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Financial derivative instruments and their applications in Islamic banking and finance: Fundamentals, structures and pricing mechanisms

Burhan Uluyol

Department of Islamic Economics and Finance, Istanbul Sabahattin Zaim University, Turkiye

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ABSTRACT

There is ongoing debate regarding the permissibility of financial derivatives in Islamic banking and finance. While traditional derivative products are rejected by most Islamic schools of thought as permissible tools for risk management, there have been developments in *Shariah*-compliant structured products to address this need. Therefore, the objectives of the study are twofold: i) to examine the permissibility and acceptability of financial derivatives within Islamic economics and finance, and ii) to investigate their structures and pricing models. This study finds that these instruments can be utilised for risk management purposes while adhering to the principles of wealth protection in Islam. It is also crucial to prohibit elements such as speculation, gambling, and *gharar* while using financial derivatives in Islamic banking and Finance. As a contribution to the study, this research aims to incorporate traditional option pricing models into *Shariah*-compliant derivatives, which has been a topic that has been scarcely explored in previous studies.

1. Introduction

Financial derivatives serve as tools for managing and minimising financial risks in contemporary businesses by deriving their values from other securities such as stocks, currencies, interest rates, sovereign bonds, or commodities. These derivative instruments come in four distinct forms: forward contracts, futures contracts, options contracts, and swaps. Among these options is the most widely utilised and heavily traded financial derivative instrument in the global financial markets (Bacha, 2001).

Since modern Islamic banking and finance (IBF) operates within conventional financial environments, it faces financial risks similar to those of conventional financial systems. To mitigate such financial risks, modern Islamic economists (Bacha, 2013, 2017; Kamali, 1999; Khan, 1988; Malkawi, 2011; Muhammad Al-Amine, 2013; Salehabadi & Aram, 2001) developed several financial derivative instruments based on Islamic principles such as *Salam*, *Isttisna*, *Joala*, and *Istijrar* among others. According to Bacha (2001), there are differing opinions regarding the use of financial derivatives in the financial system. It is believed that if used wisely, they can provide benefits such as risk reduction, improved market efficiency (Samarakoon et al., 2023), and lower transaction costs. However, their negative aspects include high financial leverage, excessive speculation, and complexity. These weaknesses should be taken into consideration when evaluating the overall impact of financial derivatives on the system (Sinkey & Carter, 2000; Gogoncea & Paun, 2013).

Financial derivatives have several positive aspects. According to Kamali (1999), risk management and risk reduction are the most significant benefits of futures and options contracts. Jobst (2007) argues that financial derivatives improve the efficiency of capital markets by allocating risks and increasing the liquidity of underlying cash markets. Sakti et al. (2016) note that financial derivative instruments are essential for hedging and risk mitigation in Islamic banking and finance. Keffala (2021) concludes that the use of financial derivatives, such as options and swaps, can increase the performance of Islamic banks. More recently, Spilker and Nugent (2022) concluded that exchange-traded derivative products could improve the standardisation, transparency, and price discovery of voluntary carbon markets. In another study, Das and Kumar (2023) found that foreign currency derivatives can enhance the value of a firm.

Policymakers, market participants, and regulatory institutions are all focused on improving the transparency and safety of financial derivatives. However, *Shariah* scholars are also concerned with the permissibility of these instruments from an Islamic perspective. According to Muhammad Al-Amine (2013) and Jobst (2007), both groups lack familiarity with the structures, mechanisms, and technical language

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E-mail address: borhanseti@gmail.com.

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of these financial instruments. Therefore, there is a need for a more detailed understanding and objective appreciation of the use of financial derivatives in the Islamic financial system.

In order to hedge or reduce some risks in Islamic banking and finance, modern Islamic economists developed several innovative instruments which are compliant with Islamic principles. Although there is ongoing debate surrounding the acceptability and permissibility of *Shariah*-compliant derivative instruments for risk management purposes, it is important to gain a comprehensive understanding of financial derivatives in Islamic finance. While some scholarly literature (Jobst, 2013; Malkawi, 2014; Rizvi et al., 2014; Sakti et al., 2016) has discussed the *Shariah* aspects of these financial instruments, less attention has been given to exploring their technical aspects, such as structures and pricing (Kiong Kok et al., 2014).

The aim of this paper is to analyse the permissibility and acceptability of financial derivatives in Islamic economics and finance. The paper will also discuss two frequently used pricing models - the Binomial Option Pricing Model (BOPM) and The Black-Scholes Pricing Model (BSOPM). Finally, we will apply these option pricing models to Islamic financial derivatives to gain a better understanding of them.

Although the *Shariah* aspects of financial instruments have been discussed in the literature, the technical aspects such as structures and pricing have largely been ignored. This paper aims to examine the permissibility and acceptability of financial derivatives in Islamic Economics and Finance, and also explores the applications of the Binomial Option Pricing Model (BOPM) and The BSOPM in Islamic Financial Contracts like *Sukuk Ijarah* with embedded options and *Istijrar*. Our objective is to make two contributions to the current literature. Firstly, we will conduct a thorough review of all *Shariah*-compliant derivatives and assess their acceptability from an Islamic standpoint. Secondly, we will attempt to merge conventional option pricing models into *Shariah*-compliant derivatives, a topic that has been scarcely explored in previous research.

Although there is some disagreement regarding the acceptability of financial derivatives from an Islamic perspective, they are necessary in Islamic finance for hedging or risk management in accordance with the principles of wealth protection in Islam. However, other aspects of financial derivatives such as speculation, gambling, and *gharar* must be prohibited in the Islamic financial system (Haruna et al., 2023; Kazak et al., 2023; Ozdemir et al., 2023).

The paper is structured into different sections. In Section 2, the requirements for Islamic financial instruments are analysed. Different types of these instruments are discussed along with a critical evaluation of various viewpoints on Islamic derivatives. This introduction section lays the foundation for further discussion. In Section 3, the related literature on the subject of Islamic financial derivatives is presented. Section 4 examines several pricing models used in financial derivatives, including the BOPM and the BSOPM. In Section 5, we explore their applications in Islamic contracts such as simple ijarah *sukuk*, *Ijarah sukuk* with embedded options (call and put), and *Istijrar* contract. Finally, concluding remarks are provided in Section 6.

2. Islamic Finance derivative instruments

2.1. Essentials of Islamic Finance contracts

To comply with the principles of *Shariah* in Islamic finance, all contracts and transactions must meet certain requirements, including the *Maqasid* of *Shariah* (Abdul Razak & Saupi, 2017; Hasan, 2022). These requirements aim to guarantee that financial agreements and transactions do not contain elements that may cause harm or result in the loss of wealth.

Furthermore, it is important to consider several prerequisites when it comes to the sale of an asset in accordance with *Shariah* principles (Kunhibava & Shanmugam, 2010). One such prerequisite is that derivatives are a form of financial asset whose value is based on an underlying tangible asset. Additionally, the underlying commodity or asset must be compliant with *Shariah* rules and exist in tangible saleable form at the time of contract. Lastly, it is necessary for the seller to have rightful ownership over the final form of the asset.

2.2. Islamic Finance derivative instruments

Many Islamic finance instruments have features similar to derivative instruments (Bacha, 2017). Some of these Islamic finance instruments will be examined here.

2.2.1. Bay' al-salam

Bay' al-salam (forward sale) is a contract in which there is an undertaking from the seller to deliver an underlying commodity at a specific future date in return for immediate payment by the buyer at spot price (Al Zaabi, 2010). Some of the aspects must be stated precisely, such as the quantity, quality, conditions and mode of delivery of the commodity at a prefixed future date to buyer. According to Islamic Fiqh, the seller is typically required to have possession of goods before selling them (Muneeza et al., 2011). However, there is an exception known as the *salam* contract, in which this requirement does not apply. Unlike conventional forward contracts where payment takes place at a future date, in a *bay' al-salam* contract, the buyer must make full payment at the time of initiating the contract. It should be noted that in a *salam* contract, cash payment is necessary for the buyer to enable the seller to purchase raw materials.

The *bay' al-salam* contract has several requirements, as follows (Muhammad & Chong, 2007; Yusoff & Kamdari, 2016):

1. Buyer needs to make full payment in advance at contract initiation.
2. Ownership is not transferred to the buyer before the delivery.
3. The commodity being sold must be standardisable, measurable and of ascertainable quality.
4. Contract price and the asset must not be *ribawi* commodities, i.e., gold, silver, salt, etc., as these require simultaneous delivery, or else, may lead to *riba*.
5. The contract should not be made for a specific asset, for example, crops from a certain farm or field, etc.
6. The contract must be made for fungible goods.
7. Quality, quantity, delivery date and delivery place have to be stated in the contract.
8. The commodity should be such that it is available in the markets all through the contract period.

Exchange traded futures (ETFs) seem to share similarities with *bay' al-salam* contracts, except that the buyer is expected to make an advance payment. This feature makes *bay' al-salam* more like a forward contract than a futures contract. However, it is important to note that the limitations of multiple coincidences present in forward contracts, which can lead to counterparty risks and price squeeze, may also be present in salam contracts. But, in salam contracts, only the buyer assumes these risks as they have made full advance payment. To protect against potential default or non-delivery from the seller and safeguard the buyer's interests, it is acceptable under *Shariah* principles for them to request security guarantees or mortgages from the seller.

Besides, a *bay' al-salam* may be used as the basis for inventory finance contracts in Islamic financial institutions (IFIs). IFIs may use a *parallel salam* contract as they may avoid having possession of an underlying commodity (Rahman & Amanullah, 2020). Although Islamic scholars differ on the acceptability of *parallel salam* (Usmani, 2021), the literature suggests two applications. These are: (i) parallel *salam* with the seller; (ii) parallel *salam* with a third party. Parallel *salam* with the seller includes a deal in which the IFI buys the commodity through the *salam* contract with delivery on maturity day. Later, the IFI performs a *parallel salam* contract with the seller again for selling the commodity on the same maturity date. The IFI would sell higher than its buying price,

which is reasonable because of the presence of a time-lapse. This form of parallel *salam* is often likened to a sales and buyback transaction. Sales and buyback transactions are criticised in the Islamic financial field. In the second arrangement, the IFI needs to sell the assets to a third party upon receiving delivery from the primary seller on the date of maturity. Here, two *salam* contracts must be independent in terms of rights and obligations. That is, the IFI is responsible for delivering the commodity to the third party even if the primary seller does not ensure delivery of the commodity on the date of maturity.

2.2.2. *Bay' al-istisna'*

The *istisna'* contract, like *bay' al-salam*, allows future delivery of a commodity or asset at a fixed future date (Hasmawati & Mohamad, 2019). Unlike *bay' al-salam*, the *istisna'* price, fixed and agreed upon by both parties, can be deferred for future lump sum or future multiple payments. The *bay' al-salam* contract is mainly for commodities and agricultural products, whereas *istisna'* is applied for produced goods or assets such as houses, manufacturing units, airplanes, etc (Al-Bashir & Al-Amine, 2001). In a typical *istisna'*, the purchaser in the contract or *mustasni* will place an order to the producer or *sani* for manufacturing the commodities based on the buyer-determined specifics for delivery upon completion in return for the deferred sale price. However, as IFIs do not want to undertake the non-completion and abandoned project risks, IFIs use a *parallel istisna'* contract for financing their customers. *Parallel istisna'* contains several steps; (i) The *istisna'* sake contract between bank and customer; (ii) The *istisna'* purchase contract between bank and producer.

2.2.3. *Istijrar contract*

Istijrar is a contract which contains an embedded option (Bacha, 1999). In *Istijrar*, the two contractors hold the right to exercise the option at the exercise price prefixed through *Murabahah* price if the price of the asset crosses the present upper and lower bounds (Rizvi and Lahsasna, 2012). *Istijrar* entails two parties-i) a customer, who could be a company seeking financing from an Islamic Financial Institution (IFI) to purchase an asset and ii) an IFI. It was first offered in Pakistan. The working mechanism of the *Istijrar* contract is presented in Section 4.3 as the pricing mechanism (see Table 1).

2.2.4. *Bai-Al-urbun*

Bai-Al-Urbun is a contract in which the purchaser of an asset pays a small deposit or down payment to the seller (Helliar & Alsahlawi, 2011). In return, the seller grants a grace period to the purchaser to complete payment. If the purchaser completes the transaction within the specified time, he can pay the price less the *urbun* amount paid earlier. But if he does not proceed with the transaction within the specified time, he agrees to forfeit the *urbun* payment. Three days is the normal period allowed in an *urbun*; much like a three-day call option. The premium paid for an options contract is not refunded, regardless of whether the option is exercised or not. However, in *urbun* transactions, the down payment or deposit made by the buyer is deducted from the agreed price when taking delivery from the seller. *Bay' al-urbun* can be transacted in two ways, as presented in Table 2 (Kamali, 1999).

2.3. *Derivative instruments from islamic Shariah perspective*

There is ongoing debate among *Shariah* scholars regarding the legality and permissibility of derivatives in Islamic finance (Danila & Jeffers Agatha, 2009). Scholars hold differing views on this matter, with some considering them objectionable while others acknowledge their need in modern business environments. The analysis of derivatives by scholars involves examining their contractual arrangements under a highly juridical framework. However, consensus has yet to be reached on this issue (Uddin & Ahmad, 2020). For a breakdown of opinions on futures and options contracts, please refer to Tables 3 and 4, respectively.

Table 1
The basic prohibited elements in financial contracts and transactions.

Criteria	Explanation
Riba (usury)	It means taking and giving interest and it can have several kinds and all of them are impermissible.
Rishwah	Bribery or corruption
Maysir (gambling)	It means unnecessary risk or deception or deliberately created uncertainty. In the case of a financial contract, *gharar* can be regarded as a transaction in which one or either parties are in doubt about the possible results of the underlying contract.
Gharar (unnecessary risk)	It translates into unnecessary risk, deception or intentionally induced uncertainty. As far as the financial transactions are concerned, *gharar* can be considered as one or both parties are uncertain about possible outcomes of underlying contract.
Jahl (ignorance)	Literary, it means ignorance. In a financial contact, it would not be permissible if one party to the transaction gains due to the other party's ignorance.

Source: compiled by authors from various sources

Table 2
Types of *bay' al-urbun* and their definitions.

Types of *bay' al-urbun*	Definition
Non-refundable *urbun*	It is the *urbun* in which the deposit made is forfeited or given as gift to the seller if the buyer does not execute the final sale transaction. This variant of *urbun* is a controversial one. The Hanafi, Maliki, and Shafii' *madzhabs* object to it. But Hanbali *madzhab* permits it.
Refundable *urbun*	This *urbun* is the one in which the deposit of the buyer is refunded to him if he does not finally execute the sale. This version of *urbun* is accepted in all four *madzhabs*.

Table 3
Opinions on futures contracts.

Fatwa giving scholar or authority	Terms and conditions
Omam Al-Haramaini Al-Jauwaini -Fatwa	The fatwa says that - if the practice of futures is based on necessity or *Daruriah* and the needs or *Hajaat* of the *ummah*, the trading of futures is permissible.
Shariah Advisory Council (SAC) of Securities Commission, Malaysia	*Shariah* Advisory Council (SAC) of Malaysia opined on the Futures contract that • If the underlying asset is permissible, then futures trading of commodities is permissible. • Crude Palm Oil futures contracts are permitted to trade. • SAC approved the concept of the Stock Index Futures (SIF) contract. However, the SIF called FBM KLCI (FTSE Bursa Malaysia Kuala Lumpur Composite Index) does include non-*Shariah*-compliant stocks, making it impermissible. A SIF contract of *Shariah*-compliant stocks would be allowable.
Mufti Taqi Usmani (Fiqh Academy – Jeddah)	Mufti Taqi Usmani opined that - Futures transactions are not allowed for the following causes: • "Based on the *Shariah*, sale or purchase cannot be affected for a future date". • "In most futures transactions, taking delivery or possession is not intended".
Ustaz Ahmad Allam (Islamic Fiqh Academy – Jeddah, 1992)	Ustaz Ahmad Allam opined that: "trading of Stock Index Futures (SIF) is impermissible, if some of its underlying stocks are not permissible. Unless SIF's underlying securities are all *Shariah*-compliant, SIF trading is not permitted".

Source: compiled by author from various sources

Table 4
Opinions on option contracts.

Fatwa giving scholar or authority	Terms and conditions
Mufti Taqi Usmani (Fiqh Academy – Jeddah)	Mufti Taqi Usmani on Options contract that- "Promises is allowable in *Shariah* as part of a contract, but the charging of a price or premium for the promise and trading is impermissible".
Abu Sulayman (Fiqh Academy – Jeddah, 1992)	Abu Sulayman opined that: Option contract is acceptable when considered from of *bai-al-urbun* perspective, but the option is unacceptable in the current setting in which it has been detached and made independent from the underlying asset.
Ahmad Muhayyuddin Hassan (1986)	Ahmad Muhayyuddin Hassan was against option trading for two reasons: • "Time to Maturity beyond three days similar to *al-khiyarat* is not permissible". • "In options, the buyer receives more benefits than the seller". So, there is an injustice in the option contract.
El Gari (1993)	El Gari supported call options based on the *bai-al-urbun* framework.
Yusuf Qaradawi	Yusuf Qaradawi opined that the judgement by Ibn Hanbal on *urbun* should be adapted in modern times in the application of options.
Shariah Advisory Council (SAC) Securities Commission, Malaysia	On options, the *Shariah* Advisory Council (SAC) issued no formal opinion. Only index options are available currently in Malaysia, with no equity options. Index options are not permissible as some stocks in the FBM KLCI are non-*Shariah*-compliant. On the other hand, the SAC has permitted the trading of Transferable Subscription Rights (TSRs) or warrants if the underlying stock is *Shariah*-compliant.

Source: compiled by author from various sources

3. Literature review

As per Islamic principles, financial transactions in Islamic banking and finance must comply with certain guidelines that prohibit interest (*riba*), uncertainty (*gharar*), gambling (*qimar*), and harmful transactions such as short selling, arbitrage, and speculation (Malkawi, 2014; Akhtar et al., 2023). To conform to these principles, extensive research has been conducted on the acceptability of various instruments of Islamic banks (Kayani, 2023), Islamic capital markets, and financial derivatives. In this section, we will review the existing literature that relates to financial derivatives from an Islamic perspective.

Bacha (1999) analysed financial derivative instruments from an Islamic perspective. The study revealed that different scholars had varying views on the acceptability of these instruments, and their reasons for objection also differed. As a result, Islamic scholars failed to see the bigger picture of why derivative instruments are necessary in complex business environments.

Jobst (2007) has documented that the various opinions in *Shariah* regarding the permissibility of financial derivatives are based on individual interpretations and different understandings of the mechanism of financial derivatives. In another article, Jobst (2007) explains the legal principles of Islamic derivatives by examining the accepted contracts and scholastic debates surrounding existing financial derivatives. His aim is to establish a principle-based permissibility of financial derivatives with Islamic principles.

Uberoi and Khadem (2012) discuss the technical objections to conventional financial derivatives from an Islamic perspective and offer possible solutions to address the misunderstandings of financial derivatives. They argue that it is necessary to address these misunderstandings methodologically to ensure the healthy growth of Islamic Finance and, at the same time, not offend the Islamic principles.

Muhammad Al-Amine (2013) argues that the acceptability of derivative instruments in Islamic finance depends on several crucial factors, such as the types of contracts, subject matter, and the way commodities are traded. Therefore, it is irrational to accept or reject these risk management tools without proper investigation. To provide a suitable alternative for Islamic banking and finance (IBF), further collective research and investigations on the Shariah foundations are required.

Malkawi (2014) compares the conventional and Islamic financial derivative instruments and argues that IBF already has several contracts and instruments whose features are similar to conventional financial derivatives, such as *Salam* and *Istista*. This study concludes that the lack of standardised principles is an impediment to the development of new Islamic financial instruments. Similarly, Rizvi et al. (2014) conclude that the original form of conventional derivatives does not comply with Islamic principles. However, several existing Islamic financial instruments can be used to manage the financial risks of IBF.

Uddin and Ahmad (2020) have analysed the arguments for and against financial derivatives in a systematic way. They have concluded that futures contracts are not compatible with Islamic principles. This is due to the reason that selling something which does not exist goes against the principles of Islam.

Setiawan (2022) has examined several financial derivative instruments of Over-the-Counter (OTC) in Indonesia. The study has carried out both *Shariah* and technical analyses. The research has found that financial derivatives are crucial for risk management purposes, but the usage of these instruments is controversial.

Most of the research on financial derivatives focuses on *Shariah* investigation. This means that most scholars examine the permissibility and acceptability of financial instruments from an Islamic perspective. Therefore, this study aims to integrate conventional option pricing models into *Shariah*-compliant derivatives. This is a topic that has been rarely explored in previous research.

4. Several option pricing models

As stated previously, the topic of Islamic derivative instruments and their pricing is not extensively discussed. This lack of discussion prompts us to present two commonly used approaches for pricing options: 1) the Binomial Option Pricing Model (BOPM) and 2) The Black-Scholes Pricing Model (BSOPM). Subsequently, we will explore how these models can be applied to Islamic financial contracts.

4.1. Binomial Option Pricing Model (BOPM)– call option

Sharpe (1978) proposed a simple option pricing model - a stock with two-level price changes such as up and down. Cox et al. (1979) further developed the concept of **the** Binomial Option Pricing Model (BOPM). This option pricing model assumes that the option value is the present value of all payoffs to the option at maturity (Benninga & Wiener, 1997; Hsia, 1983). It is assumed that the price of the underlying asset varies at a fixed time interval. Thus, it is called a discrete-time model (Cox et al., 1979). It is important to consider that there are two different types of options: European style and American style (Tian, 1999). European-style options can only be exercised at maturity, while American-style options can be exercised at any time before or on maturity. Consequently, the value of an American-style option is higher compared to a European-style option. In the subsequent sections, we will discuss how call options are priced using the BOPM. We illustrate the three-step binominal trees and demonstrate how probabilities and volatility affect the pricing of call options. Supposedly, a European call option on an underlying stock, which is trading at $30.00, is being valued. The assumptions are presented in Table 5:

Assume the stock price changes three times a year (see Fig. 1).

Table 5
The assumptions of a European call option.

Type of option	A call option with exercise price of $30, maturity is 1 year
Price changes	Assume that the price changes 3 times per year
Price volatility	Assume that the volatility of the stock is 20%
Probability	Up 50%
	Down 50%
Risk-free interest rate	8% per year

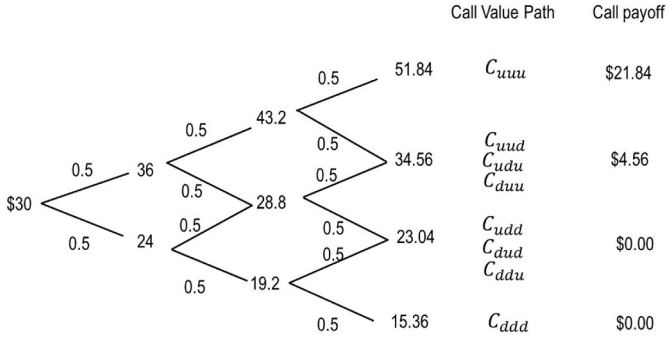

Fig. 1. Three-step binominal trees of a call option.

$$C_3 = \frac{0.125*\$21.84 + 0.125*3*\$4.56 + 0.125*3*0 + 0.125*0}{(1+0.08/3)^3}$$
$$= \frac{\$2.73 + \$1.71}{(1+0.08/3)^3} = \$4.10$$

The probability value of 0.125 is derived from the calculation based on the tree structure. By multiplying the probabilities of each step (i.e., 0.5*0.5*0.5), we obtain a probability value of 0.125. It is important to note that the second and third components need to be multiplied by three to account for their respective paths in the tree. As a result, using a 3-step binomial model, we can determine that the call option value amounts to $4.10.

4.2. Binomial Option Pricing Model (BOPM) – put option

In this section, we examine the application of the BOPM to put options. The pricing of put options in BOPM adheres to the same principles as call option pricing (Bacha, 2001). Based on previous information and assumptions, the value of a put option is determined using the following calculation (see Fig. 2).

$$C_3 = \frac{0 + 0 + 0.125*3*\$6.96 + 0.125*\$14.64}{(1+0.08/3)^3} = \frac{2.61 + 1.83}{(1+0.08/3)^3} = \$4.10$$

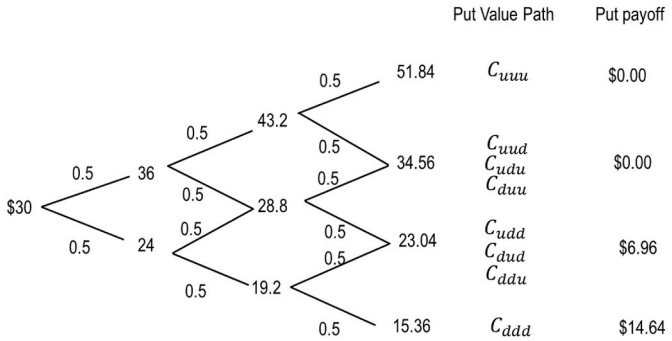

Fig. 2. Three-step binominal trees of a put option.

Table 6
The assumptions of the BSOPM model.

1	Assume that the market is efficient and there is no frictionless trading.
2	There are no transaction costs such as commissions.
3	European style exercise is available.
4	The stock does not pay dividend during the given year.
5	The log of underlying stock returns is normally distributed.
6	During option maturity, there is no changes in risk-free interest rate.
7	During option maturity, the volatility of underlying stock is unchanged.

Source: Saiti (2016)

4.3. The Black-Scholes Pricing Model (BSOPM)

The BSOPM model, which was developed by Scholes and Fischer Black in 1973, is widely known for its usefulness beyond option pricing (Black & Scholes, 1973). Scholes was awarded the Nobel Prize in 1997 for his contribution to this field. The main advantage of the BSOPM model over other models is that it provides a closed-form solution (İltüzer, 2022). This continuous-time model assumes that the time gap between changes in underlying asset prices approaches zero, whereas the binomial pricing model is based on discrete time periods (Bacha, 2017). However, it is important to note that the BSOPM model has a limitation in that it replaces the expected stock growth rate with a risk-free bond growth rate (Thompson & Williams, 1999). The assumptions of the BSOPM model are presented in Table 6.

The 6th and 7th assumptions, which assume the same risk-free interest rates and constant price volatility until option maturity, are considered highly restrictive (Shinde & Takale, 2012). Detailed explanations of the pricing of call and put options with the BSOPM model are presented in the subsequent section.

5. Option pricing in Islamic Financial Contracts

Given the interaction between Islamic finance and conventional financial systems, modern Islamic financial institutions encounter similar challenges that require hedging or reduction. Consequently, some economists (Bacha, 2017) specialising in Islamic finance have proposed inventive derivative instruments. This section examines how the Black-Scholes Option Pricing Model can be utilised in contemporary *sukuk* practices. *Sukuk* functions like a conventional bond with fixed coupons and redemption dates; however, its generated income is derived from sale or rental transactions rather than interest due to religious restrictions in Islam.

5.1. Modus operandi of ijarah sukuk and valuing a Sukuk Ijarah with embedded options/warrants

In the straightforward structure of *ijarah sukuk*, investors receive two different types of cash flows: rental income (coupon) and the sale price at maturity. Similar to conventional bonds, the value of these *sukuk* is determined by calculating the discounted present value of these cash flows. The modus operandi of typical Ijarah *Sukuk* is stipulated in Fig. 3.

The execution steps are as follows:

1. The *sukuk* issuer established a Special Purpose Vehicle (SPV) for purpose of issuing a *Sukuk*.
2. SPV sells the *sukuk* Al-Ijarah to *sukuk* investors.
3. *Sukuk* investors subscribe to *sukuk* Al-Ijarah.
4. SPV transfers the *sukuk* fund to *sukuk* issuer.
5. *Sukuk* issuer pays periodic lease payments to SPV.
6. SPV distributes the lease payments to *sukuk* investors.

According to the *sukuk* structure mentioned above, there are three important issues to consider. Firstly, unlike conventional bonds, the sale price at maturity cannot be predetermined as it is subject to market conditions and may fluctuate. In such cases where the face value is not

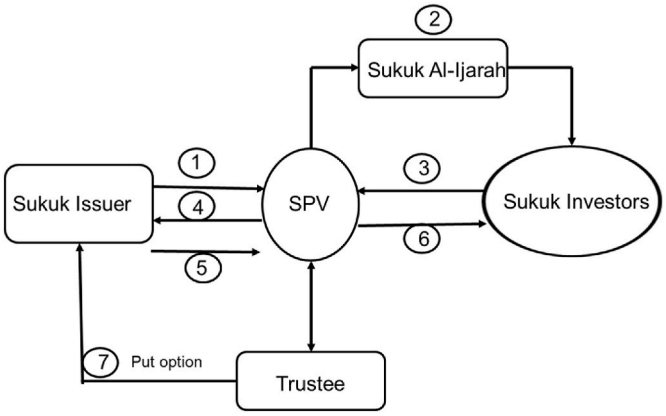

Fig. 3. Modus operandi of typical Ijarah *Sukuk*.

predetermined, one must estimate an expected price for these *sukuk*. Secondly, the *sukuk* issuer may worry that the SPV will not sell back the asset at maturity. Therefore, the *sukuk* issuer purchases a call option, which allows it to buy back the asset at maturity. Thirdly, the SPV may worry that the *sukuk* issuer will not buy back the asset. Therefore, the SPV incorporates a put option, which allows it to sell back the asset to the *sukuk* issuer.

To address the first problem, Bacha and Mirakhor (2013) suggest several methods for estimating this sale price. One method involves considering multiple possible future prices and assigning probabilities to each potential outcome, followed by determining a weighted average as an approximation for the "expected" sale price.

$$\textit{Estimated sale price} = \Sigma\ (P_t\ .\ SP_i)$$

Where

P_t = Probability of the each possible price

SP_i = Expected sale price of the *sukuk*

Illustration: Assume that there are five possible sale prices of the underlying asset of the *sukuk* with the assigned probabilities.

Scenario	Potential Sale Price (million)	Probability
1	$ 950	0.10
2	$ 980	0.15
3	$ 1000	0.50
4	$ 1040	0.15
5	$ 1100	0.10

Therefore,

Estimated Sale Price of the underlying asset = $\sum$ (0.10 x 950) + (0.15 x 980) + (0.50 x 1000) + (0.15 x 1040) + (0.10 x 1100) = $ 1008 million

Therefore, the estimated price of the basic *sukuk al-ijarah* is compromised of the following elements:

Price of *sukuk* = Total Present Value (PV) of periodic rental payments +

PV of estimated sale price of underlying asset at maturity

To address the second problem, the below actions are taken. As mentioned above, there exist intricate *sukuk* structures that incorporate certain options. An example is the sell and buyback *sukuk* structure, where the originator sells the underlying asset to a Special Purpose Vehicle (SPV) for issuing the *sukuk*. At maturity, concerns arise within the SPV regarding whether or not the originator will repurchase the asset. As a result, the SPV incorporates a put option, which allows it to sell back the asset to the originator.

Several companies have issued such 'exotic' *sukuks* with embedded options over the year; for instance, KFC Holdings *Sukuk*, the Khazanah Exchangeable *Sukuk*, etc. A warrant, if added to a *sukuk*, increases the sukuk value because of the warrant value. What actually is a warrant? Warrant is just a long-dated call option. To find the value of *sukuk* with embedded call options, the value of the call has to be measured and added to the *sukuk* value. Like in normal call options, the BSOPM can be used to measure the call value. A warrant is considered a call option as it gives a right, but not an obligation, to purchase the asset at a present price. The BSOPM gives a closed-form solution to price European-style call (or Put) options, exercisable only at maturity. The pricing of such *sukuk* is illustrated in the following section.

5.2. *Pricing of sukuk Al-ijarah with embedded options with Black-Scholes Option Pricing Model*

The literature extensively discusses the BSOPM equation (MacBeth & Merville, 1979; Bacha, 2017). According to Savickas (2002) the advantages of this model include its simplicity and accurate pricing of near-the-money options. However, MacBeth and Merville (1979) identified certain weaknesses in the model, such as underestimation of in-the-money options and overestimation of out-of-the-money options. Furthermore, MacBeth and Merville (1980) revealed systematic deviations between Black-Scholes model prices for call options compared to actual market prices. The formula for the Black-Scholes call option pricing model is as follows:

$$\mathbf{C} = \mathbf{S}.\mathbf{N}(\boldsymbol{d_1}) - \boldsymbol{K}\boldsymbol{e}^{-\boldsymbol{rt}}*\boldsymbol{N}(\boldsymbol{d_2})$$

To determine the value of the call option using the BSOPM, it is necessary to calculate the values of d_1 and d_2. These two parameters can be obtained by referencing a normal distribution table. Once these values are determined, they can be substituted into the formula outlined above to find the value of the call option. The following formula can be used to find d_1 and d_2:

d_1	d_2
$\mathbf{d_1} = \frac{\ln\left(\frac{S}{K}\right) + \left[r + \left(\frac{\sigma^2}{2}\right)\right]^* T}{\sigma\sqrt{T}}$	$\mathbf{d_2} = d_1 - \sigma\sqrt{T}$

Where:

S	:	Spot price of underlying asset
K	:	Exercise price of call option
T	:	Time to expiration
r	:	Risk free interest rate
e^{-rt}	:	Exponential function of rf interest rate and time
N(.)	:	Cumulative standard normal distribution (SND) function
σ	:	Volatility of underlying asset as measured by standard deviation
$\ln\left(\frac{S}{K}\right)$	:	Natural logarithm of S/K.

As per our earlier discussion, there are three steps you need to follow to estimate the value of a call option using BSOPM. To make it easier for you to understand the pricing processes involved, we will provide you with an example of how this model can be applied to a call option. Our aim is to enhance your comprehension of the topic.

First step	Calculate d_1 and d_2.
Second step	Using the cumulative normal distribution table, find the values of N(d_1) and N(d_2).
Third step	Plug the values into the model and solve.

5.2.1. Illustration

Table 7
Hypothetical facts of an Exchangeable *Sukuk*.

Face value of *sukuk*	USD 5000
Left to Maturity	6 months
Exercise Price	USD 20
Current price of the stock	USD 23
6-Month LIBOR	6%
Estimated stock's price volatility	20%

What is the value of the above embedded call option (see Table 7)?

Step 1: d_1 and d_2 have to be calculated.

d_1	d_2
$\mathbf{d_1} = \frac{\ln\left(\frac{23}{20}\right) + \left[0.06 + \left(\frac{0.2^2}{2}\right)\right]^* 0.5}{0.2\sqrt{0.5}} = \frac{0.1398 + 0.08^* 0.5}{0.1414} = \frac{0.1798}{0.1414} = 1.27$	$\mathbf{d_2} = 1.27 - 0.2\sqrt{0.5} = 1.27 - 0.1414 = 1.13$

Step 2: Find values of N(d_1) and N(d_2) from cumulative standard normal distribution table:

$N(d_1) = N(1.27) = 0.8980$

$N(d_2) = N(1.13) = 0.8708$

Step 3:

$\mathbf{C} = \$\mathbf{23}^*\mathbf{0.8980} - \$\ \mathbf{20}^* e^{-\mathbf{0.06}^*\mathbf{0.5}}{}^*\mathbf{0.8708}$

$20.65 – $ 19.40*0.8708 = $20.65 – $ 16.90 = $3.75

By employing the above BSOPM equation, the value of the call is derived. As a result, this call value of $3.75 is decomposed into intrinsic and time values. Since the exercise price at maturity is $20 and the redemption amount of *sukuk* is $5000, this amount can be converted into 250 stocks. Therefore, the value of the embedded call option is $937.5 (250*3.75). This calculated value of the call option is added to the present value of *sukuk* cash flows. What is the present value (price) of *sukuk* if the required annual return is 10%?

Total Value of *Sukuk* Al-Ijarah with embedded call option = Present value of future *sukuk* Ijarah Payments + Value of embedded call option

$$PV = \frac{FV}{(1+r)^t} = \frac{5000}{(1+0.1)^{0.5}} = \$4762$$

The embedded option gives the *sukuk* holder the chance to profit from the increase in the underlying stock price. So, the $937.5 is added to present value of cash flows from the *sukuk*. As the *sukuk al-ijarah* has periodic *ijarah* payments, the total value of the *sukuk* will be:

Total Value of *Sukuk* Al-Ijarah with embedded call option = $4762+ $937.5 = $5699.5

Although the BSOPM was designed to value European call options, the BSOPM can also be applied in valuing European puts. If the *sukuk* has an embedded put option, the formula below can be used:

$\mathbf{P} = \boldsymbol{K e^{-rt}{}^* N(-d_2)} - \mathbf{S}.\mathbf{N}(-\boldsymbol{d_1})$

The valuation steps are almost the same as the above-mentioned steps for call options.

Illustration: The first two steps (estimating d_1 and d_2, and getting N(d_1), N(d_2) values) are the same. But, for finding the put option value, step (iii) requires a small adjustment in changing N(d_1) and N(d_2) values into N(-d_1) and N(-d_2), respectively.

N(d_1) was estimated to be 0.8980. Therefore:

$N(-d_1) = 1 - N(d_1) = 1 – 0.8980 = 0.1020$

Likewise, N(d_2) was 0.8708:

$N(-d_2) = 1 - N(d_2) = 1 – 0.8708 = 0.1292$

So the put value is:

$\mathbf{P} = \$\mathbf{20}^* e^{-\mathbf{0.06}^*\mathbf{0.5}}{}^*\mathbf{0.1292} - \$\ \mathbf{23}^*\mathbf{0.1020}$

$19.41*0.1292 – $2.35 = $ 2.51- $ 2.35 = $ 0.16

The Put value using BSOPM is 16 cents or $0.16.

5.3. Pricing of istijrar contract

Assume a firm is seeking working capital finance for the short term to acquire a commodity required and thus comes to an Islamic bank. The

Islamic bank purchases the commodity at current price (P_0). Then it sells the commodity to the firm for price to be paid on a future date, e.g., 180 days later, mutually agreed upon by both parties.

The settlement price at maturity is dependent on the commodity's price changes from T-0 to T-180. Here T-0 is the contract starting day and T-180 is the 180th day or the day of maturity. The pricing differs from *Murabahah* in which the settlement price could basically be a present price- P*. Here $P^* = P_0 (1 + r)$; r is the Islamic bank's profit rate. The price at maturity paid in *Istijrar* could be the *Murabahah* price (P*) or a mean commodity price ($\overline{P}$) between T-0 and T-180.

Thus, *Istijrar's* settlement price is dependent on the price movements and on the party that decides on 'fixing' the settlement price. In other words, one of the counterparties will decide the settlement price at contract end. This is where the options contract comes into play. The embedded option is nothing but the right to fix, any time before the contract ending, the settlement price at maturity.

At contract start, both parties, i.e., the Islamic bank and the company, agree on these conditions: i) a prefixed *Murabahah* price or P*, ii) a lower and upper bounds around the P_0 (purchase price at T-0).

Where:

P_0	The purchase price of the bank for the commodity
P*	The *Murabahah* (cost-plus) price $P^* = P_0^*(1+r)$
P_{LB}	The price of lower bound
P_{UB}	The price of upper bound

There is another price - the average commodity price within the two bounds, indicated as $\overline{P}$. Thus, settlement price (P_S) relies on the movement of commodity price:

$P_S = \overline{P}$	If the prices of commodity remain within the two bounds.
P_S=P*	If the price of underlying asset exceeds one of the boundaries and one of parties has option to choose the *Murabahah* price which is P*.

Both parties can exercise their option and determine the *Murabahah* price (P*) as the settlement price if the spot price crosses the bounds during maturity. With regards to which party would exercise the option, it depends on the spot price change direction. The next consideration is which entity will choose the *Murabahah* price (P*), which is dependent on which way the price moves within the duration of the contract.

P_S	Price movement	Executions/Strategy
1	If P_t is lower than the lower bound ($P_t < P_{LB}$), the banks loses and the customer gains until exercise.	The bank exercises: P_S=P*
2	If the price within the boundaries, $P_{LB} < P_t < P_{UB}$,	$P_S = \overline{P}$
3	If Pt is higher than the upper bound ($P_{UP} > P_t$), the customer loses and the bank gains until exercise.	The customer exercises: P_S=P*

Where:

P_S	The settlement price at maturity
P*	The *Murabahah* (cost-plus) price $P^* = P_0^*(1+r)$, predetermined
P_t	The spot price underlying asset at maturity *t*
$\overline{P}$	Average price within boundaries

From the perspective of the options contract, the fact that *Istijrar* has two different exercise styles in one contract can be complex. The embedded options in it can be explained as follows: When the buyer or the customer has the right to set the buying price at P* when the market price is more than the upper bound, it indicates the buyer has a call option *Murabahah* price (P*) as exercise price, whereas the Islamic bank has a put option with same exercise price. Thus, in *Istijrar,* the maximum likely profit or loss is limited, unlike the conventional option contracts. This type of financing contract meets the requirement to refrain from a fixed return or *riba* in a riskless asset. In addition, there is no question of having *gharar* in the contract as both parties are aware of the *Murabahah* price (P*) from the beginning and the ranges of probable prices.

6. Concluding remarks

This study examines the prerequisites of Islamic financial instruments and explores certain elements that need to be eliminated from Islamic transactions. It further discusses various types of Islamic contracts, such as *bay' al-salam*, *bay' al-istisna'*, *Istijrar*, and *bay' al-urbun,* which bear similarities to conventional financial derivatives. Furthermore, it sheds light on the different opinions provided by *Shariah* scholars and bodies regarding the permissibility of financial derivatives in accordance with *Shariah* principles. This study has found that there is no universally agreed-upon *Shariah* opinion regarding the permissibility of financial derivatives from an Islamic perspective. Different scholars have different views on this matter. To ensure the healthy and rapid growth of Islamic banking and finance, there should be standardised and collective *Shariah* opinions on financial derivatives for the purpose of risk management and reduction. Moreover, this paper highlights the pricing aspects of simple Sukuk Ijarah and Sukuk Ijarah with warrants or embedded options, such as call and put, along with the Istijrar contract. We have integrated conventional option pricing models into *Sukuk Al-Ijarah* with embedded options (for both call and put options) using the BSOPM, accompanied by appropriate illustrations. This is a topic that has been rarely explored in previous research.

The study suggests that while there are differing opinions on the acceptability of financial derivatives in Islamic finance, they can be used for hedging and risk management purposes in line with Islamic principles of wealth preservation. However, it is important to strictly prohibit other attributes of financial derivatives such as speculation, gambling, and *gharar* within the Islamic financial framework.

Furthermore, it is recommended that future research focuses on the empirical analysis of the performance of Islamic financial instruments with financial derivative contracts. This would help to determine whether financial derivatives can add value to Islamic banking and finance or not. Such studies could also make significant contributions to the literature.

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