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Master's Thesis

Appearance of Blockchain Bonds: An Assessment of Blockchain Impact on Bond Issuance Process in European Debt Capital Market

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Abstract

Beyond cryptocurrency, blockchain technology could be considered as one of the most revolutionary driving force to reshape the current financial ecosystem. Focused mainly on the traditional securities issuance in Europe, traditional bond issuance process has been dependant on cumbersome manual workflows, intensive paperwork and involvement of a large number of intermediaries for decades. This thesis provides an in-depth analysis of current inefficiencies in the entire bond issuance value chain in Europe and how blockchain technology could be used to address these issues at stake on top of the existing conventional solutions. In particular, we aim to assess the overall impact from the perspectives of both practical implementation and market participants and thereby employ an approach of combing qualitative analysis with market observation and expert surveys. With the application of blockchain technology, bond issuance process could be driven towards an innovative path in both public and private sector, achieved by enabling smart contract-led automation, reduction of intermediaries, automated asset-servicing through a distributed ledger and 24/7 electronic audit trail along with the various phases. Given the potential streamlined process and workflows, blockchain technology could be a significant endeavour that digitalizes bond issuance process, integrates European debt capital markets, and shifts major market participants' role in the value chain.

Keywords: Bond issuance, Blockchain, Distributed ledger technology, European debt capital market, Market inefficiencies, Post-trade process, Smart contract, Tokenization

Table of Content

List of Tables

List of Figures

List of Appendices

List of Abbreviations

AML	Anti-Money Laundry
API	Application Programming Interface
BaFin	Bundesanstalt für Finanzdienstleistun gsaufsicht (German Federal Financial Supervisory Authority)
CBDC	Central Bank Digital Currency
CCP	Central Counterparties
CSD	Central Securities Depository
CSDR	Central Securities Depository Regulation
DCM	Debt Capital Market
DLT	Distributed Ledger Technology
DvP	Delivery versus Payment
EACH	European Association of CCP Clearing Houses
ECB	European Central Bank
ECSDA	European Central Securities Depositories Association
EDDI	European Distribution of Debt Instruments Initiative
EMEA	Europe, Middle East and Africa
EMIR	European Market Infrastructure Regulation
EPTF	European Post-Trade Forum
EU	European Union
GDPR	General Data Protection Regulation
ITIN	International Token Identification Number
ITP	Independent Third Party
KYC	Know Your Customer
LML	Legal Mark-up Language
MiFID	Markets in Financial Instruments Directive
MiFIR	Markets in Financial Instruments Regulation
OTC	Over-the-counter
PFMI	Principals for Financial Market Infrastructures
STO	Security Token Offering

SME	Small and Medium-sized Enterprises
T2S	Target2-securities

1 Introduction

1.1 Blockchain as a Solution to the inefficiencies and Fragmentation of EU Debt Capital Market

In the last years, blockchain technology (also referred to as distributed ledgers technology) has been in the spotlight and touted as a panacea that will revolutionize banking and capital markets. One of the most likely areas for disruption is the traditional debt capital markets, where the old-school business could be advanced and transformed into a new era. The next frontier is the "primary" side of the banks' lucrative debt underwriting businesses, where the often-knotty work of arranging issuers, investors, agents, and various parties could become much faster and more efficient.

Although some senior bankers are dismissive, sneering at efforts to graft technology on to what is an essentially human-driven business, projects under the streamer of "blockchain bonds" are proliferating across the industry. Project Mars, for example, was formed by a consortium of six bulge bracket banks in 2018 to improve pricing technology and maintain market influence. However, in addition to transforming the bond issuance process, blockchain technology has more implications on the overall bond value chain.

After a bond is first issued, the vintage capital distributing channels existing in the past decades have also raised concerns regarding fragmentation issues in European capital markets. Back in 2001, "Giovannini barriers" were identified, which describe the 15 main obstacles to efficient cross-border clearing and settlement in Europe. Later in 2017, a new review of the post-trade barriers was carried out by the European Post-Trade Forum (EPTF), which provide a detailed overview of the defined post-trade priorities to be tackled in order to achieve more harmonization in the EU. Lately, in May 2019, ECB launched a potential Eurosystem initiative called EDDI and published a market consultation stating that "exiting ecosystem results in considerable heterogeneity and complexity for market actors, including the end-investors".

Currently, how post-trade process of debt instruments including clearing, settlement, and future payment can be improved by blockchain technology can be found in rather extensive research dissertation and white papers, while the utility and impact on pre-

issuance phase remain vague and controversy. With concerns being raised by financial intermediaries regarding their role change along with technology adoption, we drove our research to unveil the seemingly abstract concept of distributed ledger technology and elaborate its influence on the entire bond issuance value chain and on a higher level, how it would contribute to a more efficient and harmonized EU capital market.

1.2 Identifying Research Questions and Study Structures

The purpose of this paper is to perform an in-depth analysis on i) blockchain technology as a potential solution to current inefficiencies in the process of bond issuance and ii) an evaluation of market perception regarding potential blockchain implementations through key market participants for a practical view of their expectations of how technology can drive the role change. Accordingly, we implement an approach combining the qualitative analysis with market evidence from i) market observations and ii) expert surveys.

The paper is structured as follows. Section 2 first reviews the relevant literature on traditional Eurobond issuance practice, where concrete steps and parties involved in both pre-issuance phase as well as post-trade phase are illustrated. In addition, we demonstrate the essence of associated blockchain technologies, laying a foundation for further discussion on the main research questions. Section 3 depicts the qualitative methods for the exploration of the research model. Qualitative data from the approach of market observation are first presented, followed by an expert survey design aiming to collect first-hand empirical data to address both research questions. Specifically, current initiatives to issue bonds using blockchain technologies are outlined as market evidence. Together with our research results, the qualitative data are integrated into the expert survey questions design, which contributes to the unification of the research methodology. Section 4 then reports and discusses on the results from both market observation and expert surveys, including existing inefficiencies and current solutions in both pre-issuance process and post-trade landscape, blockchain impact and value-add on the value chain, as well as challenge and obstacles of the technology adoption - all addressing to the 2 main research questions. Subsequently, section 5 integrates the findings, highlights both the theoretical and practical implications, and reveals the research limitation along with further research direction.

2 Literature Review and Theoretical Background

2.1 Overview of Eurobond Issuance

We concentrate on the parties and process involved in the issue of a Eurobond, which is among the most common form of debt securities and something of a paradigm for debt securities issued in the London markets. A Eurobond is a bond denominated in a globally recognized currency, which is not the currency of the country in which the bond is issued (Adams, 2016). The flourish of the Euromarkets was first due to raising restrictions in the domestic markets in the 1970s in the US. Later on, Euromarkets serve as a means to globalize the world's capital markets, providing an issuer with access to a much greater and often cheaper source of funding than in its domestic market alone.

2.1.1 Key Participants and Their Roles

In order to generate a clear overlook of the market participants and their relevant roles, we have divided the descriptions into two parts: table 1 provides key participants descriptions for pre-issuance stage, and table 2 shows the same information but for the post-trade stage.

Table 1 Key Participants in the Pre-issuance Process and Their Main Roles

Issuer	The entity that uses capital markets for raising money: 1) companies, including corporates, banks and financial institutions 2) governments / sovereign 3) public authorities 4) supranationals
Lead Manager	The financial institution mandated by the issuer to arrange the bond issuance and provide professional advice on the structure, pricing, and timing of the issue; serves as a sponsor and provide confirmation if the bond is to be listed.
Syndicate	The "co-managers" together with lead manager, providing a distribution network for the issue, sourcing investors, managing the book-building process, and completely or partially underwriting the securities.
Auditors	Auditors are involved when the issuer is an entity which produces accounts. They audit the issuer's account for at least the previous three years. When asked, the issuer's auditors will provide "comfort letters" addressed to the lead manager and the syndicate, mainly confirming no material change in the issuer's financial condition since the last published accounts,

	and a "consent letter" consenting to the publication of their report in the offering document.
Legal Advisers	Separate legal advisors will be appointed by the issuer and the lead manager. If a trust arrangement is concerned, the trustee will also instruct solicitors. If the issue involves an overseas jurisdiction, lawyers form that jurisdiction bust be instructed to ensure compliance with local laws and regulations. The role of legal advisers in a primary issue comprises the preparation of documentation, participation in the due diligence process, and production of a legal opinion for the transaction.
Listing Agent	Appointed by the issuer to communicate with the listing authority on its behalf, to lodge the necessary documents with the listing authority, and to advise the issuer on the listing rules and process.

Table 2 Key Participants in the Post-trade Process and Their Main Roles

Fiscal Agent / trustee	Either a fiscal agent or a trustee will be appointed by the issuers to help in future payments of the bonds and communications to bondholders. Main differences are that the fiscal agent only acts on behalf of the issuer, while the trustee represents the interests of the bondholders.
Principal Paying Agent and Paying Agents	Paying agents of the issuers help co-ordinate the principal and interest payments to the paying agents in the jurisdiction of bondholders where the payment is made. Alternatives can be the Fiscal agents when they have a presence in the jurisdictions.
Clearing System	Clearing systems were developed mainly to avoid physical handling of bearer instruments and facilitate transactions in both primary and secondary markets via participant's securities clearance account and cash account within the system. In the international euro securities markets, the Euroclear system and the Clearstream Service are the two systems of paramount importance.
Depository and Common Depository	A depository is an eligible bank appointed to act on behalf of a clearing system as "safe keeper" of the physical securities. A common depository is the same bank required to use when an issue involves more than one clearing system. Under the "New Global Note" structure from July 2006, securities can also be physically held by the clearing systems themselves in order to be eligible as Eurosystem collateral.

Custodian Bank	A custodian bank takes full responsibility when ensuring that the assets are properly taken into custody and accounted for, and in the case of a sale, that the assets are properly delivered and agreed payment terms are met. Compared to the depository, a custodian bank does not have the control and legal ownership of securities and is not liable in terms of investment loss.

Although a bond is newly issued (for detailed process see chapter 2.1.2) and entered into the market for future trading and settlement, the key players are intricately involved, and some of the key infrastructures are explained below:

Central Securities Depository (CSD)

A CSD is an entity which provides a central point for depositing financial securities, for example, bonds and shares. Historically, CSDs were set up by a country's national financial authorities, while nowadays most European CSDs have become privately owned and operated in different governance structures. For instance, some CSDs are owned by publicly listed companies or users drawn from the clients' pool, some operate as part of the corporate group including Stock Exchange and/or a CCP, while others operate separately from the trading and clearing venue. CSDs' clients are typically financial institutions themselves (such as custodian banks and brokers) rather than individual investors (ECSDA, 2019).

As introduced by the EU Regulation of 2014, there are three core functions performed by a CSD:

1. Settlement service: CSDs operate IT platforms for the settlement of securities transactions. A transaction is "settled" once the CSD has credited the account of the buyer with the acquired securities (and debited the according cash amount), while debiting the account of the seller with the securities (and crediting its account with the according cash amount). Such credit and debit movements typically take place simultaneous, in the "Delivery versus payment" (see chapter 2.1.2).
2. Notary service: CSDs records newly issued securities in a book-entry system (called "issuer CSD") and are often responsible for ensuring that the number of securities initially created equals the total number of securities in circulation (booked in investors' accounts) at any time in the market.

3. Central maintenance service: In settlement of a transaction, CSDs manage the rights and obligations linked to the securities holdings from the top of the securities chains, i.e. all holdings in a given financial instrument, whether by an individual or a financial institution, are ultimately kept in a security account at the CSD. CSDs therefore also provide for the safe keeping (or "central maintenance") of securities, including, e.g. the processing of corporate actions such as dividend and interest payments, or voting rights execution in the case of shares securities.

International CSD (ICSD)

While CSDs were primarily created to serve their domestic market, ICSDs were created in the 1970s to settle Eurobonds. Over the years, ICSDs have extended the scope of their services to cover all types of internationally traded financial instruments, including equities and investment funds. There are two ICSDs in the European Union: Clearstream Banking located in Luxembourg and Euroclear Bank sit in Belgium. Both of them hold a banking license and provide settlement in different currencies (ECSDA, 2019).

Central Clearing Counterparty (CCP)

A CCP interposes itself between the two trading parties becoming the buyer to every seller and the seller to every buyer. The main function of a CCP is, therefore, to guarantee the reciprocal performance of obligations between buyers and sellers (i.e. the counterparties) of financial instruments negotiated on trading venues (e.g. a stock exchange) or bilaterally between trading parties (Over-The-Counter, OTC) through a process called clearing (EPTF Report, 2017). Clearing, technically, is the process of establishing positions, including the calculation of net obligations, and ensuring that financial instruments, cash, or both, are available to secure the exposures arising from those positions (EACH, 2019).

CCP clearing provides several benefits for the post-trade process. First, CCPs facilitate risk mitigation by continuously managing the counterparty risks and maintain a "default waterfall" where the loss would not only be absorbed by clearing members' margin and contribution to the default fund, but also CCP's own capital reserve defined by EMIR. Another useful function that a CCP can provide is "netting": if a counterparty buys and sells the same financial instruments in a day,

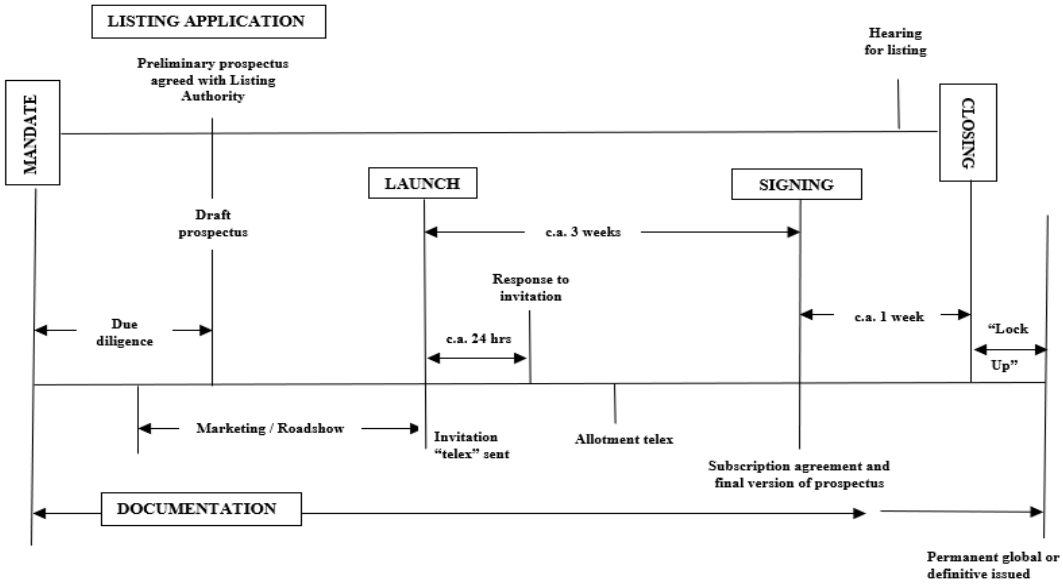
these transactions can also be netted, compressing the quantity of cash and securities to be moved (EPTF Report, 2017).

2.1.2 Issuing a bond: pre-issuance and post-trade process

In Euromarkets, the fund-raising timeframe between the issuer first instructing and investment bank to arrange the issue and when the issuer receives the money may range from three weeks to more commonly six weeks for a stand-alone bond (Adams, 2016).

In figure 1, the paradigm below shows the usual order in which each stage of the bond issuance occurs, though at times, the next stage begins before the completion of the previous stage. The primary substance of each stage is explained afterwards.

Figure 1 Paradigm Timeline for a Plain Vanilla Bond by a Debut Issuer



Source: Banking and Capital Markets, Adams, 2016

2.1.2.1 Pre-issuance Process

a) Mandate

At common practice, a particular company that decided to raise debt will appoint an investment banks to execute the issuance process. The company's directors will first have lengthy meetings with investment bank originators and its own accountants as well as legal consultants to decide whether they are in need of raising capital. At this stage, the company usually receive tailored proposals from different investment banks, who have done preliminary research on the company and drafted various bond issuance schemes that fit the company's situation and market condition.

After reviewing the schemes proposed and going through the pitch presentations, the company will appoint one investment bank to lead-manage the deal. This is called as the "Mandate".

The issuer and lead manager must first reach agreement on a couple of important matters. These include the marketing strategy, whether to list the bonds, the identity of the fiscal agent or trustee and paying agents, and the fee structure. These matters will be documented in the "mandate letter" or "term sheet" together with the bond's basic terms and conditions.

Having the mandate, the lead manager will first advise as to the most appropriate structure for an issue (i.e. which type of security), the estimated volume, and the best market to target. For instance, the lead managers may be aware that the Middle East investors are especially interested in the type of business the company runs and recommend that the issue targets at them. The lead bank will then approach its clients from the Middle East who have funding capacities and will bring in other banks that have the relevant client base to form a syndicate group (bookrunners) to help sell the bonds to institutional investors or public later.

b) Due Diligence

The due diligence process helps with providing material for the prospectus (and listing particulars) and also in checking that appropriate matters are being disclosed. A due diligence process will usually involve meetings between the lead manager and its solicitor, the relevant officers of the issuer, and the issuer's auditors to ascertain and verify the information needed for the issue. Obtaining the comfort letters in agreed form from the issuer's auditors is also part of the due diligence process following analysis of the issuer's accounts. In practice, procedures vary greatly from issue to issue depending on the security type issued and nature of the issuer and its business.

c) Documentation

A typical bond issue involves a substantial number of documents. The principal documentation required are listed in the chart below in two sections: documents relating to the underwriting, subscription and distribution of the bonds and documents which relate to and constitute the bonds themselves. Furthermore, if the bond issue is to be listed, a draft of the prospectus or listing particulars must be sent

to the appropriate listing authority usually three weeks before publication. The preparation and negotiation of these documents is the responsibility of the lead manager's solicitors and will continue through signing and only considered complete on closing when the last documents of the issue are executed.

Table 3 List of Required Documents in a Bond Issuance

Documents related to underwriting, subscription and distribution	Documents related to constitution of bonds
a) mandate letter b) invitation telex c) allotment telex d) prospectus or other offering document e) subscription agreement f) agreement among managers g) auditor's report and consent letter h) auditor's comfort letters i) legal opinions	a) fiscal agency agreement or trust deed b) paying agency agreement (if no fiscal agent) c) temporary global note d) permanent global note (or definitive form bond) e) deed of guarantee f) deed of covenant

d) Marketing

Marketing is an important job of the lead manager to help raise awareness for the issuer among investors. Roadshows in various jurisdictions are often conducted to familiarise potential investors with the issuer's business and to portray the issue as a good investment. However, the roadshow materials should be scrutinised by the solicitors and the lead manager's compliance department to ensure it complies with ss. 21 and 25 of the FSMA 2000, which put restrictions on advertising.

e) Launch and Syndication

After completion of any due diligence and marketing processes, the issue will be announced to the market (usually via online trading screens) on a date when market conditions are most favourable (e.g., avoiding launches of other competing issues, avoid dates when central bank put forward announcements), which is called a launch date.

Upon launching, the lead manager will send the invitation "telex" documenting the price of the bond and the commission fees to pre-determined syndicate banks (co-managers), await confirmation of their commitment, and subsequently send out an "allotment telex" followed by the draft subscription agreement to each co-manager.

f) Listing

A listed bond is one which is formally quoted, listed or capable of being traded on a recognised stock exchange. The primary advantages of listing an issue are to demonstrate that it has satisfied the requirements of the exchange and to attract certain investors, such as pension funds and unit trust funds, which are precluded from investing in securities that are not listed. The timetable for issuing a listed bond will usually be longer than an unlisted one due to more complicated procedures, longer time needed for the authority to review documentation of an issue and more in-depth due diligence process.

2.1.2.2 Post-trade Process

Post-trade processes take place after the pre-issuance phase and include the actual issuance of the debt security in central securities depositories (CSDs) and its delivery to investors via global or local custodians, agent banks and other intermediaries each representing different issuers or investors through multiple distribution channels. As an integral part of the financial industry value chain, post-trade services involve crediting the proceeds of the issuance of financial instruments to the issuer's account upon related post-trade services have come into play, and executing trading counterparties' agreement to buy or sell, resulting in a change of ownership.

g) Signing

A signing meeting is usually held within two weeks of the issue being launched, subject to authority's approval if the issue were to be listed. The lead manager and its solicitors will ensure the contractual documents (e.g. prospectus and listing particulars), as well as a substantial number of peripheral documents, are in final agreed forms and the relevant party has been appointed (e.g. common depository) before the signing meeting. Upon signing, the subscription agreement is executed by the issuer and the syndicate members and takes contractual effect.

h) Closing

The closing is the final stage of the issue process, and usually takes place approximately one week after signing. It is the time when the issuer receives its funds and the bonds come into being, creating the issuer's debt obligation.

Essentially, there are two sets of procedures which must take place at closing: documentary procedures and payment procedures (Adams, 2016):

- *Documentary Procedures*

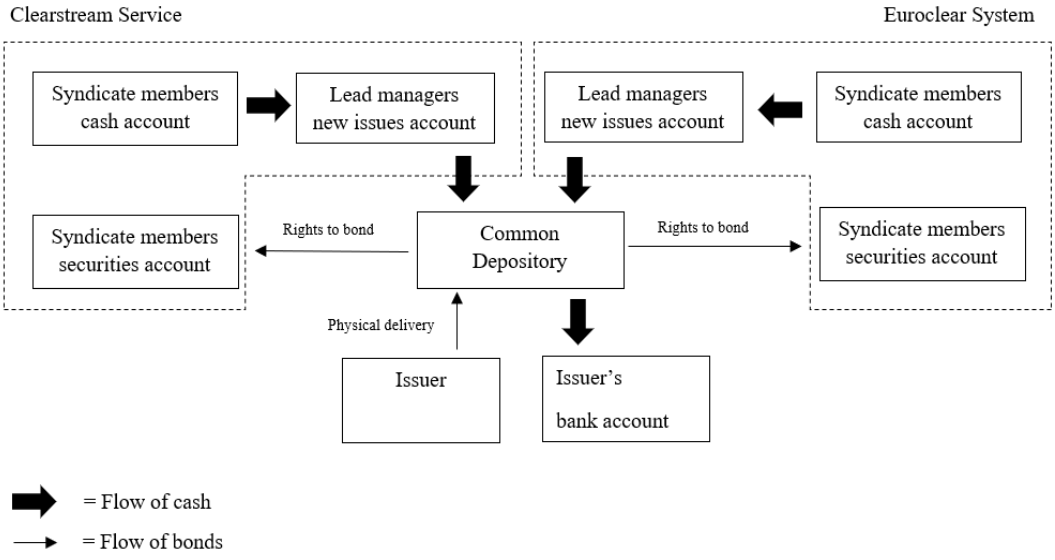
The lead manager and its solicitors will ensure all the conditions precedent to issue are met, and related documents are in the agreed form and should be executed by the end of the completion meeting. The temporary global note is authenticated (i.e. signed) by the fiscal agent (or paying agent) in order to give it legal effect and is delivered to the depository for safe keeping.

- *Payment Procedures*

Prior to closing, the lead manager will notify the clearing system of the names and amounts of bonds to be allotted to each syndicate member's securities account. The syndicate members will also inform the clearing system the amount of money to be debited to their cash account and the amount to be credited to lead manager's new issues account.

At closing, table 5 shows that the lead manager will authorise the release of its payment instruction to the depository to transfer the money of issue amount to the issuer, and the depository will then execute once it receives the notes, i.e. delivery versus payment (DvP). DvP is beneficial to reducing risks for both buyers and sellers, and the below figure further demonstrates the flow of payments and bonds at closing with DvP settlement.

Figure 2 Closing Procedures Delivery versus Payment



Source: Adams, D. (2016), Banking and Capital Markets

2.2 Blockchain Technology

Back to the 1990s, Wei (1998) proposed the digital money concept named 'B-money', an anonymous and distributed electronic cash system in an untraceable network. Even though B-money has never been launched officially, but it initiated the preliminary concept of bitcoin and the blockchain technology. After a decade, blockchain technology debuted its journey publicly with the appearance of the first decentralized cryptocurrency called bitcoin, which is a peer to peer electronic cash system using proof-of-work to record electronic transactions without relying on trusted third parties (Nakamoto, 2008). More recently, in June 2019, Facebook announced its future permissioned cryptocurrency named "Libra". Rising numbers of new cryptocurrencies and blockchain-based applications have captured increasing interest and attention of the public.

Break down into the term 'blockchain', where multiple transactions are grouped into a block, and each block contains a timestamp (Cong & He, 2016). Meanwhile, each of them is connected with its previous block in a chain-like form (Watanabe, Fujimura, Nakadaira, Miyazaki, Akutsu & Kishigami, 2016). As a type of distributed ledger technology (Kakavand, De Sevres & Chilton, 2017), blockchain refers to a particular type of ledger or a chronological encrypted database of recorded transactions in a network of computer (Peters & Panayi, 2015). The recorded transactions are distributed and decentralized because participants of the network have the right to access to the blockchain and any dynamically-updates can be captured simultaneously in everyone's copy (including regulators) without the control of any single party or authority (Werbach, 2018, Cong & He, 2016).

Regarding the practical function of blockchain, similar to the Internet, it enables a direct, peer-to-peer digital transfer of asset value without relying on a trusted authority to verify and clear the transactions (Malinova & Park, 2017). There are two critical features of the encrypted distributed storage, immutability and transparency. These features can be captured by the fact that many blockchains are publicly accessible, and the stored data cannot be changed, tampered or deleted (Peters & Panayi, 2015).

2.2.1 Types of Blockchains

There are different types of blockchains based on different categorizations. In this chapter, we will mainly focus on the categorization based on the permission model of the blockchain networks. It can be either permissionless, where anyone can publish a block (Yaga, Mell, Roby, Scarfone, 2018) and participate in the verification process (Peters & Panayi, 2015). Alternatively, it can be permissioned, where the network permissions are more tightly controlled, and verification nodes are preselected by a central authority or a consortium (Peters & Panayi, 2015).

Permissionless Blockchains

With the public nature, the permissionless blockchain networks are the platforms accessible to all Internet users (Pilkington, 2015). Each user has not only able to be a verifier but also has rights to publish blocks, read ledgers and issue transactions on the blockchain (Yaga, Mell, Roby, Scarfone, 2018). However, "In the permissionless network, the identity of each user is either pseudonymous or even anonymous." (Swanson, 2015)

To prevent the problems that malicious users or attackers may intend to subvert the network system and temper with the blockchains, permissionless blockchains rely on multiple agreements or consensus protocols for validation purposes (Peters & Panayi, 2015; Pilkington, 2015). Proof-of-Work (PoW) and Proof-of-Stake (PoS) are commonly utilized in the network to achieve consensus. In the PoW, network users need to solve a computationally intensive puzzle in order to validate transactions and create a new block (Cong & He, 2018). Meanwhile, PoS determines the next block's creator based on the creator's stake, such as wealth (Cong & He, 2018). Both PoW and PoS designs are supposed to incentivize accurate and responsible record keeping and reduce tampering and manipulating issues (Cong & He, 2018).

Apart from the technical set-up, permissionless blockchain-based digital assets have entered the market and started to serve as a service in the financial services sector. Depending on the service purposes, public blockchains can employ either monetary or utility token from the business implication perspective (Dob, 2018) and generally they are considered as "fully decentralized blockchains" (Buterin, 2015). Common examples can include both Bitcoin and Ethereum (see Section 2.3.3).

Permissioned Blockchains

Compared to permissionless blockchains, permissioned blockchains are considered as purpose-built (Peters & Panayi, 2015). They have added an additional layer of privileging to select and determine who the authorized users are (Hossein, De Sevres, Chilton, 2017). In general, "The authorized users are granted access to run nodes on the network, validate transaction blocks, issue transactions, and execute smart contracts (see Section 2.3.2) as well as read the transaction history in the permissioned blockchain." (Dob, 2018) Permissioned blockchain can solely rely on the motivations of permissioned nodes to add only valid transactions. Verifications in the ledgers are carried out by a set of trusted parties (Malinova & Park, 2017). It is similar to the current traditional finance setting, KYC Know Your Customer or KYB Know Your Business procedures are designed to identify which users are permitted to undertake operations under certain circumstances (Peters & Panayi, 2015). Meanwhile, ledger visibility to such trusted parties can be controlled and restricted (Malinova & Park, 2017).

Users are commonly the organizations that wish to cooperate together but may not yet establish fully trust among one and another (Yaga, Mell, Roby, Scarfone, 2018). In order to clarify different usage, Buterin (2015) specified that permissionless blockchains consist of consortium blockchains and fully private blockchains.

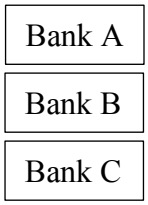
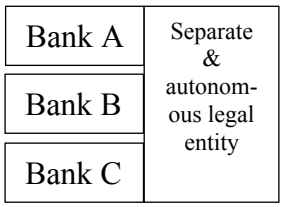
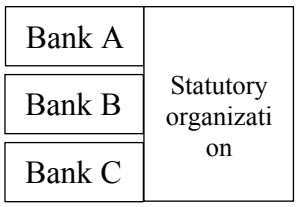
- *Consortium Blockchain*: Financial institutions are the major participants. Each participant acts as a block validator and runs their node in the blockchain. Ledger visibility can be public or restricted to the participants. Such a partially decentralized blockchain provides a hybrid between the low trust from public blockchains and the single highly trusted model from the fully private blockchains (Buterin, 2015).

- *Fully private Blockchain*: Writing permissions are kept centralized to one organization, but visibility can be either public or restricted. "It can be accurately described as a traditional centralized system linked with a certain degree of cryptographic auditability attached." (Buterin, 2015)

Nowadays, permissioned blockchains have been actively adopted by financial institutions to enhance the payment transaction systems. As a successful example of permissioned blockchain application adopted by more than 200 financial institutions around the globe, 'Ripple' is a real-time settlement infrastructure technology for

global transactions and cross-border payments (Cong & He, 2018). Consensus can be achieved by the Ripple transaction protocol 'RTXP', "in which transactions are broadcasted repeatedly in the validation network until the agreement is reached." (Cong & He, 2018) Ultimately, it does not only automate digital transfers in a real-time manner but also provides cost-saving, reliable transaction services. Benefiting from a smaller size of the network, "it becomes more efficient and easier for participants to collaborate, alter the rules or revert the transactions within the same network." (Peters & Panayi, 2015). Table 4 shows three different governance structures should be considered especially for the ledger design for the use of financial services.

Table 4 Governance Models for Alternative Permissioned Blockchain Designs

1. Consortium	**2. Joint Venture**	**3. Statutory Organization**
		
Each participant owns and operates its node. Each representative will negotiate and decide on its behalf.	The core network members/ stakeholders fund the separate and autonomous legal entity.	As a separate legal entity, the statutory organization provides and manages the common platform which is funded by the government.
Eventually, decisions are made through consensus as an association.	The legal entity owns and develops a common platform. The common platform is served as a utility for each participant to operate their single node.	Organization may include representatives from banks. Network members will follow the directives of the organization and contribute to drive the common goal.

Source: Deloitte (2017), Six Control Principles for Financial Services Blockchain

2.2.2 Smart Contract

Back to the 1990s, Szabo (1994) revealed the concept of smart contracts initially:

"Smart contracts are the computerized transaction protocols that execute the terms of contracts. On the one hand, such transaction protocols aim to achieve contractual conditions such as payment terms, liens, confidentiality or even enforcement. On the other hand, they also have objectives of eliminating malicious and accidental issues and minimizing the need for trusted intermediaries."

With the recent revolutionary blockchain technology/DLT development, smart contracts have become feasible and realistic as one of the significant blockchain business applications. By definition, smart contracts are the encoded predetermined contractual rules built-in computer code and stored on the blockchain (Sklaroff, 2017). Such encoded contractual rules can be replicated and executed across the nodes of the blockchain (Peters & Panayi, 2015). Several features can be captured in smart contracts. Firstly, they have inherited the immutability feature of blockchain, that the stored contractual rules are unmodifiable once created. (Sklaroff, 2017). Secondly, they are also permanent. Therefore, they can be reutilized to build blocks for the purpose of providing more sophisticated services (Peters & Panayi, 2015). Furthermore, from the automation perspective, "they can be self-enforcing and monitoring the external inputs from trusted sources for the settlement according to the encoded terms and conditions." (Peters & Panayi, 2015)

Nowadays, most of the traditional financial contracts are still under physical forms and involves different third parties, such as various financial intermediaries. Increasing issues and risk linked to the current physical documents have raised concerns to most of the financial institutions. Capgemini consulting analysis (2017) revealed that such physical forms could cause delays, inefficiencies and tampering and errors issues. Therefore, with the technological infrastructure set-up and specific features mentioned, the blockchain-based smart contracts are considered as the most potential optimization tools to remedy the current problems linked to financial contracts and to create efficiencies by redesigning new operating models and reducing relevant costs for participants in the financial markets. In parallel, they exist ideally in a permissioned blockchain so as to ensure a private, secured and scalable for the involved key stakeholders (Capgemini consulting, 2017).

In terms of the practical use cases, smart contracts have been increasingly adopted mainly in the derivatives trading area as they can enforce the standard transactional rules to streamline the OTC financial agreements (Cong & He, 2018). Other traditional debt instruments such as bonds and loans are also considered as the ideal candidates for the first implementation of DLT based trading because digital versions of these instruments can benefit from the smart contract features, such as automating coupon and interest payments (Malinova & Park, 2017).

2.2.3 Ethereum

Invented by Buterin in 2014, Ethereum is not only a permissionless blockchain but also a software development platform designed to provide anyone with access to smart contracts and to develop decentralized applications (Peters & Panayi, 2015). "It allows anyone to create their own arbitrary rules for ownership, transaction formats and state transition functions for their decentralized applications" (Buterin, 2014).

For the sake of efficient and smooth functions of Ethereum, its cryptocurrency named Ether is used to compensate its miners as well as to conduct transaction payments in any applications built on the platform (Garlichs & Dosch, 2017). Meanwhile, the state is composed of "accounts" in the Ethereum (Buterin, 2014). These accounts can be classified into two types due to the presence of smart contracts (Garlichs & Dosch, 2017):

- *External Owned Account*: controlled by a private key, the account has no code that means it is not associated with any smart contract. One can send any messages from an externally owned account by creating and signing transactions.
- *Contract Account*: account is controlled by code, which refers to the smart contract. Code activation after receiving message allows the account to read and write again to internal storage to become part of the state. Such functions enable the contract to handle multi-state operations.

Focused on financial applications, more and more decentralized finance (DeFi) apps operate on the Ethereum blockchain and they are mainly used for payments, lending, and tokenization or decentralized exchange (Asolo, 2019). The DeFi applications will change the financial ecosystem by solving two problems associated with the traditional centralized banking services. On the one hand, they aim at improving the

inequality of access to financial services such as loans, mortgages or insurance by eliminating the barriers for the use of the applications (Asolo, 2019). On the other hand, their decentralized characteristic implies that financial authorities and institutions do not have a method to screen or financially audit the users (Asolo, 2019). Therefore, users can have more extensive exposure to the other types of investors rather than the traditional institutions. An example in lending, the individual can benefit from the access to the global pool of the willing lenders without relying on the conventional lending institutions.

Embedded with smart contracts, a broad range of Ethereum based DeFi applications have been developed and acted as a service provider in the financial markets. To further deploy the DeFi application scalability, table 5 shows the application area where most of the Ethereum based DeFi applications are focused on.

Table 5 Scope of Ethereum Application Area in the Financial Markets

Scope of Application	Issues at Stake	Impact
Over-the-Counter (OTC) Derivatives	Financial agreements in OTC derivatives are negotiated and customized by each party and they lack a standard clearing and settlement procedure.	Contractual agreements can be encoded into smart contracts. Smart contracts can further enhance the standardization of transactional rules to streamline the financial contracts, reduce costs and speed up the settlement process.
Securities Issuance	Current securities issuance, especially for the OTC, traded financial instruments (mainly debt instruments and derivatives) is highly complex. The time and cost consuming process involve a chain of financial, legal and regulatory stakeholders. In particular, lack of a certain degree of transparency in the process leads to disadvantageous positions of investors for the price discovery	In compliance with regulations, securities issuance in the tokenized form on blockchain involves the end-to-end process, from prime issuance, registry, to clearing and settlement. Tokenization and smart contracts can simplify the process by reducing intermediaries and automating payments and delivery of the security.
Securities Trading	Securities trading for equities is still relying on different intermediaries such as broker-dealers and big banks to complete the transactions.	With tokenization of fiat currencies and smart contract, blockchain enables decentralized exchange - real-time peer to peer trading and

		order matching while eliminating trading fees, increase trading speed and improve settlement process efficiency.
Know your Customer (KYC) Verification	Increasing scrutiny of regulations and a large amount of data, paperwork and lack of transparency regarding personal and confidential data from the clients lead to the fragmented and complex KYC processes. Its inefficiencies are tired with the time-consuming manual processes, the repetitiveness of efforts and data consistency issues.	Blockchain enables a single, securely encrypted common database for the autoreactive service providers, where data recorded is auditable. It leads to a more standardized monitoring process and visibility for the regulators. Controlled by the private key, access to the confidential data can be granted to the necessary third parties or central authorities by using a smart digital signature or a one-time password (OTP) for the permission.

2.2.4 Tokenization – Security Tokens, Utility Tokens and Payment Tokens

Developed from the new token sale or so-called initial coin offering (ICO) which is a further particular mechanism for entrepreneur ventures to raise funding, the blockchain-based tokens have demonstrated radical cost reduction on exchanging value and enabled transferring digitalized assets around the world in a highly trusted level and instant manner (Rohr & Wright, 2017). In 2018, 7.8 billion dollars were raised from ICOs, and 1253 ICOs were completed according to ICOdata Statistics. The significant amount raised from token sales has evidenced that tokenization has opened up the growth opportunities for both issuers and investors and asset diversification (Staschenko, 2019). Table 6 shows the key benefits provided by tokenization.

Table 6 Key Benefits of Tokenization

Key Benefits	Description
Immutability	History and the related information of tokens is recorded and tracked given a unique ID with ensured data accuracy and consistency. Data recorded cannot be tampered once validated and approved. Immutability can solve the concerns of investors such as fraud, corruption, system errors etc.
Transparency	Most of the blockchains are permissionless/public, and users can access a record with the correct permission. Registration for token issuance needs to be in compliance with legislation.

	Transparency will increase the visibility of regulators and further promote anti-money laundry and reduce fraud and financial crimes. Meanwhile, it will also improve the confidence of both issuers and investors to issue and transfer tokens.
Automation	As the legal contracts with key elements – formation, performance and enforcement, financial instruments or tokens can be automated by using smart contracts. Digital signatures and computer algorithms can significantly improve the efficiency of the transaction process and reduce manual procedures.
Safety	With cryptography and distribution registry, the confidentiality of open-source data in the blockchain can be ensured. Only users granted with "special secret key" to review the specific confidential information like owner, business or historical transactions etc.
Decentralization	Tokenization process in the blockchain can eliminate most of the intermediaries. Buyers of the tokens can trust only the issuers, and the registers (mainly the governmental authorities) and distribution registry can be regarded as a single source of truth. It will result in a cost reduction of the contract as fewer fees need to be paid to the reduced number of intermediaries.

The blockchain-based tokens have different forms for various use cases. Some tokens can be simply served as an equivalent of a financial instrument as ownership of rights can be attached to the tokens, some can provide the token holders advantageous or privileged access (Conley, 2019). Additionally, some can even serve as an internal account for the sake of facilitating transactions between different counterparties or tracking the validations and block-writing (Conley, 2019). Based on the token categorization proposed by Blemus and Guegan (2019), the current existing tokens can be classified under three different categories:

Security Tokens

Referring also to "tokenized financial instruments" (Blemus & Guegan, 2019), security tokens are simply the financial contracts including investors' financial rights such as dividends, interest payments, profit share rights, voting rights etc. (Koffman, 2018). Fundamentally, they can serve as a value transferring approach attached with ownership of rights (Rohr & Wright, 2017) and broadly open up the asset diversification.

With the expansion of blockchain technology and its smart contracts features, traditional assets such as equities, debt instruments or even derivatives can be innovatively tokenized and exchanged in a low-cost and more efficient way thanks to the decentralized feature of blockchain/DLT. As reported by Tapscott (2018), there are mainly six types of security tokens for three different asset classes: equity tokens, debt tokens (debenture tokens and bond tokens) and derivatives tokens (option tokens, smart swap contracts and smart futures contracts).

Currently, the rising number of regulatory and legally compliant issuance and exchange platforms for the security tokens cannot be ignored. It has testified the fact that issuers are highly attracted by what security tokens can provide unlimited access to the global pool of capital without relying on traditional forms of financing and investing (Asolo, 2019). Securities tokens have broadened the fundraising access and reduced significantly entry barriers. However, compared to utility tokens, security tokens are more strictly regulated by the governments (THE TOKENIST, 2018). In table 7, there are examples of existing security token offerings (STOs) that can connect the current prototypes with the further potential application development of the security tokens.

Table 7 Examples of STOs in Europe

STOs	Description
Bitbond	Via a STO, the German blockchain-based lending platform aims to raise funding to strengthen its business and services, providing working capital loans to small businesses. The prospectus of STO has been already approved by Bafin, the German financial regulator. The security token called BB1 works like a bond, will be bought back by Bitbond after ten years.
Mt Pelerin	Building a blockchain-based bank, the Swiss fintech Mt Pelerin announced launch of KYC/AML compliant STO service to help companies to issue, deposit and tokenize securities from their bank accounts by using blockchain technology.
OFH Token	Societe Generale used the OFH (obligations de financement de l'habitat) token to represent EUR 100mm of covered bonds on the public Ethereum blockchain.
BlockState	Swiss security token platform for non-banking assets such as equity, debt or real estate for SME. Directly connecting issuers and investors, tokens are locked up in the smart contract on Ethereum (similar to asset safe-keeping by custody) and mirrored to Corda R3, the private DLT platform. Investors can choose their desire issuance protocol and custodian for the bond tokens issuance.

Utility Tokens

Focused on the term "utility", it can be simply explained by "do something" (Tapscott, 2018). Intrinsically, utility tokens have only functional nature as token holders can be granted rights to the access of an organization, an application or a service (Rohr & Wright, 2017). Simultaneously, governance and voting rights can also be granted to token holders (Rohr & Wright, 2017). Besides, utility tokens can also confer the rights of purchasing, selling, consuming or using specific items or financial instruments (Blemus & Guegan, 2019). Regarding their consumptive and speculative features (Rohr & Wright, 2017), such tokens can also be exchanged in the secondary market (Blemus & Guegan, 2019).

From a practical perspective, utility tokens could reshape the business models of financial institutions or corporates by enhancing the process and interactions between different stakeholders. However, the usage of utility tokens requires the blockchain-based infrastructure set-up such as Golem or Augur.

Payment Tokens

Payment tokens are more well-known in another expression, "crypto-currency tokens". Similar to the nature of money, payment tokens are accepted as a medium of exchange and as a store of value. Apart from this, they can be used for the goods and services purchasing or even enable immediate money and value transfers thanks to the decentralized feature of blockchain technology (Blemus & Guegan, 2019). At the moment, most widely known Top 5 cryptocurrencies such as Bitcoin (BTC), Ethereum (ETH), XRP, Litecoin (LTC) and Bitcoin Cash (BCH) possess more than 0.23 trillion dollars market capitalization.

Subject to expensive and inefficient settlement process, as well as price volatility in holding cryptocurrencies, "JPM Coin" was introduced early this year by JP Morgan. With appearance of JPM Coin, digital stablecoins for payments have become an important topic related to improving current complex post-trade landscape. Theoretically, stablecoin is a cryptocurrency that can be fiat-collateralised, crypto-collateralised or simply algorithmic. In the financial services sector, the fiat-collateralised stablecoins are mostly adopted for the settlement purpose. Thus, they can be used by the decentralized autonomous organizations who control issuance and pricing. Initially, stablecoins were created to mitigate some risks linked to traditional

crypto currencies, such as price volatility, instability and transparency challenges. As a matter of fact, the fiat-collateralised stablecoins could have a massive impact on reducing complexity of settlement, speeding up the procedure and freeing up the capital for better management of intra-day liquidity.

3 Data and Methodology

Due to complexity of the research subject and the lack of market complex data, two qualitative research methods were opted for the thesis. First one is market observations and the second one is expert surveys and interviews. Explicitly for market observations, the observation period is set from the appearance of bitcoin in 2009 until August 2019. These two methodologies can significantly combine both market information and practical market overviews together.

3.1 Market Observations from Current Initiatives

Regarding first research method named observation from the market, it provides direct access to research phenomena with high flexibility of application and generating a permanent record of phenomena which can be referred to later (Dudovskiy, 2018). Therefore, we started from documenting the current market well-known initiatives (Ipreo, project Mars and European distribution of debt instruments EDDI) through some financial media websites such as Thomson Reuters, Bloomberg and Financial Times, the official reference as well as ECB website. For a better understanding of their impacts and benefits, relevant analysis and report by other financial were referenced for Ipreo and project Mars. Regarding EDDI, we focused on gathering more information not simply based of the EDDI reports from ECB, but also public feedbacks received from the major market stakeholders, such as IHS Markit, ECSDA European Central Securities Depositories Association, and AFME Association for Financial Markets in Europe and ICMA International Capital Market Association. Besides these three initiatives, other market practices of issuing debt instruments on various DLT framework have been documented as well. For a more detailed overlook of these blockchain-based market exercises, information such as debt security types, size, precise DLT infrastructure such as different protocols, practical application areas were recorded in a consolidated list.

3.1.1 Current Initiatives

With the emergence of blockchain technology, machine learning, and artificial intelligence, market participants in the EU have explicitly urged for further harmonization of the issuance process and more efficient infrastructure set-up in the debt capital market. However, the low level of automation and digitalization in the miscellaneous pre-issuance process, increasing scrutiny of regulations and the lack of integrity as a single domestic market with different jurisdictions have contributed to the complexity and fragmentation of European debt market.

Urgently seeking for solutions to further improve the operational workflows of issuance process in a time and cost-saving manner, market participants and fintech companies accelerate shaking up the primary market with an increasing number of pilot projects, new platforms and other initiatives. The following examples include private initiatives such as Ipreo and project Mars, public consultation launched by the ECB and a list of new blockchain applications in the bond market. Current efforts can reveal how technology can elevate the functions of the existing ecosystem, roles of different stakeholders, and infrastructure and system set-up from pre-issuance to post trade phases.

Ipreo

Concerning the primary debt capital market, Ipreo offers some comprehensive solutions to support the main stakeholders such as issuers, sell-side (dealer banks) and buy-side (investors) during the pre-issuance stage. Such services can help them through the entire process in a highly digitalized manner and significantly alleviate the current communicational inefficiencies.

Regarding issuers, Ipreo's Issuer View provides them with direct access to the live order book during the deal execution to maintain the data consistency between issuers and underwriting banks. Consequently, this service can streamline the underwriters' workflows as banks can avoid sending issuers regular updated excel files for the order updates. With a comprehensive product suite MUNIS for municipal financial products, issuers can access to the real-time information of investors' orders and data, syndicates' orders and participations, subscription level, market data, deal analytics, consolidated reporting and prospectus. Besides, issuers can receive the bids from

underwriters electronically via the platform or through the traditional way as fax, phone or email.

For dealer banks, MUNIS enables the booking running of municipal bonds highly automated with instantaneous information flows among the account members. Fully automated syndication process can better handle structure and pricing. Meanwhile, book building and order entry through the electronic platform can eliminate the need for phone or ticket orders and further avoid human error.

For the investors, its essential software product "Investor Access" brings the investors and dealer banks together on a common electronic platform incorporating distribution and communication of deal terms, orders and allocations. It brings the investors a better image and experience on price discovery, deal benchmarking and execution. Furthermore, higher transparency in the process can significantly reduce the frustration of over-order in the current practice.

Embedded with the complex global financial and investor data, Ipreo has facilitated and improved the new issuance workflows for the key participants in the market. Until the end of 2018, more than 290 investors placed their orders, and more than 160 banks are using the Ipreo service around the world. The emergence of Ipreo development has powerfully demonstrated the willingness of engagement of the primary market participants. They are willing to test the new technology product and consider promoting a more efficient, harmonized, and integrated ecosystem for the future of the primary market.

Project Mars

Project Mars is a private sector initiative aiming at modernizing the process of corporate bonds issuance and streamlining the information exchange flows in the primary debt market (Bloomberg, 2019). The project will initially focus on the US investment-grade bond in 2018 (Bloomberg, 2019). However, the detailed set-up or plans of the project is still fuzzy in public.

Project Mars was initiated by a consortium of three US bulge bracket banks and had a similar service offering from its rival platform - Ipreo. However, Ipreo has difficulty to enter into the US market compared to its success in Europe. According to IFR International Financing Review (2018), the reason can be firstly explained by the fact that major US players are concerned about the ownership of Ipreo and its

potential monopolistic market position as a single fixed income service vendor. Secondly, it is due to the different dynamics in the US primary debt market. According to figure 3, Bloomberg investment-grade bond deal denomination breakdown updated till August 2019, the top five US underwriters arranged around 45% of the market shares versus 32% in EMEA. Remarkably, European markets have a more competitive environment linked to more significant number of dealers competing for clients.

Figure 3 League Tables of US and EMEA Investment Grade Corporate Bonds

Top 5 managers in the US	Market share (%)	Top 5 managers in EMEA	Market share (%)
JP Morgan	10.95%	BNP Paribas	7.63%
Bank of America Merrill Lynch	10.10%	Barclays	6.75%
Citi	9.64%	HSBC	6.40%
Morgan Stanley	7.24%	Societe Generale	6.01%
Goldman Sachs	6.64%	Banco Santander	4.87%
Total	**44.57%**	Total	**31.67%**

Source: Bloomberg, August 2019

European Distribution of Debt Instruments (EDDI) Initiative

In May 2019, ECB launched a consultation regarding EDDI imitative with the major participants in the primary debt market such as dealer banks, issuers, investors, custodians, CSDs and other relevant stakeholders. EDDI intends to resolve the existing inefficiencies in the primary European market such as reliance on traditional communicational method and streamline workflows of issuance process from pre-issuance to post-trade stage. Inherently, it aims at creating a pan-European issuance mechanism to promote a single domestic market for euro debt instruments distribution and harmonizing the currently fragmented market structure. However, EDDI will only go ahead if positive feedbacks are received.

According to ECB (2019), EDDI would focus on the entire debt issuance process. In the pre-issuance stage, EDDI offers a standardized toolkit that covers the creation of order book, collection of orders from investors, debt allocations and supports communications for information transmissions. In the post-trade phase, EDDI would facilitate issuers (CSDs) to issue debt securities to all national markets on an equal basis and develop a new structure within the existing real-time gross settlement services T2S Target2 Securities.

Based on publicly available feedbacks received from IHS Markit and associations as ECSDA, AFME and ICMA, market participants provided various views and feedbacks on the initiative. Most participants argue that EDDI may have an adverse effect on pre-issuance as the current process is functioning well and adding an additional layer in the process may lead to a lengthier process and additional costs. Also, they concerned and questioned further clarifications and more empirical evidence on substantialized and quantified market demand, future governance framework, the optionality of adoption, neutrality of the initiative, the precise cost of the layer, other or new advantages compared to the private initiatives (i.e. Ipreo and project Mars). Moreover, participants mentioned that EDDI offers less added-value compared to Ipreo and project Mars and focuses on a narrower scope.

In the view of the fact that it is only focused on the Euro-denominated debt securities, many issuers in the Euro zone also issue in US dollars or other international currencies. In Figure 4, an overview regarding Euro denominated debt securities gross issuance by 19 Eurozone countries residents is showed. For this reason, some consultation participants argued that main beneficiaries will be the European supranational and intergovernmental issuers. Comparing to EDDI, participants agreed that Project Mars offers more added value to wider extent of the market, which is a global and multi-product venture (AFME & ICMA, 2019). Therefore, ECSDA has encouraged for multi-currency solutions as the ongoing implementation of Central Securities Depository Regulation CSDR could set another barrier for a CSD without banking licence to provide multi-currency settlement services. Despite the questions and concerns raised from the participants, EDDI consultation has provided us with a more comprehensive and practical outlook of the European primary market today.

Figure 4 Euro Denominated Debt Securities Issuance in the Eurozone

Year	Gross issues of debt securities	Gross issues of Euro denominated debt securities	Gross issues of Euro denominated debt securities (%)
2008	14327766,97	13454141,67	94%
2009	13540687,42	12592047,99	93%
2010	12120071,31	10873258,26	90%
2011	12019249,08	10837349,24	90%
2012	11506698,29	10173839,27	88%
2013	8768611,32	7214090,343	82%

2014	7624407,806	6088658,876	80%
2015	6755067,529	4910113,739	73%
2016	6822197,485	4834616,819	71%
2017	7366884,556	5087685,383	69%
2018	7396288,187	5015829,33	68%
2019YTD	3496653,882	2372527,528	68%

Source: SEC Securities and ECB Statistical Data Warehouse, from Jan. 2008 to Jun. 2019
Unit: Million EUR

3.1.2 Other Initiatives to Issue Bonds on Different DLT Framework

Nowadays, there are more pilot projects initiated in order to test or to experiment the performance of blockchain technology in combination with traditional financing process. Table 8 has consolidated a list of successful completion of the pilot projects and market practices with publically available information. Furthermore, a large number of participants such as market makers, IT service providers, deal councils (legal advisors), lead managers, issuers and investors are currently involved in these exercises in order to promote the applications to a larger scale in the future.

Table 8 New Blockchain Applications in the Debt Market

Date	Participants	Debt Securities Type and Size	Description
Sept 19	Banco Santander	Bond, USD 20 mm	Using public Ethereum blockchain, Banco Santander issued its first end-to-end blockchain bond with tokenized cash (ERC-20) for the settlement. In another word, the entire lifecycle from issuance to maturity only takes place on the blockchain.
Jul 19	YES Bank, Vedanta Limited, MonetaGo	Commercial Paper(CP), INR 100 Crores (Approx. EUR 12.6mm)	First CP digitally issued in Asia. Focused on CP issuance and redemption, blockchain based solutions provide immutable digital records of the entire transaction documents, real-time visibility of the process and common network for all involved participants.
Jun 19	EIB, Euroclear, Banco Santander & EY	European Commercial Paper (ECP)	End-to-end blockchain solutions from issuance to settlement. One consolidated hub for issuing ECP with Delivery versus payment (DVP) by Euroclear will significantly reduce bilateral processing time between market participants. Full transparency and traceability of ECP issuance related activities can reduce time and

			operational cost, also makes the ECP same day issuance possible.
May 19	Finledger, Deka bank, DWP bank, DZ bank & Helaba	Schuldscheindarlehen (German Promissory Note Loans)	Issuance of Schuldscheindarlehen by Deka bank. Using Ethereum blockchain provided by Finledger, a base point standard for the digital settlement processing of financial instrument was established. Processing including business confirmation, document creation, certificate changes, assignments as well as loan cancellations can be executed fully digitally in the ledger.
Feb 19	Commerzbank, Continental, Siemens, GSK Stockmann	Euro-denominated Electronic CP, EUR100,000	Transaction of money market security with a term of three days was initiated and settled directly between Siemens and Continental in the Corda-based blockchain platform provided by Commerzbank. The transaction was adviced legally by GSK Stockmann.
Feb 19	BBVA, MAPFRE	Structured Green bond, EUR 35 mm	Blockchain technology was used for negotiation of terms and conditions for bond issuance. Structured bond as a negotiable asset, the blockchain-based platform provides flexibility to the clients in terms of bond design that suits their needs and streamlined the negotiation time-frame. Documentation creation and deal structure and prices negotiation took place in the same ledger.
Oct. 18	OeKB	Austrian Government Bond	Blockchain technology for data notarization of reports in Austrian government bond auctions. A unique hash is derived from the document encryption and the hash is clearly assignable to the original documents but any conclusions to specific data content are not allowed. Further level of data authenticity and security can be guaranteed.

Aug 18	World bank, Commonwealth bank of Australia (CBA), TD Securities, IHS Markit, Microsoft and King& Wood	Bond-I (blockchain Operated New Debt Instrument), AUD 110 mm	The world's first bond (two-year term) to be created, allocated, transferred and managed by using DLT.
Apr 18	National bank of Canada (NBC), J.P. Morgan	Yankee Certificate of Deposit, USD 150mm	Simulation of issuance by using blockchain technology. The blockchain based debt issuance application is designed to mirror the entire issuance process and transactions, starting from origination till clearing and settlements. The issuance application runs on an open sourced variant of Ethereum named Quorum.
Feb 18	Telefonica Deutschland, LBBW& DZ Bank	Schuldschein (German Promissory Note Loan), EUR 250mm	The Schuldschein issuance was marketed by LBBW and DZ Bank. The announcement was made through traditional placement and an exclusive blockchain based tranche offered by LBBW. In the end, the tranche was three times oversubscribed with a large number of investors linked to the blockchain.
Nov 17	Nivaura	Cryptocurrency-Denominated Bond Issuance	The world's first fully automated cryptocurrency-denominated bond issuance process carried out by using a public blockchain infrastructure. Nivaura includes the cloud-based service for issuance and administration of legally enforceable financial instruments. Governance is guaranteed by the legal mark-up language (LML) component since it enables the conversion of standard legal contracts into machine-readable format to active the automated formation, performance and enforcement of the financial instruments.
Sep 17	Commerzbank, KfW, MEAG, asset manager of Munich Re and ERGO	Euro Commercial Paper (ECP), EUR 100,000	ECP was issued by KfW. Key transaction elements of ECP issuance and settlement were simulated and replicated by using a blockchain technology, the R3-Corda platform. Data structure and smart contracts focused on automating processing of transactions were built in the

			blockchain. It leads to reduced intermediaries and immediate posting.
Jun 17	LBBW & Daimler	Coporate Schuldschein (Loan Agreement), EUR 100mm	Entire transaction starting from origination, distribution, allocation, execution to the confirmation of interest payment and repayment is executed by using blockchain technology. Meanwhile, all the processes were in parallel with the compulsory process required by regulatory authorities.
Jan 17	Commonwealth bank & Queensland Treasury Corporation (QTC)	Government Bond	First government bond was created in digital form by using smart contracts. The cryptobond was issued for QTC in a private permissioned blockchain platform for the end-to-end issuance process. Via the blockchain platform, QTC was able to generate bond tender, view investor bids in real-time, finalise allocation and settle with investors instantly. In addition, coupon and interest payments were automated when due thanks to smart contracts.

Source: ICMA International Capital Market Association, Crowdfund Insider

From the list of blockchain applications in primary bond market, we observed that most of the market exercises used either Ethereum or R3 Corda to build up the digitalized blockchain platform. Different from Ethereum, R3 Corda is a distributed platform of permissioned private blockchain, specifically used for financial services transactions (Sandner & Valenta, 2017). Providing more refined consensus, there are two types of consensus are involved in determining if a transaction is a valid ledger update in Corda: validity consensus and uniqueness consensus. The first one is checked by required transaction signatures and the second consensus is checked by notary service. Additionally, Corda also takes the regulatory and legal aspect into account since its smart contracts coded with legal prose (Sandner & Valenta, 2017). However, it is debatable whether Corda is a blockchain. Experts have pointed out that Corda is technically rather a distributed ledger technology than blockchain as Corda confirms each transaction in real-time instead of storing transaction information into a block and confirming them in one go.

3.2 Expert Surveys and Interviews

Before initiating the design of our surveys, the aims of this survey need to be defined in order to drive the design and help questions selections to be more relevant, precise and efficient (Burgess, 2001). Therefore, we have identified three research goals for the design. Firstly, we would like to understand detailed inefficiencies linked to the bond issuance process and workflows of participants in different roles. Secondly, we desire to study market participants' perception of technology. Thirdly, we want to receive their views regarding potential technology impact on both the issuance process and their roles. In principle, all the questions were designed with a focus on these three research goals in order to further estimate the future potential impact of blockchain technology on European bond market.

3.2.1 Criteria of Selection and Interviewees Profiles

In fact, most of the people involved in the debt capital market may not be familiar with blockchain technology or its related function such as tokenization, smart contracts, and protocol types. Therefore, it would be difficult for them to form their visions of specific technology topic, such as potential blockchain usage in the primary business. In this research, we would like to generate a more complex and practical view regarding current workflows and process inefficiencies and how market participants perceive general technology/blockchain technology. Thereby, the sample of survey participants is selected in a more general nature to drive the results more real-business related.

In the sample of participants, we have selected twenty market participants who are currently engaged in a different stage of the primary issuance process. Regarding their profiles, our survey sample covers participants in both pre-issuance and post-trade process, including issuers, traders (e.g. syndicates), salespersons, legal advisors and middle office/back-office officers from different European financial institutions.

3.2.2 Survey Methodology

A mixed design using web-based expert surveys, traditional mail surveys and paper-and-pencil surveys was chosen to further emphasis the current inefficiencies and participants' perception of technology development in the primary market. The web-based expert survey methodology differs from the traditional mail surveys since the answers can be directly downloaded into the data matrix without the need for coding

procedures or data entering (Dahlberg, 2007). However, it has also been empirically proven that paper-and-pencil surveys should also be served as an alternative as they can yield a higher response rate compared to online surveys (Dahlberg, 2007). Thus, it is essential to identify the experts and establish a connection with them via emails or phone calls (Dahlberg, 2007). Eventually, we decided to design our surveys using the mixed survey methodologies. In our surveys, more than twenty participants from several financial institutions were contacted by us to answer the survey questions in various ways.

3.2.3 Questions Design

Our questions were designed in a more general but less technical perspective since that not all the participants are familiar with the latest technology trends. Our questions were designed in a clear and concise way which would be beneficiary for us to get the best responses (Burgess, 2001).

Ten questions were designed with a focus on three categories. There are three questions related to the pre-issuance topic, three questions related to the post-trade subject and four general topic related questions regarding participants' profiles, individual role impact and their expectation of changes. The survey sample and individual responses can be seen in appendix 1.

Meanwhile, different questions categories have been taken under consideration for the survey design. We have mainly chosen open questions and questions with rated responses regarding three hypotheses. Regarding open questions, it is useful for us to understand the precise judgements of each survey participants (Burgess, 2001). We have also chosen question type with rated responses since it enables a better evaluation such as calculating an average of possibility or likelihood. We have mainly used the questions with the rated response to justify our three hypotheses:

H1: In the pre-issuance process, it is essential to have a standardized common platform to improve documentation workflow.
H2: In the post-trade process, blockchain adoption will result in substantial reduction of intermediaries' roles in a decade from now.
H3: In general, we see a high likelihood that the blockchain solutions will be immersed in the entire bond issuance process in the next ten years.

With such a structured question category, participants can have a clearer vision of the questions and dynamic experiences when filling in the survey.

3.2.4 Data Collection and Analysis

In order to achieve a high response rate to the survey, we provided three different methods for the inviters to fill in the survey: online survey, word file in the email attachment or personal interview. In total, we have invited 40 professionals who are involved in the bond issuance life-cycle to participate in our survey. For the survey distribution, we have used our networks during our internships in different financial institutions and connections on LinkedIn to approach these potential candidates mainly from the banking sector.

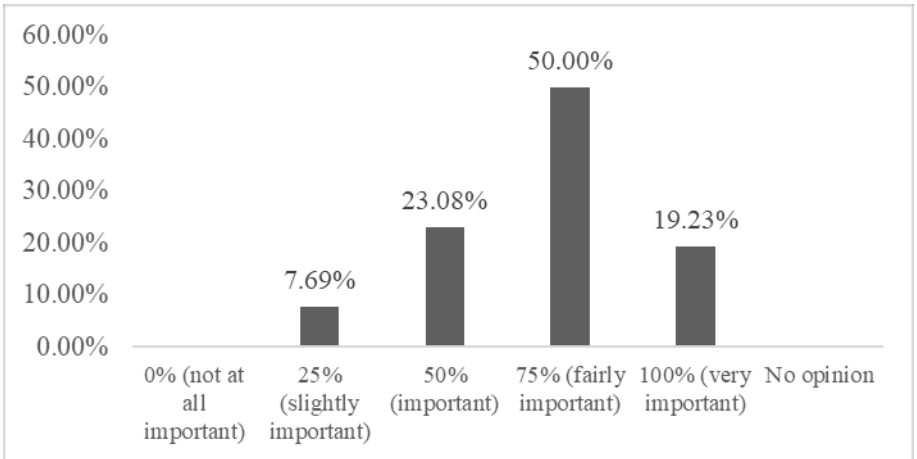
Eventually, we have collected 26 responses from August till September 2019 in order to further analyse the technology impact on the bond issuance process and workflows of the participants. With an average completion rate of 85%, participants spent 16 minutes on average to fill in our survey.

The following data analysis is divided into three sections based on our question categories: pre-issuance section, post-trade section and general questions section.

Pre-issuance Section

In order to testify our first hypothesis regarding the importance of creating a market-wise common platform to improve documentation workflow, we have first assessed the causes of lack of digitalization and automation and then the possible inefficiencies regarding information flow in the pre-issuance process. Our survey results are shown in figure 5, half of the participants (50%) consider such a common platform is fairly important to improve the workflow, but still there are remaining 7.69% of participants consider this effort is just slightly essential.

Figure 5 Importance of a Standardized Platform to Improve Documentation Workflow in the Pre-issuance Process



By applying weighted arithmetic mean,

$$\bar{X}_w = \frac{\sum wx}{\sum w}$$

The weighted average of importance is equal to 70.19% (in Appendix 2). Such a significant figure further illustrated that market participants believe in the added-value created by implementing new technology in order to automate information distribution. Meanwhile, participants have commonly agreed that there is a lack of digitalization and automation in the bond issuance process. A Green bond specialist stated in our survey, *"Relevant documents such as prospectus, term-sheet, green bond framework, as well as second party opinion are all sent via email, which causes difficulty to keep track of documents and leads to extensive email traffic."*

Several reasons for this situation were mentioned. Firstly, there is a lack of resource, knowledge and outdated IT set-up to adopt new technologies. Secondly, there has been a lack of technology immerse for decades, and DCM as a traditional field of investment banking still stands in a priority position and does not feel external pressure for innovation. Thirdly, preparation of deal still involves many human interventions by issuers and arranging banks. Meanwhile, potential investment factor and criteria cannot be simply auto-handled by the machine, which can justify why there are a small proportion of participants (10%) consider the importance of such a platform is just slightly important. In short, some human interaction and procedures have intrinsic value-add to the transaction that cannot be simply replaced by technology, as quoted from directly our expert survey result:

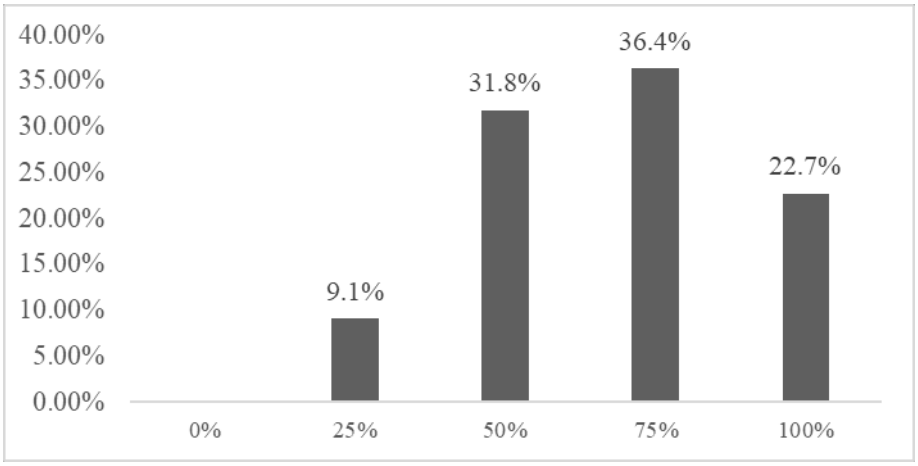
"For green bonds, the analysis of the investor base is crucial. There is currently no system in place that lets banks or issuers differentiate the ESG criteria of an investor. This process needs to be looked at in terms of technical innovation"

Regarding current inefficiencies, they have frequently mentioned manual workflow and data consolidation, which drives the process inefficient. However, with the appearance of the market initiative such as IPREO, participants could foresee how technology innovation could impact their future workflow and should not underestimate its potentials. It explains the fact that more than half of the participants (55%) agreed on the fairly importance of improving documentation. However, the bond issuance process is still functioning well the way as it is today.

Post-trade Section

For testifying our second hypothesis regarding the probability of the substantially reducing functions of intermediaries in a decade, we have analysed the current inefficiencies and risks in the clearing and settlement cycle, as well as participants' views regarding current market infrastructure (i.e. T2S).

Figure 6 Probability of Substantial Intermediaries' Function Reduction



We have calculated that the weighted average of probability from figure 6 is equal to 68.18% (in Appendix 2), which can be justified by our survey responses. Participants pointed out that the post-trade remains complex and is lack of automation, especially for corporate actions. Also, clearing and settlement cycle varies for different security type. The lengthy process could result in counterparty risk and process inefficiency. However, 22.7% of participants considered the 100% likelihood, which shows that the complete disintermediation will not be possible in

such a relatively short timeframe, as the legislative, fiscal and tax systems remain highly complex and different under different jurisdictions within the EU. Besides, on-going implemented regulation such as central securities depository regulation could add an additional barrier for the cross-border transactions.

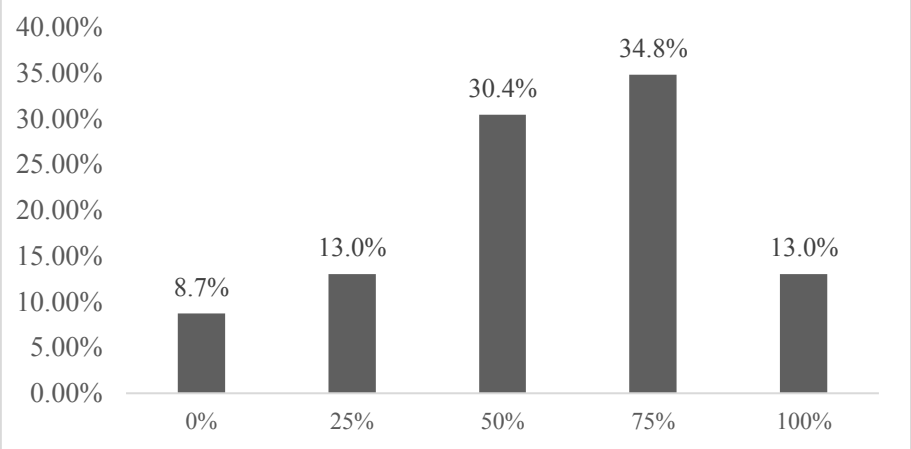
General Questions Section

To testify the third hypothesis concerning a high likelihood that blockchain solutions will be immersed in the entire bond issuance process in a decade, we have reviewed participants' overview regarding current technology initiatives in the market, their professional profiles, as well as their estimations regarding how technology could impact their potential roles.

Table 9 Type of Survey Participants

Institution Type	Number of Participants	Percentage
Private	17	65.38%
Other	6	23.08%
Public	3	11.54%

Figure 7 Likelihood of Bond Issuance on Blockchain in a Decade



According to the survey participation, most of the participants are syndicates, bond specialist, originators, salespersons and middle office officers. As shown in table 9, 65.38% of them are working in the private financial institutions and their detailed professional profiles are embedded in appendix 3. Based on their responses, they expect the new technology could promote standardization and automation in this area. Thus, they believe that new players will gradually step in to drive the market more efficient and cost-saving. In figure 7, with a weighted average likelihood of

57.61% (in Appendix 2), most of the participants are highly optimistic about how blockchain solutions will reshape the traditional banking field. To explain the relatively humble results, our survey participants stated the fact that

"10 years is not a long timeframe. If there is no major initiative from regulators and the C-level to change their way, people will just keep doing how they use to. It will be a gradual change unless a major initiative is undertaken across the whole sector."

4 Results and Discussions

4.1 Existing Inefficiencies in the Debt Capital Market

In chapter 2.1, we illustrated the process of a single traditional bond issuance process, where lengthy meetings, multifarious documentations, manual administration, and time-consuming communication are involved.

Still, there are a number of challenges and inefficiencies with this traditional bond issuance process that might be addressed by future innovation. Here in this chapter, we further discuss the inefficiencies combing our expert survey results focusing on the European bond overall lifecycle in both pre-issuance and post-trade processes.

4.1.1 Inefficiencies in Pre-issuance Process

Pre-issuance includes the preparation of issuance, choosing the modalities of the price discovery mechanism (syndication, auctioning, or private placement) and striving agreements between the issuer and investor on the economic terms of the securities.

From the Standpoints of Dealer Banks

In the responses regarding pre-issuance workflow, a majority of respondents from dealer bank origination indicated that the manual-intensive work is one of the main causes for inefficiency: "*there is no or quite no digitalization in pitching phase and contract phase*", "*manual effort in preparing pitching docs and contract, preparing signing*", and specifically, an experienced KYC officer pointed out that the pre-issuance phase contains "*manual effort in documentation preparation and verification, plus it is lack of harmonisation and time-consuming*."

Particularly in the underwriting process, there is a lot of back and forth discussion that occurs between the lead manager, issuer, syndicate, and investors as the latter seek to understand the deal structure, credit quality, and industry dynamics. The communication usually happens via i) email and ii) Bloomberg chat, which means there is no one data room to store documents and hard to keep track of information flow in the future. As a specialist in the green bond origination space pointing out:

"*Relevant documents (prospectus; term sheet, green bond framework; green bond second party opinion) are sent via email. This makes it difficult to keep track of documents and results in extensive email traffic.*"

Furthermore, the lack of standardised information storage practice also leads to reconciliation inefficiency. Particularly in book-running process, salesperson negotiating in private conversation with prospective investors, investors submitting bids via fax/email/telephone, trading desk accumulating bids in spreadsheet, and information sharing with investors via separate digital channels are resulting in multiple versions of truth. Since each participant maintains their own version of record, a time-consuming reconciliation process between participating systems will need to be continuously executed to keep everyone in the same status quo (Capgemini consulting, 2016).

From the Standpoints of Investors

The single source of truth is of paramount importance when multiple participants and regulators are involved for the securities issuance process with data referencing being a major pain point. In current practice, multiple identifier systems are in use and the process of obtaining security identifiers slow down the speed for trading in the secondary market to some extent. For instance, while a substantial amount of securities worldwide is assigned with an ISIN number, the most commonly used identifier for stocks and bonds in the US and Canada is CUSIP, and in the UK SEDOL is more recognizable.

Another inefficiency in the information flow is reflected by the fact that the distribution of deal terms to investors requires human intervention and the process is not always optimal. For one thing, bank syndicates determine which sales people to send deal terms to and those sales people determine which investors to send to, resulting in that some investors may not see deals that they might be interested in.

For another, sales people typically distribute deal terms to rather static distribution lists, which can be a laborious process for sales people who are progressively focused on providing value or insights to the buyside in a resource-constrained environment (IHS Markit, 2019).

Therefore, from an investor's point of view, it would be appreciated to have a platform with access to all relevant information. This issue at stake is further stressed by an experienced individual of market participant from a dealer bank syndicate team:

"…the amount of information needed varies also. Frequent and well-rated issuers are well-known and investment decisions by investors depend also on the overall market backdrop whereas bond issues from non-frequent and/or high yield issuers need to provide a lot more information in the run up to a bond issue. The lower the rating scale the more deal specific information are needed."

From the Standpoints of Issuers

From the results of our expert surveys, a couple of potential future improvements in the pre-issuance process, which would be beneficial to issuers, are brought into the picture.

On one hand, *"current practice will contribute to a good relationship between issuers and banks likewise investors and banks as well as a direct feedback (including nuances in answers / tones) due to personal contact*" - according to a data specialist. On the other hand, it is pointed out by a public issuer's quantitative analyst that the unbalance flow of knowledge results in the situation that *"information about investors is often of poor quality"*, along with the yet-to-be developed *"investor identification and classification"* system.

Another notifiable inefficiency revealed by a funding officer from the public issuer's side is described as the following:

"When preparing syndicated issuance, the potential bank contacts are limited. It depends on other factors like how many need to be contacted and how these are selected, but in public institutions this more linked to internal policy (need to justify the choice) than anything else. Inefficiencies are more linked to this "political" angle, which cannot be avoided in my view."

From the Standpoints of Overall EU DCM

On a higher-level view over the European debt capital markets, inefficiencies are also incurred from the fragmentation of existing EU distribution ecosystem. In the current debt distribution practice in euro-system, there is no pan-European issuance platform like other major currency areas, e.g. US, Japan or China where truly domestic issuance distribution channels exist (EDDI consultations, 2019). Various networks in EU are based on a hierarchical model and maintain a privilege for the initial issuance location, which may compromise the level playing field and hence impact on the equal access to the European debt securities by investors. Many market participants only use national structures and solutions, limiting the efficiency with which capital is distributed and transferred across Europe.

Moreover, the lack of standardise EU tax and securities law, different levels of disclosure requirements, and multiplicity of non-interoperable issuance platforms and proprietary procedures with a very low level of automation and digitalisations are posing challenges to a harmonized European DCM market (AFME, 2019; ICMA, 2018).

The following pieces of evidence, though not in themselves conclusive, are together indicative of the home bias and limited efficiency of the debt securities market in the EU:

- According to TARGET2-Securities 2018 Annual Report, in 2018, the daily average volume and value of intra-CSD transactions represented around 99% of all transactions in T2S. Respectively, the daily average volume and value of cross-border transactions shown in figure 9 represented by cross-CSD settlement only factor about 1% of all settlement values.
- ECB's 2018 Financial Integration Report reveals empirical observation on the home bias, which means that investors tend to hold a significantly higher amount of domestic assets than foreign assets. As directly intercepted from the report, a bond issued by a euro area non-financial corporations (NFC) is about 1.7 times more likely to be held by domestic than by other euro area investors.

  From an issuer perspective, home bias may upsurge the costs of corporate bond issuance. While the well-diversified source of financing with stable and predictable cost represents an excellent opportunity for both issuers and investors,

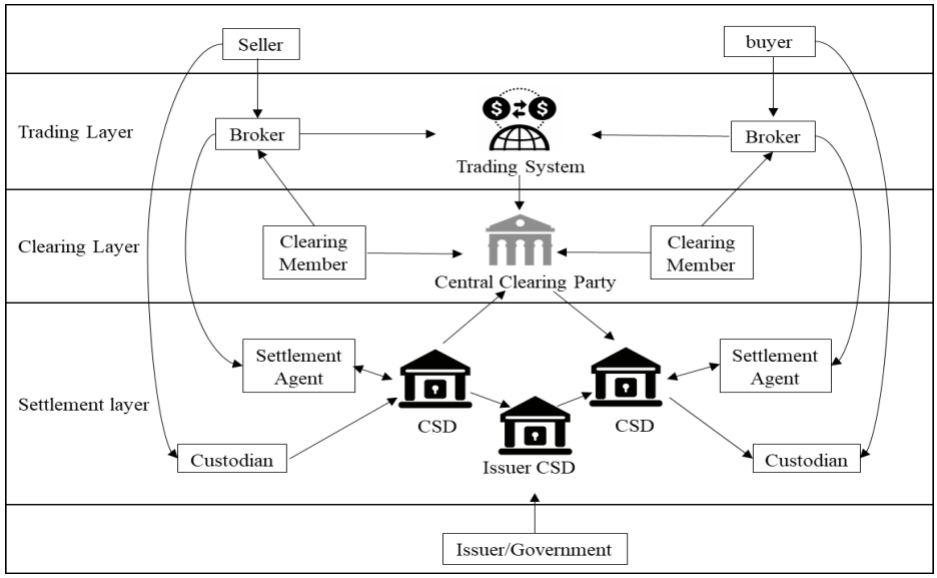
the term "home bias" implies that issuers might face additional barriers to place bonds outside their domestic country. As a result, they would need to bear additional costs if domestic conditions determining the pricing of their bonds were less favourable than those prevailing in international markets (Lau, S.T., Ng, L. & Zhang, B., 2010). In addition, home bias might make it harder for corporate bond markets to act as diversification of investments if domestic banking stress is accompanied by wider stress in domestic markets (ECB, 2018).

4.1.2 Inefficiencies in the Post-trade Landscape

Post-trade processes take place after the pre-issuance stage and comprise the actual issuance of the debt securities in central securities depositories (CSDs) and their delivery to investors through global or local custodians, agent banks and other intermediaries each representing different issuers or investors through multiple distribution channels. As an integral part of the financial industry value chain, post-trade services involves crediting the proceeds of the issuance of financial instruments to the issuer's account upon related post-trade services have come into play, and executing trading counterparties' agreement to buy or sell, resulting in a change of ownership.

The current post-trade landscape involving multiple financial intermediaries can be generally divided into three layers: trading layer, clearing layer, and settlement layer, as shown in figure 8 below.

Figure 8 Three Layers in the Post-trade Landscape



Source: Pinna & Ruttenberg (2016), Distributed Ledger Technologies in Securities Post-trading

In the current post-trade landscape, market inefficiencies arise from several perspectives.

First, financial intermediaries keep multiple separated records of the same information and the fact that they have to update their own accounts every time a new transaction occurs create a redundant workflow and additional risks. The lack of interoperability between centralised database systems restricts straight-through processing for a range of non-vertically integrated financial institutions across the three layers. In addition to widening the settlement cycle and increasing the cost of back-office procedures, the need to reconcile information kept in different intermediaries creates certain risks, such as failures in settlement chains (e.g. delayed settlement of one transaction may disturb the settlement of trades with third parties), human errors (as the system sometimes being reconciled manually), and limited collateral fluidity (Pinna & Ruttenberg, 2016).

Second, the payment chain of throughout the bond's lifecycle is rather complicated and costly. Specifically, principal and interest payments of the bonds are made by the issuer through a paying agent, typically a large international bank. When paying bondholders, the issuer pays the paying agent who makes forward payment through the clearing systems, where it flows down to the final beneficial owner. Consequently, payments will have to go from the issuer to the paying agent to the clearing systems and then possibly to one or more custodians before it eventually arrives at the person entitled to it. Some market participants also choose a trustee to represent the bondholders and protect their interests.

Third, from the perspective of legal workflow, the documentation process of a traditional bond issue is relatively complex and cost-inefficient. The terms of the global certificate clarifies that while the nominee holds legal title, the account holders in the clearing systems hold the beneficial title. The split between legal and beneficial title to the bonds is realized by entering the name of a nominee into the register, evinced by the issue of a global certificate, which characterizes the entire issuance. The documents also make full provision for the issue of definitive certificates which would be issued to individual investors in certain situations, including if the clearing systems ceased to function. This would involve entering each accountholder into the register. The association between the issuer and the registrar, and the issuer and the paying agent, also needs to be contracted and documented. For capital markets

practitioners, this is standard procedures, but for an issuer that has never issued a bond before and wants to understand and access the market, it can be a time consuming and costly process (Cohen, Smith, Arulchandran & Sehra, 2018).

On a higher-level point of view, the current infrastructures do not upkeep full financial integration and the EU-wide risk sharing of a single capital market. Currently, there is no option available in Europe that allows issuers to reach their European investors in a neutral (without national bias) and standardized way. Instead, issuers and investors rely on a network of connections between different national CSDs or on international CSDs, and on the services, tools and procedures provided by large custodian and dealer banks. Over and above the potential risks and costs associated with a variety of connections and standards, the securities issued always reflect a specific national bias, and thus they are not truly "European". Even though this model functions well for national issuance, it is sub-optimal when seen from an all-embracing European perspective.

Regarding most significant inefficiencies in clearing and settlement, according to ECSDA's response to EDDI consultation, arise from cross-border legal and fiscal hurdles, resulting from a lack of harmonization of European fiscal, securities, and corporate legislation.

4.2 Current Conventional Solutions under Development

4.2.1 Solutions for the Pre-issuance Process

To forester standardization and harmonization in the pre-issuance process, various initiatives have been exploring solutions to stress the inefficiencies and fragmentation in the current European environment.

IHS Markit Products

IHS Markit, a global information provider that acquired Ipreo in 2018, provides a set of services to debt capital markets worldwide, especially in the pre-issuance space that offers a substantial benefit to market participants in terms of standardization and harmonization.

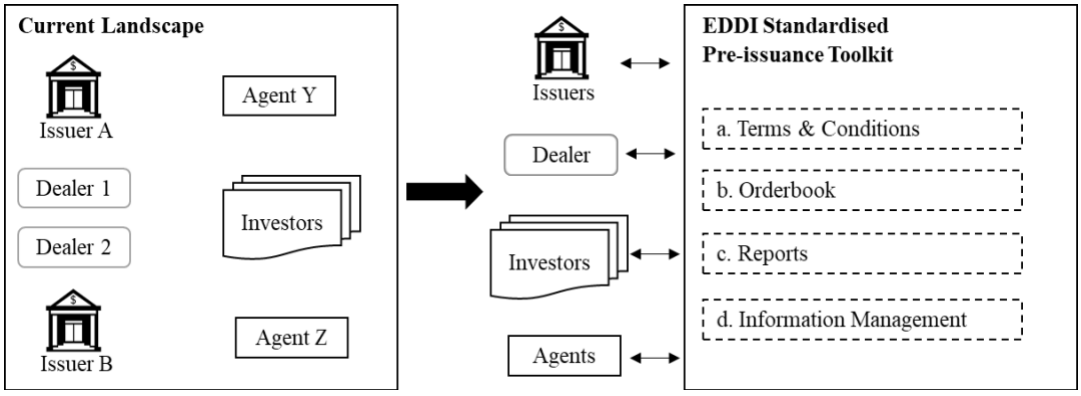
Its IssueBook and IssueNet products provides a pre-issuance platform that enables banks to price deals faster, removes risk from the pre-issuance process and has also implemented many innovations that have benefitted the industry such as unified book

building and standard deal terms. IHS Markit's IssueLauch solutions also contribute to the harmonization by developing a set of mandatory deal terms in consultation with banks and investors and using embedded logic to certify that deal terms reach the correct investors and critical sales team resources are optimized. This has been adopted by the market and is so far used on 95% of Euro denominated investment grade deals (IHS Markit, 2019). IHS Markit products are serving more than 180 banks worldwide and have promoted the adoption of standards that have created greater homogeneity across the global market.

EDDI Standardised Toolkit

As described in chapter 3.1.1, ECB brings out EDDI with the aim of developing a centralized and standardized service for EU issuers and market infrastructures in order to facilitate the issuance and distribution of euro-denominated debt securities in Europe. To address some of the inefficiencies we discussed in the pre-issuance process, EDDI is exploring the possibility of developing a standardized technical toolkit, which grants main players such as dealer banks, investors and agents efficient access to the platform and use the same database, thereby enabling them to manage and share debt issue-related information efficiently and in real-time (Figure 9).

Figure 9 EDDI Standardized Toolkit for Pre-issuance



Source: ECB (2019), European Distributed of Debt Instrument (EDDI) Initiative

Specifically, the technical toolkit will be available for issuers (or their issuer agents and/or dealer banks upon authorization) offering them functionalities which support the definition and communication of an upcoming debt issue, the creation of the order book, the collection of orders from investors and the allocation of the debt instrument issuance to these orders (EDDI Consultation, 2019)

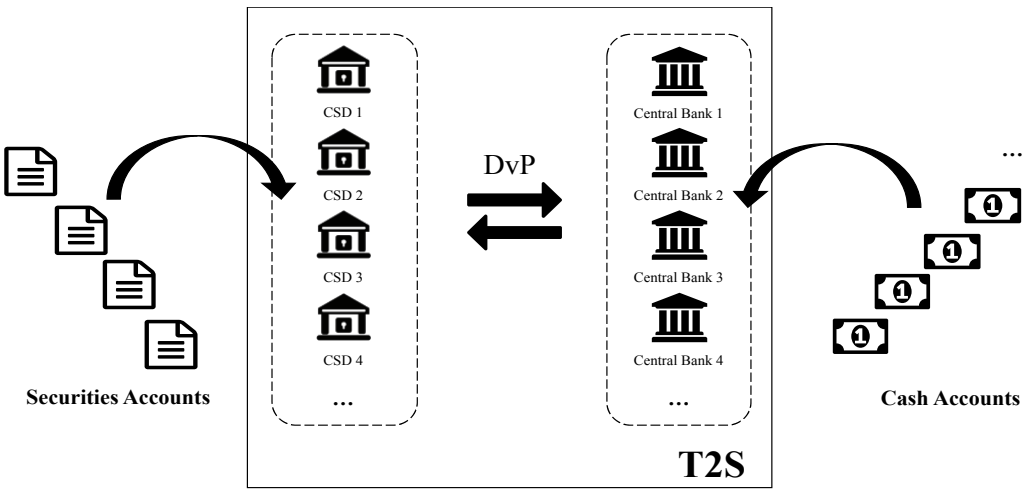
4.2.2 Solutions for the Post-trade Process

In the efforts of promoting an integrated European post-trade landscape, harmonization in infrastructures and regulations have taken place in the past decades. Among others, the T2S platform and CSDR are in the process of adoption by market participants and are expected to lay a solid foundation for future market integration and technology innovation.

Target2-Securities (T2S) Settlement Platform

Launched in June 2015, T2S has been a revolutionized platform aimed to offer a safe and simultaneous settlement to pan-Europe securities markets and facilitate the integration of previously fragmented settlement infrastructures. In general, it tackles the complexity of cross-border settlement procedures by implementing harmonized rules and practices, reduces settlement risk by using central bank money for transactions, fastens settlement process by pooling collaterals and liquidities from different jurisdictions, and improve the post-trade level playing field by breaking the home bias structure set-up. In addition, T2S also offers a set of sophisticated technical features, including optimization algorithms to enhance settlement efficiency and advanced auto-collateralization mechanisms. Currently, 21 CSDs from 20 European countries are onboard the T2S platform, through which around 600,000 securities transactions are processed every day (ECB T2S annual report, 2019).

Figure 10 T2S Delivery versus Payment (DvP) Basis



Source: Own creation

In order to settle transaction via T2S platform, a market participant needs to hold a security account with one of the participant CSDs and a committed cash account with one of the central banks onboard to the platform. These accounts sit alongside on T2S and are matched when the instructions from the CSD and the central bank come in. T2S then settles the transaction on a delivery-versus-payment (DvP) basis using central bank money, which means the cash and securities change hands simultaneously. As a result, not only investors from the same CSD can realize instant settlement, but also investors account from different CSDs and jurisdictions can also achieve settlement on the same efficiency. Currencies other than Euros can also be used for settlement as long as the concerned central bank add it to their brackets.

T2S is a critical infrastructure, which enables a more integrated and efficient European securities market and affects not only the payment and settlement layers but also the clearing and trading layers. T2S alone removes six out of the 15 barriers to cross-border clearing and settlement identified in the Giovannini reports of 2001-03 (ETPF report, 2019). T2S is now a predominant platform and is expected to cover a total of 21 European countries and settle almost 100% of securities transactions in euro central bank money.

CSD Regulation (CSDR)

The CSDR is the newest major piece of EU infrastructure legislation launched in 2014 with the purpose to improve the securities settlement process in Europe and introduces a common authorization, supervision and regulatory framework for CSDs. Alongside the EMIR Regulation, (MiFID I / MiFID II and MiFIR), the implementation of CSDR complements the regulatory framework for the transaction lifecycle.

The legislation applies the Principles for Financial Market Infrastructures (PFMI) standards to CSDs in a harmonized way across the EEA and facilitates competition. The CSDR also introduces a ‘settlement discipline’ regime intended to reduce settlement failures (EPTF Report, 2017). Moreover, the Code of Conduct for financial market infrastructures, signed by FESE, EACH, as well as ECSDA and representing an important step towards promoting transparency and competition into post-trade, was built upon further by the CSDR.

Although CSDR has not yet been fully developed and implemented, it has made some notable achievements in addressing market inefficiencies:

• *Long settlement time:* The CSDR has already had some effects, including adoption in all European markets of the T+2 timeline for the settlement of securities transactions. The dematerialization/immobilization of securities is promoted together with the usage of central bank money for settlement of securities transactions.

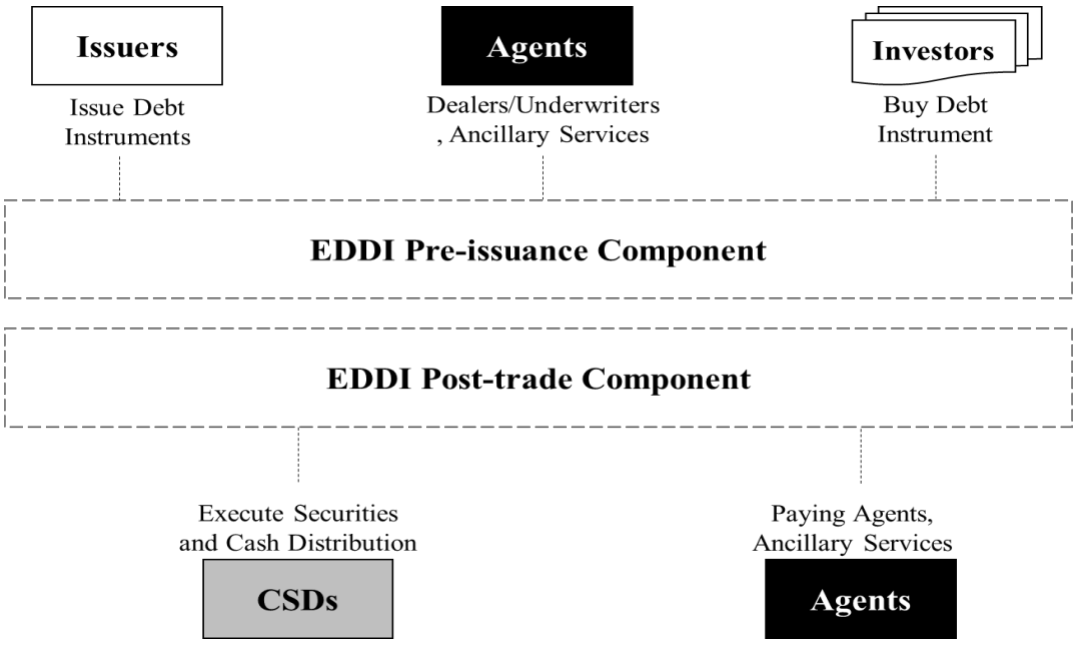
• *Interoperability of current platforms:* The optionality of degrees of account segregation at CSD level and the harmonization of finality rules (at three different stages of the settlement process) are also introduced.

• *Fragmentations in current structures:* CSDR addresses the existing fragmentation in the process of handling settlement fails in the EU by imposing mandatory buy-ins. Detailed rules on the buy-in process are in development.

EDDI End-to-end Channel

To improve the efficiency of the European primary debt securities' value chain, EDDI put forward a high-level blueprint for future development into a harmonized domestic EU market (figure 11).

Figure 11 EDDI End-to-end Channel



Source: ECB EDDI Consultation, 2019

Following the pre-issuance standardized toolkit, the post-trade component would receive final allocation directly from the pre-issuance component and perform an initial distribution function to end investors in close collaboration with CSDs connected to EDDI. This model is designed to support participants in the pre-issuance and initial distribution end-to-end process with standardized interactions and information flows. It is said to be possibly developed within the current framework of the TARGET Services "in order to achieve a high degree of synergies with existing market infrastructures" (ECB EDDI Consultation, 2019). However, concerns are expressed from market participants that the EDDI initiative will most likely introduce an additional redundant layer of operation and compliance, which, on the contrary further escalate market inefficiency.

4.3 Blockchain Technology Impact on Debt Issuance Process

Nowadays, bond issuance process in Europe remains paper-intensive, manual and lengthy due to involvement of various intermediaries. With increasing urgent demand on efficiency improvement and cost-saving during the capital-raising process, blockchain is considered as one of the advanced technology solution for the digital transformation. From origination till clearing and settlement, blockchain technology can not only transform the pre-issuance process but also save resources with reducing involvement of intermediaries in the post-trade phase through the entire issuance lifecycle. In this chapter, we would like to discuss what blockchain technology could offer beyond the current technology-driven conventional solutions in the financial market.

In general, the concept of using DLT in the bond issuance process could be applied most likely to the bonds issued and managed by government agencies, sovereign nations or international organizations. Within the ledger, central regulators can easily monitor the flows and activities via their "observation nodes" and ensure the process is in compliance with legal and regulatory requirements. In addition, the digital nature of blockchain offers immutable electronic audit trail plus enhances market access with the 24/7 available secured network.

4.3.1 Blockchain Bonds

Beginning with the Bond-I issued by the world bank to the recent increasing adoptions of blockchain technology in the debt securities issuance process, blockchain technology has demonstrated its massive potential to enhance the current

outlook. However, during our survey questions' design, we have realized that not all market participants are familiar with the technology trends. Thereby, it is hard for them to understand blockchain applications and formulate their own view. In this chapter, a complex description of bond issuance on blockchain will be provided, focusing on the definition, pre-conditions, considerations, potential design and each single step for the set-up.

Starting from creation, allocation, transferring to management, the entire lifecycle of blockchain bonds takes place on the distributed ledgers. In the light of blockchain technology, traditional physical bond certificates or notes can be substituted by digitalised debt instruments that can be directly issued on the distributed ledger. During the bond issuance process, blockchain technology could enable real-time book building, but also direct dealings and communications among issuers, lead manager, syndicate members and investment banks. Hence, smart contracts can further enhance the execution automation with respect to the terms and conditions encoded in the smart contracts, as well as automate both securities and cash can be tokenized to streamline and speed up the clearing and settlement process.

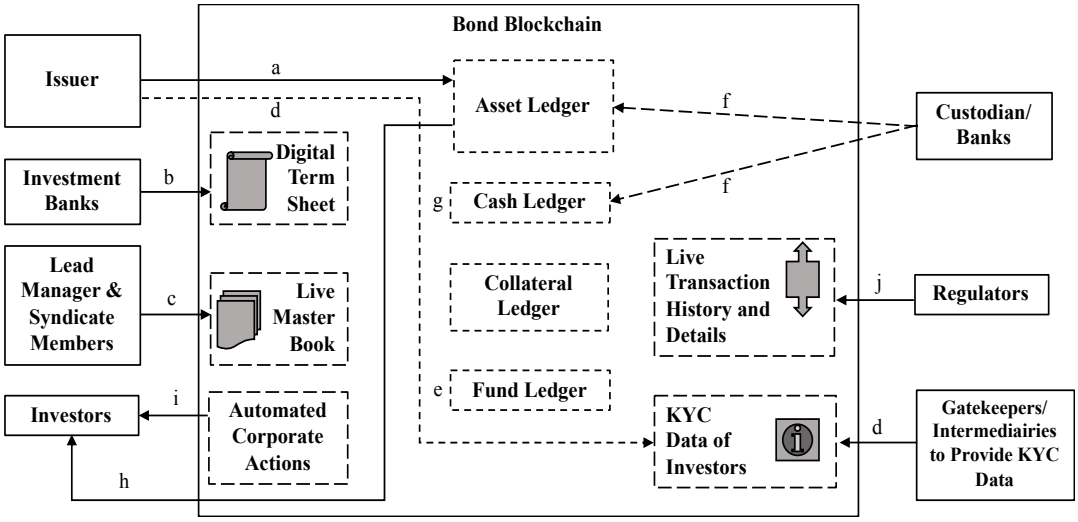
When designing the blockchain solutions for bond issuance, there are several factors need to be considered and specified as bond issuance is a strictly government-regulated activity:

- Specifying the digital bond token including the type, value, size, ownership, terms and conditions and actions of the debt instrument
- Defining governance structure of the blockchain by implementing accurate authorization protocols to identity ownership and rights in the network
- Ensuring regulators' access to the transaction blocks for the monitoring and audit purposes
- Providing due diligence mechanism to prevent financial fraud or abuses (e.g. KYC workflow), given the fact that procedures vary from issue to issue, depending on the security type and nature of the issuer and its business
- Identifying on-chain currency for the cash tokens (e.g. adoption of fiat-collateralised stablecoin)

A potential architecture design to issuer digitalised bonds on blockchain is shown in the figure 12. Firstly, each participant owns their own node with different level of

visibility, authorization and rights in the ledgers. Secondly, both cash and securities are tokenized for the purpose of realizing real-time settlement. Thirdly, less intermediaries would be involved in the post-trade process while the remaining ones are facing changes of their roles. Along with all the transactions taken place in the ledger, regulators could also monitor, investigate and access directly to transactions' details by setting up their observation nodes. Ultimately, regulators would be able to detect and investigate potential financial crimes, fraud or money laundry issues dedicatedly.

Figure 12 Potential Blockchain Design for Digitalised Bond Issuance



Source: Own creation, referencing Capgemini Consulting *Blockchain Disruption in Security Issuance*, 2016

The potential blockchain solution design shown in table 11 is constituted by the following macro-steps:

a) Issuer issues the bond in the tokenized form into the asset ledger
b) Approached by the issuer, investment banks initiate a digital term sheet and receive sign-off from the issuer
c) Lead manager and syndicate members have individual single view on the master book regarding bids and orders from the potential investors
d) In order to add investors into the bond blockchain, issuer seeks KYC details of investors which are provided by the gatekeepers/intermediaries
e) Fund managers hold tokens that record investors' holdings, either cash or debt instrument. Tokens will be used when settlement occurs

f) Transactions take place when the deal comes to the closing stage after signing. During settlement, Custodians or banks will act as token keepers and transfer money/debt instrument to the beneficiary accounts based on instruction
g) Cash is tokenized in the cash ledger to facilitate and complete buying or selling
h) Via on-chain delivery-versus-payment, near real-time settlement can be achieved in the blockchain network. Instead of physical certificate, debt instruments will be credited to the corresponding investors' accounts in the digital token form
i) Smart contracts enable automated execution of corporate actions, such as dividend and coupon payments, interest, return of capital etc.
j) Via the observation nodes, regulators are able to access directly to the detailed transaction data so that they can provide a live audit-trail. Thus, they will be able to monitor and investigate the transactions and the blockchain platform activities to ensure they are in compliance with legal and regulatory requirements.

4.3.2 Potential Added-value from Blockchain

4.3.2.1 Impact on Pre-issuance

In our survey, several syndicates brought up a common opinion that "*Nowadays, pre-issuance is still highly manual dependant regarding preparing pitching docs and contracts, as well as preparing signing. Depending on the risk profile, nature of the business and frequency of issuance, the amount of information varies for different issuers.*"

Observing from the capital market, existing conventional solutions such as Ipreo and EDDI have explicitly worked on standardization of information and communication, workflow streamline in book-running, allocation. Nevertheless, a head of e-Trading responded in our survey that

"Digitalization / automation could help finding reliable patterns and strategies for given market / investor / issuer situations. Blockchain will play a massive role in the issuance process importantly the allocation and booking/delivery/payment process. However, the pre-issuance could stay more face to face at least in situations where issuers try to place certain kind of bonds or unpopular maturities for the first time."

In this chapter, we would further discuss what blockchain could offer beyond the existing initiatives.

a. Eliminating Physical Documentation

Traditional bond issuance process involves a significant number of physical documents including documents related to underwriting, subscription and distribution, and documents regarding constitution of bonds. By opting blockchain technology/DLT, documents can be stored in the hashes on-chain more digitally and verified only by the authorised users on the blockchain. Therefore, substantial number of related documents in the physical form can be eliminated. Moreover, digital form of documents can efficiently prohibit problems raised from the physical form, such as delays, inefficiencies, tampering and errors issues.

b. Creating Single Source of Truth

Currently, each financial institution owns their individual view of the record which leads to data inconsistency. A syndicate mentioned in our survey that *"Information is exchanged verbally, which makes the data unreliable and difficult to cross-check."*

Instead of using various identifiers as in current practice. Blockchain promotes the single source of truth (e.g. data consistency) among the network via creation of unique referenced data record system with a unique identifier, which can be shared and viewed in the network in a real-time manner. Essentially, overcoming pain points caused by mismanaged data could eliminate internal and external data reconsolidations and keeps everyone updated on the same status quo. With streamlined workflow, participants could focus on more value added work. Meanwhile, it results in lower administrative costs, reducing traditional manual workflow and speed up the process especially the book-building process and order transmission.

c. Enabling more Transparent and Standardized Process

With direct dealings and communications among issuer, investment bank, lead manager and syndicate group, blockchain solution allows documentation creation, deal structuring, price negotiation and order transmission taken place in the same network. Firstly, lead manager and syndicate members have individual access to the real-time master book for book running instead of the current manual accounting book-entry in excel. Documentation creation regarding pre terms and conditions

could be automated via smart contracts. A CEO from a private financial institution stated in our survey,

"*If we just get the standardization done alone would able to speed up by providing documentation over smart contracts along with all the above mentioned would cut down on time and make everything more efficient and transparent.*"

Secondly, sales person gains easier access to the investors for communication and marketing purposes while in compliance with regulations. Thirdly, issuer gains better insight of the deal structure regarding the potential investors and their positions. Technological innovations are more likely to develop in a competitive environment and spurs increasing order flow (Learner, 2011). Increasing visibility for pricing and execution driven by blockchain technology can simultaneously provide better price discovery experience and clarity to the investors. Observing previously from the market, a structured green bond was issued on blockchain by BBVA. As a negotiable asset with specific terms and conditions, the entire documentation, deal structure and prices negotiation took place in the same distributed ledger. Blockchain solution creates a more competitive environment with greater participation and trading volume, which minimize the risk in underwriting, lower transaction costs and spreads.

Along all different workflows of all pre-issuance participants, regulators can easily access to the transaction details in order to prevent financial misconducts and crimes. Real-time monitoring by the regulators leads the pre-issuance process more secured and compliant.

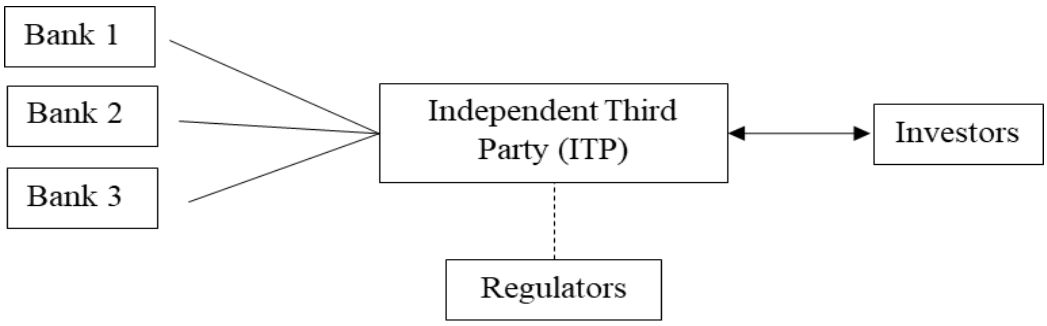
d. Facilitating KYC/Client On-boarding

Remarked from market practices, a quantitative analyst concluded that "A lot of manual efforts need to be invested to on-board investors due to the poor quality of investors". Facing the challenges, blockchain provides two alternatives to facilitate the current complex and time-consuming diligence/KYC process. Firstly, participants especially issuer can access to the KYC data of the investors via an independent third party (ITP) that provides official and consolidated KYC. Secondly, individual bank of the consortium group can share directly KYC checks with the other members in the mutual accessible ledger. In order to improve the current time-consuming due diligence workflow, one of our participants (KYC officer) from an investment bank stated a possible solution that

"70% of the investor base among all banks are the same. Instead of each bank doing their own KYC, one centralized distributed ledger and assigned third-party can perform due diligence on clients. Then summary of findings/ comments can be provided to all banks. If bank agrees on KYC summary, banks can enter into BR Business Relationship with the client. All participants in the network can get notifications instantly in the ledger also regulator can monitor the performance or effectiveness of the third-party service provider."

Our survey participant also drafted a potential model for a consortium group can be designed as shown in figure 13. In fact, it is inefficient for each bank performs their own due diligence. From the blockchain bond issuance concept, outsourcing KYC to a trusted third party which acts as an autoreactive service provider is offered by the blockchain solution.

Figure 13 Potential Model for Due Diligence/KYC Process



Source: Own creation

The process in figure 13 can be divided into several macro-steps:

a) Investors approach to the bank for product or service
b) Banks request ITP to perform due diligence on client and request additional information or documents from client
c) ITP performs name list screening (NLS) and due diligence and ask for further information if necessary
d) Based on the consent of the investors, ITP provides KYC summary to the bank.
e) Bank decides to establish new relationship with client or to reject it based on the KYC summary
f) Regulator should monitor the performance and effectiveness of ITP

e. Broader Access to the Capital Markets

We have previously discussed the term "home bias", which implies that issuers might face additional hurdles to place bonds outside their domestic country. Contrary to the traditional financing channels, the DeFi applications have demonstrated the possibility to provide market participants with a better access to the lending pool and reduce significantly the barriers to the financial markets. With blockchain development, issuers could enjoy better access to a wider range of target investors and face reducing obstacles for cross-border transactions.

4.3.2.2 Impact on Post-trade Stage

Current lengthy post-trade cycle involves multiple counterparties such as custodians, agent banks, central securities depositories CSDs and central counterparty clearing houses CCPs. Crowded with various intermediaries and lack of automation, the current post-trade infrastructure set-up remains highly complex and fragmented. Facing the current challenge, DLT/blockchain technology has the potential to disrupt the current clearing and settlement cycle and reduce significantly transactional and operational costs.

Observing previously from the pilot projects of debt securities issuance on blockchain, even same day issuance is already possible nowadays (i.e. the European commercial paper issued by European Investment Bank) thanks to the almost real-time settlement and automation enabled by blockchain technology. Conclusively, market practices show that blockchain could significantly reduce the issuance timeframe and provides digitalization to the process. In other terms, blockchain solutions are most likely to create tremendous effect on setting up a standard for the financial transactions, automating the lengthy process without manual intervention and achieving real-time settlement with involvement of substantial reducing intermediaries.

a. Tokenization and Real-time Settlement (DvP)

The ultimate goal for the settlement cycle is to achieve real-time settlement instead of T+5 or justifiable time-frame. In order to apply blockchain technology to achieve this goal, delivery versus payment (DvP) and immutability of blockchain are the two key challenges need to be considered for design of the new process set-up. (Committee on capital markets regulation, 2019).

In order to achieve DvP, tokenization has been considered for clearing and settlement in the financial services industry. A settlement coin such as stablecoin has been recently developed and used for the permissioned blockchain. The stablecoins are plegged to the fiat currencies and settlement would occur in it. With both stablecoins and security represented on the same blockchain system, transactions written into the block would include the security transferred from issuer to investor and stablecoin transferred from investor to the issuer. In practice, majority of issuers are rather global than EU or Euro market issuers (AFME, 2019), the tokenization of central bank currencies could advance multi-currency settlement services and facilitate cross-border transactions.

Regarding the immutability of blockchain records, it is impossible to alter, void or reserve the transactions. In spite of that, immutability can be eased in the permissioned blockchain structure by embedding with trusted permission nodes that have rights to void or reverse the transactions or writing conditions into smart contracts in order to automating voiding or reversing transactions under certain circumstances (Committee on capital markets regulation, 2019). For instance, different markets or security types require some specific operating schedules due to some local specifications (ECB, 2019). Thereby, blockchain technology/DLT should also work on alternative solutions which allow a flexible settlement cycle.

Compared to conventional settlement procedure, centralised T2S or TIPs, applying blockchain technology could offer something beyond the real-time settlement. It can effectively mitigate the issue of "single point of failure" with its decentralized feature and guarantee a 24/7 electronic audit trail for the transaction activities. A complex design and development of blockchain structure would enable real-time settlement with improved speed, drive the post-trade landscape more resilient and automated. Ultimately, it can significantly reduce operational costs linked to the transactions. Optimising liquidity management, implementing blockchain technology in the post-trade process could potentially free up billions of capitals held as collateral which ensure security against uncertainty or failure of settlement.

b. Automation and Better Asset Servicing

Theoretically, smart contracts execute automatically based on the programmed logic. Incorporating blockchain technology in the post-trade process results in declining

reliance on manual processes and ultimately prevents manual frictions and errors. Smart contracts would enforce auto-execution of pre-defined terms and conditions, as well as confidentiality agreement before the transactions.

Corporate actions (i.e. coupon payment, interest, dividend payments, return of capital, splits or mergers) remain complicated in Europe due to the difference of tax regimes and securities laws. Such a particularity of European post-trade landscape has built barriers for some financial institutions to adopt the conventional solution T2S. Based on the ownership of the asset or fiat tokens in the blockchain, corporate events could be encoded into smart contracts and auto-executed while keeping all members of asset and cash account updated. Hence, in the case of fin-ledger, business confirmation, document creation, certificate changes, assignments as well as redemptions can be executed fully digitally in the ledger. Simplifying the complexity by automation, current operational and systemic risks and administrative barriers linked to manual and multi-steps process could be reduced as well.

In fact, asset and cash can be tokenized and stored in the ledger by using blockchain technology. With multiple cryptographic signature protection, it provides a more secured and digital asset safe-keeping set-up. To promote and implement comprehensive market standards for the token markets, International Token Standardization Association ITSA currently works on providing a unique international token identification number ITIN, detail token classification and database for analysis purposes. Attaching a unique identifier for both security and fiat tokens used in transactions enhances operational efficiency, infrastructure simplification and reduces administrative costs.

c. Substantially Reducing Intermediaries

With the automation and near real-time settlement, the functions of a substantial number of intermediaries such as central counterparty clearing CCP and a series of back-office agents (i.e. paying agent, issuing agent, bill &deliver agent) would be faded. Lack of transparency of current process is caused by the fact that different intermediaries are working on different systems and a market standardized workflow is challenging to be implemented. With involvement of gradual decreasing number of intermediaries led by blockchain solutions, this new technology could help

eliminating counterparty risk, reducing administrative cost of holding assets, driving the process more transparent with more streamlined layers.

4.3.3 Changing Roles of Market Participants

Through the entire issuance life-cycle, blockchain adoption and overall IT development could also have an evolutionary impact on each participant's role and daily work. Based on the survey to the key market participants and the observation from current market initiatives, we have assessed and evaluated the potential impact on each player in the debt capital market:

Issuers

Blockchain/DLT solutions could help to create a b-2-b platform that helps to bring investors and issuers together without the involvement of intermediaries. Meanwhile, issuers could gain complete transparency of the entire bond issuance life-cycle taken place in the ledger to better monitor the deal preparation. With an elaborate KYC set-up in the ledger, issuers would need much fewer efforts for the KYC in order to onboard the investors in the future. A higher degree of transparency and rigorous compliance check leads to reducing administrative costs for raising capital and better access to the investors for the securities servicing and transmissions.

Lead Manager and Syndicate Members

Blockchain solutions bring standardization and simplification to the entire process. With a unified view of a master book, manual workflows for periodic basis data reconciliation would be eliminated, and the process would be more streamlined. Thus, data consistency could create a single source of truth and leads to reducing operating costs for the process. Several syndicates mentioned in our survey that *"Data mining and assessment would become more critical to advise the issuers for the deal structure."* Also a trader mentioned that *"Technical innovation especially implementation of smart analytics will boost the importance of the processes and teams working around trade/client/competitor analysis"* Besides, salespeople could gain better access to investors for marketing and communication while in compliance with regulations. Despite the importance of data management, our survey participants also mentioned that *"Human-based (i.e. pitching phase and contract phase) phases and more senior, as well as relationship-focused positions, would not be impacted much."*

Legal Advisors

Similar to dealers, the law advisory service will not be simply replaced by technology, but rather switch to the focus of standardising contract terms in order to automate the documentation process. The real value-add work lays in the client advice and negotiation of additional terms, conditions and covenants that impact the performance and enforcement of the financial instruments. Lawyers should not be expected to code legal logic into computers to automate contract creation, but instead they should be contributing to streamlining the process by standardising and marking existing legal documents so that the terms can be read and understood by computers.

Focused on the utilization of tokens, legal advisors should consider different definitions and requirement for the cross-border transactions in the post-trade stage. A case-by-case analysis should be included for each transaction as a harmonized regulatory landscape will need much more effort and time to be realized.

Custodians or Sub-custodians

From a medium-term perspective, market participants do not see complete disintermediation as an option linked to the integration of blockchain technology. Their roles and functions may change and narrow to token-custody. Instead of safe-keeping securities, custodians safe-keep and execute transferring corresponding dematerialized debt securities such as debt tokens and payment tokens such as fiat-currency on blockchain or stablecoins in order to achieve a real-time settlement. Regardless of token safe-keeping, custodians will also need to ensure the proper functionality of the automated securities servicing in the future.

Intermediaries

The functions of a substantial number of intermediaries such as settlement agents, clearing members would be gradually faded and no longer needed in the bond issuance process due to the automation achieved by blockchain solutions.

Investors

In the pre-issuance phase, they could potentially have better access (i.e. standardized common platform/interface for data sharing) to all relevant information of the issuers and the corresponding debt securities. Higher transparency in the process can

simultaneously provide better price discovery experience and deal clarity to the investors. In the post-trade stage, they would benefit the process efficiency driven by automation, especially in the execution of corporate events.

Regulators

Regulators would not only monitor the publicly accessible transaction records but also workflows in the blockchain. They could further enhance their abilities to investigate and prevent market manipulations, unfair pricing, market fraud and abuses in a real-time manner. At the same time, a 24/7 live digital audit-trail could be enabled as well.

4.4 Challenges and Obstacles

"I think the role of the disruptors and anything that uses distributed ledger technology, whether you call it crypto assets, currencies or whatever—and it's far from the Bitcoins we used to talk about a year ago—that is clearly shaking the system." Christine Lagarde, the managing director of the IMF International Monetary Fund believes that blockchain is disruptive and will revolutionize the financial world. Its impact will shake the structure of the market. Despite the fancy description of its benefits, security and stability of the financial system should be also considered all along the emergence of this new technology.

Blockchain is one of the promises to bring greater transparency, process simplification and efficiencies for securities issuance. Although there are many compliments regarding how blockchain technology could reshape the securities issuance process, some of the features and benefits remain fantasies than facts rather. On the one hand, it exists some limits of adoption due to different technological capacities and interests of market participants. On the other hand, development and adoption of blockchain remain questionable regarding how they can integrate into the regulatory landscape and what is the role of law in the ledgers.

4.4.1 Limits of Adoption

Technology Challenges

Particularly in the financial services sector, most of stakeholders or consortium group would opt for either private or public permissioned blockchain to improve their workflow and to facilitate information and transaction flows. Despite the glamorous

view on how blockchains will bring tremendous value to the processes, most of the permissioned blockchains require a significant high level of technological skills and core infrastructure set-up in order to enable its effective functions (Rodriguez, 2019). In another word, it is associated with the technological expertise skills within the organization and large amount of investment at the early stage. In reality, there are several real challenges linked to permissioned blockchain applications (Rodriguez, 2019). Table 10 describes the detailed descriptions of challenges that each core infrastructure in permissioned blockchain is encountering.

Table 10 Technology Challenges in the Permissioned Blockchain

Core Infrastructures	Challenge Description
Integration to External Communication	External communications occur because smart contracts rely on connecting to off-chain systems of application programming interfaces (APIs). Oracles as a market well-known component in the blockchain structure that handles external communications, workflows. Exercises linked to Oracles are intensive and require many efforts.
Data Storage	Used as a new form of database, a permanent storage of immutable cryptographic blockchain API keys is associated with large off-chain data storage. Blockchain is not considered as the best vehicle for large volume data storage. Current service such as blockchain complementary storage model is still under developed and needs more trial and market practice.
Data Privacy	Permissioned blockchains used in financial services area are in a highly regulated environment with strict data privacy constraints. Protecting and enforcing data access control is a key requirement for the safe functions of blockchain.
Data Access	In the permissioned network, it is a better experience to write information rather than reading on it because data recorded on blockchain can be hard to access and unintelligible. Therefore, both read-access and write-access should be ensured and harmonized.
Identity Management	Identity management is critical for the design of the consensus mechanism to run smart contracts. Problems are raised when participants can have several identities linked to their different roles in the network and security issues when the participant decides to exit the network. Concerning identity anonymity, optional disclosure of identity relating to transactions' compliance in AML and regulations should also be considered to ensure the data authenticity further.

Even though there are already some relevant protocols and tools under development to overcome the technical implementation barriers, individual participant still resists since opting blockchain technology/DLT entails a significant investment in IT, but the benefits remain hard to be estimated and quantified precisely. Especially in the post-trade stage, A CEO of financial institution mentioned in our survey that "*At the moment I don't know a Blockchain protocol which is stable enough to handle all that volume."* Most importantly and which requires many efforts, it is that participants need to restructure their technology platforms and set up robust plan to buffer against technological risks (i.e. systemic shocks), in order to incorporate the blockchain/DLT technology and achieve an effective functionality of the ledger.

Conflicts of Interest

There are a lot of resistance and reluctance for financial institutions to adopt blockchain technology/DLT even though its benefits seem obvious from the pioneering market practices.

Firstly, blockchain can potentially redirect economic interactions away from traditional channels (PreSale Ventures, 2018). Compared to the fintech companies, financial institutions such as big banks might have different interests as they belong to the traditional channels and stand at a strong priority position for decades. With the appearance of Defi applications that provides market participants with the possibility of equal access to the financial markets, a current barrier such as "home bias" faced by issuers can be gradually reduced as well. Thus, it evidences that new technology can threat the traditional investment banking area. However, maintaining the status quo can protect their current advantages of the business explains the resistance of adopting blockchain technology by the traditional financial institutions. Regarding the responses to EDDI consultation from AFME, many members consider current manual workflows in the pre-issuance system function smoothly, and such fragmentation does not cause any adverse effect on the market. Eventually, if there is a lack of cooperation and motivation of core market participants, the effect of blockchain technology seems to be meaningless.

Secondly, increasing transparency represents either benefits or costs for different market participants based on an analysis of transparency in European bond markets conducted by Learner (2011). On one hand, greater transparency enables better

investor protection and improved market efficiencies. For investors, they can benefit from a better price discovery experience with more efficient and robust price information. Plus, they can enjoy an improved access to the market information and conditions. Ultimately, this stimulates competitions among market makers and dealers, and results in lower transaction costs and lower bid-offer spreads. Additionally, regulators could enhance their abilities to investigate and prevent market manipulations, unfair pricing, market fraud and abuses. On the other hand, effect can be adverse for the brokers/dealers due to the strengthened competition in the market. With better price discovery of investors, it leads to a higher cost for dealers to hedge their positions. Thus, issuers especially in the public sector may raise concerns regarding KYC fulfilment/ client on-boarding responsibility since investors have direct access to approach to them (ICMA, 2019). In reality, for those who act as government bond auctions backstops, increasing transparency may hamper the liquidity provisions at the auctions (Learner, 2011).

Thirdly, blockchain stands for a source of growth, along with conflicts with the forces of stability such as banks, governments and even cautions from each investor (PreSale Ventures, 2018). In our survey, a syndicate from a European primary dealer bank mentioned,

"Technical innovation would definitely drive the data mining and assessment more important to advise issuers. Nevertheless, it will also increase volatility, shrink the importance of intermediaries, or will shift the business to a few major global operating banks/ global asset managers. Thereby, technical innovation could potentially result in execution risk and oligopoly market structures."

In order to maintain the stability of the market, other market participants who responded to EDDI consultation have argued that "any new technological set-up, infrastructure or platform should be based on complementing the current market infrastructures instead of creating disruptive changes." (AFME, 2019)

4.4.2 Regulatory and Legal Issues

Blockchain's integration into the regulatory landscape remains specifically as a challenging and debatable topic for issuance of securities (Capgemini consulting, 2016). In nature, regulations play a critical role between addressing risks (i.e. cybersecurity and data privacy protection) and ethically allowing innovation. Since

the issuance of debt securities is a government-regulated process, market participants should take careful consideration and understand the evolution of regulatory guidance before adopting blockchain technology.

One of the major concerns in blockchain/ DLT usage was also raised by ECB, about how network operators will comply with national provisions on professional confidentiality and secrecy. In fact, legal, tax regimes and regulatory requirements vary greatly under different jurisdictions even though EU is a political and economic union in definition. Thereby, it results in the fact that nodes are distributed across different legislations. On one hand, countries under different legislations and have different regulations of capital market. For instance, in order to achieve a pan-European project (e.g. EDDI), concerns of cross-jurisdictional issuance have been voiced due to difference of prospectus regulations, tax and fiscal systems, fund regulations, notary requirements and national government auction mechanisms. With such an undoubtedly complex legal environment, a widespread integration of applicable law across EU could be served as the biggest driver to foster further technology adoption in the capital markets. On the other hand, there are different data and information privacy protection laws applied to information storage and transmission around the globe - one of the key usages of blockchain. As for example, information privacy is much more restricted under GDPR General Data Protection Regulation in Europe than under the US privacy model, since the data privacy is not highly regulated and legislated in the US. Regarding the confidentiality issue, jurisdictional variations can consequently result in participants' reluctance to adopt the technology while taking the risk.

When coming to the technology set-up, it would be hard to identify the governance structure such as responsibilities over the operations of the DLT framework for the development of blockchain. In practice, geographical base of investors is one of the factors that impact issuers' choice of the issuance place. Owing to complexity of multiple regulations of investors from different nations and appearance of new regulation such as CSDR for security settlement, the choice of governing law for the contractual relationship among participants in the blockchain network remains hard to be decided.

Another issue is the legal enforceability of smart contracts (Mathias, 2018), as legal justification of smart contracts remains unclear (Valenta, Sandner, 2017). Despite the

blockchain types, the business logic is encoded by using smart contracts. So far, smart contracts are not necessarily contracts by legal definition. Although there have been efforts driving the smart contracts accurately reflect the written legal contract (Peters & Panayi, 2015), common question such as "Is code prevailing on the law?" is still raised frequently.

Despite the challenges, Europe has been actively involved in promoting the integration of blockchain technology and building a necessary regulatory infrastructure to simplify and facilitate the issuance of securities tokens. Nowadays, securities tokens are regulated as securities under MiFID II. In other word, security tokens such as debt tokens could be potentially treated as a "transferable and negotiable securities" (Steis, 2019). Since the beginning of 2019, the German financial regulatory authority BaFin has already approved two STOs which work like bonds for two German fintechs to raise funding. Hence, other EU nations have also started to actively participate in the regulatory harmonization of blockchain integration based on various indications – marketing, addressing investors and sales. Regardless of the current effort, the approval of STOs remains case-by-case in the EU zone. A structured, standardized strategic guidance and framework to regulate and monitor STO/securities issuance on DLT is still missing.

5 Conclusion, Limitations and Further Research

5.1 Conclusion and Implications

This research aimed at identifying added-value and efficiencies created by blockchain solutions in the bond issuance process, embedded with an evaluation of market participants' perception regarding blockchain technology implementation and potential technology impact on their functions. Beginning with outlining step-by-step the traditional bond issuance process and detailed blockchain usage and application in the market, this study first demonstrated the complexity of current process and blockchain could be one of the solutions to heal the dilemma and inefficiencies through the current issuance life-cycle. Combining both market observations and expert surveys, the mixed-method of qualitative analysis sought to deliver a nuanced perspective on the interlinkages between available market information and practical market overviews.

Market observations evidenced the existing inefficiencies in the process and market primarily. Following through the existence of currently available conventional solutions in the capital market, we observed that market participants and central authorities had been actively searching for solutions to promote efficiencies and transparency in the market. In the pre-issuance process, we observed that private initiative Ipreo and Project Mars aim at standardizing and digitalizing the entire workflow. Also, ECB launched EDDI consultation regarding the establishment of a pan-European system for the Euro-denominated debt instrument issuance process. In the post-trade process, infrastructures such as T2S and relevant regulations to harmonize and accelerate clearing and settlement cycle have been in place for decades. In order to experiment with the performance of blockchain technology in combination with the traditional financing process, we observed that many market players, such as financial institutions had been actively cooperated with fintechs to perform pioneering projects.

Delving deeper into these innovative projects and conventional solutions, this research further evidenced the potential added-value provided by blockchain solutions beyond the conventional solutions. In the pre-issuance process, blockchain solutions could effectively eliminate physical documentation, create a single source of truth, and standardize the process and streamline KYC/client on-boarding. In the post-trade phase, adopting tokenization concept could effectively facilitate and accelerate securities clearing and settlement. Meanwhile, smart contracts automate the execution of corporate actions, which allows better asset servicing to investors. Rooted in the decentralization feature, blockchain technology promotes more secured and stable process and eliminates a single point of failure. Based on the pilot projects to issue bonds on different DLT framework, we designed a potential blockchain structure of bond issuance on blockchain in order to demonstrate the pre-conditions, considerations, potential design and every single step for the technology set-up in detail.

Concerning these findings, the results of the expert survey revealed that market participants remain positive and optimistic regarding how blockchain or technology, in general, could reshape their current workflows and entire market infrastructure. In the pre-issuance section, more than half of the participants consider that building a standard interface for data creation, storage and creation is relatively necessary to

streamline their workflows. Although some other market participants considered current workflow remain efficient with existing conventional solutions and new technology should not reshape the status-quo fundamentally. In the post-trade section, market participants considered that blockchain or technology adoption is necessary to empower digitalization and automation for more efficient clearing and settlement. However, survey participants argued that technology adoption should not cause complete disintermediation effect. Thereby, the results revealed that maintaining market stability is the premise of adopting new technology.

Focused on the impact on major participants, this research articulated the changing roles and responsibilities of each involved player. However, advisory and negotiable functions often rely on personal judgement and experience. Due to personal contact, relationship management among issuers, banks, investors could be better managed. Thereby, a certain level of human interactions remains irreplaceable and could not be automated much. Starting from issuers, they could have better access to the potential investors, more transparent outlook of the deal and invest less effort into KYC/client on-boarding process. Regarding lead manager and syndicate members, the daily manual task such as data reconciliation would be eliminated due to the single source of truth in the live master book enabled by blockchain solutions. For legal advisors, they would focus on standardising contract terms in order to automate the documentation process. Concerning investors, they could benefit from a more transparent price discovery experience and automated execution of corporate actions. Most obviously, intermediaries such as clearing members and settlement agents would be substantially eliminated for the time being. With the development of various settlement payment tokens, custodians would mainly focus on safe-keeping dematerialised security and fiat-currency based tokens. Last but not least, regulators could better access to the transaction data records and workflows in the ledgers for better monitoring purposes.

Regardless of the fascinating opportunities created by adopting blockchain technology, this research also exhibited some challenges in the practical implications. Firstly, regulations, legalizations, tax regimes and data protection laws vary under different jurisdictions in the European market. As a highly governmental regulated activity, and technology integration in the issuance process should remain compliant with local legal and regulatory requirements. In the blockchain set-up, many other

complexities need to be tackled so as to establish more sophisticated solutions for multi-regional and multi-time zone accessibility and governance structure while in compliance with different regulations. Secondly, technology adoption needs to win massive support if it aims to change the market infrastructure or behaviour. In order to maintain the stability of the debt capital market, market participants have urged that technology should focus on creating efficiencies and value for the current set-ups/infrastructure instead of completely replacing them. Hence, blockchain adoption should not cause complete disintermediation effect as human interactions in the advisory functions are still in need, especially for the deal negotiation in the pre-issuance process. Last but not least, blockchain should not be considered as a single solution to improve issuance efficiencies; it should interoperate with other innovative technology such as artificial intelligence and cloud computing.

5.2 Limitations and Further Research

During our research study, we were excited to learn how blockchain can transform the bond issuance process but also encountered some challenges. Throughout the distribution of the survey, we had limited time-frame to access to the potential survey participants and receive survey answers. Besides, a quantitative analysis is missing due to the lack of market available data. As a booming topic, a lot of new pioneering projects and new regulations in the EU regarding blockchain applications entered into the market during our writing period. Therefore, our observation window is defined from the appearance of blockchain in 2009 till August 2019.

For further research study, researchers could work on the substantial and quantified potential impact of blockchain technology on the bond issuance process. From a practical perspective, researchers could also study how to motivate and accelerate the implementation of blockchain technology in the major players of European debt capital market. From a legal standpoint, up-to-date legal studies of the potential integration of blockchain technology into the debt issuance process could be conducted as well.

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7 Appendices

Appendix 1 Survey Design and Response Summary

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Master's Thesis Survey

Dear survey participants,

This survey is designed for our master thesis only for academic purposes. Our research is focused on market participants' perception of the present and future technology-driven changes, particularly in the estimation of the future impact of blockchain technology on European primary bond market. This thesis is under the supervision of Dr Philipp Sandner from the Blockchain Center of Frankfurt School of Finance & Management and Dr Martin Hillebrand from the European Stability Mechanism.

The goal is to better understand inefficiencies and potential technology impact in the current processes and workflows linked to debt issuance in the primary market. For this, we would kindly ask you to participate in the survey and provide your valuable insights. Your participation will help us receive a more practical view of the current issuance process and provide us with solid arguments for the thesis results and discussions.

The survey will be kept safe after completion of the research project and will be deleted at the latest after two years. A publication of the results will ensure that an identification of the interviewee is not possible. All your information will be anonymous and strictly confidential.

Once completed, please send it back to Wanli Chen (Phone: +33 616282978, E-Mail: wanli.chen@fs-students.de) or Qianxia Wang (Phone: +49 17647144832, E-mail: qianxia.wang@fs-students.de). If you have any questions or would like to have further discussions, please do not hesitate to contact us.

Comments are most helpful if they:

Are short and precise
Contain clear evidence or rationale
Highlight your role or position in the debt issuance process
Describe a potential alternative that should be taken into account

*If the question is not in your scope, please write "not in my scope" in the answer.

A. In the pre-issuance process

Question 1: Do you think there is a lack of digitalization and automation in the pre-issuance process? If so, what is your view regarding the underlying causes?	
Respondent 1	I do not think so. Frequent issuers can access the capital markets at very short notice already today. I also do not think that more digitalization or automation will help to speed up specific problems in terms of regulation, tax treatment or legal issues. Preparation of a deal needs to be monitored by carefully by issuer and arranging banks to mitigate all potential risk factors.
Respondent 2	Yes. Cause is Lack of investment into IT.
Respondent 3	Yes, no or quite no digitalization in pitching phase and contract phase.
Respondent 4	Lack of Software/Tools.
Respondent 5	Yes, the process remains highly manual for decades. There is a lack of an industry-wide standard tool.
Respondent 6	Respondent skipped this question.
Respondent 7	Yes, there is probably a lack of resources for adapting to new technologies.
Respondent 8	Infrastructure especially IT set-up isn't up to date.
Respondent 9	I think there is a huge lack of digitalization and automation in the pre-issuance process. This is mainly based on Debt Capital Markets being a very traditional field of Investment Banking which so far did not felt external pressure for innovation as Bond Markets kept growing over the past decades.
Respondent 10	Yes, despite this issue, the current process still requires a lot of human interaction and that's something can't be replaced by technology.
Respondent 11	The reason behind can be explained that the process involves a lot of human interactions. However, standardization in communication, data, book-building and order transmission is in need.
Respondent 12	Yes, traditional financing channels might face less challenges even though lack of digitalization and Automation.
Respondent 13	Traditional investment banking field but gradually facing challenges from the latest technology development.
Respondent 14	Yes, I think the current issuance process can be further streamlined. The cause might be the lack of Motivation in changing traditional practice and the slow Adoption map for new Technology.

Respondent 15	No.
Respondent 16	I would say the level of digitalization is pretty high although middle offices and back offices are still not very digital, I think due to the high costs, most of the banks are anyway starting to invest heavily to replace mid and back office
Respondent 17	Yes. Causes: Lack of expertise, unwillingness to adopt new technologies.
Respondent 18	In pre issuance not really, rather in the settlement.
Respondent 19	Yes, there is a lack of digitalization/automation in the process. In a public bond transaction, a group of underwriters work together via i) email and ii) Bloomberg chat. There is usually no one data room to store documents; a lot of information is exchanged via email and chat.
Respondent 20	Not in scope.
Respondent 21	There is a lack of automation (hence digitalization) regarding investors and issuers capability to assess their "counterparties" current investment / issuance strategy and future investment / issuance needs. Digitalization / automation could help finding reliable patterns and strategies for given market / investor / issuer situations
Respondent 22	Yes. Reason: lack of technical skills, lack of efficiency pressure in the past
Respondent 23	Yes, there is lack of digitalization and automation in the pre-issuance and the main the underlying cause is lack of knowledge (education) about it. People set with their way how they get things get done and not too eager to way learn new way to do thigs. Needs to come from the top-down approach before people take it seriously.
Respondent 24	Yes. The data is in a structured format. It is difficult to operationalize many steps of the process through a traditional automation.
Respondent 25	Pre-issuance is often relying on personal judgement and experience. It is a "people's business" that cannot be automated much in my humble view.
Respondent 26	Yes. The participants tend to stick to the old ways of doing the business, lack of standards.
Question 2: In terms of information flow in the pre-issuance process, what are your views regarding the possible inefficiencies in the current practice? Can you specify how does it impact your daily work?	
Respondent 1	From an investor's point of view, it would be appreciated to have a platform with all relevant information. However, this can already be obtained from the banks. IPREO already have all deal specific info. The amount of information needed varies also. Frequent and well-rated issuers are well-known and investment decisions by

	investors depend also on the overall market backdrop whereas bond issues from non-frequent and/or high yield issuers need to provide a lot more information in the run up to a bond issue. The lower the rating scale the more deal specific information are needed.
Respondent 2	Not in scope.
Respondent 3	Manual effort in preparing pitching docs and contract as well as preparing signing.
Respondent 4	Annoying copy/paste and formatting tasks.
Respondent 5	Manual effort in documentation preparation and verification. Lack of harmonization and is time consuming.
Respondent 6	Not in scope.
Respondent 7	Inefficiencies might come from using outdated MS office suits; this slows down the process.
Respondent 8	Not in scope.
Respondent 9	I have the opinion that mainly the work of interns and analysts could easily be automated as the daily work consist largely of setting up PowerPoints and Pricing slides.
Respondent 10	Not in scope.
Respondent 11	Manual and paper intensive workflow.
Respondent 12	Heavy manual workflow. Especially a lot of effort in Setting up pricing slides and data consolidation on a daily basis and it is something can be automated.
Respondent 13	Data consolidation on a frequent basis, should be advanced by Adoption of technology.
Respondent 14	From my experience, the Information flow mainly via personal communication e.g. syndicate call, Investors call, etc. The massive wave of Information lacks a centralized storage process and is hard to Keep track in the future life cycle of the securities.
Respondent 15	Not in my scope.
Respondent 16	Often the various docs review rounds carried out pretty slowly, but I think no solution on this since it requires legal signoff.
Respondent 17	Not in my scope.
Respondent 18	It might be beneficial to have a system to help the review of legal docs.
Respondent 19	Relevant documents (prospectus; term sheet, green bond framework; green bond second party opinion) are sent via email. This makes it difficult to keep track of documents and results in extensive email traffic.
Respondent 20	Not in scope.
Respondent 21	Current practice will contribute to a good relationship between issuers and banks likewise investors and banks as well as a direct feedback (including nuances in answers / tones) due to personal contact. On the other hand, this personal contact will always be more inefficient than automated information distribution.
Respondent 22	Too much manual work. Particularly information about investors is of poor quality (investor identification and classification).

Respondent 23	Not in scope.
Respondent 24	Some portion of the information flow and data flows may need to be automated so people can spend more time on the more value-added work.
Respondent 25	When preparing syndicated issuance, the potential bank contacts are limited. It depends on other factors like how many need to be contacted and how these are selected, but in public institutions this more linked to internal policy (need to justify the choice) than anything else. Inefficiencies are more linked to this "political" angle, which cannot be avoided in my view.
Respondent 26	Information is exchanged verbally, it is unreliable, difficult to cross check. The fact that is unstructured makes it difficult to do analyses.
Question 3: How would you estimate the necessity/importance of improving documentation workflow, by creating a standardized market-wise common platform/interface for data recording, storage and sharing? Please justify your answer (optional). A. 0% (not at all important) B. 25% (slightly important) C. 50 % (important) D. 75% (fairly important) E. 100% (very important) F. No opinion	
Respondent 1	B. 25% (slightly important) Please justify your answer (optional): The process has been hugely improved over the last years and it will be improved going forward. It is not a bottleneck in the issuance process but will - in context with the overall IT development - further improved and accelerated in the future.
Respondent 2	D. 75% (fairly important)
Respondent 3	E. 100% (very important) Please justify your answer (optional): There is no way to avoid standardized, common platforms. We see already some fintechs who step in the market. new technology e.g. blockchain will revolutionize the business
Respondent 4	D. 75% (fairly important)
Respondent 5	D. 75% (fairly important) Please justify your answer (optional): For KYC, 70% of the client base among banks are the same. However, same company has different business line in different banks. In first scenario, being able to use the consolidated data from data vendors, official primary data source from the common ledger will significantly improve the data gathering process and the data can be served as golden source. In second scenario, a consortium of several bank can outsource the KYC to a 3rd party service provider. Clients, banks and the 3rd party KYC can use the common ledger for better informational exchange. Blockchain can control the data access right in the network. In conclusion, aggregate cost and time for banks to spend on KYC will decrease significantly as only one external party is doing KYC for all banks.
Respondent 6	D. 75% (fairly important)
Respondent 7	D. 75% (fairly important)

Respondent 8	C. 50% (important)
Respondent 9	D. 75% (fairly important)
Respondent 10	C. 50% (important)
Respondent 11	D. 75% (fairly important)
Respondent 12	D. 75% (fairly important)
Respondent 13	C. 50% (important)
Respondent 14	D. 75% (fairly important)
Respondent 15	E. 100% (very important)
Respondent 16	B. 25% (slightly important)
Respondent 17	E. 100% (very important)
Respondent 18	C. 50% (important)
Respondent 19	D. 75% (fairly important) Please justify your answer (optional): Improving documentation is fairly important; at the same time the bond issuance process is functioning well the way it is.
Respondent 20	D. 75% (fairly important)
Respondent 21	D. 75% (fairly important) Please justify your answer (optional): Standardization will always lead to a more cost efficient over all process
Respondent 22	C. 50%(important)
Respondent 23	E. 100% (very important) Please justify your answer (optional): If we just get the standardization done alone would able to speed up by providing documentation over smart contracts along with all the above mentioned would cut down on time and make everything more efficient and transparent.
Respondent 24	D. 75% (fairly important)
Respondent 25	C. 50%(important) Please justify your answer (optional): Documentation (post-transaction) indeed seems to have some efficiency potential. It is done between the issuer, banks and external law firms - and even with an existing debt issuance programme, the effort is non-negligible.
Respondent 26	E. 100% (very important) Please justify your answer (optional): It would enable informed and more precise analysis that is needed for efficient issuances.

B. In the post-trade process

Question 4: Do you see any inefficiencies and risks in the current long clearing and settlement cycles? Can you specify?	
Respondent 1	I am not an expert in ledger technology, but I believe this is an area where blockchain technology can help and improve the process

Respondent 2	Lack of automation
Respondent 3	Not in scope.
Respondent 4	Match codes etc. are often outdated
Respondent 5	Lack of automation and the length of clearing and settlement varies depending on the security type.
Respondent 6	Not in scope.
Respondent 7	Not in scope.
Respondent 8	Timeframe for clearing and settlement for different security type varies and a lot of particularities should be considered.
Respondent 9	The long clearing and settlement cycles increase the risk for involved banks as it increases capital requirements and counterparty risk.
Respondent 10	There are still many barriers for the cross-border clearing due to different jurisdictions within EU. Additionally, settlement and also corporate actions could be further improved as well.
Respondent 11	Lack of automation and is complex.
Respondent 12	Yes, quiet complex as there is lack of legislative, fiscal and tax harmonization in Europe
Respondent 13	Not in scope.
Respondent 14	Not in scope.
Respondent 15	Just like in the payment world where instant payments is introduced through RTG, same can be done in the post-trade process.
Respondent 16	Not in scope.
Respondent 17	Not in scope.
Respondent 18	Plenty, all the settlement is extremely slow and subject to errors, moreover the check of all the data takes much time.
Respondent 19	Yes, there is a lack of digitalization/automation in the process. In a public bond transaction, a group of underwriter works together via i) email and ii) Bloomberg chat. There is usually no one data room to store documents; a lot of information is exchanged via email and chat.
Respondent 20	Yes, different from the other big markets, there are different legal systems, different central banks and different sovereign issuers. Unharmonized legal landscape cannot promote efficiencies in the post-trade process.
Respondent 21	Not in scope.
Respondent 22	The process takes too long time. Without knowing too much of the details, it must be connected with too much manual input.
Respondent 23	Besides it is time-consuming and working on current legacy system which is becoming outdated and slow I don't see any other issues.
Respondent 24	Not sure about the potential usage of blockchain's application.
Respondent 25	In addition to the documentation needs, I do not see this as a problem. Standard settlement is still T+5 (which might seem long), but we have been able to adjust to T+4 or T+6 for justifiable reasons (avoiding accrued interest in a tap, faster disbursement, end-of-quarter considerations). Reducing further is possible, but from my perspective this is not needed.

Respondent 26	Not in scope.
Question 5: What are your views regarding the current T2S settlement process? Do you know anything about other new digital set-ups for clearing and settlement? If so, what are these digital infrastructures?	
Respondent 1	Positive.
Respondent 2	Not in scope.
Respondent 3	Not in scope.
Respondent 4	Not in scope.
Respondent 5	T2S helps in reducing settlement cost and speeding up the process.
Respondent 6	Not in scope.
Respondent 7	Not in scope.
Respondent 8	Originally T2S aims at reducing settlement fees and increases stability and harmonization for European capital market. So far, it is still hard to see if T2S can bring such an added value.
Respondent 9	I just heard of the existence of the T2S platform but not if its possible implications.
Respondent 10	T2S provides already issuers with an option to distribute their debt instruments to the investors in a more competitive environment. However, future CSDR central securities depository regulation implementation will drive the environment more competitive among CSDs.
Respondent 11	Should drive the competitions more intense.
Respondent 12	Not in scope.
Respondent 13	T2S speeds up significantly the Clearing and Settlement process but whether it is efficient for the market remains questionable.
Respondent 14	I believe there will be positive Impact.
Respondent 15	The T2S will increase the cross-border securities transactions, as easy as SEPA. I believe there is something same set up in by ASEAN.
Respondent 16	Not in scope.
Respondent 17	Not in scope.
Respondent 18	Not in scope.
Respondent 19	Not aware of the T2S process.
Respondent 20	As a pan-European infrastructure, I think it will further drive the process more secured and efficient.
Respondent 21	Not in scope.
Respondent 22	Not in scope.
Respondent 23	My understanding is that same day settlement can be done today but not preferred by the banks because of lending. At the moment I don't know a blockchain protocol which is stable enough to handle all that volume.
Respondent 24	Not in scope.
Respondent 25	N/A - not my field of expertise.
Respondent 26	Not in scope.
Question 6:	

How would you estimate the probability that the role of intermediaries is substantially reduced in the post-trade process in 10 years from now? A. 0% B. 25% C. 50% D. 75% E: 100%	
Respondent 1	100%
Respondent 2	Not in scope.
Respondent 3	50%
Respondent 4	75%
Respondent 5	50%
Respondent 6	50%
Respondent 7	75%
Respondent 8	75%
Respondent 9	100%
Respondent 10	50%
Respondent 11	75%
Respondent 12	75%
Respondent 13	25%
Respondent 14	50%
Respondent 15	100%
Respondent 16	Not in scope.
Respondent 17	Not in scope.
Respondent 18	75%
Respondent 19	50%
Respondent 20	75%
Respondent 21	75%
Respondent 22	100%
Respondent 23	100%
Respondent 24	50%
Respondent 25	25%
Respondent 26	Not in scope.

C. General questions

Question 7: What are your general views regarding the tech-driven initiatives to improve bond issuance efficiency (i.e. Ipreo, Project Mars and EDDI)?	
Respondent 1	It probably helps to bring investors and issuers together without intermediaries, such as a b-2-b platform.
Respondent 2	Not in scope.
Respondent 3	IPREO is the main driver at the moment. New player will step in the market especially on the buy side.
Respondent 4	Not in scope.
Respondent 5	Not in scope.
Respondent 6	Not in scope.
Respondent 7	They provide value for quicker analysis and data retrieval.
Respondent 8	Project EDDI should also consider how to connect the new set-up and existing market infrastructure in order to maximize the effect.

Respondent 9	In my opinion, these initiatives are good starting points to greatly disrupt the DCM business we have today. The question is whether new disruptions like Blockchain DCM transactions will make banks as intermediaries obsolete. I think that the focus of banks will shift from the complete technical execution of trades to an integrated advisory approach (like in M&A, Corporate Finance Advisory).
Respondent 10	There are a lot of further clarification regarding how EDDI can integrate into the complex legislative and fiscal systems within EU.
Respondent 11	Can have a significant impact for future technology adoption like AI, Blockchain or Machine learning.
Respondent 12	They could bring issuer and the potential Investors more closely together, with consistent data and better communication tools.
Respondent 13	They could promote a standardization for the workflows especially in the pre-issuance stage.
Respondent 14	I think the initiatives started off from a common ground to promote market standardization. However, I believe multiple initiatives running in parallel will result in additional inefficiency.
Respondent 15	Not in scope.
Respondent 16	Not in scope.
Respondent 17	Not in scope.
Respondent 18	Never used it at my current bank.
Respondent 19	Bond issuance is a highly complex process. Therefore, it cannot be automated per se. In particular when markets are getting difficult, the transformation of risk cannot be automated. The marketing of transaction also plays a large role; this is also difficult to automate.
Respondent 20	Not in scope.
Respondent 21	These initiatives and platforms help to streamline the process and ultimately give smaller issuers access to the market due to lower entry hurdles (e.g. cost).
Respondent 22	They play an increasing role in the issuance business. Important.
Respondent 23	All good initiatives and more coming but at the moment it's still trying to improve on the old way of doing things rather think outside the box and do in a different way.
Respondent 24	Solid testing is needed.
Respondent 25	Not necessary in my view.
Respondent 26	Not in scope.
Question 8: How would you estimate the likelihood that an entire bond issuance will be carried out on a blockchain in 10 years from now? Please justify your answer (optional) A. 0% B. 25% C. 50% D. 75% E: 100%	
Respondent 1	75%. Please justify your answer (optional):

	In markets like these and for frequent issuers bond issuance can be carried out via new platform. Similar to auctions already today. But what will happen once volatility increases (like in the aftermath of Lehman bankruptcy). The execution risk could significantly increase. Big global investors could become too powerful in the issuance process going forward. Intermediaries are regulated, serve both issuers and investors and soften execution risk and volatility.
Respondent 2	75% Please justify your answer (optional): Amongst others, Blockchain Technologies can automate post trade e.g. via Smart Contracts
Respondent 3	100% Please justify your answer (optional): We saw already first movements. The market is not yet prepared but within the next years the bond issuance process will change completely, and the interesting point will be: what is the banks role?
Respondent 4	50% Please justify your answer (optional): Also this market / technologies need to be regulated
Respondent 5	75% Please justify your answer (optional): Technology can have a disruptive effect
Respondent 6	50%
Respondent 7	25%
Respondent 8	75%
Respondent 9	75%
Respondent 10	50% Please justify your answer (optional): Still a lot to work on the legal perspective.
Respondent 11	100%
Respondent 12	100%
Respondent 13	75%
Respondent 14	50%
Respondent 15	25%
Respondent 16	Not in scope.
Respondent 17	Not in scope.
Respondent 18	50%
Respondent 19	50% Please justify your answer (optional): Bond transactions tend to become more complex rather than standardized. Looking at green bonds, it entails an entire new process that has been developed. The same is true for hybrid bonds or liability management, where outstanding bonds are bought back.
Respondent 20	75%
Respondent 21	75% Please justify your answer (optional): Blockchain will play a massive role in the issuance process most importantly the allocation and

	booking/delivery/payment processes. However, pre-issuance could stay a more human (face to face) process at least in situations where issuers try to place certain kind of bonds or "unpopular" maturities for the first time.
Respondent 22	0%
Respondent 23	50% Please justify your answer (optional): 10 years is not a long time and if there is no major initiative from regulators and the C-level to change their way people will just keep doing how they use to. It will be a gradual change unless a major initiative is undertaken across the whole sector.
Respondent 24	25%
Respondent 25	0% Please justify your answer (optional): Things adjust slower in financial sector as one thinks.
Respondent 26	Not in scope.
Question 9: Are you working for: 1) A private financial entity or a public financial entity? 2) An issuer, a primary dealer, an investor, or others? Please specify your role in your organization.	
Respondent 1	1) private 2) primary dealer Your role in your organization: syndicate
Respondent 2	1) Private Your role in your organization: Sales
Respondent 3	1) Others Your role in your organization: Project Management
Respondent 4	1) Bank 2) Primary dealer Your role in your organization: DCM Origination
Respondent 5	1) Private 2) Investment bank Your role in your organization: KYC officer
Respondent 6	Respondent skipped this question.
Respondent 7	1) Private 2) Investment bank Your role in your organization: DCM Origination
Respondent 8	1) Private 2) Securities services - Middle office Your role in your organization: Processing
Respondent 9	1) Bank 2) Primary dealer Your role in your organization: DCM Origination
Respondent 10	1) Private 2) Custody middle office Your role in your organization: Tax Operations

Respondent 11	1) Private 2) Primary dealer Your role in your organization: Sales
Respondent 12	1)Private 2)Investment bank Your role in your organization: Sales and client service
Respondent 13	1) Private 2) Investment bank Your role in your organization: Origination
Respondent 14	1) Private. 2) Primary dealer. Your role in your organization: Bond origination.
Respondent 15	1) Private financial entity 2) Others Your role in your organization: Analyst
Respondent 16	Prefer not to say.
Respondent 17	Prefer not to say.
Respondent 18	1) Private financial entity Your role in your organization: Analyst
Respondent 19	1) Private 2) Bank/underwriter Your role in your organization: green bond specialist
Respondent 20	1) Private 2) Securities services Your role in your organization: Client Servicing
Respondent 21	1) Private Financial Institution 2) Data Specialist Your role in your organization: Head of e-Trading
Respondent 22	1)Public entity 2)Issuer Your role in your organization: Quantitative analyst
Respondent 23	1) Private Financial entity Your role in your organization: CEO
Respondent 24	1) Senior investment officer 2) risk management
Respondent 25	1)Public financial entity 2)issuer Your role in your organization: Funding Officer
Respondent 26	Prefer not to say.
Question 10: How would you estimate the impact of technical innovation on the role and work processes where you are involved?	
Respondent 1	Data mining and assessment thereof becomes more important to advise issuers. Volatility will increase and importance of intermediaries will shrink and/or will shift to a few global operating banks (and/or big global Asset Managers) which could lead to oligopoly structures.
Respondent 2	Innovation will Change a Lot in the future.

Respondent 3	There is no impact in my role, because I work already on digitalization project. The role will be even more exiting
Respondent 4	Simplification of processes, easier store of information:
Respondent 5	1. If in the same ledger with regulators, data vendors and all golden source providers, it will be easier for us to access to a consolidated and complex data package. 2. If the KYC is outsourced to a third-party service provider, we will probably lose our job since we are no longer required by clients.
Respondent 6	There will be fairly high impact.
Respondent 7	It can have significant impact in efficiency with automation.
Respondent 8	We would provide better asset-servicing to the clients and reduce manual workflows.
Respondent 9	I think that technical innovations will mainly impact Junior roles as well as syndicate functions. The more senior and relationship focused positions will not be impacted much.
Respondent 10	Workflows will be more streamlined with technology development.
Respondent 11	Better access to the investors.
Respondent 12	We would have better Access to the targeted Clients and some workflows to generate documentation should be automated in a secured way.
Respondent 13	We would have a market-wise toolkit for any Information generation.
Respondent 14	Technical Innovation will definitely result in streamlining of the process and administrative workflow, and at the same time the role of origination will be more client-oriented and require better understanding of the Client Needs than machines.
Respondent 15	On the scale of 1 to 10, I believe 30% of the work can be fully automated in a time period of 5 years.
Respondent 16	Not in scope.
Respondent 17	Not in scope.
Respondent 18	No settlement or payments are carried out by front office teams, it would rather help middle officers.
Respondent 19	In green bonds, the analysis of the investor base is crucial. There is currently no system in place that lets banks or issuers differentiate the ESG criteria of an investor. This process needs to be looked at in terms of technical innovation.
Respondent 20	The functions of middle and back office will gradually be weakened due to the technology development, especially the manual process must be automated to reduce the operational and admin costs.
Respondent 21	Technical innovation especially implementation of smart analytics will boost the importance of the processes and teams working around trade/client/competitor analysis.
Respondent 22	Not in scope.
Respondent 23	High.
Respondent 24	High.
Respondent 25	Low.
Respondent 26	Not in scope.

Appendix 2 Weighted Average Results of Rated Questions in the Survey

1. Pre-issuance Section:

How would you estimate the necessity/importance of improving documentation workflow, by creating a standardized market-wise common platform/interface for data recording, storage, and sharing?

Choices	%	Participants	Weighted Average
0% (not at all important)	0.00%	0	0
25% (slightly important)	7.69%	2	1.9%
50% (important)	23.08%	6	11.5%
75% (fairly important)	50.00%	13	37.5%
100% (very important)	19.23%	5	19.2%
No opinion	0.00%	0	0.0%
Sum	100.00%	26	70.19%

2. Post-trade Section:

How would you estimate the probability that the role of intermediaries is substantially reduced in the post-trade process in 10 years from now?

Choices	%	Participants	Weighted Average
0%	0	0	0.0%
25%	9.1%	2	2.3%
50%	31.8%	7	15.9%
75%	36.4%	8	27.3%
100%	22.7%	5	22.7%
Sum	100.00%	22	68.18%

3. General Questions Section:

How would you estimate the likelihood that an entire bond issuance will be carried out on a blockchain in 10 years from now?

Choices	%	Participants	Weighted Average
0%	8.7%	2	0.0%
25%	13.0%	3	3.3%
50%	30.4%	7	15.2%
75%	34.8%	8	26.1%
100%	13.0%	3	13.0%
Sum	100.000%	23	57.61%

Appendix 3 Survey Participants' Profiles

No.	Institutions	Role of Institutions	Individual Role
1	Private	Primary Dealer	Syndicate
2	Private	Investment Banks	Sales
3	Other	Investment Banks	Project Management
4	Private	Primary Dealer	DCM Origination
5	Private	Investment Banks	KYC Officer
6	N/A	N/A	N/A
7	Public	Primary Dealer	DCM Origination
8	Private	Custody Middle Office	Processing
9	Private	Primary Dealer	Syndicate - Intern
10	Private	Custody Middle Office	Tax Operations
11	Private	Primary Dealer	Sales
12	Private	Investment Banks	Sales
13	Private	Primary Dealer	DCM Origination
14	Private	Primary Dealer	DCM Origination
15	Private	Other	Analyst
16	N/A	N/A	N/A
17	N/A	N/A	N/A
18	Private	Other	Analyst
19	Private	Primary Dealer (Underwriter)	Green Bond Specialist
20	Private	Securities Services - Middle Office	Client Servicing
21	Private	Data Specialist	Head of E-trading
22	Public	Issuer	Quantitative Analyst
23	Private	N/A	CEO
24	N/A	Senior Investment Officer	Risk Management
25	Public	Issuer	Funding Officer
26	N/A	N/A	N/A

* N/A: Not Available

Statement of Certification

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Frankfurt am Main, 26/09/2019 — City, Date

Wanli Chen, Qianxia Wang. — Author's Signature