Blockchain Bond Issuance

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Blockchain bonds are digital securities designed to address inefficiencies in the bond market. With global interest and recognition, digital securities represent a revolutionary phase in entrepreneurial and corporate finance. Blockchain applications in security issuance mark the beginning of a broad shift in public capital markets by significantly increasing efficiency and establishing relationships of trust between issuers and investors. In this paper we document the evolution of blockchain bond applications leading to recent bonds projected to have their full lifecycle on blockchain. We discuss the remaining challenges and risks associated with blockchain technology adoption.

Keywords: bond, blockchain, distributed ledgers, smart contracts

INTRODUCTION

Academics and practitioners alike recognize that importance of harvesting the benefits of blockchain technology in securities issuance. Blockchain is a chain of block transactions linked together by cryptographic signatures and stored in shared ledgers across a network (Fisch and Momtaz, 2020). Based on fundamental concepts such as cryptography, smart contracts, and distributed ledger, blockchain disrupts the traditional business process by removing the need for third party authentication and offering instead a collaborative infrastructure.

Blockchain has grown rapidly in financial services and primarily in securities issuance, albeit at varying rates across different assets (Hughes et al, 2019; Howell et al, 2020; Janssen et al., 2020). The most recent three years have witnessed a spectacular surge in Initial Coin Offerings (ICOs) and equity security token offering (STOs), though many blockchain applications in the bond market required a prolonged pilot or trial stage. While the functioning of both ICO and STO markets is well documented (Giudici and Martinazzi, 2018; Momtaz, 2020, Lambert et al., 2020), only scant evidence is available on blockchain bond issuance. This is a critical research gap since blockchain technology is expected to yield significant benefits by transforming the global bond market (Malamas et al, 2020). This paper contributes to closing the gap by documenting the blockchain bond issues, drawing parallels between blockchain and conventional bonds, and discussing the remaining challenges on the blockchain adoption.

The regular bond issuance is a lengthy and highly technical process, which involves many intermediaries and stakeholders with sometimes conflicting objectives (Van der Wansem et al., 2019). Lack of standardization in the primary markets exacerbates the information asymmetry and results in inefficient

pricing, high transactional costs, and long settlement times in the secondary markets (Shaikh and Zaka, 2019; Malamas et al., 2020). Starting with world's first blockchain bond application enabled by the Commonwealth Bank of Australia, blockchain technology has provided solutions to several challenges associated with bond issuance. Reliable results demonstrate that blockchain bonds yield significant gains in operational efficiency and resilience by automating a previously manual process (Cohen et al., 2018; HSBC, 2019; Cheng and Wang, 2020). However, blockchain applications have reached a mature stage only in the area of bond structuring, registration, sales and distribution. Blockchain technology has been partially applied in the area of bond transfer of ownership, payment and settlement and is yet to be applied in benchmarking and reporting. Nonetheless, an important milestone towards a fully digitized bond was recently acknowledged by John Whelan, head of Digital Investment Banking at Banco Santander, who stated that "*debt security can be managed through its full lifecycle on a blockchain*" (December 10, 2019).

BLOCKCHAIN

Blockchain is an append-only distributed database that enables data sharing across a network of participants (Yli-Huumo et al., 2016). Transactions are organized in chronological blocks linked together cryptographically. The accuracy and the order of transactions are safeguarded by a consensus algorithm running on all participating nodes. While several consensus algorithms provide different levels of speed, computation time, security and scalability, the two most widely used algorithms are the Proof of Work (PoW) and the Proof of Stake (PoS). Notwithstanding a wide range of applications, all blockchain systems ensure persistence among transactions and data, security and integrity of data, coordination of transactions, trusted direct interaction among the network users, and the auditability, transparency and verifiability of network activities (Arnold et al., 2019).

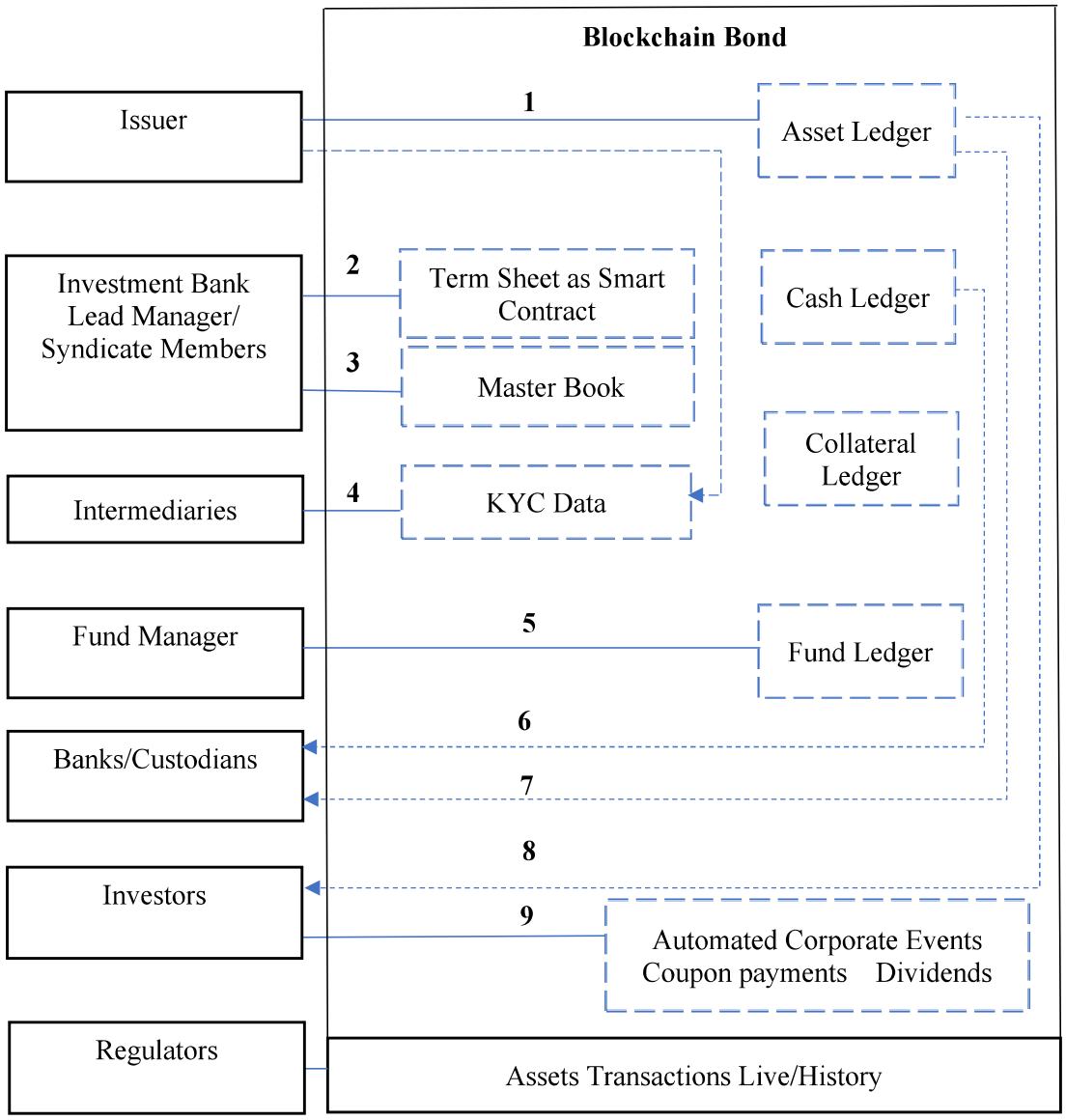
Blockchain networks are classified as public, permissioned, and hybrid. Public blockchains provide anonymity and wide distribution by allowing any user to participate as a node in the network. However, public blockchains are slow and energy intensive. Permissioned blockchains are open exclusively to a consortium or group of individuals who share a copy of the ledger. As such, permissioned blockchain is a restricted ecosystem blockchain where only trusted and recognized participants append to the network. Although anonymity is not preserved, their consensus mechanisms are computationally inexpensive. Permissioned blockchains better fit the needs of organizations where transactions are conducted internally (i.e. ledger need to share to the restricted nodes). The third type of blockchain, consortium blockchain, is a hybrid, semi- decentralized blockchain, where all transactions are validated by specific nodes. Since all nodes are owned by trusted users, consortium blockchain uses pre-defined consensus rules for an almost instant confirmation of transactions. With primary applications in the banking sector, Hyperledger and Corda represent the two main consortium blockchains.

Within a blockchain network, users can deploy secure computer programs representing agreements that are automatically executed when a set of predetermined rules are met. These programs, known as smart contracts, are series of if/the statements programmed and saved on the blockchain. The source code of smart contracts is stored in every node and, when triggered, the contract is automatically executed and the resulting action is stored and shared across the blockchain (Arnold, 2019). Smart contracts are recognized for fostering autonomy, transaction credibility, automation and efficiency (Casino et al., 2019; Cong and He, 2019), but they bring their own cybersecurity risk by exposing a large security surface area for attackers to exploit. Thus, code reviews are needed and, when appropriate, they may include automated review mechanisms to validate that nodes are free from security risks (Kehoe et al., 2017).

As shown in Figure 1, blockchain bond issuance comprises several distinct stages (Chen and Wang, 2020). The bond is first issued in tokenized form into the asset ledger. Next, the investment bank initiates a digital term sheet as a smart contract and receive sign-off from the issuer. The bids and orders from potential investors are recorded in the master book and the issuer, using the Know Your Customer (KYC) details provided by the gatekeepers or intermediaries, adds investors to the bond blockchain. Tokens, representing cash or security based on the investor transaction, are used to determine investor portfolio value based on the holdings as recorded on a fund ledger. The deal comes to the closing stage after signing,

when custodians and banks act as token keepers and execute the instructions to transfer money or debt instrument to the beneficiary accounts.

FIGURE 1
BLOCKCHAIN BOND ISSUANCE



Source: Own illustration, based on Capgemini Consulting, 2017.

An important aspect of the process is that blockchain allows for near real-time settlement via on-chain delivery-versus payment. Furthermore, regulators have direct access to the data and thus, they can monitor the transactions to ensure compliance with the legal and regulatory environment. The process is facilitated by the fact that each blockchain bond has an ID similar to the ISIN's unique identifier for bonds. The International Securities Identification Number (ISIN) is administered by the Association of National Numbering Agencies (ANNA) or the Financial Instrument Global Identifier (FIGI) that is maintained by the Object Management Group (OMG), with Bloomberg as Registration Authority. Similarly, the International Token Standardization Association (ITSA) e.V. has developed the International Token Identification Number (ITIN) as a unique identifier for DLT-based cryptographic tokens. Moreover, ITIN is designed to

complement ISIN by creating a bridge between the traditional and new financial world through a paring of ITIN with already existing traditional identifiers (Sanders, 2020).

BLOCKCHAIN BOND ISSUANCE

This section presents several applications of blockchain technology in the bond market. We create a comprehensive list of blockchain bonds, based on data obtained from https://www.icmagroup.org/ and additional blockchain bonds identified from other aggregator websites. As shown in Table 1, our sample of blockchain bonds includes eleven issues. Additional information on each issue was manually collected from press releases and white papers and is presented below in chronological order.

One of the first experiments with blockchain bonds took place in January 2017, when Commonwealth Bank of Australia and Queensland Treasury Corporation (QTC) created the first working prototype of a blockchain bond by a government entity. QTC, acting as both issuer and investor, used the blockchain to generate a bond tender, view investor bids in real time, finalize investment allocation and settle instantly with investors. However, the bond was not tradable and did not carry any debt obligation.

TABLE 1
BLOCKCHAIN BOND ISSUES

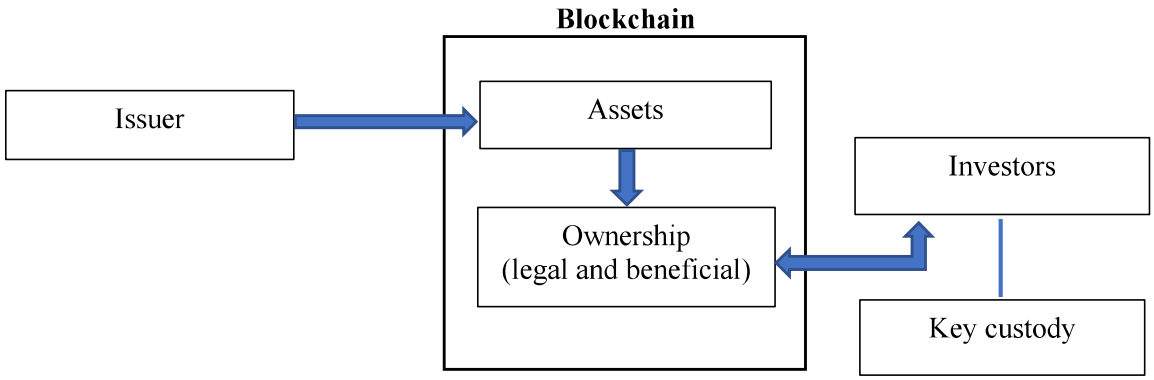
	Issuer	Date	Blockchain	Issuance	Amount (USD m)
1.	Commonwealth Bank of Australia	January 2017	Private Ethereum	NA	NA
2.	Daimler AG	June 28, 2017	Private Ethereum	1-year bond	111
3.	Fisco	August 10, 2017	Private Ethereum	3-year bond	0.813
4.	Sberbank	May 18, 2018	Hyperledger Fabric	Commercial bond	12
5.	Societe Generale	April 18, 2019	Public Ethereum	5-year covered bond	112
6.	World Bank	August 24, 2018 August 16, 2019	Private Ethereum	2 tranches of "Bond -i	108
7.	Santander	September 12, 2019	Public Ethereum	1-year bond	20
8.	INVAO	September 27, 2019	Public Ethereum	10-year bond	20
9.	Bank of China	December 3, 2019	Proprietary Blockchain	2-year bond	2,800
10.	Bank of Thailand	September 11, 2020	IBM Blockchain	Savings bond	1,600
11	China Construction Bank	TBD	Proprietary Blockchain	3-month	3,000

The second issuance of blockchain bonds of a €100 million, one-year Schuldschein, was completed by Daimler AF on a private version of the Ethereum. A Schuldschein is a vehicle used by corporations to borrow amounts as high as €500 million for a period of 3-10 years from a group of private investors with only minimal disclosure and regulatory requirements. The entire cycle, from origination, distribution, allocation and execution of the loan agreement, to the confirmation of repayment and of interest payments, was automated through the blockchain network. Daimler partnered with Landesbank Baden-Württemberg

(LBBW) to sell the bond to savings banks Esslingen-Nürtingen, Ludwigsburg and Ostalb. Only a couple of months later, Fisco, a financial data provider and bitcoin exchange operator in Japan completed the first issuance of Bitcoin bonds. The three-year bond offered a three percent rate of return and was exchanged between two units under Fisco umbrella. Although the Bitcoin bonds were not considered to be a "Bond" as defined in Article 2, Item 23 of the Companies Act of Japan, they were developed to have the same properties as conventional bonds

Another notable development took place when the blockchain startup Nivaura initiated the first bond cleared, settled and registered on the public Ethereum blockchain. With a life of only one week, the bond was issued by the London-based luxury retail startup LuxDeco and several counterparties were involved in its creation. Nivaura received input from JP Morgan for the development of an automated bookbuilding process and legal advice from law firm Allen & Overy to construct legally compliant documentation that automated the work using Ethereum smart contract. Credit rating firm Moody's priced the instrument to reflect the perceived risk of using a cryptocurrency prone to price fluctuations. Lastly, trustee services were provided by Australia-Based Link Asset Services.

FIGURE 2
NIVAURA BLOCKCHAIN BOND



Source: Own illustration based on *Banking on the Blockchain,* 2018

Nivaura's bond issuance is illustrated in Figure 2. The process requires lower legal fees reflecting a simpler structure where legal and beneficial title are united and no contractual relationships between issuer and registrar are needed. The use of smart contracts removes the paying agent and facilitates direct payments to investors. The role of custodian, different from that of regular bonds, ensures internal consistency as "assets/cryptocurrency held by investors private key is accurate".

Another significant milestone was reached when World Bank raised AUD110 million by issuing a blockchain operated bond-i, a two-year bond with a 2.20 % coupon. The World's Bank digital bond-i transactions were supported by a group of institutions that included Commonwealth Bank (CBA), First State Super, NSW Treasury Corporation, Northern Trust, QBE, SAFA, and Treasury Corporation of Victoria. On August 16, 2019, Bond i's market participation was expanded to three joint lead managers and new market participants. Although Bond-i's underlying private blockchain was built with Ethereum technology, it was denominated in the Australian dollar, not cryptocurrency. Both coupon payments and cash settlements were made via SWIFT, the global financial-messaging provider.

The first structured green bond using blockchain technology was issued by BBVA group. Structured bonds are negotiable assets with a fixed maturity, designed according with the required rate of return, term, and risk tolerance of the investor. In a private placement, MAPFRE, a global insurance company, invested EUR 35 million in a six-year term bond linked to the evolution of the five-year euro swap rate. Whereas the transaction took place on the Hyperledger Fabric permissioned blockchain accessible only to authorized counterparties, the bond had the record of transactions written to the public Ethereum for full visibility to any observer.

In April 2019, Societe Generale Group issued about $112 million worth of covered bonds in the form of a security token on the public Ethereum blockchain. Societe Generale issued the five-year bonds to itself and no outside buyers were involved. PwC advised the project on technology and the French law firm Gide Loyrette Nouel was a legal advisor. One year later, Societe Generale SFH (the covered bond vehicle of Societe Generale) issued €40 million of covered bonds as security tokens directly registered on a public blockchain. The tokens were fully subscribed by Societe Generale, which paid the issuer in a digital form of euros issued by the Banque de France. The transaction was performed end-to-end using blockchain infrastructure.

The first commercial blockchain bond transaction in Russia was completed by Sberbank, a banking and financial services company, and MTS, a telecom firm. The transaction was based on Hyperledger Fabric 1.1, involved 750 million rubles of commercial bonds with a maturity of 182 days and an annual coupon rate of 6.8 percent.

The next two bond issuances, based on public Ethereum blockchain, were completed by Banco Santander and Blockchain Investment Manager INVAO. Banco Santander's issuance of a $20 million bond represented the "first truly digital front to back execution process, which securely uses relevant data to tokenize both the assets and cash to enable on-chain settlement and coupon payments." The bond carried a quarterly coupon of 1.98%. The bond issuance was completed by several participants within the same group pf companies, with Banco Santander as issuer and Santander Securities Services acting as tokenization agent and custodian of the cryptographic keys.

The most recent three bond issues reflect the beginning of a mature stage of blockchain applications for security issuance. Using a "self-developed blockchain bond issuance system," Bank of China raised $2.8 billion by issuing two-year bonds with a coupon rate of 3.25% According to the bank, the self-developed system is "the nation's first bookkeeping system based on blockchain technology" and covers three stages, issuance preparation, bookkeeping filling, pricing and placement. It also provides support to bond issuers, bookkeepers, underwriters and direct investors. Next, the Bank of Thailand launched a new platform leveraging blockchain technology for Government Savings Bond issuance. A collaborative effort of eight Thai institutions, the blockchain bond aimed to enhance investor's buying experience, improve operational efficiency and reduce overall cost. During the first week, fifty billion baht of government savings bonds were sold out. Investors benefited from a speedy bond issuance and the use of IBM Cloud's blockchain allowed for a decrease in operational complexity and the overall cost. Finally, China Construction Bank announced a plan to raise up to $3 billion by issuing blockchain bonds with an annualized interest of Libor plus 50 basis points, or roughly 0.75%. The innovation is that bonds are being used as tokenized certificates of deposits on the blockchain, which supports the issuance of bonds with a par value as little as $100. The tokenized certificates of deposits will be traded on the Fusang exchange, where traders can exchange Bitcoin for U.S. dollars in order to purchase the bonds.

BLOCKCHAIN BONDS CHALLENGES AND RISKS

Whereas blockchain yields benefits such as real-time efficiency, elimination of intermediaries, transaction cost reduction to irreversibility and immutability, a large-scale implementation of blockchain technology faces significant hurdles due to lack of awareness, lack of standardization, issues related to privacy, and lack of regulatory clarity.

One of the main challenges associated with blockchain implementation is the lack of awareness and understanding of the technology. A survey of more than 1,000 senior executives in seven countries found that while many executives considered their knowledge of blockchain technology to be in the Excellent to Expert range, executives in Health Care, Financial Services, and Life Sciences were slightly less proficient, and Public Sector executives were much lower in the learning curve (Deloitte, 2019). Further evidence provided by an annual survey conducted on 1,000 working finance professionals indicates that 19% of the respondents were completely unaware of blockchain utilization within the finance sector and 29% had only a basic understanding of the technology (Onguard, 2019). Raising awareness of the blockchain benefits and drawbacks is essential and needs to be broadly understood by decisionmakers (OECD, 2019).

FIGURE 3
BLOCKCHAIN ADOPTION PATH

Source: Own illustration based on Euroclear & Oliver Wyman

Another major obstacle is the lack of standardization among blockchain platforms. Whereas various platforms and networks are currently available, no standards exist to allow their interaction (Wintergreen Research, 2018). However, the International Organization for Standardization (ISO) has been the primary driver in the push for blockchain standardization. With significant efforts towards reaching this goal, blockchain technology standardization is likely to be finalized by 2021 (Moody's, 2019). The timeline coincides with the blockchain adoption path advanced by the Euroclear and Oliver Wyman, as shown in Figure 3.

The third challenge relates to privacy and switch in trust. Blockchain technology lacks the functionality to keep identity and transactions anonymous. Ethereum co-founder Vitalik Buterin stated "*solutions for privacy are in some cases easier to implement (though in other cases much, much harder), many of them compatible with currently existing blockchains, but they are also much less satisfying. It's much harder to create a "holy grail" technology which allows users to do absolutely everything that they can do right now on a blockchain, but with privacy; instead, developers will in many cases be forced to contend with partial solutions, heuristics and mechanisms that are designed to bring privacy to specific classes of applications.*"

While private permissioned blockchain is invoked as a response to privacy concerns of public blockchain, permissioned blockchain requires a controlling authority and a layer of credential management which runs counter to the trustless distributed nature of a blockchain.

Finally, the lack of regulatory clarity is another factor obstructing the wide adoption of blockchain technology. In the United States, several state governments have tried to promote the blockchain technology and cryptocurrencies by passing favorable regulations, while others have passed laws considered restrictive on the adoption of this technology (Cai, 2018; Dewey, 2020). A similar argument is made by Reyes (2016) who notes that "*regulators adopted an increasingly aggressive approach to enforcing existing regulations against the drastically new, different, and emerging technology. The resulting barriers to entry and climate of legal stigma are stifling the nascent decentralized technology industry and preventing further innovation*."

Three proposals have emerged as alternative solutions to the inadequate regulatory approach to the decentralized technology industry. The first proposal attempts to apply the existing law to cryptocurrencies by classifying them into a specific type of assets and property category. In line with this proposal, an SEC investigation concluded that DAO tokens should've been classified as securities and sales of digital tokens "are subject to the requirements of the federal securities law." The second group of proposals advances the idea that federal financial services law should apply to all decentralized virtual currencies, but the remaining policy issues should be addressed by the states. For example, the New York Department of Financial Services has granted a digital currency license to several companies and licensed technology-money transmitters under New York's money transmitter law and digital currency exchanges. The third group of proposals call for a three-tiered self-regulatory approach that includes the code itself, self-imposed contractual obligations and private lawsuits. Regardless of the elected solution, any excessive or premature application of regulatory constrains would stifle innovation and opportunities to leverage technology to achieve policy objectives (Werbach, 2018).

CONCLUDING REMARKS

Inefficiencies in the current bond market process highlight the scope for improvement in the areas of cost, reporting, and settlement process. Extant experiments have demonstrated the potential of blockchain bonds to increase reporting transparency and reduce the number of intermediaries and the length of the settlement process. Recognizing blockchain as a technology well positioned to revolutionize the bond markets, several major financial institutions have embraced the blockchain technology and applied it to bond issues. The timeline of blockchain bond issues shows a swift progress over time leading to these debt securities now being managed through their full lifecycle on a blockchain.

Despite all recent advancements, blockchain integration faces multiple barriers including the lack of clear regulations, the need for standardization of technological platforms and ongoing challenges related to awareness and trust. However, recent strides made by regulators and the International Standard Organization (ISO) accelerated the adoption of blockchain application and led to significant advances in the blockchain bond issue. While the process suffers from occasional mishaps, such as the delay in the blockchain bond issue by the China Construction Bank, blockchain technology is paving the way towards an efficient and truly global bond market.

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