Blockchains and the Credit Underwriting Process in the Banking Sector

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Abstract

The future banking landscape is being shaped with new business models, rising customers' expectations and more stringent regulations. In bank lending, the demand to deliver almost instant credit responses while keeping loans quality and compliance will increasingly pressure credit underwriting. In this context, technology will play an important role. Some of them may become central, as is the case of blockchain. This dissertation brings both subjects together. It aims to identify and discuss opportunities to enhance bank's credit underwriting through the use of blockchain technology.

The data for the study was collected from semi-structured interviews conducted with experts in credit and/or blockchain from different countries. The data collected was analysed through Thematic Analysis as per Braun & Clarke (2006).

The results show that, according to the study participants, there are opportunities in two areas of the process: compliance and financial risk analysis. By enabling the share of KYC processes and other mandatory checks between financial institutions, blockchain can help credit areas to meet compliance obligations. By promoting the share of customer data and facilitating the access to collateral records, blockchain can improve the financial risk analysis. Consortiums to explore blockchain technology will be a trend and cooperation between banks will pave the way for the future (instead of competition). Challenges and concerns are also raised. For the participants, the settle of some foundational elements will be a critical factor of success.

The findings of this study may be of great significance for the Banking Industry since it is the first time the potential of blockchain technology is looked at from the perspective of credit underwriting and opportunities in this field are discussed at the same time. If implemented, such opportunities may bring enormous gains in efficiency and cost savings.

Keywords: Blockchain, Credit Underwriting, Banking.

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Contents

List of Abbreviations

AI	Artificial Intelligence
AML	Anti-Money Laundering
APAC	Asia Pacific
API	Application Programming Interface
B3	Brazilian Stock Exchange
BIS	Bank for International Settlements
CBDC	Central Bank Digital Currency
CERC	Receivables Central
CIP	Interbank Payments Chamber
CRDC	Credit Rights Records Center
CTF	Counter Terrorist Financing
CEE	Central and Eastern Europe
DLT	Distributed Ledger Technology
EC	European Commission
EMEA	Europe, Middle East and Africa
EU	European Union
FI	Financial Institution
FinTech	Financial Technology
GDPR	General Data Protection Regulation
ICO	Initial Coin Offerings
IoT	Internet of Things
IT	Information Technology
KYC	Know Your Customer
LATAM	Latin America
OECD	Organisation for Economic Co-operation and Development
PSD2	Second Payment Services Directive
PwC	PricewaterhouseCoopers
UCC	Uniform Commercial Code

Chapter 1

Introduction

1.1 Background of the study

Banks perform several roles in the economy. They are often described as intermediaries between savers and users of the capital (Allen et al., 2008). As financial agents, banks need to measure several risks when they attract available financial resources, in the form of deposits, and sell to the ones that demand, in the form of a credit. To decide if the risk of lending is going to be accepted, banks usually rely on Credit Underwriting Processes.

Many variables are considered in the process. Banks need to know how trustworthy the borrower is, generally looking at the proponent's credit history. Other essential variables are the cash flow and the ability to repay the debt, the applicant's capital and leverage level, if any collaterals are being offered or can be required, the conditions of the market, the purpose of the loan and how the money is going to be applied. Not less important is to properly identify the customers, to prevent frauds and to assure that the customer is not involved with money laundry or other illicit activities, in order to comply with regulations.

The risk assessment is based on information collected from several sources: the borrower, internal databases, public repositories, credit agencies and even competitors. The access to the information may sometimes be very costly. This is the case of the information obtained from the credit agencies or bureaus, intermediaries which centralize information, compile them and generate reports and credit scorings to help the banks in the credit decisions. Just in 2019, Experian, Equifax and TransUnion, some of the bureaus with global presence, reported together revenues over $10 billion (Experian, 2020; Equifax, 2020; TransUnion, 2020), which are

basically the fees paid by the banks and other financial institutions.

Banks' risk management has considerably changed in the last decade. Harle et al. (2016) highlight trends which are shaping this bank activity. Regulations will continue to expand and deepen, customers' expectations are rising in the same vein as changes in technology, technology and analytics are evolving, new risks are emerging (e.g. cybersecurity risk) and pressure to reduce costs will continue. According to the authors, "customers will expect access to services at any time on any device, personalized propositions, and instant decisions" (Harle et al., 2016). To be prepared for these challenges, banks are heavily investing in new technologies. Big data, Machine Learning and Artificial Intelligence are just some of them (OECD, 2018a).

Blockchain, the most known form of distributed ledger technology (DLT), is another one. Although many still associate it just with cryptocurrencies like Bitcoin and Ethereum, it is, in fact, being explored for several other purposes, like the creation of digital identities, land registry, management of health records, tracking of goods in supply chains, to cite some (OECD, 2018b; OECD, 2019b). Within the banking industry is not different. There are several projects ongoing, which intend to modernise payments, improve the financial flows worldwide, facilitate trade-finance operations, manage syndicated loans and reduce settlement time, among others (Hassani et al., 2018).

In this context, cooperation seems to be a key word. There are several examples of initiatives taken from banks in partnership with other banks and organizations in order to explore and use the technology (Crosby et al., 2016; Rega et al., 2019). The formation of consortiums is an evidence of that (Rega et al., 2019). In a recent report issued by Deloitte, the authors go beyond: new partnerships and alliances can become imperatives for banks to survive in the next decade (Srinivas et al., 2020).

Considering the trends and challenges involving the future of bank's risk management and the main features of blockchain, such as immutability, decentralization, transparency and security, could the technology be used to enhance the credit underwriting process in banks? This is exactly what this study aims to find out.

Experts in credit and/or blockchain from different countries were interviewed. They are high

qualified professionals, with a large background in Financial Services. From their answers, it was possible to collect innumerable and meaningful insights, which fed the analysis and discussions conducted in this dissertation.

1.2 Rationale and Objective of the Study

A new wave of disruption, much more powerful than the one witnessed in the last years, will likely unfold the next decade and technology will be one of the drivers for the changes. This wave will also impact how banking is done (Srinivas et al., 2020). Some technologies may become central in this process, as is the case of blockchain. It can radically change the way information is shared and introduce a great level of automation, security and privacy control into many processes (World Bank Group, 2019). The initiatives in banks aim to gain operational efficiencies, reduce costs, enhance risk and compliance management and improve the customer experience (Cocco, 2017; Hassani et al., 2018). Some estimate blockchain can save billions, not just for banks, but also for consumers (Tapscott & Tapscott, 2017).

There is a plethora of literature which explore the use of blockchain in several banking business lines, such as trade finance, payments, capital market & fund management, and document management, but nothing dedicated to analyse how the technology could impact Credit Underwriting, which is a core area for banks. At a first glance, it seems that there are several opportunities. In this process, the collection of data is crucial to evaluate the creditworthiness of the customers. A great portion of the data required is the same for all the banks. If blockchain can change the way the information is shared, how could it be applied in this area? Could it incentivize cooperation between banks? The fees paid to get information sometimes consume a great part of the credit areas budget. Would it be possible to reduce them using blockchain? Customers are expecting instant decisions from banks. Could blockchain improve the credit response time? Are there risks? What are the main concerns in regard to the use of the technology in this area? These were some of the doubts which instigated the conduction of this research.

This study may be of significant importance for banks, since lending practices are being strongly challenged and blockchain seems to have the potential to offer solutions which can considerably increase efficiency in this field. The research objective is, therefore, to identify and dis-

cuss opportunities created by the technology, which can improve banks' Credit Underwriting. This dissertation attempts to generate new data to help understand the potential impact of blockchain in bank lending and maybe open the door for future research.

The study will seek to answer the following question: Can blockchains enhance the credit underwriting process in the banking sector?

1.3 Outline of the Chapters

This study is divided into 5 chapters. The present chapter aims to familiarise the reader with the background of the study and to outline the objective of this research. It is followed by Chapter 2, which provides a review of the most relevant and up-to-date literature found with regards to the area of this study. It starts approaching the latest developments on FinTechs and it is narrowed down, until more specific literature is brought up, highlighting possible use cases of blockchain for credit underwriting.

Chapter 3 presents the research methodology. It outlines the underlying rationale for the research design chosen, the methods chosen for the collection and analysis of the data, the ethical considerations taken, the limitations of the study and how they were overcome. Chapter 4, which comes subsequently, presents and analyses the findings gathered from the interviews vis-à-vis the ideas outlined in the literature review .

This research concludes with Chapter 5, which provides the main outcomes of the study, final marks, conclusions, and recommendations for further studies.

Chapter 2

Literature Review

2.1 Introduction

The main objective of this review is to gain theoretical knowledge about recent works on the field of blockchain and its application in the banking sphere. It commences with an overview of the latest developments on financial technologies (FinTechs) and it is narrowed down, passing through blockchain general use cases, blockchain in financial services until the topic blockchain in banking is reached. It ends up with a discussion on possible use cases of blockchain in banks' credit underwriting.

2.2 FinTechs – Latest Developments

Advancements in technology have been profoundly reshaping financial services in the last years. The so called "FinTechs" are enabling the transformation of business models, improving the consumer experience and completely changing the way financial consumers interact with financial services providers. The Financial Crisis may have accelerated the development of FinTechs (Haddad & Hornuf, 2019; Arner et al., 2017; Philippon, 2016). After the crisis people lost confidence in traditional banks. Credit became more scarce and costly. Regulations became tougher for banks and that led to higher intermediation costs (Darolles, 2016; Arner et al., 2017). The need for alternative financing sources and lower financial costs paved the way to new entrants. This is where many FinTechs came into play.

The latest developments in FinTech are associated with emerging technologies as Big Data, Internet of Things (IoT), cloud computing, Artificial Intelligence (AI), biometric technologies, augmented/virtual reality, Application Programming Interface (API) and DLTs (Philippon, 2016; OECD, 2018a). They have increasingly been used together to deliver solutions in several financial fields as payment services, investment, trading, funding and lending, insurance, among others (OECD, 2018a; Srinivas et al., 2020).

In payment services the changes are noteworthy. Utilizing online or mobile services, payments that were previously made via cash, cheques or cards are being now made remotely (FinCoNet, 2016). According to Statista, around 42% of the worldwide population had a smartphone in 2019 (Plecher, 2020; O'Dea, 2020). Online-only banks (or neobanks) and technological companies, such as Apple and Google, are new players in the market (Romānova & Kudinska, 2016). They are attracting customers by offering payment services, even cross-border, in a faster, more tailored and cheaper way (EC, 2015; FinCoNet, 2016). Cryptocurrencies, which have DLTs as underlying technology, are also a recent phenomenon. The first one, the Bitcoin, was launched in 2008 (Nakamoto, 2008) and currently there are around 2,700 of them (CoinMarketCap, 2020).

In lending and funding, FinTechs are making credit more accessible, especially for customers that struggle to get it from traditional lenders. Small enterprises are examples of such customers (Barkley & Schweitzer, 2020; Lipman & Wiersch, 2015). According to the 2019 Federal Reserve's Small Business Credit Survey, the percentage of small firms that applied for online (nonbanks) lending in 2018 was of 32%, versus 24% in 2017 and 19% in 2016 (Federal Reserve, 2019). Many online lenders use peer-to-peer platforms to connect borrowers and lenders. For the customer risk assessment, these platforms are using alternative data (like social media), big data, machine learning and AI (Lipman & Wiersch, 2015; Balyuk & Davydenko, 2019; Jagtiani & Lemieux 2019).

Insurance is another sector impacted by technology advancements. Mobile phones and APIs are improving the interaction between customers and insurance companies (Lee et al., 2007; OECD, 2017). Telematics (IoT domain) is being used for tracking or monitoring purposes, enabling the offer of a new range of products and fairer calculation of premiums (Azzopardi & Cortis, 2013; Eling & Kraft, 2020). And this is not just in auto insurance, but also in health, in association with wearables tech, in household, through the use of cameras and sensors to

detect fire, leaks, etc, and in transport insurance (Eling & Kraft, 2020; OECD, 2017).

Through the use of AI, robo-advisors are helping customers to choose the best investment options (Belanche et al., 2019; OECD, 2018a). Big data analytics and the IoT are helping businesses to identify revenue and/or cost savings opportunities (OECD, 2018a; Camilleri, 2020). Online and mobile activities of consumers are being tracked and used to better target the markets (Camilleri, 2020). Big data and AI are being used for fraud detection (Kuzmanova, 2020). The list of new FinTech developments is endless.

In spite of all the advancements, FinTechs raise some challenges and concerns. Regulation has been a great challenge (Philippon, 2016). Some question if the rules applied to mature players should also be applied, for instance, to small FinTech businesses (Darolles, 2016). Taking as a premise that regulation should be technology neutral, how to guarantee a fair competition among the financial players without discouraging innovation (OECD, 2020)? The recent introduction of PSD2 (Second Payment Services Directive) and Open Banking in the European Union (EU) are examples of recent changes in regulations towards the creation of a more egalitarian financial market (Zachariadis &Ozcan, 2017).

The compliance with Anti-Money Laundering (AML) and Counter Terrorist Financing (CTF) laws is a major concern (Duhaime et al., 2019). Whereas in some cases technology is helping to identify such crimes, on the other hand, some FinTech providers are not even asking for the customer's address to commence the relationships. The Know Your Customer (KYC) due diligence was never so important (Darolles, 2016; OECD, 2018a). Consumer security and privacy is another concern (Kshetri, 2013; Kshetri, 2014; Gai et al., 2018). Big data is helping consumers to get better products and prices, but the high and concentrated volume of data is also appealing for hackers (Gai et al., 2018). Data breaches can expose sensitive data of people and cause deep economic and social harms. According to a recent survey performed by PricewaterhouseCoopers (PwC), security, compliance and data privacy risks are considered the top challenges to FinTech growth (PwC, 2019).

2.3 Blockchain Use Cases

Out of the several new technologies which emerged in the last years, there is one that has the potential to deeply transform business models, especially due to its peculiar features. DLT, or Blockchain, the most used form of DLT, can improve the efficiency of several activities and services (OECD, 2018a; OECD, 2019a; Varma, 2019).

Disintermediation, decentralization, trust, tamper-proof, peer-to-peer, immutability, traceability, smart contracts are all words associated to the blockchain jargon which are used to explain how the technology works (Nakamoto, 2008; Ellul & Pace, 2019). Blockchain is best known for the technology behind the cryptocurrencies, but, in fact, it is being adopted by several other sectors of the economy.

In the Public Sector, according to the Organisation for Economic Co-operation and Development (OECD), there are more than 200 blockchain initiatives launched around the world, involving more than 50 countries (OECD, 2018a). Several use cases have been explored. One of them is the establishment and management of digital identities for citizens. The ID2020 Project, which is a partnership between the United Nations, private companies as Microsoft and Accenture, and foundations as the Rockefeller Foundation, is an example of that (OECD, 2018b). Through the use of a blockchain-based platform and an API, it aims to provide an official identity for people who currently live without one. Another use case is in land title registry (Berryhill et al., 2018). To cite an example, the Republic of Georgia implemented in 2016 a blockchain-based system to avoid illegal alterations usually done by government agencies on the land records (Shang & Price, 2019). Another field pursued by governments is the management of citizens personal data, like health records. In 2017 the government of Estonia signed a deal with the startup Guardtime to develop a system using blockchain to secure the health records of nearly 1 million Estonian citizens (Heston, 2017). The main challenges of government initiatives stem from the privacy and security concerns of people (OECD, 2018a).

In supply chain, blockchain has been used for product traceability, to share information and improve transparency between players (OECD, 2019b). There are several initiatives ongoing. Using an IBM's blockchain solution, Walmart is tackling food. The first pilots involved the track of pork in China and mangoes in the Americas (Kamath, 2018). Bytable Inc., a blockchain

food traceability company, is tracking organic, free-range, and pasture-raised eggs, from farm to consumer, for an American brand (Bumblauskas et. al, 2020). Some challenges in this field are the impossibility to control the quality of the data entered into the system, the informality of some players and the lack of incentives for the technology adoption (OECD, 2019b).

2.4 Blockchain in Financial Services

A variety of possible use cases has been explored in financial services. According to the Bank for International Settlements (BIS), 70% of the Central Banks around the world are looking at central bank digital currencies (CBDC) and most of them are evaluating the use of DLT as the underlying technology (Barontini & Holden, 2019; Varma, 2019). The Eastern Caribbean Central Bank, for instance, already launched a pilot (ECCB, 2019). There are, however, design decisions that still need to be taken (e.g. distribution, governance, balance between privacy and transparency) and risks that need to be addressed (Bouchaud et al., 2020).

Blockchain has also been used in fundraising. Through Initial Coin Offerings (ICOs), or token sales, entrepreneurs have been able to raise capital to finance projects (Martino et al., 2019; Momtaz, 2020). At the time of this writing, there were 5,726 projects published which raised $27 billion so far (ICOBench, 2020). As any new business model, ICOs imply some risks, like the uncertainties in regard to which regulatory framework applies, lack of investors protection mechanisms and the high volatility of cryptocurrencies (OECD, 2019c; Tapscott & Tapscott, 2017).

In Insurance blockchain is being exploited to streamline the payment and claims management, reducing dependence on third parties and costs (Grima et al., 2020; Popovic et al., 2020; Gatteschi et al., 2018). Another use is to prevent frauds. It is estimated that 5 – 10% of insurance claims are fraudulent (Mckinsey, 2017). By working as a cross-industry, blockchains can help, for instance, to identify claims that are made to multiple insurers at the same time, involving an only forged accident (Grima et al., 2020; Mckinsey, 2017). In spite of the benefits, there is still some resistance in this industry for the technology acceptance. The survey conducted by Grima et al. with insurance professionals in Europe reveals that whereas the openness is high, people more aware about the technology are still reluctant to adopt it in their businesses

(Grima et al., 2020).

Another potential field for the implementation of DLTs in finance is on KYC (Polyviou et al., 2019; Higginson et al., 2019a). This is a mandatory process which involves paperwork and can be very challenging, costly and time-consuming (Walker, 2018; Hassani et al., 2018). Parra-Moyano et al. (2019) propose the formation of a consortium of financial institutions (FI) to create a private blockchain-based system that allows the KYC process of a specific customer to be shared among the FIs that operate with the customer, and, obviously, the inherent costs. The solution involves some assumptions such as, all the FIs need to work under the same regulatory framework, a common cost would have to be agreed, etc, but it can potentially solve all of the problems previously mentioned and guarantee dynamic updates of the consumer profile. The idea of standardizing and sharing a single KYC record by client, mutualizing the efforts to conduct the due diligence is also present in Reuters (2017) and Sachs (2016). The implementation of KYC solutions enabled by the blockchain technology depends on various factors as regulatory reforms to support blockchain-based applications, appropriate infrastructure, standardization of processes regarding customers identity verification and open access to data, especially primary sources (Walker, 2018; Sachs, 2016).

2.5 Blockchain in Banking

The initiatives in Banking aim to use the blockchain technology to gain operational efficiencies, reduce costs, enhance risk and compliance management and improve the customer experience (Cocco, 2017; Hassani et al., 2018). HSBC Group, for instance, has been researching and testing blockchain ideas since 2015. In 2018, using R3's Corda scalable blockchain platform, the bank issued a letter of credit to ING Bank to guarantee a trade finance transaction of the agriculture giant Cargill (HSBC, 2018; Hassani et al., 2018). The paper-based conventional process usually takes 5-10 days. This one took 24 hours. In 2018 J.P.Morgan Chase & Co launched the IIN (Interbank Information Nework) Project to develop an ecosystem of bank users using a blockchain platform to improve and speed up cross border payments. Currently more than 330 banks have signed up to be part of it (Business Wire, 2019). In November 2018, the Spanish BBVA reported that a €150 million syndicated loan was settled utilizing its DLT-based platform (Karppinen 2018). The negotiation involved two other lenders, the French

BNP Paribas and Japans MUFG bank, the beneficiary, Red Electrica Corporation (operator of Spain's national grid), and two legal advisor companies. The use of DLT increased trust, since all the activities were available to the six parties involved at any time. Hassani et al. (2018) cite many other examples involving banks of several jurisdictions.

These examples suggest that banks are increasingly working together with other banks and institutions to find solutions enabled by DTLs (Crosby et al., 2016; Rega et al., 2019). An evidence of cooperation may be the formation of consortiums. The R3 Consortium is one of the most influential among them (Guo & Liang, 2016), currently working with more than 350 partners among financial institutions, regulators, technology companies, etc to set up blockchains utilizing Corda, its distributed ledger platform (R3, 2020; Brown, 2018). We.trade and Batavia are examples of blockchain-based platforms developed by consortiums between banks (Rega et al., 2019). It is not clear, however, to what extent this cooperation will go, especially considering the high level of competition of the sector. For Harris & Wonglimpiyarat (2019) and Carson et al. (2018) this is important, because resolving the "coopetition" paradox, i.e. the bank's pursuit of competitive or collaborative strategy, can define the future banking landscape.

Despite the large investments made so far by banks in the blockchain technology, none of the initiatives have been implemented at scale (Higginson et al., 2019a; Deloitte, 2017). The setup and operating costs, the need of common standards, cybersecurity, regulation, scalability, integration of procedures and behaviour change are some of the challenges being faced by banks, as pointed out by various authors (Hassani et al., 2018; Crosby et al., 2016; Deloitte, 2017). Another possible hindrance for a wider adoption of the technology in banking may be the dilemma between the offering of cheaper services and a possible reduction of revenues (Higginson et al., 2019b; Hassani et al., 2018).

2.6 Blockchain and Banks' Credit Underwriting

Blockchain is enabling the development of initiatives in several banking business lines. Just a few authors, however, look at the technology from the perspective of credit. Guo & Liang (2016) believe blockchain can help to address some issues in this field. The first issue is scarcity and poor quality of data for the credit analysis. That can lead banks to deny credit or manage

delinquencies. Another difficulty is inter-institutional data sharing. The third one is the unclear ownership of data. For the authors, blockchain can upgrade and transform banks' credit systems, by promoting the share of data between institutions and establishing data ownership. For Seiffert-Murphy (2018) areas that require extensive work in exchanging information are excellent targets for the application of blockchain solutions. That is why the author also sees opportunities for the application of the technology in the credit area.

In the absence of literature more specific on credit underwriting and blockchain, the closest literature to this study is the one which assesses components of the process.

One of the activities performed during the credit underwriting which can possibly be benefited by blockchain technology is the KYC due diligence. Indeed, the literature is vast in this field, as previously mentioned (Polyviou et al., 2019; Higginson et al., 2019; Walker, 2018; Hassani et al., 2018). McKinsey & Company estimates that the use of blockchain solutions for customers onboarding, regulatory compliance and reduction of fraud losses, could save by $9.5 to $13 billion for retail banks globally (Higginson, 2019a). A digital fingerprint could be used by the customers as a unique identifier, who would use it to submit applications or prove identity (Higginson, 2019a). Nevertheless, although many experiments are in place, just a few projects were implemented and no one at national level.

Since disintermediation is one of the features of blockchain, one may also find in the technology an opportunity to reduce the dependence on credit bureaus. Currently, these companies act as intermediaries. They compile data from several sources and sell them in the form of reports or credit scorings in order to facilitate banks' decisions (Ortlepp, 2019; Kafshdar Goharshady et al., 2018). Some of the Credit Bureaus that have a global presence are Experian, Equifax and TransUnion. Together they reported revenues over USD 10 billion in 2019 (Experian, 2020; Equifax, 2020; TransUnion, 2020). These are basically the fees paid by banks to access the customers data needed to carry out the current lending activity of many institutions. Since they concentrate a large volume of customer data, these agencies also raise some concerns. In 2017 Equifax breach compromised 143 million Americans' private records (DiGrazia, 2018). Some authors believe blockchain-based platforms might improve the process of collecting customer data, by allowing the exchange of data and the creation of an interconnected ecosystem between banks. That could allow the creation of common credit scores, speed up the credit

decisions, make the process more up to date and less vulnerable to frauds (Higginson et al., 2019a; Swam, 2017; Hassija et al., 2020).

An example of initiative which involves a credit bureau and blockchain is a project being developed by the Polish Credit Office (BIK), the largest credit bureau in Central and Eastern Europe (CEE), to implement a blockchain-based platform for the storage and secure access to sensitive customer information (Ortlepp, 2019). The bureau is owned by the largest banks of Poland and currently tracks the credit files of over one million businesses and 24 million individuals. The solution is being considered one of the world's first GDPR-compliant blockchain platforms, since the customers will be able to control their data. That can change the way customer data is collected, stored and utilised by lenders (Ortlepp, 2019).

Seiffert-Murphy (2018) cites an initiative being developed by the State of Delaware in the United States which will use a blockchain-based platform to incorporate companies and allow the track of stocks and assets in real-time. For the author, the access to platforms like this, upon customers permission, would facilitate the understanding of the companies' ownership and the requirement of collaterals in a credit underwriting process.

2.7 Conclusions

Financial Services were completely reshaped in the last years by the emergence of FinTechs. DLT, or Blockchain, its most used form, is one of them. Uncountable initiatives utilizing the technology are in progress in several fields such as digital identity, land registry, management of health records and supply chains. In Financial Services the technology is being tested by Central Banks around the world to issue digital currencies, in ICOs to raise funds for projects, in Insurance to streamline payment and claims management and to prevent frauds, to cite some use cases. Banks are also strongly investing in the technology. There are several banking business lines being benefited by initiatives which explore the technology. It seems that credit underwriting has received scant attention so far. Are there opportunities in this field? This dissertation intends to identify and discuss some of them. It aims to contribute to the Banking industry by raising ideas which can help to enhance the credit underwriting process and maybe remodel the way bank lending is being done.

Chapter 3

Methodology

3.1 Introduction

The current study aims to discover how blockchains can enhance the credit underwriting process in banking. This sector will be dedicated to explaining the methodological approach undertaken to understand the points of view and experiences of the professionals who took part in the research and how they believe blockchain will impact, or is impacting, their activities. It will include the thorough process, how the data was collected and analysed, in order to address the research question which is pertinent to the study.

3.2 Research Question and Aims

The research question guiding this study is: Can Blockchains enhance the Credit Underwriting Process in the Banking Sector?

The aim of the dissertation is to identify and discuss opportunities created by the technology, which can improve banks' Credit Underwriting. This is a very important process for banks, especially taking the premise that lending is one of the banks' primary functions. Bad quality loans may result in delinquency and, ultimately, significant losses. On the other side, in order to keep competitiveness, there will always be an interest to expand loan volumes and speed up credit responses. To face these challenges, banks are continuously looking into new ways of improving this process (Johnson, 2019). This study aims to find out if they are considering

blockchain to achieve that, by hearing from professionals that are directly involved in this field.

3.3 Underlying Rationale of Research Design

As per Trochim (2006), there are two broad methods of reasoning, which are known as deductive and inductive approaches. In the first one, the reasoning works from the more general to the more specific. In the second one, it works the other way. Deductive research mainly focuses on verifying theories, whereas inductive research focuses on building new theories. Since some ideas of how the credit underwriting process could be improved by the use of the blockchain technology were already in mind and the goal was to check if they could be confirmed or not, the approach used in this dissertation was the deductive one.

Whereas quantitative research involves the collection of data which is quantified and subjected to statistical treatment, qualitative research primarily involves discovery (Williams, 2007). Given that the subject is relatively new and the area is very specific, a qualitative research was deemed more suitable, since it would allow, through the thoughts and experiences of selected experts, develop the ideas and gain an in-depth understanding on the subject.

3.4 Participants

This study was based on a sample of 10 individuals, from four different countries: Malta, Brazil, United States and Mexico. All the participants are professionals with a large experience in the financial sector, 8 of them are currently working for banks, 6 are experts in Credit management. The degree of knowledge about blockchain is not the same. Whereas 4 of the participants are specialists on the subject, 6 of them have an average level of understanding. There were no exclusion criteria. Participants were recruited directly based on their knowledge and expertise in the field, via email. All participants are aged over 18.

Given the scarcity of professionals with qualifications in both of the fields of this research, credit underwriting and blockchain, the sample was deemed sufficient for the analysis being proposed. The small sample size allowed for a richer and deeper analysis (Clarke & Braun, 2013).

3.5 Data Collection

The data for this research was collected through semi-structured interviews. This data collection method was deemed appropriate since the aim was to collect in-depth qualitative data. During semi-structured interviews, the participants could share their own experiences and ask questions, which significantly enriched the research. The method also allowed for extemporaneous questions, based on the participants' responses.

The questionnaire, which served as guide to the interviews, consisted of a total of 7 questions that can be found attached to Appendix 4. The questions were structured based on the review of various preceding studies, where some key topics were identified. They approached themes as cooperation between banks to explore the technology, formation of consortiums, creation of a single KYC process by customer, sharing of customers' data which are used by banks for modelling credit scores and the use of blockchain to facilitate the determination of loans' collaterals.

All the interviews were carried out between 13th and 30th of September 2020. The interviews were audio-recorded. They lasted on average 45 minutes each.

3.6 Data Analysis

Data was analysed through Thematic Analysis (Braun & Clarke, 2006). In this kind of analysis, the data collected is identified and broken down into a series or correlating patterns or themes. The themes or patterns help the researcher to make inferences and address the research question (Braun & Clarke, 2006). It goes much beyond than just summarising the data collected. A good Thematic Analysis allows for insightful and meaningful results (Maguire & Delahunt, 2017).

Thematic Analysis is becoming a common analytic tool in qualitative research, specially due to its flexible nature and also for not being tied to any particular theory (Javadi & Zarea, 2016). The method allows the participants to collaborate in the research. It is also useful

for summarising key features of data, while highlighting similarities and differences. Another advantage is that it allows for both social and psychological interpretations of data (Braun & Clarke, 2006). For those reasons it was considered appropriate for the purpose of this study.

As per Braun & Clarke (2006), Thematic Analysis involves the six following steps: become familiar with the data, generate initial codes, search for themes, review themes, define themes and write-up.

In order to familiarize with the data collected, the interviews were transcribed and repetitively read. At this stage, key sentences were highlighted as to have a referral point. Following the steps of Braun & Clarke (2006), initial codes were generated, by trying to collapse data into meaningful labels. In the search for themes, the codes were grouped and potential themes were assigned to each one. In the following, the potential themes started to be reviewed and some of them were discarded due to the lack of enough data to support the analysis or because they were too diverse. In the next phase, the themes were refined and finally defined. Once the themes were set, the analysis and final report were carried out.

3.7 Ethical Considerations

An Ethic Form was filled and submitted together with supporting documents for the Faculty of Economics, Management and Accountancy Research Ethics Committee (FEMA FREC) records on June 17th, 2020 (see Appendix 1). It was endorsed by the research supervisor on June 18th, 2020.

The participants who showed interest and availability were given additional information about the data collection process through an Information Letter (see Appendix 2). Participants were also required to sign a Consent Form whereby all the terms to take part of the research were specified (see Appendix 3).

Before starting the interviews, the participants were reminded that their identity would remain confidential and anonymous. It was also reinforced that upon the completion of this dissertation the audio recordings as well as the transcripts would be deleted.

3.8 Limitations

For the recruitment of the participants, initially there was an attempt to reach, through emails, professionals who are currently working for Maltese banks. Most of the emails, however, were not answered. The ones who replied, explain that they could not entertain the request due to internal policies and confidentiality issues. Since this strategy was not successful, networks started to be explored and the geographical perimeter was amplified. That helped to overcome the initial limitation.

A second limitation was the scarcity of professionals with knowledge in both the credit and blockchain fields. Some of the participants showed a bit of resistance in the beginning, especially the credit experts with an average understanding about blockchain. For those, the questionnaire was anticipated a few days before the interview, which made them feel more comfortable to answer the questions in the following.

3.9 Conclusions

The aim of this sector was to explain the research methodology used to achieve the goals of the study. A qualitative research was deemed the most appropriate. The data was collected through semi-structured interviews. The method chosen for the analysis of the data was Thematic Analysis as per Braun & Clarke (2006). The results of the study will be presented and discussed in the subsequent sectors.

Chapter 4

Analysis and Results

4.1 Introduction

This chapter presents the results and an analysis of the qualitative data collected during the interviews. Thematic Analysis is used to identify the main themes which helped to address the research question. The results are presented, question by question, to facilitate the understanding of how the initial codes were generated. Then, the themes identified are analysed vis-à-vis the ideas outlined in the literature review.

4.2 Participants Profile

A total of 10 professionals participated in this research. They are from four different countries: 4 are from Brazil, 3 from Malta, 2 from the United States and 1 from Mexico.

All the participants are highly qualified and have a large experience in the Financial Sector. None of them have less than 20 years of work background. They are currently engaged in one of the following roles: Credit Manager, Risk Manager, Chief Risk Officer, Chief Financial Officer, Blockchain Strategy Advisor, Blockchain Specialist, Cybersecurity and Financial Technology Advisor and Academic of Insurance.

4.3 Results

4.3.1 Question 1

In the first question of the questionnaire the participants were asked to talk about the banking services or processes which, in their opinion, are going to be the most impacted by the blockchain technology. The idea was to collect the initial impressions, but also check if services/processes related to credit underwriting were going to come up in the participant's first thoughts.

The KYC due diligence was the process most cited by the participants. It was in the speeches of 7 of them. The second area most mentioned was Trade Finance (5 participants). Insurance, Payment Processing and Lending were each one cited by 3 participants. Other areas brought up were Prevention of Money Laundry (2), Prevention of Frauds (2) and Home Mortgages (1). Some participants also used more generic statements as: blockchains are going to impact areas "where there are lots of parties that need to access the same information" (mentioned by 5) or "where there are opportunities for disintermediation" (mentioned by 3). Also, "it will reduce the flow of papers" (mentioned by 3) and "it can increase the speed of doing things" (mentioned by 3).

Cooperation between banks was a topic approached by 3 participants. Sentences like "There needs to be an ecosystem. A bank cannot have a blockchain only by itself", "it will create an environment of cooperation between institutions" and "it will be used in syndicated loans, with big banks involved" were used. One, however, stated that there might be some resistance to share information: "companies might find it a little bit less agreeable to have their confidential information being shared across systems."

Concerns with privacy and data security were in the speeches of 4 participants. Some of the sentences used were: "the system needs to be trusted", "it needs to be certified by the government", "the information needs to be released upon the consumer consent" and "they used triple blind checks". Two participants expressed they have some worries about regulations. One stated that "you need to check that everything is aligned with the requirements and the regulations" and the other one cited the need of adaptations due to the introduction of Open Banking. A concern with infrastructure costs was brought up by 1 participant. For him, especially the smaller organizations, will not afford to pay them.

One participant stated that blockchain "it's not going to replace the banks systems", meaning that blockchain can be used to improve some banking processes, but not the banking core systems. The same participant argued that not always the intermediaries will be taken off and cited Forex as an example: "...you need the depositary, you need the custodian, you still need a middleman".

Finally, 2 participants suggested that they don't see too much implementation in a short time: "I find it a bit difficult to have all customers, and all those companies adopting the system in a few years. It will take a lot of time".

Some of the codes which emerged from this question were: KYC process, Trade Finance, Insurance, Payment Processing, Lending, Prevention of Money Laundry, Prevention of Frauds, share of information, disintermediation, digitalization, cooperation, data privacy, customer consent, costs, regulation, long time adoption.

4.3.2 Question 2

Technology can lead to a reduction of costs and, consequently, products and services could be offered at lower prices. That, however, can reduce banks' revenues. In the second question the interviewees were asked if this kind of dilemma could be hindering the implementation of blockchain solutions.

Most of the participants (9) stated that, in their opinion, the technology will reduce operational costs and improve profitability. Their answers were pretty much in line with the following idea: "it will give you the possibility of opening up new revenues sources". Thus, they don't believe banks are retarding the use of blockchain because they are afraid about losing revenues.

One participant initially expressed disagreement with the question's statement. In his opinion, blockchain technology will lead to an increase of costs since it is creating new risks. He cited cybersecurity risks and also that "costs are going to increase, because you will need experts, which today are scarce". Another participant also thinks costs might increase, but just in the implementation phase: "maybe initially, there will be higher fixed costs, higher overheads to

implement the technology. But the long term aim is to achieve cost savings and efficiencies."

Competition may push banks to invest in the technology, according to 2 participants. Both mentioned that Fintechs are challenging banks. One of them cited Neobanks and Challenger Banks. The other one said that collaborative strategies, such as the formation of the We.Trade consortium, will help the banks to face the competition of Fintechs.

One participant stated that there will have to be a cultural change for the technology to be wider accepted, because "people still don't know what the technology is, they still do not understand the risks and are afraid about it". For another one a possible hindrance will be the integration of blockchains with legacy systems. Maybe the statement of a third one brings together these last ideas: "banks will have to embrace the full digital transformation".

Three participants mentioned the importance of following regulations: "you have to create the environment, the legislation", "the system needs to follow under the legislation" and "European banks need to embrace PSD2".

The codes noted from this question were: costs, competition with Fintechs, collaborative strategies, cultural change, digital transformation, regulations.

4.3.3 Question 3

The third question approached cooperation between banks, like the formation of consortiums, to explore and/or use blockchain. Originally it consisted of two parts, "3a" and "3b", but since most of the participants preferred to give a unique answer, they will be analysed together.

All the participants agreed that cooperation between banks to explore and use the technology do exist and consortiums are "a good idea". One stated that "consortiums are a smart decision. It's a way of educate yourself and stay competitive." Another one pointed out that "banks that do not cooperate may be left behind." A third one said that "banks are much more willing to share information nowadays, because in the end they have an interest as well".

For two participants, although cooperation between banks is increasing, this is not something

new. One of them recalled that a few years ago the banks created a consortium to launch the Swift. And complemented: "maybe when blockchain becomes more mature, I see it replacing it [Swift]."

One of the participants highlighted that consortiums as R3 and Hyperledger Fabric are important to develop and mature the technology and that open source movements are helping to accelerate its adoption. The same participant stated that consortiums like We.Trade and Batavia, which were formed for businesses purposes, will help to amplify gains, reduce the risk of frauds and increase the offer of products.

Cooperation goes beyond banks in the opinion of 3 participants. Banks are working together with Fintechs, insurance companies and even other industries. In the point of view of 2 participants there will be more cooperation between the larger banks, whilst 1 had a contrary opinion: "consortiums will be more explored by small and mediums banks, to gain competitiveness."

Three participants approached the digital transformation in finance while commenting about banks cooperation. Some of the sentences used were "a true revolution is happening, and it is in the whole business model", "we are living in an ecosystem model, we are talking about open banking, open finance ecosystem", "data belongs to the customers and not to the banks anymore".

Competition in the financial market as a whole is fostering the use of technologies according to 3 participants. One stated that banks are always asking "what are my competitors doing, why they are doing this, what will happen if I don't do this." Thus, this is incentivizing collaboration between banks.

One participant commented that the formation of consortiums may increase "once banks gain more assurance and more comfort with the technology". The importance of having the customer consent when talking about data sharing was mentioned by 2 participants.

The codes generated from this question were: Cooperation between banks, cooperation between players, consortiums, open banking, digital transformation, competition and data privacy.

4.3.4 Question 4

In the fourth question the participants were asked to give their opinion about having a shared KYC process between banks utilizing blockchain.

The majority of the participants believe that blockchain can be used to promote the share of KYC processes between banks. The technology can significantly improve the process in their opinion. The main gains cited by the professionals were in speed (3), reduction of compliance costs (4), reduction of credit response time (2) and reduction of losses (1).

"It needs to start from digital identities". That was emphasized by one the participants to express that there will be needed the government's support. Another one added that "the digital identities are really coming".

Four participants showed more enthusiasm than the others. For one of them, "the more time passes, and the more AML becomes a bigger concern for policy makers and banks, I think the likelihood of having shared KYC processes will definitely come on stream". For another one, "this is one of the best use cases for blockchain". A third one stated: "I think sooner or later this is going to happen".

Two participants were more skeptical and revealed that they don't think that the share of KYC process is something feasible, independently of the technology which would be used for that. As a whole, various concerns and challenges were pointed out by the participants. For one participant, "the biggest problem is that it doesn't depend on one entity alone. You need the collaboration/cooperation of others". Another participant also mentioned that "not everyone is moving at the same speed or at the same direction in relation to the use of blockchain".

One participant stated that he sees some resistance from banks in terms of sharing information, but, in his opinion, that is going to change with the implementation of Open Banking regulations. Another one believes the larger banks will be less willing to share information, unless they are compensated.

Security and/or costs with security were mentioned by 4. Some of the sentences used were: "it needs to be assured that the information will not leak", "the cybersecurity framework

needs to be set" and "not all the companies can afford to pay, to have the best cybersecurity officers". Another one raised the question "which bank will be liable if there is a data breach?".

The compliance with regulations was cited by 3 participants. One stated that currently there are contradictory regulations and different requirements. The others recalled that all needs to be done on the basis of consumer consent.

One commented that she has some concerns regarding administration, the governance around it.

From question number 4 the following codes have emerged: shared KYC processes, digital identities, access to data, governments support, different directions and speed, compensations, regulations, security, costs, governance, skepticism.

4.3.5 Question 5

In question number 5 the participants were asked to give their opinion about the creation of consortiums or networks between banks to share customers' information utilizing the blockchain technology. They were also asked about the possible use of a common credit score and if blockchain could help to reduce the dependence on credit bureaus.

Nine participants are favourable to the idea of sharing information between banks to facilitate the credit underwriting. That would streamline the process bringing more efficiency and speeding up decisions, according to most of them. Five participants mentioned that Open Banking is going to promote the share of information and three of them believe blockchain is a technology which could be used for that.

The use of a common credit score, however, have not convinced most of the participants. They would prefer to collect the information and use it in their own scoring models. One justified his opinion stating that "each bank has its particular appetite for risk, defined according to specific guidelines".

Five participants argued that for them not just blockchain, but the combination of Open Banking, AI, machine learning, big data and other tools can threaten the credit agencies or even

make them obsolete.

One of the participants immediately brought up concerns with data privacy regulations: "The risks of having something like this are so large, given the fines that are given for GDPR in those areas". Contrarily, for 1 participant blockchain could be used as a mechanism to help to control the use of personal data.

Two participants pointed out governance concerns. "There should be something in between; who is the person who is responsible?". Three participants mentioned security concerns. Some of their statements were: "you need to have systems that are secure enough" or "we are talking about a high concentration of data and sensible data." Three participants noted that new regulations are empowering customers. Some commented that customers might not be willing to authorize the share of their data and that this is something that will have to be overcome. Two cited more resistance from the older population.

The codes which emerged from this question were: sharing of information, open banking, data privacy, governance, security, customer empowerment, common credit scoring, credit agencies, Open Banking, combination of technologies.

4.3.6 Question 6

Question number 6 was about the use of blockchain to manage assets. Participants were asked if that could help to determine collaterals in a credit underwriting process.

There was a consensus at this point, being all the participants in favour of initiatives like this.

One of the participants cited a real case recently implemented in Brazil, which uses the R3's Corda blockchain platform, to register and monitor receivables and, in this way, prevent the use of the same collateral to guarantee more than one loan. Following the same line, another participant mentioned that a system to manage receivables would help her institution, since large amounts of credit are released to dealers through discount of receivables.

For another one it would help with mortgages over properties. He commented that the process

in his country is still very paper based and time consuming.

A blockchain based system could also help to determine the value of an asset that will be accepted as collateral, according to another one: "If we could know the history of a tractor, trace down the ownership, then we could better evaluate its value."

The main benefits of having a blockchain-based system to track collaterals pointed out by the participants were: reduction of risks (4 participants), faster decisions (3), transparency (2) and increase of efficiency (1).

Some of the codes raised from question number 6 were: loans' collaterals, tracking of assets, tracking of collaterals, registry of receivables and land registry.

4.3.7 Question 7

The last question was an open question to give to the interviewees the opportunity to bring up other ideas that would involve blockchain and the enhancement of the credit underwriting process in banks.

Three participants repeated that they see opportunities on the management of assets. Two of them added that it would be useful not just for determining the collaterals, but also to monitor the risk, after the credit is granted. Another one reinforced the utility of having a system to verify land ownership. Two participants suggested the use of blockchain as a repository of financial statements, but one of them, also pointed out that it would be necessary to define who would validate them.

Some other thoughts not directly connected with credit underwriting were the use of blockchain in Collections (2 participants), storage of documents (1 participant), in audits and controls (1 participant).

The codes noted from the last answers were: tracking of collaterals, risk monitoring, repository of financial statements and Collections.

4.4 Analysis

After the generation of the initial codes, they started to be interpreted and sorted, in the search for themes. Some of the codes were discarded, since they would not help to address the research question, as for example, "trade finance", "payment processing" and "collections". Some were combined and transformed until they ended up as themes or sub-themes, as for instance, "data privacy", "data breaches", "security", "regulations", "cultural change" and some others resulted in "challenges and concerns".

As soon as the themes and sub-themes were identified, their names were reviewed and refined, in order for the essence of each one to be captured. In the following, each theme is addressed in turn and analysed with reference to the main ideas extracted from the literature.

4.4.1 Themes

The table below introduces the key themes and sub-themes identified and gives to the reader an idea of how the codes helped to define them.

Codes	Themes	Sub-themes
KYC Process		
Prevention of Money Laundry		
Prevention of Frauds		
Digital Identities	Meeting Compliance Obligations	Reshaping the Current Process
Open Access to Data		Challenges and Concerns
Governments Support		
Cybersecurity		
Share of information		
Disintermediation		
Digitization		
Cooperation		
Open Banking		Sharing Customer Data
Credit Agencies	Improving Financial Risk Analysis	Determining Collaterals
Tracking of Assets		Challenges and Concerns
Registry of receivables		
Land registry		
Data privacy		
Data breaches		

Table 1: Turning Codes into Themes and Sub-themes

4.4.2 Meeting Compliance Obligations

Reshaping the Current Process

The KYC and AML procedures are important tools used by banks to prevent frauds and to assure that customers are not involved with illicit activities, such as money laundry, corruption and terrorist financing. In 2019, just in the United States, banks lost $16.9 billion with identity frauds, according to Javelin Strategy and Research's report (Tedder & Buzzard, 2020). In another report, issued by LexisNexis Risk Solution, we find that the cost of AML compliance within the key markets of APAC, EMEA, LATAM and North America amounted to $180.9 billion in 2019 (LexisNexis, 2020). The fines against global financial institutions for non-compliance with AML/KYC regulations since the Global Financial Crisis were estimated at $36 billion (Fenergo, 2020).

This topic was one of the most discussed during the interviews conducted to collect the data of this research. Even in the first question, which was on purpose more generic, it was cited by 7 participants as a potential field for the application of blockchain technology in banks. This goes pretty much in line with the literature. In the opinion of several authors, consulting firms and international organizations, if well implemented, blockchain can be very useful to improve the KYC process and make compliance with current requirements (OECD, 2018a, Polyviou et al., 2019; Hassani et al., 2018; Higginson et al., 2019a). The comment of one of the participants is transcribed below.

"There are some services directly related to blockchain that can really improve. One is definitely from a KYC compliance perspective. The more time passes, and the more AML becomes a bigger concern for policy makers and banks, I think the likelihood of having shared KYC processes will definitely come on stream".

Banks are working hard and making strong investments in order to fight financial crimes and keep up with compliance rules and regulations (Higginson et al., 2019a). However, although efficiency has increased to combat those problems, the costs, consumption of time and bureaucracy involving the related procedures climbed to unprecedented levels, as previously mentioned in this job (Walker, 2018; Hassani et al., 2018). The current process is inefficient (Hassani et al., 2018). If a customer works or intends to work with several financial institutions, the KYC

due diligence will be repeated several times. Although a great part of the task is the same for all the institutions, each one currently performs its own, multiplying costs and efforts when we look at the overall picture (Parra-Moyano et al., 2019). Several participants also pointed out the inefficiencies of the current process. Some added that, from a customer perspective, the process is always an unpleasant experience.

"Today financial institutions spend a lot of time and resources trying to correctly identify the customer: KYC/AML/FT processes, long forms to be filled by customers, fraud scorecards, fraud prevention teams...".

"You have to put your information every time you apply for something. Sometimes the banks already have the information. For them it is easier to ask for everything again. But for the customer it is annoying".

Several characteristics of blockchain made this technology a potential candidate to improve the efficiency of the current process. The idea of sharing a single KYC by customer utilizing the blockchain technology is stood by many authors, as discussed on Chapter 2 of this job (Walker, 2018; Sachs, 2016; Reuters, 2017). Parra-Moyano et al. (2019) propose and develop a blockchain-based system for KYC, utilizing smart contracts to manage the share of costs. Such a system would be maintained by a national regulator, which also is in charge of the approval of the FIs which would make part of the network (a consortium). The solution involves some other assumptions such as, all the FIs need to work under the same regulatory framework and common costs would have to be agreed. As explained by the authors, since the costs are shared, each due diligence would cost for a FI m/k, being m the cost and k the number of FIs working with the customer. To have access to a process performed by a first FI, a second one must pay $m/2$ and then the customer package is released. If any update is needed, the participants are informed, and the cost of the update is also shared. All the payments are managed via smart contracts. The ideas found in Parra-Moyano et al. are clearly identified in one of the participants comments:

"If you think as an Industry, if the onboarding cost is $100, for a customer to be onboarded into 2 banks, the industry cost would be $200. If the process is done just once, just by the first financial institution, the industry cost would reduce to $100, $50 for each bank. Now, imagine

if the customer has a relationship with 5 financial institutions..."

Although a few participants revealed that they don't think the share of KYC processes is something feasible, the majority do believe blockchain can be used to make this possible. For one of the most optimistics, "This is one of the best uses for blockchain". The solutions based on blockchain technology seek to streamline the KYC process, considerably reduce banking costs and eliminate double efforts (Walker, 2018; Sachs, 2016; Reuters, 2017; Parra-Moyano et al., 2019). These benefits were also highlighted by various participants of the study. Two of them reinforced their arguments by using real examples. One mentioned an application in Canada called "SecureKey", which was developed by 3 banks, 3 telecoms and the Canadian government in 2017. The other one recalled that the consortium R3 recently tested an application to share KYC processes using a blockchain-based system, in a project which is involving many banks, central banks and regulators.

Challenges and Concerns

As brought up in Chapter 2, the implementation of blockchain solutions usually involve several challenges and concerns. The setup and initial operating costs, cybersecurity, regulations, data privacy and cultural changes are just some of them (Hassani et al., 2018; Crosby et al., 2016; Deloitte, 2017; Walker, 2018; PwC, 2019).

On the compliance side, although all the participants believe that blockchain can potentially improve the current processes, all of them, some in higher degree than the others, also pointed out some pain points to be overcome.

At the literature which more specifically covers KYC solutions enabled by the blockchain technology, we find that there are some dependencies required in order to make the implementation of such solutions feasible. Some of them are regulatory reforms to support blockchain-based applications, appropriate infrastructure, standardization of processes regarding customers identity verification and open access to data, especially primary sources (Walker, 2018; Sachs, 2016). Most of the participants' opinions match the researched literature.

One of the foundational elements for a shared KYC process is the creation of digital identities,

according to the participants. Another requirement will be the creation of a system with strong customer authentication, since the share of information needs to be done on the basis of the customer's consent. A great challenge pointed out was the creation of common standards and procedures, considering that currently each FI follows its own. The access to the information and the creation of the proper environment for the sharing of the information was also mentioned by some. The support of regulators was considered a critical factor. Many participants cited concerns with risks involving cybersecurity and the costs to create a proper cybersecurity framework. Set up costs as investment in infrastructure and employment of specialized IT resources were additional worries raised during the interviews.

4.4.3 Improving Financial Risk Analysis

Sharing Customer Data

Banks are always trying to balance two extremes: if, on one side they need to meet compliance obligations, on the other one they need to deal with customers for whom speed is more important than anything else. In a lending process, the financial risk analysis can take a few minutes or a few weeks. The quality of the data collected and the way it is processed can make all the difference.

A combination of technologies, including blockchain, AI, machine learning, cloud, big data and others, will more and more improve the way banks collect and process the data needed for the credit underwriting. That was the opinion of several participants, according to the discussions originated from question 5 of this study. This converges with what was found in the literature about FinTechs. Technologies are increasingly being used together to deliver solutions (OECD, 2018a; Srinivas et al., 2020). The statement below was extracted from the speech of one of the study participants.

"Banks can today, through Open Banking, access accounts of their own clients in other different banks, aggregate data through AI, machine learning, big data and easily identify any particular trends or threats on the basis of that data."

As per the literature review, the introduction of PSD2 and Open Banking concepts are exam-

ples of changes introduced by regulators which envisage a more egalitarian financial market (Zachariadis & Ozcan, 2017). Although not so well explored in that chapter, this subject appeared in the speeches of the study participants several times, as evidenced in the extract above. For most of them, blockchain can be used to build the data-sharing protocols that will enable the success of Open Banking, assuring that data will be shared in a secure way and that the customer's rights will be preserved. Even one professional from the United States, where there is no formal regulation in place yet, cited that they are already "preparing the house" and maybe blockchain could be used for that, since it's a technology which promotes the share of information.

During the study, it was explored the dependence of banks on credit agencies to obtain customers data, given that this is a very costly process for banks nowadays (Ortlepp, 2019; Kafshdar Goharshady et al., 2018). Some authors are proposing the creation of blockchain-based platforms which could be used by banks to share customer information, possibly eliminating the need of intermediaries as the credit agencies (Higginson, 2019a; Swam, 2017; Hassija et al., 2020).

In the opinion of the participants, the use of new technologies and changes in regulation will make the access to data much easier. As a consequence, credit agencies may become obsolete or they will change their businesses models. Thus, the costs for getting data from them will naturally reduce, but not necessarily just because of the blockchain technology. In other words, blockchain will be another facilitator in the process of collecting customer data for analysis.

Cooperation between banks to explore and use the blockchain technology was an idea also considered in this study, based on the literature findings (Crosby et al., 2016; Rega et al., 2019; Guo & Liang, 2016). Rega et al. (2019) discuss the formation of consortiums between banks. Most of the participants believe this is really a trend. Some believe the environment is being created for that (changes in regulations), whilst for others, banks are joining efforts to face the competition, for instance, of the FinTechs companies.

During the literature review, cooperation was put at stake by some authors (Harris and Wonglimpiyarat, 2019; Carson et al., 2018). The participants do not believe the banks will compete to create the best blockchain-based solutions, but they will increasingly work together

to find solutions which will benefit the entire ecosystem. And, according to them, the partnerships will not just be built between banks, but between various players. "Collaboration" was the watchword, instead of "Competition". The two following examples given by the participants reinforce this idea. The first one is a Brazilian Central Bank project, called "PIER", which was developed utilizing blockchain to share data between the Central Bank and 3 other financial regulatory bodies (Superintendence of Private Insurance, Securities Commission and National Pension Funds Authority). The second one is a consortium called "B3I", which was formed between insurance market participants around the world and uses blockchain to improve efficiency in insurance and reinsurance processes.

Determining Collaterals

As per the literature review conducted, one of the use cases for the blockchain technology is the management of assets (Berryhill et al., 2018; Shang & Price, 2019). It is estimated that just one-third of countries track property ownership digitally (Deininger, 2018). Out of the four countries which had participants in this study, just one of them has an automated system to track assets, which is the Uniform Commercial Code (UCC) Central File, in the United States. Blockchain can be used to address these issues, due to its immutable and transparent nature, making the verification of asset ownership a much easier task. That would be very helpful for banks in the determination of loans' collaterals (Seiffert-Murphy, 2018).

The potential use of the technology for this purpose was favourably seen by all the study participants. According to them, several difficulties are faced by banks in the current processes. In loans which involve mortgages, the confirmation of the properties' ownership can sometimes be a hard task. Most of the processes are still paper-based and, due to that, prone to mistakes. When dealing with discount of receivables, various participants mentioned the lack of visibility. In a fraudulent process, for instance, customers can use the same receivable to get credit from several banks. In loans which have used units as collateral, such as vehicles, trucks, tractors, the determination of the value of these assets may be challenging and sometimes costly.

Land title registry is one of the blockchain projects more pursued by governments around the world, according to the OECD (Berryhill et al., 2018). But the potential of blockchains goes much beyond that. Following the same principles of land title registry, the technology can

also be used to track any other asset. At Chapter 2 there are examples of projects which use blockchains to track assets in supply chains (Kamath, 2018; Bumblauskas et. al, 2020). The access to assets' records would not just facilitate the determination of possible collaterals, but it would also make possible the monitoring of what is happening to them, after the credit was granted, according to some participants. Some loans are secured by movable assets, as vehicles, and just by knowing where the assets are, the risk can significantly be reduced, as explained by them. In summary, blockchain-based systems which manage assets could bring more visibility to banks, speed up the decisions, prevent frauds and reduce the risks.

One of the study participants cited a project recently implemented in Brazil which uses blockchain to manage receivables. It was developed by the Brazilian Stock Exchange (B3), Receivables Central (CERC), Interbank Payments Chamber (CIP) and Credit Rights Records Centre (CRDC) using the Corda platform from R3. It will be used as a mechanism to ensure the uniqueness of the receivables which are used as collateral in credit operations. This is, indeed, concrete evidence that blockchains can help banks in this field.

Challenges and Concerns

Notwithstanding the great expectations of most of the participants towards the changes in regulations and evolution of the technologies, when it came to the use of blockchains to promote the share of customer's data, there were still doubts and concerns.

The main concern brought out by the study participants was on data privacy and possible data breaches. There is a high concentration of customers' sensible data in banks. Therefore, a blockchain-based system built with the purpose to share data between banks needs to assure that it is secure enough to avoid the leak of information. Besides that, the participants also demonstrated high concerns with regulations such as the GDPR, reinforcing that nothing can be shared without the customers' consent. This goes in line with the previous literature, which revealed that security, compliance and data-privacy are considered the great challenges for the new technologies (PwC, 2019).

One of the challenges pointed out by some participants involves cultural aspects. At the literature review we briefly cited a survey conducted with insurance professionals in Europe which

revealed that whereas openness is high, they are still reluctant to adopt the blockchain technology (Grima et al., 2020). In the same way, according to the participants, people might not be willing to share the information, especially the older generation, because they simply don't understand the risks.

On the side of assets management, the only concern raised by the participants was regarding the input of the data. A blockchain registry would only be good if the data inputted is also good. This is one of the challenges for the implementation of the technology in supply chain, according to the OECD, as is pointed out in Chapter 2 (OECD, 2019b). Indeed, there were not too many concerns raised at this point, probably because the information to be shared is of a public nature.

4.5 Conclusions

At this chapter the results and an analysis of the qualitative data collected during the interviews were presented. Thematic Analysis was used to identify the key themes of the research, which were analysed vis-à-vis the ideas outlined in the literature review. "Meeting Compliance Obligations" was the first one. It was split into two sub-themes, "Reshaping the Current Process" and "Challenges and Concerns". At this part, it was analysed the opinion of the participants about the use of the blockchain technology to create shared KYC processes between banks, its impacts and requirements. The second theme was "Improving Financial Risk Analysis". From this theme, three sub-themes were generated: "Sharing Customer Data", "Determining Collaterals" and "Challenges and Concerns". The main ideas analysed at this point involved the use of blockchains to enable the sharing of customers' information between banks and to collect data on assets which can be used as loans' collaterals. It encompassed discussions involving cooperation, new regulations and risks identified by the study participants.

Chapter 5

Discussions, Recommendations and Conclusions

5.1 Discussion of Results

Blockchain has been explored as solution to improve processes in many banking businesses lines, such as Trade Finance, Payments, Capital Market & Fund Management, and Document Management. We don't hear much, however, about the potential use of the technology to improve Credit Underwriting, which is a core area for banks. Indeed, the literature on this specific field is scarce. Considering the main features of the technology, such as immutability, decentralization, transparency and security, would it be possible to use blockchains to facilitate the collection of the data which is needed for credit underwriting? Could it be used to speed up credit decisions? Are there opportunities to reduce the costs of the process? What are the risks? What are the dependencies for the implementation of blockchain-based solutions which could improve credit underwriting? Those were some of the thoughts which drove the conduction of this research.

This study sought to answer the question: Can blockchains enhance the credit underwriting process in the banking sector? The results based on the research conducted revealed they can. Ten experts were interviewed and, according to them, there are opportunities to enhance the credit underwriting process performed by banks in two important areas: compliance and financial risk analysis.

Just as any other financial instrument, lending can open the door for money laundering, frauds

and other financial crimes. Before accepting a borrower, banks need to verify the customer identity and be sure that there is no involvement with any illicit activity. This is a routine not just carried out on customers onboarding, but also when they apply for loans. For most of the professionals who participated in this study, blockchains can make this task easier, faster and cheaper.

Meeting compliance obligations became a burdensome work for banks. If on one hand more stringent compliance regulations are helping to combat financial crimes, on the other one they created new and time-consuming operating models for banks, substantially increasing costs. Not to talk about the regulatory fines and penalties in the case of non-compliance. Most of the study participants know exactly the implications of such rules, since they directly impact their day-to-day activities in banks. That may help to explain why they are so unsatisfied with the current process. The feeling is that, by carrying out compliance due diligence, they are deviating from their goals which would be, ultimately, to give a credit response. As per one of the participants: "We spend time and resources."

The idea of sharing KYC processes between banks utilizing the blockchain technology is largely explored by the literature (Parra-Moyano et al., 2019; Higginson et al., 2019a; Walker, 2018; Hassani et al., 2018). When asked to give their opinion on that, the majority of the participants answered that they do see potential for that. The main benefits, according to them, would be an enormous increase in efficiency, since the process would be streamlined and sped up, and, as a consequence, costs would be reduced. A few participants were more skeptical and revealed that they have doubts regarding the sharing of KYC processes between banks, independently of the technology which would be used for that. The majority was more optimistic. They have concerns and see challenges, but for them, "sooner or later this is going to happen".

Some of the concerns raised by the participants are common concerns related to the implementation of new technologies, as for instance, set up costs, mainly the ones pertinent to infrastructure, and the need of specialized resources in IT. There were huge concerns in regard to data privacy and security. For most of the participants, to make it possible, the initiatives must have the support of regulators and governments. There are also foundational elements which need to be set, as for instance, the creation of digital identities and the digitization on public records. Another huge challenge will be the standardization of procedures.

Financial risk analysis is another process which can be enhanced by blockchain technology, according to the study participants. If, on one side, banks have been pressured by regulations to meet compliance obligations, on the other one, customers are increasingly demanding faster credit responses when they apply for a loan. Data is the raw material of any credit underwriting process. To be able to collect and process customer data in a more efficient way and meet the customers' expectations, banks are heavily investing in new technologies. Here is where blockchain can come into play.

New regulations as the PSD2 in the EU, are slowly introducing the deep changes which are going to shape the next years in finance. Open Banking is definitely one of them. With the new regulations, customers are being empowered. Now they can choose what data they want to share, with whom and when. However, at the same time customers are getting more control over their data, they are also assuming more risks. For the information to be shared, customers will have to rely on third-party providers. In this context, trust becomes an important element and if trust matters, blockchain can be an alternative. The technology could be used to create the protocols which would allow the data sharing between FIs in a secure and transparent way, assuring to the customers they will continue to have full control of their data. In short, and in line with the discussions taken with the study participants, the environment is being created for data sharing and the features of the blockchain technology make it a good candidate to promote that.

Another way to share data utilizing blockchains is through the formation of consortiums between banks. Indeed, the professionals who took part in this research believe this a trend. And this is not just going to happen between banks, but between banks and several other players, according to them. Some of the consortiums will be created to develop and mature the technology, as Hyperledger Fabric, others will be formed for businesses purposes, as We.Trade, and others will do both, as R3. Cooperation, collaboration, partnership will be the watchwords.

The combined use of technologies such as blockchain, AI, machine learning, big data, and the collaborative environment being created will facilitate the access and the processing of information. Therefore, the expectation is that such advancements will significantly help to reduce credit response times. Besides that, there might also be a reduction of costs. Currently many

banks are still dependent on data provided by credit bureaus and they pay a high price to access it. This is a business model which tends to become obsolete in the future, since, in essence, it is there to centralize data, and the financial system is moving exactly in the opposite direction, according to the majority of the participants.

If multiple parties are going to have simultaneous access to data the risks of data breaches substantially increase. That was the main concern raised by the participants in regard to data sharing, especially because banks deal with sensible customers' data. Thus, for a blockchain-based system to work, all the measures need to be taken to assure that it will be secure enough to avoid the leak of information. Over and above, nothing can be shared without the customer's consent. That was also reinforced several times. One of the main challenges for banks can be to convince the customers to share their information, particularly the older generation. People may not be willing to share, simply because they don't understand the process and want to avoid risks.

Finally, the professionals who participated in this study also pointed out opportunities to improve the determination of collaterals, which is also a component of the financial risk analysis. Some of the main difficulties currently faced by credit underwriters when analysing loans which will be backed by assets are the verification of the ownership (e.g. in mortgages), the estimation of the asset value (e.g. used units) and the confirmation that the asset was not used in duplicity (e.g. in the case of receivables). The track of assets through blockchain-based solutions has been increasingly used in supply chains, but it can also be used to improve credit underwriting. Due to the immutable and distributed features of the technology, blockchains can securely store the records of any asset. By having access to this information, banks could not only speed up decisions, but also significantly reduce risks. Obviously one of the challenges in systems like that would be to assure that the data is properly inputted.

On September 24th, 2020, exactly at the time this study was being conducted, the EC issued a digital financial package which includes among other subjects a Digital Finance Strategy for the EU (EC, 2020). One of the priorities will be enhancing data sharing within the financial sector. Also, as part of the strategy, the Commission will propose to harmonise rules on customer onboarding and to implement an interoperable cross-border framework for digital identities. Interestingly, the strategies are aligned with various ideas discussed in this study. It is not clear

which technologies will be used, but the package issued leaves some clues that DLTs are on the EC radar.

5.2 Significance of Findings

The findings of this study may be of great significance for the Banking Industry, since it's the first time the potential of blockchain technology is looked at from the perspective of credit underwriting and several opportunities in this field are discussed at the same time. For these opportunities to become real, banks will have to cooperate not just between each other, but also with other players, from regulators to competitors. If implemented, however, there will be enormous gains in efficiency and cost savings for the entire system.

The findings may also be used to educate credit professionals and other banking professionals on the potential of blockchain technology. This study may serve as important learning material for them to be prepared for the coming changes.

5.3 Recommendations for Further Studies

This study specifically brought to light banks' credit underwriting. Although this process aims to minimize risks, it is not a guarantee that the customers will repay their loans as agreed. Banks' delinquency has several causes. It can happen because the customer simply decides not to pay, or because the customer lost the repayment ability due to unexpected events and, in more serious instances, due to frauds. A potential theme for a further academic study would be how blockchain technology could be used to manage banks' delinquency. The literature on this specific topic is scarce and certainly that would be a theme of great interest for banks as well.

Furthermore, another field of research could be the impact of open banking in lending and the use of blockchain as the enabling technology to create secure environments. That was a topic greatly discussed with the study participants and the changes on the financial environment are just at the beginning.

Finally a broader recommendation. Extensive literature has been published on blockchain technology and new academic research is, obviously, always welcome. However, this is a topic which always generates lots of uncertainties, as it was possible to observe during the conduction of this study. For the technology to be wider applied it is missing research on practical applications. Therefore, a recommendation would be the creation of more regulatory sandboxes, to allow firms or groups of firms to test their solutions under the supervision of regulators. That would encourage innovation and help others to build upon the lessons learned.

5.4 Conclusions

This study sought to find out how blockchains could enhance the credit underwriting process in banks. To this end, ten experts in financial services and/or blockchain technology were interviewed. The results of the research revealed that there are opportunities in two spheres, according to the study participants: compliance and financial risk analysis.

Lending can open the door for money laundry, frauds and other financial crimes. Meeting compliance obligations is also part of the duties of any credit area. For most of the participants, Blockchain could be used to make this task easier, faster and cheaper, by allowing the sharing of KYC processes and other compliance checks between banks. For such an initiative to gain amplitude, however, the professionals pointed out that some foundations need to be set, such as the creation of digital identities and the support of governments and regulators.

Customers' data is the raw material of any financial risk analysis. In this sphere, the participants believe blockchain could be used to promote data sharing between banks. Indeed, with the introduction of new concepts as Open Banking and Open Finance, the environment is already being prepared for that, as many recalled. Blockchains could make this process secure and transparent, assuring to the customers that they will continue to control their data. Another way to promote the sharing of information is through the formation of consortiums. For the participants, this is a trend, and it will continue to happen not just between banks, but between banks and several other players. Cooperation will pave the way for the future, instead of competition. That was a unanimity. The new environment and the combined use of

technologies will facilitate the access and the processing of information, significantly increasing banks' efficiency. That can also reduce the dependence on credit agencies, whose businesses models may be challenged in this context. Dealing with customer data is a very sensible task and the participants expressed deep concerns with that. Therefore, any blockchain-based system built with the purpose to share such kind of information will have to be properly designed to avoid any breaches and to assure that the information is shared upon the customer's consent. Actually, convincing the customers to share their information will also be a challenge for banks, in the opinion of the interviewees.

The last opportunity identified by the professionals who took part in this study is related to the determination of collaterals, which is also a component of the financial risk analysis. Since blockchains can securely store and track the records of any asset, such as land, vehicles, receivables, by having access to assets information, banks could improve the verification of ownership, better estimate the assets value and confirm that they are not being used in duplicity. That can speed up decisions and significantly reduce risks. The challenge brought up by the participants was to assure that the data is properly inputted in the systems.

References

Allen, F., Carletti, E., and Gu, X. (2008). The roles of banks in financial systems. *In The Oxford handbook of banking. Oxford University Press.*

Arner, D. W., Barberis, J. and Buckley, R. P. (2017). FinTech, RegTech, and the Reconceptualization of Financial Regulation. *Northwestern journal of international law & business, 37(3), p.371.*

Azzopardi, M. and Cortis, D. (2013). Implementing automotive telematics for insurance covers of fleets. *Journal of Technology Management & Innovation, 8(4), 59–67.*

Balyuk, T. and Davydenko, S. A. (2019). Reintermediation in FinTech: Evidence from Online Lending.

Barkley, B. and Schweitzer, M. (2020). The Rise of Fintech Lending to Small Businesses: Businesses' Perspectives on Borrowing. *Federal Reserve Bank of Cleveland, Working Paper No. 20-11.*

Barontini, C. and Holden, H. (2019). Proceeding with caution - A survey on central bank digital currency. *BIS Paper, (101).*

Belanche, D., Casaló, L. V. and Flavián, C. (2019). Artificial Intelligence in FinTech: understanding robo-advisors adoption among customers. *Industrial Management & Data Systems.*

Berryhill, J., Bourgery, T., and Hanson, A. (2018). Blockchains unchained.

Bouchaud, M., Lyons, T., Saint Olive, M. and Timsit, K. (2020). Central banks and the future of digital money. *Consensys White Paper.*

Braun, V. and Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology, 3(2), 77-101.*

Brown, R.G. (2018). The corda platform: An introduction. *Retrieved, 27, p.2018.*

Bumblauskas, D., Mann, A., Dugan, B. and Rittmer, J. (2020). A blockchain use case in food distribution: Do you know where your food has been?. *International Journal of Information Management, 52, 102008.*

Business Wire (2019). J.P. Morgan Interbank Information Network Grows to 300+ Banks. *Available at: https://www.businesswire.com/news/home/20180925005617/en/J.P.-Morgan-Interbank-Information-Network%E2%84%A0-Expands-75. Access: 14 August 2020.*

Camilleri, M.A. (2020). The use of data-driven technologies for customer-centric marketing. *Int. J. Big Data Management, Vol. 1, No. 1, pp.50–63.*

Carson, B., Romanelli, G., Walsh, P. and Zhumaev, A. (2018). Blockchain beyond the hype: What is the strategic business value. *McKinsey & Company, pp.1-13.*

Clarke, V. and Braun, V. (2013). Teaching thematic analysis: Overcoming challenges and developing strategies for effective learning. *The psychologist, 26(2).*

CoinMarketCap (2020). *Available at: https://coinmarketcap.com. Access: 09 August 2020*

Cocco, L., Pinna, A. and Marchesi, M. (2017). Banking on blockchain: Costs savings thanks to the blockchain technology. *Future internet, 9(3), 25.*

Crosby, M., Pattanayak, P., Verma, S. and Kalyanaraman, V. (2016). Blockchain technology: Beyond bitcoin. *Applied Innovation, 2(6-10), p.71.*

Darolles, S. (2016). The rise of FinTechs and their regulation. *Financial Stability Review, (20), 85-92.*

Deloitte (2017). Blockchain in Banking. *Available at: https://www2.deloitte.com/content/dam /Deloitte/in/Documents/strategy/in-strategy-innovation-blockchain-in-banking-noexp.pdf. Access: 31 August 2020.*

Deininger, K. (2018). For billions without formal land rights, the tech revolution offers new grounds for hope. *Available at: https://blogs.worldbank.org/developmenttalk/billions-without-formal-land-rights-tech-revolution-offers-new-grounds-hope. Access: 15 October 2020.*

DiGrazia, K. (2018). Cyber Insurance, Data Security, and Blockchain in the Wake of the Equifax Breach. *13 J. Bus. & Tech. L. 255.*

Duhaime, BA, JD, CAMS, B. C. (2019). The Role of Anti–Money Laundering Law and Compliance in FinTech. *The RegTech Book.*

EC (2015). Green Paper on retail financial services: better products, more choice, and greater opportunities for consumers and business.

EC (2020). Digital Finance Package. *Available at: https://ec.europa.eu/info/publications/200924-digital-finance-proposals_en. Access: 20 October 2020*

ECCB (2019). ECCB to Issue World's First Blockchain-based Digital Currency. *Press release.*

Eling, M. and Kraft, M. (2020). The impact of telematics on the insurability of risks. *The Journal of Risk Finance, 21(2), 77-109.*

Ellul, J. and Pace, G. (2019). Blockchain and the Common Good Reimagined. *arXiv preprint arXiv:1910.14415.*

Equifax (2020). 2019 Annual Report. *Available at: https://investor.equifax.com/financial-information/ annual-reports-and-proxy-statements. Access: 01 September 2020.*

Experian (2020). Experian Annual Report 2019. *Available at: https://www.experianplc.com/media/ 3788/experian-2019-annual-report.pdf. Access: 01 September 2020.*

Federal Reserve, 2019. Small business credit survey.

Fenergo (2020). AML, KYC & Sanctions Fines for Global Financial Institutions Top $36 Billion Since Financial Crisis. *Available at: https://www.fenergo.com/news/aml-kyc-and-sanctions-fines-for-global-financial-institutions-top-$36-billion-since-financial-crisis.html. Access: 10 October 2020.*

FinCoNet (2016). Online and mobile payments: Supervisory challenges to mitigate security risks.

Gai, K., Qiu, M. and Sun, X. (2018). A survey on FinTech. Journal of Network and Computer Applications, 103, 262-273.

Gatteschi, V., Lamberti, F., Demartini, C., Pranteda, C. and Santamaría, V. (2018). Blockchain and smart contracts for insurance: Is the technology mature enough?. *Future Internet, 10(2), 20.*

Grima, S., Spiteri, J. and Romānova, I. (2020). A STEEP framework analysis of the key factors impacting the use of blockchain technology in the insurance industry. *Geneva Papers on Risk and Insurance. Issues and Practice, 45(3), 398-425.*

Guo, Y. and Liang, C., 2016. Blockchain application and outlook in the banking industry. *Financial Innovation, 2(1), p.24.*

Haddad, C. and Hornuf, L. (2019). The emergence of the global FinTech market: economic and technological determinants. *Small Bus Econ 53, 81–105.*

Harle, P., Havas, A., and Samandari, H. (2016). The future of bank risk management. *McKinsey Global Institute.*

Harris, W.L. and Wonglimpiyarat, J. (2019). Blockchain platform and future bank competition. *Foresight.*

Hassani, H., Huang, X. and Silva, E.S. (2018). Banking with blockchain-ed big data. *Journal of Management Analytics, 5 (4). pp. 256-275. ISSN 2327-0012.*

Hassija, V., Bansal, G., Chamola, V., Kumar, N., and Guizani, M. (2020). Secure Lending: Blockchain and Prospect Theory-Based Decentralized Credit Scoring Model. *IEEE Transactions on Network Science and Engineering.*

Heston, T. (2017). A case study in blockchain health care innovation. *International Journal of Current Research.*

Higginson, M., Hilal, A. and Yugac, E. (2019a). Blockchain and retail banking: Making the connection. *McKinsey & Company.*

Higginson, M., Nadeau, M.C. and Rajgopal, K. (2019b). Blockchain's Occam problem. *McKinsey & Company. Hentet, 14, p.2019.*

HSBC (2018). HSBC and ING execute groundbreaking live trade finance transaction on R3s

Corda Blockchain platform. *Available at: https://www.hsbc.com/media/media-releases/2018/hsbc-trade-blockchain-transaction-press-release. Access: 15 August 2020.*

ICOBench (2020). *Available at: https://icobench.com. Access: 02 August 2020.*

Jagtiani, J. and Lemieux, C. (2019). The roles of alternative data and machine learning in FinTech lending: evidence from the LendingClub consumer platform. *Financial Management, 48(4), 1009-1029.*

Javadi, M. and Zarea, M. (2016). Understanding Thematic Analysis and its Pitfalls. *Journal Of Client Care 1(1) , 33-39.*

Johnson, K. N. (2019). Examining the Use of Alternative Data in Underwriting and Credit Scoring to Expand Access to Credit. *Available at SSRN 3481102.*

Kafshdar Goharshady, A., Behrouz, A. and Chatterjee, K. (2018). Secure Credit Reporting on the Blockchain. *arXiv, pp.arXiv-1805.*

Kamath, R. (2018). Food traceability on blockchain: Walmart's pork and mango pilots with IBM. *The Journal of the British Blockchain Association, 1(1), 3712.*

Karppinen, U. (2018). BBVA signs world-first blockchain-based syndicated loan arrangement with Red Eléctrica Corporación. *Available at: https://www.bbva.com/en/bbva-signs-world-first-blockchain-based-syndicated-loan-arrangement-with-red-electrica-corporacion. Access: 31 August 2020.*

Kshetri, N (2013). Privacy and security issues in cloud computing: the role of institutions and institutional evolution. *Telecommun. Policy, 37 (4) (2013), pp. 372-386.*

Kshetri, N. (2014). Big data's impact on privacy, security and consumer welfare. *Telecommun. Policy, 38 (11) (2014), pp. 1134-1145.*

Kuzmanova, T. (2020). Fine-Tuning Europe: How to Win the Global FinTech Race?

Lee, C. C., Cheng, H. K. and Cheng, H. H. (2007). An empirical study of mobile commerce in insurance industry: Task–technology fit and individual differences. *Decision support systems, 43(1), 95-110.*

LexisNexis (2020). True cost of financial crime compliance study. *Global Report.*

Lipman, B. and Wiersch, A. M. (2015). Alternative Lending through the Eyes of "Mom-and-Pop" Small-Business Owners: Findings from Online Focus Groups. *Special Report, Federal Reserve Bank of Cleveland.*

Maguire, M. and Delahunt, B. (2017). Doing a thematic analysis: A practical, step-by-step guide for learning and teaching scholars. *All Ireland Journal of Higher Education, 9(3).*

Martino, P., Bellavitis, C. and DaSilva, C.M. (2019). Blockchain and Initial Coin Offerings (ICOs): a New Way of Crowdfunding.

McKinsey & Company. (2017). Digital disruption in insurance: Cutting through the noise.

Momtaz, P. P. (2020). Initial coin offerings. *Plos one, 15(5), e0233018.*

Nakamoto, S. (2008). Bitcoin: A peer-to-peer electronic cash system.

O'Dea, S. (2020). Number of Smartphone Users Worldwide from 2016 to 2021. *Statista.*

OECD (2017). Technology and innovation in the insurance sector.

OECD (2018a). Financial Markets, Insurance and Private Pensions: Digitalisation and Finance.

OECD (2018b). Embracing innovation in government: Global trends 2018.

OECD (2019a). Blockchain at the OECD. *OECD Going Digital Policy Note, OECD, Paris.*

OECD (2019b). Is there a role for blockchain in responsible supply chains?

OECD (2019c). Initial Coin Offerings (ICOs) for SME Financing.

OECD (2020). Digital Disruption in Banking and its Impact on Competition.

Ortlepp, B. (2019). A feasibility study on using the blockchain to build a credit register for individuals who do not have access to traditional credit scores.

Parra-Moyano, J.,Thoroddsen, T. and Ross, O. (2019). Optimised and dynamic KYC system based on blockchain technology. *Int. J. Blockchains and Cryptocurrencies, Vol. 1, No. 1, pp.85–106.*

Philippon, T. (2016). The fintech opportunity *(No. w22476). National Bureau of Economic Research.*

Plecher, H. (2020). World: Total population from 2009 to 2019. *Statista.*

Polyviou, A., Velanas, P. and Soldatos, J. (2019). Blockchain Technology: Financial Sector Applications beyond Cryptocurrencies. *In Multidisciplinary Digital Publishing Institute Proceedings (Vol. 28, No. 1, p. 7).*

Popovic, D., Avis, C., Byrne, M., Cheung, C., Donovan, M., Flynn, Y., ... and Shah, J. (2020). Understanding blockchain for insurance use cases. *British Actuarial Journal, 25.*

PwC (2019). Global FinTech Report 2019. *Available at: https://www.pwc.com/gx/en/industries/financial-services/assets/pwc-global-fintech-report-2019.pdf. Access 15 August 2020.*

R3 (2020). About R3 – History. *Available at: https://www.r3.com/history/. Access: 31 August 2020.*

Rega, F., Riccardi, N., Li, J. and di Carlo, F., 2019. Blockchain in the banking industry: An Overview.

Reuters, T. (2017). A Blockchain Enabled KYC Solution: New Horizon or False Dawn.

Romānova, I. and Kudinska, M. (2016). Banking and Fintech: a challenge or opportunity?. *In Contemporary issues in finance: Current challenges from across Europe. Emerald Group Publishing Limited.*

Sachs, G. (2016). Blockchain: putting theory into practice. Equity Research, 24.

Seiffert-Murphy, A. (2018). How Blockchain and Distributed Ledger Technology Could Revolutionize the Trade Credit Space. *The National Magazine of Business Fundamentals. Business Credit, vol. 120, no. 8, pp. 10-11.*

Shang, Q. and Price, A. (2019). A Blockchain-Based Land Titling Project in the Republic of Georgia: Rebuilding Public Trust and Lessons for Future Pilot Projects. *Innovations: Technology, Governance, Globalization, 12(3-4), 72-78.*

Srinivas, V., Schoeps, J., Ramsay, T., Wadhwani, R., Hazuria, S. and Jain, A. (2020). 2020 banking and capital markets outlook. *Report. UK: Deloitte Insights.*

Swan, M. (2017). Anticipating the economic benefits of blockchain. *Technology innovation management review, 7(10), 6-13.*

Tapscott, A. and Tapscott, D. (2017). How blockchain is changing finance. *Harvard Business Review, 1(9), 2-5.*

Tedder, K. and Buzzard J. (2020). 2020 Identity Fraud Study: Genesis of the Identity Fraud Crisis. *Javelin Strategy & Report.*

TransUnion (2020). 2019 Annual Report. *Available at: https://www.annualreports.com/HostedData/Annual Reports/PDF/NYSE_TRU_2019.pdf. Access: 01 September 2020.*

Trochim, W. M. (2006). Deduction and induction.

Varma, J. R. (2019). Blockchain in finance. *Vikalpa, 44(1), 1-11.*

Walker, G. (2018). Is KYC using blockchain the answer for banks?

Williams, C. (2007). Research Methods. *Journal of Business & Economics Research (JBER), 5(3).*

World Bank Group (2019). Disruptive Technologies in the Credit Information Sharing Industry: Developments and Implications.

Zachariadis, M. and Ozcan, P. (2017). The API economy and digital transformation in financial services: the case of open banking.

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Appendices

Appendix 1

UREC Form

UNIQUE FORM ID: 5714_12062020_Carla Mattedi
No self-assessment issues ticked. Submitting to FREC for records.

L-Università ta' Malta

ETHICS & DATA PROTECTION

PART 1: APPLICANT AND PROJECT DETAILS

1. Name and surname: Carla Mattedi
Email Address: carla.mattedi.19@um.edu.mt
2. Applicant status: UM student
3. Faculty: Economics, Management and Accountancy
4. Department: Centre for DLT
If applicable
5. Principal supervisor's name: Jonathan Spiteri
6. Co-supervisor's name:
7. Study-unit code: DLT5900
8. Student number: 1909874

9. Title of research project: Blockchains and the Credit Underwriting Process in the Banking Sector
10. Research question/statement & method: Research question: Can Blockchains enhance the Credit Underwriting Process in the Banking Sector? I´m planning to collect data from interviews with professionals that work in the financial sector (with focus on banks) and use Tematic Analysis, as per Braun & Clarke (2006), to analyse and interpret the data.
11. Collection of primary data from human participants?
Yes/Unsure (PLEASE ANSWER NEXT QUESTION)
12. If applicable, explain: a. I´m planning to interview 5-15 participants. All participants will be professionals working in the financial sector, with a specific focus on banks. All will be aged 18 and over.
b. Participants will be recruited directly based on their knowledge and expertise in the field, via email.
c. They will be required to answer blockchain-related questions. No personal data or other sensitive information will be requested, and anonymity will be ensured throughout.
d. The estimated duration of the interviews will be of approximately 1 hour.
e. No inducements, rewards or compensations will be offered.
f. Participants may benefit from ideas or future processes improvements that may be suggested after the conclusion of this research.

PART 2: SELF-ASSESSMENT

Human Participants

1. Risk of harm to participants:
2. Physical intervention:
3. Vulnerable participants:
4. Identifiable participants:

Appendix 1

UREC Form

UNIQUE FORM ID: 5714_12062020_Carla Mattedi

No self-assessment issues ticked. Submitting to FREC for records.

5. Special Categories of Personal Data (SCPD):
6. Human tissue/samples:
7. Withheld info assent/consent:
8. Opt-out consent/assent:
9. Deception in data generation:
10. Incidental findings:

Unpublished secondary data

11. Was the data collected from human participants?
12. Was the data collected from animals?
13. Is written permission from the data controller still to be obtained?

Animals

14. Live animals out of habitat:
15. Live animals, risk of harm:
16. Dead animals, illegal:

General considerations

17. Cooperating institution:
18. Risk to researcher/s:
19. Risk to environment:
20. Commercial sensitivity
21. Other potential risks:

Self-assessment outcome: No self-assessment issues ticked. Submitting to FREC for records.

PART 3: DETAILED ASSESSMENT

1. Risk of harm to participants:
2. Physical intervention on participants:
3. Vulnerable participants:
4. Identifiable participants:
5. Special Categories of Personal Data (sensitive personal data):
6. Collection of human tissue/samples:
7. Withholding information at consent/assent:
8. Opt-out consent/assent:
9. Deception in data generation:
10. Incidental findings:
11. Unpublished secondary data - human participants :
12. Unpublished secondary data - animals:
13. Unpublished secondary data - no written permission from data controller:
14. Lasting harm to animals out of natural habitat:

Appendix 1

UREC Form

UNIQUE FORM ID: 5714_12062020_Carla Mattedi

No self-assessment issues ticked. Submitting to FREC for records.

15. Risk of harm to live animals :
16. Use of non legal animals/tissue:
17. Permission from cooperating institution:
18. Risk to researcher/team:
19. Risk of harm to environment:
20. Commercial sensitivity:
21. Other issues
    - 21a. Dual use and/or misuse:
    - 21b. Conflict of Interest:
    - 21c. Dual role:
    - 21d. Use research tools:
    - 21e. Collaboration/data/material collection in low/lower-middle income country:
    - 21f. Import/export of records/data/materials/specimens:
    - 21g. Harvest of data from social media:
    - 21h. Other considerations:

PART 4: SUBMISSION

1. Which FREC are you submitting to? : Economics, Management and Accountancy
2. Attachments: Information and recruitment letter*, Consent forms (adult participants)*
3. Cover note for FREC :
4. Declarations: I hereby confirm having read the University of Malta Research Code of Practice and the University of Malta Research Ethics Review Procedures., I hereby confirm that the answers to the questions above reflect the contents of the research proposal and that the information provided above is truthful., I hereby give consent to the University Research Ethics Committee to process my personal data for the purpose of evaluating my request, audit and other matters related to this application. I understand that I have a right of access to my personal data and to obtain the rectification, erasure or restriction of processing in accordance with data protection law and in particular the General Data Protection Regulation (EU 2016/679, repealing Directive 95/46/EC) and national legislation that implements and further specifies the relevant provisions of said Regulation.
5. Applicant Signature: Carla Luciana Mattedi
6. Date of submission: 12062020
7. If applicable data collection start date: 01072020
8. E-mail address (Applicant): carla.mattedi.19@um.edu.mt
9. E-mail address (Principal supervisor): jonathan.v.spiteri@um.edu.mt
10. Conclude: Proceed to Submission

Appendix 2

Information Letter

[Date]

Information letter

Dear Sir/Madam,

My name is Carla Mattedi and I am a student at the University of Malta, presently reading for a master's degree in Blockchain and Distributed Ledger Technologies. I am conducting a research study for my dissertation titled "Blockchains and the Credit Underwriting Process in the Banking Sector"; this is being supervised by Dr. Jonathan Spiteri, Resident Academic at University of Malta. This letter is an invitation to participate in this study. Below you will find information about the study and about what your involvement would entail, should you decide to take part.

The aim of my study is to investigate if the Blockchain technology may help to enhance the credit underwriting process performed by banks to grant credit to their customers. Your participation in this study would contribute to a better understanding of the feasibility of the application of the technology in this specific area. Any data collected from this research will be used solely for purposes of this study.

Should you choose to participate, you will be asked questions about credit underwriting processes and related use of Blockchains. I intend to explore if, in the point of view of the interviewees, there are opportunities for the implementation of the technology, what could be changed and what should not be changed, the possible benefits, the challenges and/or risks for the implementation, etc.

Data collected will be treated confidentially and accessed just by my supervisor and myself.

Participation in this study is entirely voluntary; in other words, you are free to accept or refuse to participate, without needing to give a reason. You are also free to withdraw from the study at any time, without needing to provide any explanation and without any negative repercussions for you. Should you choose to withdraw, any data collected from your interview will be deleted.

If you choose to participate, please note that there are no direct benefits to you. Your participation does not entail any known or anticipated risks.

Please also note that, as a participant, you have the right under the General Data Protection Regulation (GDPR) and national legislation to access, rectify and where applicable ask for the data concerning you to be erased. All data collected will be erased on completion of the study and following publication of results.

A copy of this information sheet is being provided for you to keep and for future reference.

Thank you for your time and consideration. Should you have any questions or concerns, please do not hesitate to contact me by e-mail carla.mattedi.19@um.edu.mt; you can also contact my supervisor over the phone: (+356) 2340 3188 or via email: jonathan.v.spiteri@um.edu.mt.

Sincerely,

Carla Mattedi
carla.mattedi.19@um.edu.mt

Dr. Jonathan Spiteri – UM Resident Academic
jonathan.v.spiteri@um.edu.mt
(+356) 2340 3188

Appendix 3

Consent Form

PARTICIPANT'S CONSENT FORM

Blockchains and the Credit Underwriting Process in the Banking Sector

I, the undersigned, give my consent to take part in the study conducted by **Carla Mattedi**. This consent form specifies the terms of my participation in this research study.

1. I have been given written and/or verbal information about the purpose of the study; I have had the opportunity to ask questions and any questions that I had were answered fully and to my satisfaction.
2. I also understand that I am free to accept to participate, or to refuse or stop participation at any time without giving any reason and without any penalty. Should I choose to participate, I may choose to decline to answer any questions asked. In the event that I choose to withdraw from the study, any data collected from me will be erased.
3. I understand that I have been invited to participate in an interview in which the researcher will ask questions about Credit Underwriting Processes and related use of Blockchains to investigate if the technology can enhance the activity in the Banking Sector. I am aware that the interview will take approximately 1 hour. I understand that the interview is to be conducted in a place and at a time that is convenient for me.
4. I understand that my participation does not entail any known or anticipated risks.
5. I understand that there are no direct benefits to me from participating in this study. I also understand that this research may benefit others by bringing ideas to improve the credit underwriting processes in banks through the use of Blockchains.
6. I understand that, under the General Data Protection Regulation (GDPR) and national legislation, I have the right to access, rectify, and where applicable, ask for the data concerning me to be erased.
7. I understand that all data collected will be erased on completion of the study and following publication of results.
8. I have been provided with a copy of the information letter and understand that I will also be given a copy of this consent form.
9. I am aware that, if I give my consent, this interview may be audio recorded and converted to text as it has been recorded (transcribed).
10. I am aware that, if I give my consent, extracts from my interview may be reproduced in these outputs, either in anonymous form, or using a pseudonym [a made-up name or code – e.g. respondent A].
11. I am aware that my identity and personal information will not be revealed in any publications, reports or presentations arising from this research.

I have read and understood the above statements and agree to participate in this study.

Name of participant: _____

Signature: _____

Date: _____

_____ _____

Carla Mattedi
carla.mattedi.19@um.edu.mt

Dr. Jonathan Spiteri – UM Resident Academic
jonathan.v.spiteri@um.edu.mt
(+356) 2340 3188

Appendix 4

Questionnaire

1) The Evolution of FinTechs in the last decade has been radically changing Financial Services, transforming business models and improving the consumer experience. Blockchain is one of the emerging technologies. Banks have been allocating lots of resources in research and development to benefit from the features of the technology. In your opinion, which banking services or processes are going to be most impacted by blockchain?

2) A possible hindrance for the wider adoption of a new technology by banks can be the dilemma between the offering of cheaper services and a possible reduction of revenues. Do you believe this is retarding the implementation of blockchain solutions by banks?

3) R3, We.trade, Batavia are examples of consortiums being formed between banks, financial institutions, technology companies, regulators and others to explore the blockchain technology. Cooperation between banks seems to be a key element if the idea is to maximize the benefits of blockchain.

a) Do you think this is a trend? Do you see more consortiums being formed by banks to explore the potential of blockchain technology?

b) Competition is higher, and margins are tighter for banks these days. What can incentivize cooperation towards the implementation of blockchain solutions if there is lack of competitive advantages?

4) What is your opinion regarding the creation of a shared KYC process between banks utilizing blockchain technology? Do you think it could enhance the credit underwriting process? What would be the obstacles for this implementation?

5) Currently many banks rely on Credit Bureaus to collect information for credit underwriting, like for instance, credit scorings. What do you think about the creation of networks or consortiums among banks to share customers data in blockchains? Could them be used for the calculation of a common credit score? Do you believe this could replace the use of current traditional credit bureaus and help to reduce banks costs? What could hinder their creation?

6) The State of Delaware in the United States is developing a blockchain-based platform to incorporate companies to a blockchain network, what would allow the track of stocks and assets in real-time. Do you see platforms like this being used by banks to facilitate the understanding of the companies' ownership and the requirement of collaterals in a credit underwriting process?

7) Do you see other opportunities to enhance the credit underwriting process of banks by utilizing the blockchain technology?