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Robo-Sukuk pricing for Chinese equities

Klemens Katterbauer [a,*], Hassan Syed [a], Laurent Cleenewerck [a], Sema Yilmaz Genc [b]

[a] Center for Islamic Meta-Finance, EUCLID University, Central African Republic
[b] Yildiz Technical University, Turkey

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Abstract

Sukuks have assumed increasing importance in the global financial industry, with both institutional and retail investors realizing the benefits of Sukuk, both in terms of their adherence to Islamic principles, as well as being more stable and robust. The growing importance of the Sukuk markets has happened simultaneously with the significant development of China. With the financial crisis and other recent events reducing the trust and confidence of investors in the existing financial system structures, Islamic financial products have received great attention due to their connection to real assets and risk-sharing. While Sukuk financial instruments differ significantly from their conventional bond counterparts, pricing has mostly followed conventional bond pricing methodologies. This represents a significant challenge as the characteristics of Sukuk are not considered, misrepresenting the value and associated performance of the Sukuk. An innovative data-driven methodology for the pricing of Sukuk in the Chinese equity market is presented. It overcomes the challenges with conventional bond pricing methodologies applied to Sukuk pricing. The methodology integrates a deep learning framework for the estimation and forecasting of Sukuk prices, considering factors, such as cashflows, net income, and stock price performance, in addition to textual information. Illustrated on thirty major Chinese corporations listed on the Hong Kong Stock Exchange, the framework provides a more market and value-based approach to pricing Sukuk considering the partnership nature of the Islamic financial product.
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Keywords: Islamic finance; Islamic capital market instrument; Sukuk; Structure of Sukuk; Pricing of sukuk; Artificial intelligence; Robo-Sukuk pricing

1. Introduction

Sukuk (Islamic bonds) have a long history of allowing corporations to finance their operations via the issuance of an Islamic financial certificate. Conventional bonds are not permissible due to the presence of Riba. Riba is the charging of interest which is a core feature of conventional bonds that promises to return the principal in addition to interests in exchange for the principal amount. Islamic law clearly forbids the charging of interest as money by itself cannot create value, which is interest in this instance. While the origins of Sukuk are related to the early Islamic period in around 700 AD, the modern Sukuk market is relatively new (Ahmed, Islam, & Hashim, 2020). The Organization of Islamic Conference laid the basis for the development of the Sukuk market with its statement in 1988. The AAOIFI, established in 1991, plays a key role in the harmonization of standards for Shariah law, specifically the implementation of Sukuk financial instruments. The first Sukuk was issued in the 1990s by Shell MDS in Malaysia, reaching 125 million Malaysian Ringgit. The first US-Dollar Sukuk was issued by the Malaysian company Kumpulan Guthrie that raised 150 million USD in 2001 (Ahmed E. R., Islam, Alabdullah, & Amran, 2019). The early 2000s have led to a massive increase in the interest of Sukuks, where just between 2005 and 2007, Sukuk issuances increased from 25 billion USD to 48 billion USD (Uddin, Sabri, Bhatti, Rafique, & AsadUllah, 2022). While the Sukuk market experienced challenges considering the global financial crisis, the market has easily recovered and reached more than 754.1 billion USD of outstanding Sukuk in the

* Corresponding author.
E-mail address: katterbauer.klemens@gmail.com (K. Katterbauer).
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second quarter of 2021 (Al Natoor & Shawqi, 2021, July 14). This growth is significant and outlines its increasing importance (IMarc Group, 2021).

With the growing importance of Sukuk markets and greater investment by institutions and retail investors alike, questions arise of how to price Sukuk, considering both the risks and opportunities as well as the financial conditions of the issuing party. Sukuk can support wealth circulation and development, including the fair distribution of funds to individuals (Elian, 2015). This makes it both attractive to large-scale financing as well as small and medium-sized enterprises in addition to individuals. Sukuk have been frequently utilized for supporting policy programs such as building roads, hospitals, and airports, which all support the real economy. These programs lead to infrastructure enhancements and the creation of jobs. Such jobs and the income derived from it allow to reduce poverty and improve the standard of living. This gradually improves healthcare conditions, education levels, and enhanced housing. Furthermore, it assists in the equal distribution of wealth across the society, which will help in the circulation of wealth amongst the overall society (Rahman et al., 2020).

2. Sukuk types

Pricing of Sukuk instruments is a challenge. In general, the pricing of Sukuk follows the concept of pricing of bonds. Specifically, Sukuk may be in the form of fixed or variable depending on whether the Sukuk is linked to an index or the returns of an asset. Fixed income securities imply that the coupon is fixed, while variable implies that the coupon may vary.

To evaluate approaches to the pricing of Sukuk instruments, a thorough analysis of pricing approaches to conventional bonds is required. The first pricing approach is the yield to maturity approach (Katz, 1974). The yield to maturity is also in many instances, denoted as the internal rate of return, which is the percentage rate at which all the cash flows are discounted such that they match the issuing price. In such an approach, the yield to maturity is a comprehensive number encompassing inflation, risk, and any other factors.

Another pricing option for bonds is the par yield. The par yield is the yield on fixed-income security where the market price is equal to the face value of the security (Gürkaynak, Sack, & Wright, 2007). Par yields are frequently used for addressing the coupon effect. Specifically, two bonds with the exact same maturity date but different coupon rates may not necessarily have the same yield to maturity. The difference arises from the different coupon cashflow streams over the lifetime of the bond, even if the maturity date and the coupon payment dates are the same.

Another conventional bond form is the zero-coupon bond, in which the bond does not pay any coupon and can be redeemed at face value at maturity (Sinkala, Leach, & O'hara, 2008). These forms of bonds do not pay any interest but trade at a steep discount and render a profit at maturity. The difference between the purchasing price and the par value represents the investor return.

These pricing forms may also be applied to Sukuks via the indication of returns. However, Sukuk structures differ significantly from bonds and fail to consider the connection of sukuks to real assets that underlie them. Hence, a firm understanding of the various Sukuk structures is essential to establish a proper pricing procedure. Furthermore, conventional pricing procedures have at its core the focus on interest rates and that money by itself generates values. This contrasts with the Islamic view that money needs to be connected to real activities to create economic value (Alam, Hassan, & Haque, 2013).

The structure of sukuks plays a key role in how these sukuks are evaluated and the risks they entail, as well as the potential revenues. The most popular sukuk structures are the Wakalah, Ijarah, Musharakah, Murabaha and Mudarabah structure. These structures account for more than 90% of the overall Sukuk issuance (Al-Amine, 2008).

Mudharabah Sukuks are certificates that underlie projects or activities that are based on a partnership based on a trust contract (Mudharabah contract). The Mudharabah Sukuk involves the presence of a mudarib that will manage the project. There is furthermore the owner of capital (Rabbul-Mal) that provides the capital to the project. For the Sukuk, the issuer of the Sukuk certificate is the mudarib, while the subscribers are the capital owners and provided the Mudharabah capital. The holders of the certificate own the assets of the Mudharabah contracts and share the profits according to the agreement. Similarly, the capital providers may also bear any losses (Salah, 2010, pp. 507–517).

A usual form of a Mudarabah sukuk is the CMB, which stands for Cagamas Mudharabah Bonds. This type of Sukuk started in 1994 and involves the purchase of an Islamic housing financing and Islamic hire purchase product from an Islamic financial institution. Bay al-dayn underlies the Sukuk to purchase the housing debt, while the mudharabah concept is then utilized for the issuance of the CMB. Within this agreement, the holders of Sukuk and Cagamas will share the profits according to a specified ratio (Jobst, Kunzel, Mills, & Sy, 2008).

Mudarabah Sukuks are equity based Sukuk structures that lead to a sharing of profits and losses between the partners. Fixed returns and guaranteed principals are not permissible under Shariah Law. While there have been variations in which the originator either provided additional funding or took any surpluses as incentives to provide fixed returns, these go against the principle of Mudharabah Sukuk forms. There are several questions that arise from Bay Al-Inah (sale and buy back between two parties) where potential loopholes and conflicts may arise. Hence, other Sukuk contracts forms such as those based on a partnership may be more suitable (Ismath Bacha & Mirakhor, 2018).

Al-Ijara sukuks are significant Sukuk forms as they are based on a rental contract and make a substantial portion of the Sukuk issuance. Ijara contracts are based on an exchange contract that is like a conventional lease. Ijara contracts are characterized by the fact that one party purchases and leases the equipment for a rental fee, and the duration of the rental as well as the fee are pre-determined. Ijara leases are commonly used in real estate purchases. The ijara provider is purchasing the

asset for the customer, and the customer then pays rental fees until the cost, in addition to a fee, has been paid, after which the asset can be transferred to the customer. The expected returns are not fixed as maintenance, and insurance-related expenditure may lead to a variation in the return. The contract itself becomes negotiable and can be traded on a secondary market (Mutia, Rahmawaty, & Afrianandra, 2018).

When referring to an Ijara Sukuk, then this is a security that demonstrates ownership of a well-defined existing and known asset that is related to a lease contract. The returns are payable to the Sukuk holders. The ijara rental payments may be unrelated to the usufruct assumed by the lessee in terms of time, and the most important objective is to have a joint decision.

The advantages can incorporate various forms of contracts and Sukuk for different purposes. For Ijara sukuks, the issuer represents a special purpose vehicle (SPV) that purchases one or multiple assets from the obligor that obtains the financing. The assets are leased to the lessee, that then makes periodic payments to the holders of the sukuks. When the maturity ends, the obligor repurchases the asset at a predetermined price, and any proceeds from the sale are provided to the Sukuk holders (Hussin, Muhammad, & Awang, 2012).

Another form of sukuk is the Murabaha sukuk. A Murabaha Sukuk is an Islamic trust contract where the original price and the markup are disclosed. Such sukuks are primarily utilized for asset acquisition purposes and can be structured either in the form of Bay al-inah or Tawarruq. Murabaha is related to the Arabic word ribh that refers to an increase of an amount. Murabaha contracts are based on a sale, and the seller must disclose the markup to the purchase for a trust-sale to be executed. Murabaha contracts are permissible if it fulfills one of several methods. The first method is called bay al-musawamah (bargaining sale), where the price to the seller is determined during price negotiation. The second method is called Bay Al-Amanah (trust-based sales), where the sellers reveal the actual cost of the good, and then the buyer proposes a fair price to offer the seller based on the seller's cost. Murabaha implies that the good is bought for more than what was the cost. Murabaha sukuks are either formed via a factual purchase and sale involving three basic parties or via a pre-arranged sale and buy back between the seller and buyer, or via a three-party agency sale encompassing a commodity Murabaha, also called tawarruq (Kahf & Habbani, 2016).

Al-wakalah Sukuk is based on wakalah, which is an arrangement between two parties, where one party acts on behalf of the other. This is then like an agency agreement, and the principal (or investor) appoints a wakeel or agent to invest funds into a pool of investments or assets. The wakeel provides their expertise to manage the fund to generate an agreed profit return. This requires that both the wakeel and principal enter into the agreement. The principal is typically an SPV, and the profits are returned to fund the periodic distribution amounts payable to the investors. Mudharabah and wakalah Sukuk share some similarities but differ in terms of that there is no pre-agreed profit ratio for the wakalah. The wakeel will solely receive a performance or incentive fee based on the agreed profit (Rahim, 2018).

3. Chinese sukuk market

Sukuk, as an alternative to conventional bonds, has attracted considerable attention in various non-muslim countries, given the beneficial structure in comparison with conventional bonds. The United Kingdom, and other countries have experienced an increase in the utilization of Islamic Sukuk for financing their needs. The key features of Islamic investing options are the focus on ethical business practices, social responsibility, and fiscal conservatism. This has been primarily exemplified in the form of more stable returns, transparency, and achieving greater diversification. In Asia, Malaysia and Indonesia have been the major issuers of Sukuk financial instruments between 2001 and 2020 (Fig. 1). However, in recent years other Asian countries have been attracted to Sukuk as an alternative financing option. Hong Kong has been at the forefront as the gateway to China and launched two sukuks in 2014 and 2015. This has necessarily led to a positive increase in interest amongst Chinese corporations to utilize Sukuk as an alternative financing format for their operations. Sukuk may be suitable for a variety of funding formats such as the financing of plants, acquisitions of other companies, and large infrastructure projects. The One Belt One Road Initiative has been a catalyst for Muslim investors seeking attractive returns in China with adequate risk-return investment opportunities. This makes Sukuk attractive, if regulators ensure that there is a facilitative framework and strategic measures exist. This would strengthen investment opportunities for various Islamic countries in investing in Chinese corporations, potentially achieving considerable returns (Bo, Ali, & Saiti, 2016).

Hong Kong has been amongst the first governments making use of the issuance of Sukuk. In 2014, the HKSAR government issued a 1 billion USD Sukuk bond with a coupon rate of 2.005% per annum and represented a critical event for the development of an Islamic capital market (Hong Kong Monetary Authority, 2017). The five-year Sukuk was in the form of an ijarah Sukuk and issued by an SPV. When the first Sukuk was issued by the HKSAR Government, regulations were still in its infancy and had to be developed (IIFM, 2021, p. 55). The key aspect was to ensure that the Sukuk bonds are treated like conventional bonds in terms of income tax, property tax, and stamp duty liabilities. These were key

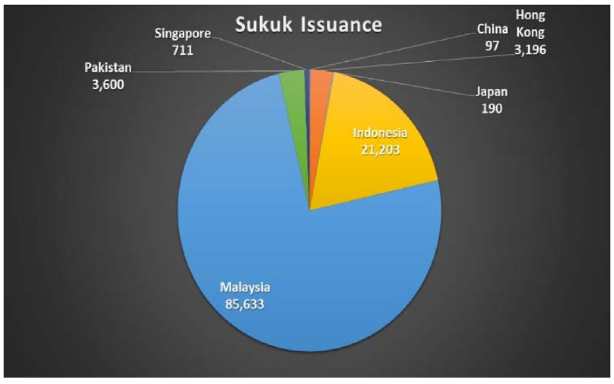


Fig. 1. Sukuk issuance (in million USD) from 2001 to 2020 by Asian countries.

requirements to enable the development of a Sukuk market in Hong Kong (Wong & Bhatti, 2019).

The Sukuk-type instruments are referred to as alternative bond schemes, which allow them to be similarly treated as conventional bonds. A critical question arises from why the Sukuk ijarah structure was mostly used. There are reasons, such as the strong acceptance of Shariah scholars, the growing familiarity of the ijarah Sukuk structure amongst investors, and sovereign parties typically prefer ijarah structures for their first issuance. A second Sukuk was issued utilizing the wakalah structure. This was primarily to evaluate the flexibility of the Hong Kong Sukuk issuance platform and utilized a combination of tangible assets and receivables from the sale of commodities (Ali, Azman, Zain, Hassan, & Kassim, 2019).

The Chinese Sukuk market is still in its infancy but rapidly growing. This primarily arises from the growing importance of Muslim investors in the global financial system and investor sentiment shifts in the United States and other European countries to limit their investment in the Chinese market. Sukuk laws are still in their infancy in the Chinese market, which requires the development of a robust legal framework to cover such agreements. The other challenge is that the Sukuk ijarah structure requires to be backed by appropriate assets. Evaluating the value of the assets and ensuring that it fulfills the ijarah Sukuk requirements is essential to develop an adequate Sukuk market that attracts Muslim investors (Ahmad, Hashim, & Abd Rahim, 2020).

Modern Islamic finance gained a foothold in China, only starting in 2009 when the first Islamic banking products were offered. The One Belt on Road initiative was a major catalyst for the Islamic finance field to strengthen ties between China and Asia, Middle East, and Africa. Local state-owned companies, such as the Sichuan development holding, have made strives in entering the Sukuk market to raise around 300 million USD initially, and more than 1 billion USD in total through sukuks. Specifically, the China-Pakistan economic corridor support large projects that are financed with Islamic finance options. The province of Shandong focused on utilizing a Sukuk structure to fund its railway expansion projects and strive to have an active engagement with banks in Dubai to support their expansions (Kirk, 2013).

4. Sukuk pricing methodology

Given the nature of sukuks, conventional bond-related pricing may not be suitable for the pricing of sukuks. Specifically, sukuks are always related to the real economy and represent more a form of partnership rather than a pure conventional bond. Specifically, sukuks share considerable similarities with equity-based investments, linking the performance and returns of the Sukuk to the performance of the asset that underlies it.

Hence, utilizing a simplified calculation model with fixed return or risk assumptions may be misleading and may cause sukuks to be improperly priced. In contrast to conventional bonds that are priced based on the ability to repay the bond obligation irrespective of the business, ethical, and underlying assets, sukuks must encompass Islamic values in their evaluation. Given the challenges of both forecasting revenue levels in addition to the risks related to the market value of the underlying asset, an annuity or cashflow-based approach may not sufficiently capture the inherent risks associated with such investments. Given the considerable correlation with equities by corporate sukuks, the integration of the Sukuk pricing with the corporation's equity allows enhancing fair pricing of sukuks. While equity valuations play a critical role, balance sheet conditions, cashflow and revenues as well as size of the corporation play an additional essential role. Furthermore, integration of ESG factors plays a critical role in evaluating the adherence of a corporation to Islamic principles, and inferior performance may make them less attractive as an investment as compared to a Sukuk from a strongly Shariah complying corporation.

Integration of these critical parameters makes a conventional bond pricing approach challenging as the price of the Sukuk does not solely depend on the coupon rate but on the quality of the equity that underlies it. Furthermore, Shariah compliance and the degree of compliance significantly affect the Sukuk pricing risk, which must be considered.

Artificial intelligence has gained considerable attention in a variety of areas for enhancing decision-making and automation. Artificial intelligence has been widely employed in finance for risk assessment, stock price forecasting, and loan investment decision-making assistance. This has led to a wide variety of different applications as well as may be integrated in conventional modeling approaches to enhance estimations (Zhang & Chen, 2021).

To perform the Sukuk pricing, an XGBoost approach was utilized (Fig. 2). The XGBoost is an optimized gradient boosting algorithm for decision trees and has been very successfully utilized for a variety of different applications. The algorithm has won various competitions and can be easily applied to regression, classification, and ranking problems. Furthermore, the algorithm is optimized to manage missing values and regularizes efficiently to avoid overfitting or the introduction of biases. This is essential for forecasting and bond pricing, given the challenges that may arise from data inaccuracies and data completeness challenges (Ramraj, Uzir, Sunil, & Banerjee, 2016). The XGBoost approach combines a classification routine in addition to the estimation of the

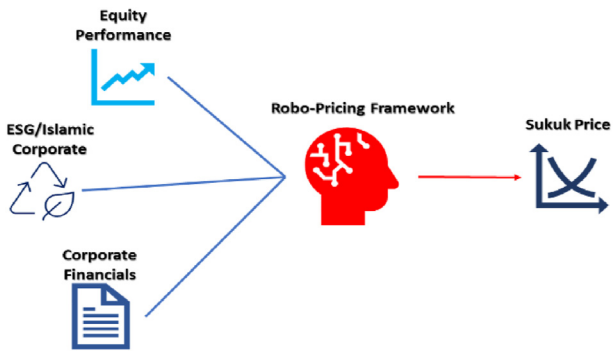


Fig. 2. Graphical illustration of the robot-pricing framework for Sukuk pricing.

Sukuk price. The classification plays a key role in determining the potential risks to the price and Shariah compliance of the Sukuk structure, allowing for investors to assess the risk associated with their investment into the Sukuk (Wang & Guo, 2020, pp. 205–221). Furthermore, risk and returns are balanced with this approach that allows considering the potential changes with respect to Shariah and equity compliance.

5. Sukuk pricing results

To evaluate the performance of the new AI-driven Sukuk pricing framework, the thirty major Chinese companies listed on the Honk Kong Stock exchange were evaluated in terms of various Sukuk issuing forms and repayment forms. These sukuk forms may be in the form of different annuities or zero-coupon payments, as well as fixed annuities. The thirty corporations, as outlined in Table 1, are major corporations in the Chinese market and include both local corporations, such as CLP holdings, but also large Chinese corporations such as CNOOC, the Industrial and Commercial Bank of China, and Xiaomi corporation. These major Chinese corporations attract significant investment interest from the Islamic investment community.

Evaluation of the framework targets five different Sukuk scenarios that exhibit various payment schedules and forms. In all the scenarios, the assumption is that the sukuks support the business operations of the corporation via the utilization of funds for the funding of real assets. The first step of the AI-supported Sukuk pricing form is the determination of whether a corporation fulfills Shariah compliance. The corporation Galaxy Entertainment is not eligible given that it has major operations in the gambling industry, which makes it not Shariah-compliant. The AI framework processes with a natural language processing framework the corporate information and extracts information that indicates business activities in non-Shariah compliant sectors. While business in the hospitality industry is permissible, Galaxy Entertainment engages in gambling in their resorts, which excludes it from the permissible corporations list.

After the initial AI screening, the step was the training of the XGBoost model for the pricing of the Sukuk. Pricing of Sukuk requires considering multiple factors that may influence its pricing structure. This includes the corporate performance, such as cashflows and net income, as well as the overall stock performance. Stock performance represents an important parameter as it reflects the support of investors for the corporations and is typically for larger corporations positively correlated with the overall business outlook for the company.

We display in Table 2 the root mean squared error rates for the forecasting of Sukuk prices for the training and testing dataset. The results indicate that the XGBoost performs well with relative RMSE being mostly below two percent for all the corporations on the training dataset and below ten percent on the testing dataset. These results provide significant confidence in the performance of the framework to predict Sukuk prices.

Finally, we display in Fig. 3 the value of the Sukuk for the various payment scenarios. These scenarios differ in terms of their average payments over time and whether they are variable

Table 1
List of Chinese stocks used for the bond pricing analysis.

Symbol	Company name
0002.HK	CLP Holdings Limited
0003.HK	The Hong Kong and China Gas Company Limited
9988.HK	Alibaba Group Holding Limited
1044.HK	Hengan International Group Company Limited
0012.HK	Henderson Land Development Company Limited
2331.HK	Li Ning Company Limited
0386.HK	China Petroleum & Chemical Corporation
2020.HK	ANTA Sports Products Limited
0017.HK	New World Development Company Limited
0267.HK	CITIC Limited
1398.HK	Industrial and Commercial Bank of China Limited
0883.HK	CNOOC Limited
9618.HK	JD.com, Inc.
0241.HK	Alibaba Health Information Technology Limited
1299.HK	AIA Group Limited
0027.HK	Galaxy Entertainment Group Limited
0101.HK	Hang Lung Properties Limited
1810.HK	Xiaomi Corporation
0960.HK	Longfor Group Holdings Limited
0669.HK	Techtronic Industries Company Limited
1038.HK	CK Infrastructure Holdings Limited
2688.HK	ENN Energy Holdings Limited
2018.HK	AAC Technologies Holdings Inc.
2319.HK	China Mengniu Dairy Company Limited
3690.HK	Meituan
1109.HK	China Resources Land Limited
2269.HK	WuXi Biologics (Cayman) Inc.
2628.HK	China Life Insurance Company Limited
1093.HK	CSPC Pharmaceutical Group Limited
6098.HK	Country Garden Services Holdings Company Limited

Table 2
Scaled root-mean-squared error rates for the bond price forecasting.

Stock	Train	Test
0002.HK	0.004444	0.011725
0003.HK	0.00504	0.014189
9988.HK	0.002917	0.088491
1044.HK	0.008769	0.019332
0012.HK	0.007925	0.016341
0386.HK	0.008916	0.020051
2020.HK	0.019459	0.054024
0017.HK	0.007461	0.090223
0267.HK	0.009131	0.039086
1398.HK	0.008291	0.015931
0883.HK	0.010351	0.024981
9618.HK	0.001666	0.039075
1299.HK	0.007718	0.024016
0101.HK	0.008826	0.018704
0960.HK	0.011571	0.09112
0669.HK	0.01031	0.084409
1038.HK	0.005728	0.0163
2688.HK	0.01162	0.058351
2018.HK	0.013673	0.034114
2319.HK	0.011195	0.260638
1109.HK	0.012313	0.076304
2628.HK	0.010267	0.046373
1093.HK	0.011532	0.034324

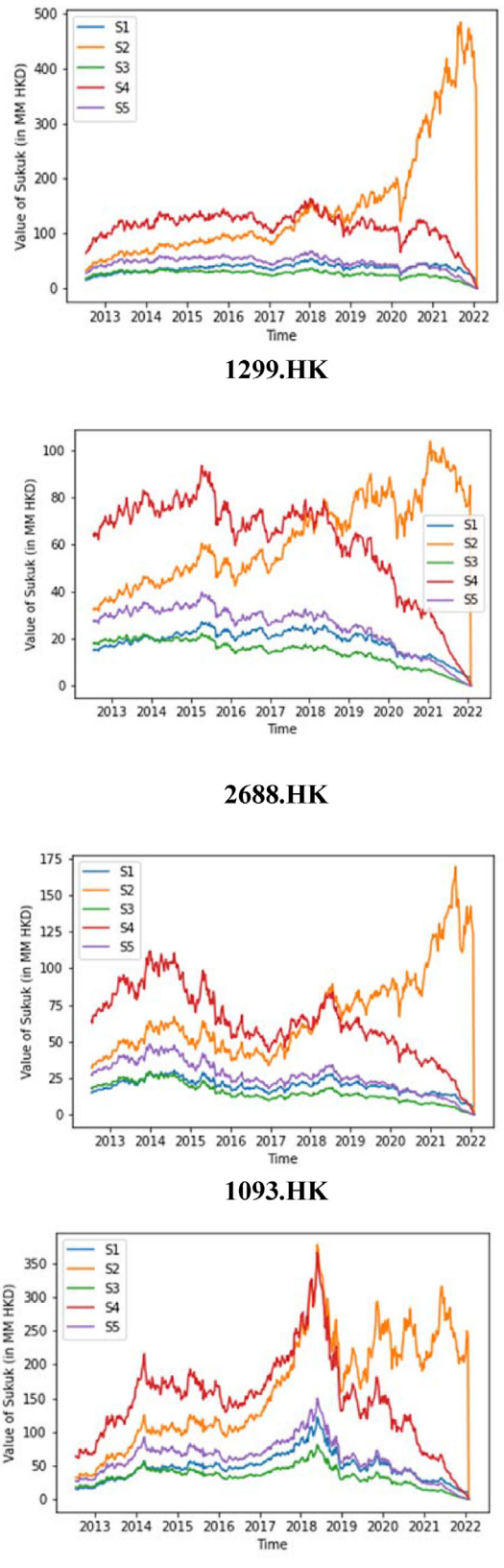


Fig. 3. Sukuk values for five different Sukuk repayment scenarios.

or fixed or incorporate a large repayment at maturity. Furthermore, the framework also considers inflationary effects. The nominal value of the Sukuk at each time represents the value of the remaining payments until maturity in January 2022. Case S2 represents a Sukuk structure with a final major repayment, like S4 that experiences higher repayments close to maturity. Conventional bonds follow an interest approach if the underlying real asset and corporations maintain its business performance. This is not the case which makes a conventional bond pricing approach not reflective of the value changes in the value of the asset or corporation. Specifically, a corporation that experiences a positive outlook and enhancement in its business performance profits should get the incentive to have its Sukuk valued higher as compared to a corporation that has poorer business performance. Furthermore, for investors, this compensates for the potential risks that arise and allow them to reap the benefits of an improved business environment in case a corporation does well. Similarly, if the corporation performs poorly, then the value of the Sukuk decreases significantly.

6. Conclusion

Sukuk instruments have received widespread interest in the last few years, given the growing interest of Islamic institutions and retail investors in obtaining Shariah-compliant financial products. Furthermore, the international investment community has been attracted to the Sukuk market, given its benefits for both the investor, and issuing party. Specifically, Sukuk has a strong connection with the real economy and assets, implying that the financier and Sukuk benefitting party share risks and usufructs from the positive performance of the underlying asset. Furthermore, Sukuk are safer as compared to conventional bonds, given that they have an underlying real asset, in contrast, to solely a liability.

China has experienced growing interest by international investors, and this has led to more investors attracted to the Chinese Sukuk market.

A major challenge for existing Sukuk investments is the pricing of sukuks. Given their substantial difference, conventional bond pricing approaches are not adequate to consider the characteristics and features of sukuks.

We have presented a novel AI-driven approach for Sukuk pricing and outlined its application on Chinese equities. The framework performed well, considering factors such as company performance and cash flows to reflect the value of the Sukuk accurately.

The framework represents a major milestone in developing a suitable Sukuk pricing methodology based on big data to represent the value of sukuks and consider their unique nature.

Conflict of interest

None.

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