *Bai Al Arboun* deposit.

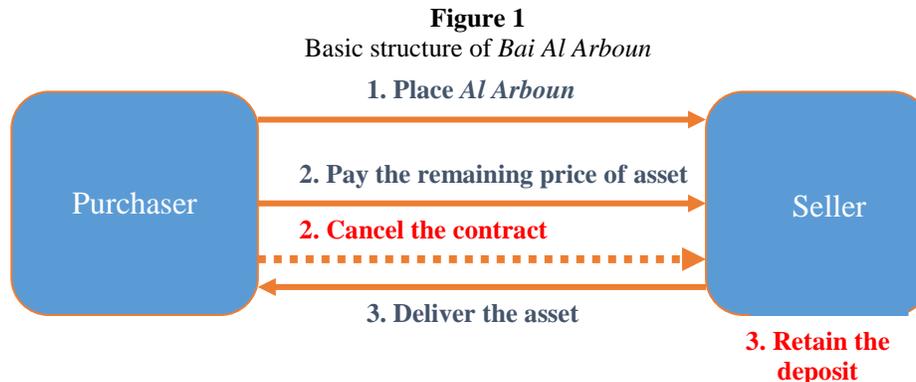
The paper is organized as follows. The first three sections introduce briefly *Bai Al Arboun*, conditions of Shariah compliance, and terms of validity of *Bai Al Arboun*. Section VI highlights the similitude and differences between *Bai Al Arboun* and call options. In Section VII, we explore the modelling of *Bai Al Arboun* using the Binomial model for pricing the deposit amount. We adapt this model by adding Shariah compliant assumptions and conditions for pricing *Al Arboun* deposit. The methodology, hypothesis as well as modeling are described in this section. In Section VII, we provide the numerical results. The last part, Section VIII, offers concluding remarks.

II. DEFINITION OF BAI AL ARBOUN

The Council of the Islamic Fiqh Academy¹ defines *Bai Al Arboun* as a “sale of a commodity with the buyer making a down payment *Al Arboun* to the seller on the understanding that if he took the commodity the down payment would be deducted from the selling price and if he dropped it then the down payment would be the seller’s property”.

A. Basic Structure

The following diagram shows the basic structure of *Bai Al Arboun* as follows:



If the buyer continues with the contract within the stipulated time period, the earnest money becomes a part of the price negotiated already. In the case the buyer decides to cancel the transaction, the earnest money is forfeited by the buyer. The deposit money can be kept by the seller.

To simplify the steps outlined above, (1) the buyer and seller agree on the price of the asset and the amount of “*Al Arboun*” (deposit) in advance by the purchaser. In this contract, two elements must be specified: the underlying asset and the date of delivery; (2) upon delivery, the seller delivers the asset to the buyer, control and checks the condition of the asset delivered; and (3) once delivered, the buyer reimburses the seller the balance of the purchase price.

B. OIC Fiqh Academy's Position

The Resolution n° (72/3/8) of the OIC Fiqh Academy at its eight Session in Bandar Seri Bagawan, Brunei Daru Salam, from 1 to 7 Muharram 1414H (June 21-27, 1993) stipulates that “Down payment sales are permissible if the time frame of the contract is set, and the down payment is considered as part of the selling price if the purchase is carried through, and as the property of the seller if the buyer desists”.

C. Terms of Validity of “*Bai Al Arboun*”

In a *Bai Al Arboun* sale, a number of Shariah Compliant conditions should be considered.

1. Shariah compliance of the underlying asset. Islamic Jurisprudence is based on five fundamental principles of Islamic financial system:

- Prohibition of *Riba*². *Riba* can be roughly translated as "Usury", or unjust, exploitive gains made in trade or business. *Riba* is forbidden in Islamic economic jurisprudence (*Fiqh*) and considered as a major sin. There are two types of *Riba* discussed by Islamic jurists: (*Riba Nasiaa*) an excess charged for a loan in cash or kind, and (*Riba Al Fadl*) the simultaneous exchange of unequal quantities or qualities of a given commodity.

- Prohibition of *Gharar*. *Gharar* is a form of deception in trade or trading of risk where an asymmetric information and risk profile exists in a contract. *Gharar* can be more broadly defined as the sale of goods that the existence and characteristics are not certain.

- Prohibition of *Haram*. *Haram* (sinful) refer to any act that is forbidden in the religious texts of the Quran and the Sunnah. Investment in businesses that provide goods or services that the Shariah considers unlawful and considered contrary to Islamic principles (e.g. pork, alcohol, drugs, traditional banking,...) is also prohibited or haram. In addition, underlying assets of all types of contract must be Shariah Compliant.

- Profits and losses sharing. The basic principle of Islamic banking is based on risk sharing, which is a component of trade rather than risk-transfer, which is common practise in conventional banking. The Islamic financial system promotes the concept of participation in a transaction backed by real assets, utilising the funds at risk on a profit and loss sharing basis. Islamic banking introduces concepts such as profit sharing (*Mudharabah*), safekeeping (*Wadia*), joint venture (*Musharaka*), cost plus (*Murabaha*), and leasing (*Ijara*)³.

2. Specification of the date of delivery. According to the definition given to “*Bai Al Arboun*” by the Islamic Fiqh Academy, the sale is dependent on the accuracy of the time in order to remove any uncertainty or *Gharar* in the contract of sale. The date of delivery should be clearly specified in the contract.

3. Identification of the underlying asset. A condition of validity of the contract is that the asset must be physical, exchangeable, clearly identified. This asset can be a commodity, a product manufacturer, share, etc.

4. Asset backing. The actual holding of the underlying assets by the seller from the date of conclusion of the contract at maturity guarantees backing the financial product to a tangible asset and thus contribute to greater economic and financial stability.

5. Determination of the amount of the deposit. The deposit or *Al Arboun* is part of the global price and not an independent component. Eventually, in case of termination of contract by the buyer, the counterparty retains the deposit.

D. Islamic Risk Management

With the genesis of the financial derivatives market in the last decade, risk management was understood as the use of derivatives to hedge against market risks exposure. In Islam, there is a lack of consensus among Islamic finance practitioners on what constitutes the “Maqasid al-Shariah⁴ of risk management”. “Islamic risk management seeks to achieve prudence in the use of resources and the avoidance of waste and damage. Islamic prudence means the ‘aversion of damages (*mafasid*) and generation of utilities (*masalih*). In other words, the risk of financial loss is a damage which is assigned as a higher priority than the prospect of profit.”⁵

Risk is an integral component of all Islamic financial transactions. When investors are willing to invest, they actually agreed to take the risk, just as they have agreed to accept the benefit of the investment.

Islamic financial institutions have to manage a number of crucial risks such as credit risk, liquidity risk, market risk and even rate of return risk. Moreover, in practice, Islamic finance faces additional risks such as the risk of *Murabaha*⁶ and *Ijara*⁷ contracts, which are not included in the traditional banking sector. The main difference between Islamic and conventional management risk is the principle of risk sharing.

When dealing in a very volatile environment, risk management tools are essential for managing and controlling business risks including price risks. “Currently Islamic investment instruments have very limited applications in the risk management area of Islamic financial institutions. Due to a limited number of available Islamic financial instruments, important issues in managing balance sheet and liquidity risks face major difficulties in Islamic banks. The inability to manage the banking risks properly has made Islamic banking activities at times more risk prone and less profitable. The Islamic banking community needs new financial instruments for risk and asset/liability management purposes” (Arani, 2004).

Thus, until alternative and appropriate innovative tools are discovered, researchers generally agree that hedging is permissible and necessary as a tool of risk management. It can be generally concluded that hedging is permissible if the following conditions are met:

- The risks being managed or mitigated should themselves be Shariah compliant: Risk management should be by way of Shariah compliant means, modes and contracts (as opposed to the use of conventional risk management products).
- The objective should be the management, mitigation or lowering of risk only, but not to fully eliminate or to earn profits from such risk by use of conventional styled investment products.
 - It must include risk sharing and participation features.
 - It must satisfy investment and hedging needs.

E. Bai Al Arboun as An Alternative to Conventional Call Option

Theoretically, the basic reasoning of Call Options is similar to that of *Bai Al Arboun* particularly in the way that both could be employed as a risk hedging strategies or a method by which investors have more flexibility prior to executing their contracts. However, the main difference is that *Al Arboun* is a part of the Global price if the purchase is carried out, while the premium of the Call Option it is not.

The actual holding of the underlying assets by the seller from the date of conclusion of the *Bai Al Arboun* contract until the maturity guarantees backing the financial product to a tangible asset and thus contribute to a greater economic and financial stability. The underlying asset of *Bai al Arboun* should be physical, exchangeable, clearly identified and must be retained by the seller from the date of conclusion of the contract to a maturity. This asset can be a commodity, a manufacturing product, a stock ...

The down payment is a predetermined amount, non-refundable, that buyer must pay when concluding contract. It is the "price" of the optional component of the contract. However, unlike the premium for a Call, the down payment is part of the Global Price and not an independent component. Eventually, in case of termination of contract by the buyer, the counterparty retains the deposit.

To illustrate *Bai Al Arboun*, consider an underlying Asset that is a stock. Initially, the counterparties agree on a global price (K) of 100 Dh, and 5 Dh deposit *Al Arboun* (A) that the buyer pays immediately. On the other hand, the counterparty (an Islamic bank) opens an account on behalf of the buyer. Then the bank buys the stock, keeps it in the account and set up its hedging. In this way, the bank holds the underlying Asset effectively, which is not the case for a "call".

At the Maturity of the contract, two situations are observed according to the evolution of the Market price of the underlying Asset. If the spot price is lower than the Amount Remaining ($K - A = 145$ Dh), the buyer should cancel the contract. In this way, he limits his loss to the amount of the deposit (-5 Dh). On the other hand, the buyer has no incentive to cancel the contract. In this case, He will buy the Stock on a Global Price of 150 Dh but he will only pay the remaining amount 145 DH in addition to the deposit 5 Dh originally paid.

The profit and loss diagram of "*Bai Al Arboun*" studied in the previous example based on the spot price of the underlying asset can be represented in Figure 2. In appearance, the Profit and Loss diagram of Bai Al Arboun is quite similar to that of a conventional Call. From a conceptual point of view, the Bai Al Arboun allows the buyer, as in the case of the Call to fully explain the increase in disbursing only a small amount relative to the Global Price and limit downside risk to the Deposit amount. Nevertheless, two major differences are to remind: (1) the Shariah Compliance of the underlying asset. (2) the down payment (*Al Arboun*) should be a component of the Global Price unlike the option premium. (3) asset backing principle: The actual holding of the Underlying Asset by the bank during the contract guaranteed the backing of the financial product to a tangible asset and thus contributes to greater economic and financial stability.

F. Profit and Loss Diagram of *Bai Al Arboun*

The *Al Arboun* (down payment) is a component of the Global Price thus, the Net Profit in the case of *Bai Al Arboun* contract is: $P_{\text{profit}} = \text{Max}(S_T - (K - A), 0) - A$; where $A = \text{Al Arboun}$ or the deposit of *Bai Al Arboun*, S_T : the price of the underlying asset at maturity, and K : the strike price. The following table summarizes the profit and loss of the buyer and seller of *Bai Al Arboun* according to the evolution of the underlying asset at maturity.

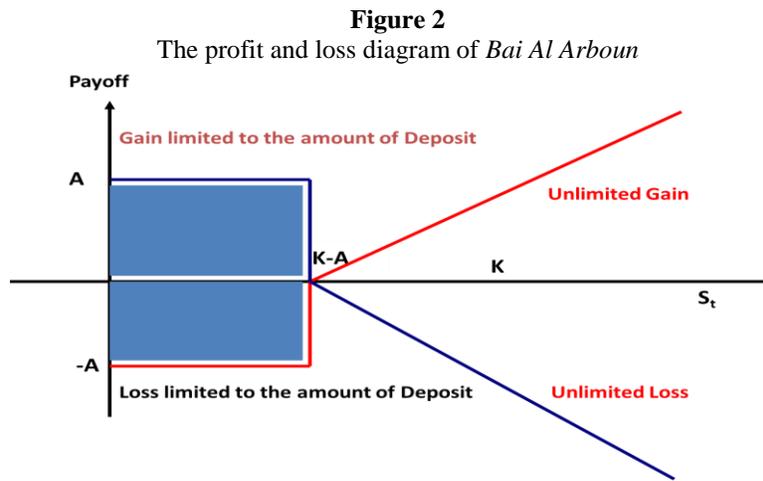


Table 1
Profit and loss diagram of *Bai Al Arboun*

Payoff	Buyer	Seller	(. ; .)
$S_T < K - A$	$-A$	$+A$	$(-; +)$
$S_T = K - A$	0	0	$(0; 0)$
$S_T > K - A$	$S_T - K + A$	$K - A - S_T$	$(+; -)$

III. MODELLING BAI AL ARBOUN

We study the possibility of modeling *Bai Al Arboun* using the binomial model for pricing of the deposit amount. This model, widely used for pricing options, will be adapted on the basis of the rules of Shariah for pricing deposit *Al Arboun*.

The Binomial model determines the price of *Al Arboun* using a discrete time framework to trace the evolution of the underlying asset via a tree for a given number of steps, which corresponds to the time between the valuation date and the expiration

date of the option. Each node of the tree is a possible price of the underlying asset at a specific point in time. This price trend is the basis for the evaluation of options. The evaluation process is iterative. We start from the end node of each branch and then “back” to the first node (valuation date), where the result of the calculation is the value of the option.

A. Binomial Method: The Cox-Ross-Rubenstein (CRR) Model

The Cox-Ross-Rubenstein model is the first binomial model proposed for pricing options. This model assumes that the price of the underlying asset can be approximated by a binomial process. At each time interval, the price of the underlying asset moves up to (u) or down (d).

The evaluation process is iterative. We start from the end node of each branch and then we go back to the first node where the result of the calculation is the value of the option.

1. Basic Assumptions

We will try to adapt the basic assumptions of the Binomial model with the principles of Shariah and introduce other assumptions Shariah compliant that does not affect the development of the model. We assume that the following conditions are respected.

a. Shariah compliance assumption

Compliance requirements of the underlying asset to the Shariah rules include:

- The underlying asset must be Shariah compliant.
- The underlying asset must be tangible, identifiable and owned by the owner of the asset at the time of conclusion of the contract (asset backing principle).
- The deposit A is a component of global price.
- R is the low risk return rate: it is the return rate of a riskless asset whose emitter is characterized by a higher level of solvency (example, Sovereign Sukuk Ijara⁸).

b. Assumption of the Cox-Ross-Rubenstein model

The price of the underlying asset follows a random process, which is described by a binomial distribution with discrete points in time.

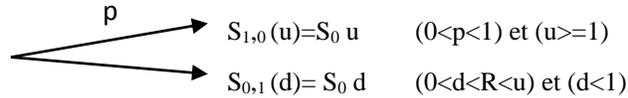
- No dividends are paid out during the life of the option.
- The option is American; it can be exercised at any time prior to maturity.
- The market is frictionless: liquidity is perfect, no information asymmetry, trading in continuous time, no transaction costs.
- Each stock is perfectly divisible.
- Absence of arbitrage opportunities (i.e., there is no way to make a riskless profit).
- p The Probability “low risk” of rising in the price of underlying asset between each period and (1-p) the Probability of the decline in the price of the underlying asset.

- The binomial probability p is accepted as constant for the duration of the option.
- The period to maturity is divided by n sub-periods when a binomial tree is constructed.

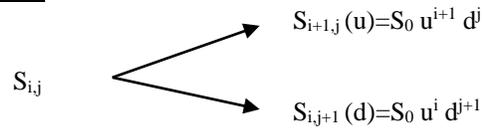
2. Definition of the Price of the Underlying Asset

We define S_n = price of the underlying asset and A_n = value of "Al Arboun" at n . For each node of the tree, using the fact that the price of the previous node is already known. For the first node, the spot price of the underlying asset:

For one period:



Generalization:



Price calculation by retrograde recurrence:

$S_{i,j}$ = the value of the underlying asset for the node (i, j) ; $S_{i,j} = S_{i-1,j} * u^i$; j = the index j corresponds to the position; $S_{i,j+1} = S_{i,j} * d^j$; i = the index i corresponds to the period;

$$u = e^{\sigma\sqrt{\Delta t_i}}; \quad d = e^{-\sigma\sqrt{\Delta t_i}}; \quad \Delta t = T/n$$

The value A of *Bai Al Arboun* must satisfy the following relationship:

$$A(S, t) \geq \max [0, S - (K - A(S, t)) \exp(-Rt)] \quad (1)$$

$$A(0, t) = 0; \text{ pour tout } t [0, T] \quad (2)$$

$$A(S, T) = \max \{ (S_T - K - (A(S, T))), 0 \} \quad (3)$$

It is possible to generate a binomial tree in which the value of the underlying asset at each node is S_{ujdi-j} for j varying from 0 to i where the index i corresponds to the period and the index j indicates the position.

The valuation of *Al Arboun* at any position (i, j) on the tree, denoted $A_{i,j}$ is performed by a recursive procedure, starting from the due date T and by traversing the tree until the present moment. On the maturity date T , the value of *Bai Al Arboun* is:

$$A_{n,j} = \max [0, S_{uj dn-j} - (K - A_{n,j})] \quad (4)$$

where $S_{uj dn-j}$ is the value of the asset after j upward movements and $(n - j)$ downward movements. The value of "Al Arboun" on any node is obtained from the following two by the value found in the low risk return rate R :

$$A_{ij} = \exp(-R\Delta t) [p A_{i+1,j} + (1-p) A_{i,j+1}] \quad \text{pour } 0 \leq i \leq n-1 \quad 0 \leq j \leq i. \quad (5)$$

In the case of *Bai Al Arboun* the option price shall be at least equal to its intrinsic value:

$$A_{ij} = \text{Max} [S_{uj} d_{i-j} - (K - A_{ij}), \exp(-r\Delta t) (p A_{i+1,j+1} + (1-p) A_{i+1,j})]. \quad (6)$$

B. Numerical Results

The table below compares the numerical results of *Bai Al Arboun* and those of the American Call Option under similar market conditions assuming that the two contracts have the same exercise price, the same rate of return and the same maturity and that the underlying asset has the same volatility and performance.

Table2

Comparison between *Al Arboun* and the premium of an American call option using the following parameters:

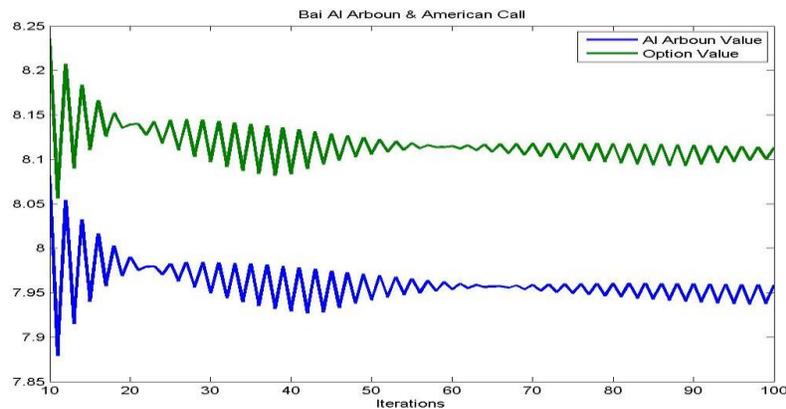
$R = r = 0.05$, $\text{Sigma} = 0.25$, $T = 1$, N : Number of tree steps = 50, $K = 100$

St	<i>Al Arboun</i>	American Call Option
115	23.31	23.20
110	19.39	19.33
105	15.72	15.68
100	12.55	12.28
95	9.45	9.41
90	6.95	6.90
85	4.84	4.79
80	3.18	3.12

C. Graphical Presentation

Figure 3

The evolution of the *Al Arboun* and the premium of an American call option under similar market conditions



IV. CONCLUSION

Islamic researchers and financial authorities must be involved in a continuous process of engineering and designing new financial instruments and finding innovative solutions to financial problems within the Islamic frameworks. This is essential since most traditional financial engineering products, like conventional derivatives or investment products are not permissible under Islamic law. A major justification for financial engineering products is provided in terms of the need to manage risk of fluctuation of the values of those assets. It is, indeed, a challenge in itself to develop new Islamic contracts that exclude Riba, Gharar and Maysir and are not easily subject to speculative abuses.

The large sample of derivative contracts prohibited by Shariah engineered through Financial Engineering are powerful tools for the resolution of risk/return trade off and the liquidity problems of Islamic banks. A massive joint effort should be made to create new investment instruments for the development of Islamic financial markets.

As presented in this paper, *Bai Al Arboun* could be employed as strategy of hedging risks and a method by which stakeholders have more flexibility prior to executing their contracts. It could be used as a Shariah compliant alternative to conventional Call options.

We studied the possibility of modelling *Bai Al Arboun* for pricing the amount of the deposit by adapting the Binomial Model to Shariah rules. We compared the numerical results of *Bai Al Arboun* and those of the Call Option under similar market conditions assuming that the two contracts have the same exercise price, the same rate of return and the same maturity and that the underlying asset has the same volatility and performance.

ENDNOTES

1. Islamic Fiqh Academy is an Academy for advanced study of Islam based in Jeddah, Saudi Arabia. It was created at the decision of the second summit of the Organization of the Islamic Conference (OIC) 1974 and inaugurated in February 1988.
2. <http://en.wikipedia.org/wiki/Riba>
3. https://en.wikipedia.org/wiki/Islamic_banking
4. Maqasid al Shariah are goals or purposes of Shariah. In Islamic terms, there are five foundational goals (Maqasid al-Shariah). These are the preservation of Religion / Faith, Life, Lineage / Progeny, Intellect, Property / Wealth.
5. Workshop on Risk Management: Islamic Economic and Islamic Ethico Legal Perspectives on the Current Financial Crisis (Husam el Khatib, London school of Economics, 2009).
6. *Murabaha* is not an interest-bearing loan, which is considered *Riba* (or excess). *Murabaha* is an acceptable form of credit sale under Shariah (Islamic religious law). Similar in structure to a rent to own arrangement, the intermediary retains ownership of the property until the loan is paid in full. It is important to note that to prevent *Riba*, the intermediary cannot be compensated in addition to the agreed

upon terms of the contract. For this reason, if the buyer is late on their payments, the intermediary cannot charge any late penalties.

7. *Ijarah* is an exchange transaction in which a known benefit arising from a specified asset is made available in return for a payment, but where ownership of the asset itself is not transferred. The Ijara contract is essentially of the same design as an installment leasing agreement. Where fixed assets are the subject of the lease, such can return to the lessor at the end of the lease period, in which case the lease takes on the features of an operating lease and thus only a part amortization of the leased asset's value results.
8. Sukuk as explained by AAOIFI as undivided shares in the ownership of underlying assets relating to a particular project or investment activity, Globally, it appears that Ijarah based Sukuk may be the most popular. Thus, Ijarah in Islamic finance industry means the transfer of the usufruct of an asset to another person in exchange for a lease payment from him. However, Sukuk al-Ijarah as defined by AAOIFI "refers to the buying and leasing back of assets by the investors to the issuer and such Sukuk shall represent the undivided beneficial rights/ownership/interest in the asset held by the trustee (SPV) on behalf of the investors".

APPENDIX

The implementation of Equation (6) is as below:

Definition of the parameters: dt, R, σ, u, d et p .

$$\begin{aligned} dt &= t / n \\ u &= \exp(\sigma * \text{Sqr}(dt)) \\ d &= \exp(-\sigma * \text{Sqr}(dt)) \\ p &= (r - d) / (r * (u - d)) \\ R &= \exp(-R * dt) \end{aligned}$$

Definition of Function: $A(S, K, r, \sigma, t, n)$

Initialization

Boundary conditions

For $j=1$ to n
 $A(0, j) = 0$
 $A(\text{infini}, j) = 0$
 End for

Terminal condition

For $i=1$ to n
 $A(n, i) = \text{Max}(S * u^n * d^{(n-i)} - (K - A(n, i)), 0)$

Fixed Point Method

1. Give an initial value $A(0, i)$ and a tolerance ϵ .
 $g(A(n, 0)) = \text{max}(S_n * u^n * d^n - (K - A(n, 0)), 0) = A(n, 0)$
2. Ask $A(n, 1) = g(A(n, 0))$ and $n = 1$.
3. While $|g(A(n, i)) - g(A(n, i-1))| > \epsilon$ do :
 - $A(n, n) = g(A(n, i)) = \text{max}(S - (K - A(n, i)), 0)$

```

      • n ← n - 1.
    4. g (A(n,i))
  End For

Calculation of Ai,j
For i=n to 0
  For j= 1 to i
    A(i,j) = Max(S* u ^i * d^(j-i)-(K-A(i,j)), exp (-Rdt) (1-p) * A(i,j+1) +p*A(i+1,j));
  End For
End For
End Function

```

REFERENCES

- Arani, Shahin Shayani, 2004, Engineering Islamic Option Contracts.
- Ayub, M., 2003, "Derivatives and Islamic Finance", available online at http://www.sbp.org.pk/departments/ibd/derivatives_islamic.pdf
- Bacha, O.I., 1999. "Derivative Instruments and Islamic Finance: Some Thoughts for Reconsideration", *International Journal of Islamic Financial Services*, 1(1).
- el Khatib, Husam, 2009, Workshop on Risk Management: Islamic Economic and Islamic Ethico Legal Perspectives on the Current Financial Crisis , London school of Economics.
- Khan, Fahim, 1997, "Islamic Futures and Their Markets", *Islamic Research and Training Institute*.
- Omrana, S. and R. Aboulaich, 2013, "Bai Al Arboun A Shariah Compliant Alternative to Conventional Call Options, *International Journal of Finance and Economics*, Issue 115.
- Salehabadi, A., and A. Mohammad, 2002. "Islamic Justification of Derivative Instrument", *International Journal of Islamic Financial Services*, 4(3).
- Suwailem, Sami, 2006, "Hedging in Islamic Finance", *Islamic Development Bank*.