DEPARTMENT OF BUSINESS AND MANAGEMENT

Master Thesis in Advanced Corporate Finance

Blockchain disruption: a focus on the banking system

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Introduction

This work examines the phenomenon of the Blockchain. Technically it is a database that records and stores transactions on a widespread network. Two preliminary clarifications are needed: the database, as a repository of information, is decentralized and the management of its content is peer-to-peer. Thanks to these characteristics blockchain can be defined as a simple public register for the management of data related to transactions stored in blocks that make up the chain, that is the network. In other words, in order to have a practical image of what blockchain is, it is possible to think of it as a google document. With blockchain is possible, for everyone participating the network, to access the document and editing it. Everybody has documentation of what has changed and what hasn't changed, but none of the participants has the power of changing what another participant recorded in it. The only way a transaction can be "reversed" is by tracking back the original block and create a link to a new one which specifies that anything that is on that block must be referred to the updated one.

In the last months I've been working in the banking environment with Accenture which is a technology-oriented consulting company and that has put me in the condition of getting to know the different shades of that phenomenon that the blockchain is. The public opinion seems broken into two sides: blockchain enthusiasts and people who believe that this new technology will result in a big failure. When I first approached the topic, I found myself among the second group: the general enthusiasm of blockchain appeared to rely on big profits opportunity coming from the high volatility of Bitcoins. There is where I believe the problem stands. When talking about blockchain, people tend to confuse it with cryptocurrencies, that is like confusing e-mail services with the internet. After digging on what blockchain is and how it works I remained fascinated by its potentials. The basic concept is that this technology enables users to engage transactions without the need for trusting each other. Transaction can be anything that involves an exchange of information, from trade to identity recognition. In the following work I try to explain what the blockchain is and what could be its implications. The thesis follows a conic structure.

The first chapter aims at providing a definition of what blockchain is, what are its basic components and what are the different types of blockchain. The chapter continues by illustrating how, on a worldwide basis, the authorities are reacting to it and it ends with a short excursus on how blockchain came to life highlighting its lights and shadows.

The second chapter investigates the impacts of blockchain on the banking industry. After an analysis of the current situation of the Italian banking environment and a focus on banks' core activities, the analysis points at understanding how those activities may be impacted by the blockchain.

The last chapter focuses on how the mortgage process could be disrupted by this technology, what would be the consequences both for the institutions and for the final consumers.

By the end of the analysis it is made clear that blockchain represents mostly a business process improvement able to cut costs both for suppliers and customers and above all to significantly improve the customer experience.

1. Blockchain: what it is and how it works

1.1 Distributed ledger

The concept of blockchain has been introduced in 2008 by Nakamoto, an unknown person considered to be the father of Bitcoins and because of this, people usually identify blockchain with cryptocurrencies. Nakamoto published a pamphlet where he described a structure in which users were able to engage transactions without the need for intermediaries. The main revolutionary element in this structure was the process of validation, which enabled the network to achieve consensus without need for trust among participants. The process of validation in this case is called mining, which has as final results both adding the transaction (block) to the blockchain and the release of new Bitcoin (or of a portion of it), as reward for the activity of mining.

Before getting further into details it's useful to understand what the basic components of blockchain are:

- Nodes: this term refers to the participants of the blockchain and more in particular to the computers of the participants. Each computer represents a node.

- Transaction: it represents the transfer of information broadcasted to the network that needs to be validated by other participants.

- Block: it is constituted by multiple transactions that need to be validated. Once a block is completed it is added to the chain containing all the previous transactions.

- Ledger: it's the book of records of all transactions and it's made up of all the blocks.

- Hash: it is a mathematical operation which converts every text of any length in a unique code of given length. It enables to identify each block but not the content of it.

In simple words the transaction contains all the information about the receiving party's public address, the characteristics of the transaction and the cryptographic signature that guarantees the security and authenticity of the
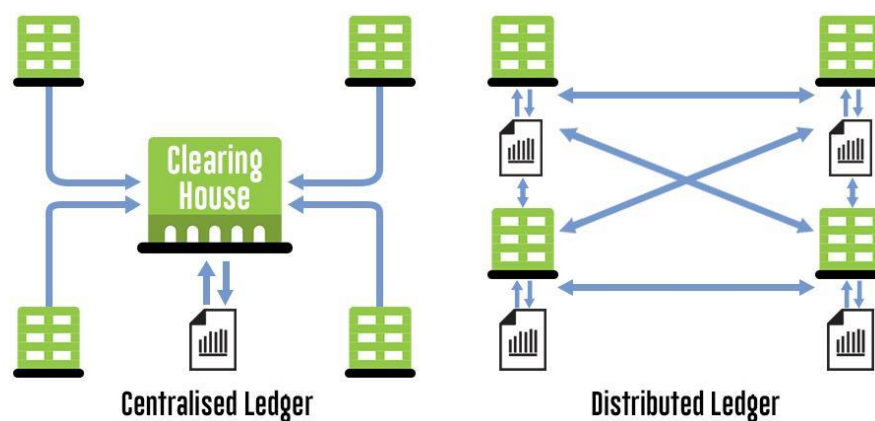
transaction. The block contains all the transactions and it has a hash on the header containing all information about the previous blocks.

When talking about blockchain the main issue is defining what this technology is. Many people tend to confuse it with Bitcoin since it has been born with it. Bitcoin is a digital currency which uses encryption to generate digital cash and to verify the transfer of funds. The blockchain is the underlying technology used to create Bitcoins, or cryptocurrencies in general.

In order to provide a better and more detailed definition of blockchain, it's necessary to understand the difference between centralized and distributed ledger. A centralized ledger is a book of records which contains all the transactions related to a company budget. Data are managed by a central authority which receives inputs peripherally, it stores and holds them, being itself the center of the organization.

The distributed ledger doesn't have a central authority and it's impossible for one or more parties to obtain the control of the network. Data are stored cryptographically and once they are stored they become an immutable part of the database and are shared among all the participants that can have their own identical copy of the ledger.

Image 1.1: Centralized vs distributed ledger

Source: quantinsti [1]

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[1] *How Will Blockchain Change Stock Markets?* (Sushant Ratnaparkhi, 2017)

It's now possible to define the blockchain as a reliable transaction cloud containing a distributed ledger of transactions, repeated in an identical copy, in multiple nodes.

In the case of a centralized ledger, an attack to the central authority is able to violate the all system. With blockchain as a distributed ledger it would take a simultaneous attack to all the copies of the network, and therefore to all participants' computers, in order to violate the ledger, which only theoretically impossible.

Cryptology is critical within blockchain technology and it's used to ensure that copies are identical, and no transaction is duplicated. The main point is that there is no need for intermediation since cryptology is able to ensure trust. Participants validate the transactions through a set of rules established by the network and consensus is met via majority. It is possible to summarize the blockchain as a sequence of steps:

1. A transaction is requested

2. The transaction is transmitted to all participants

3. Participants validate the transaction

4. Transactions are stored in a block and sealed with a hash

5. Once the block is validated, it is added to the blockchain

6. The transaction, being part of the blockchain, cannot be modified anymore.

The following picture helps understanding how blockchain works:

Image 1.2: How the blockchain works

How it works:

Someone requests a transaction.

The requested transaction is broadcast to P2P network consisting of computers, known as nodes.

Validation

The network of nodes validates the transaction and the user's status using known algorithms.

A verified transaction can involve cryptocurrency, contracts, records, or other information.

Once verified, the transaction is combined with other transactions to create a new block of data for the ledger.

The new block is then added to the existing blockchain, in a way that is permanent and unalterable.

The transaction is complete.

Cryptocurrency

Cryptocurrency is a medium of exchange, created and stored electronically in the blockchain, using encryption techniques to control the creation of monetary units and to verify the transfer of funds. Bitcoin is the best known example.

Has no intrinsic value in that it is not redeemable for another commodity, such as gold.

Has no physical form and exists only in the network.

Its supply is not determined by a central bank and the network is completely decentralized.

Blockgeeks

Source: Blockgeeks[2]

It is subsequent that blockchains continue to grow as new blocks are added, keeping all the records of transactions from their very beginning to the last changes.

It is possible to identify ten blockchain innovation characteristics[3]:

- Access: it's an open network, meaning that anyone can add blocks and review the entire blockchain from inception.

- Open source: technology is freely available to anyone.

- Trust: it allows individuals and businesses that don't know or trust each other to transfer value and information via an identified address.

- Redundancy: blockchain ledger is replicated on servers across the globe leaving no room for a single point of failure.

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[2] *How does Bitcoin Blockchain work and what are the rules behind it?* (Tipalti Account, 2017)

[3] Accenture research

- Disruptive: it disintermediates third parties and their associated transactional fees.

- Anonymity: it allows anonymous exchange of digital assets and data.

- Real time: blocks can be verified and added to the blockchain in near real time, it reduces arbitrage risk or data-sync problems.

- Secure: uses cryptographic algorithms based on private/public key encryption.

- Safekeeping: it maintains comprehensive life-cycle asset, contract and data ownership without having physical possession.

- Decentralized: maintained by a global network of nodes, it obviates the need for a central authority.

According to our definition, blockchain stores data that have value such as money, stocks and bond, but it can also store patents, identity, votes and so on. The benefits then are not just economic, they can be political, social and humanitarian, making of blockchain a disruptive technology.

1.2   Blockchain as a P2P network

Another possible way to define the blockchain is as a peer-to-peer network. Daniel Drescher, author of *Blockchain Basics: A Non-Technical Introduction in 25 Steps,* defines peer-to-peer systems as "distributed software systems that consist of nodes (individual computers), which make their computational resources (e.g., processing power, storage capacity, or information distribution) directly available to another. When joining a peer-to-peer system, users turn their computers into nodes of the system that are equal concerning their rights and roles. Although users may differ with respect to the resources they contribute, all the nodes in the system have the same functional capability and responsibility. Hence, the computers of all users are both suppliers and consumers of resources"[4]. In other words, it means that if a file is shared among a peer-to-peer community it can be downloaded by any

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[4] *Blockchain basics, A non-technical introduction in 25 steps* (Daniel Drescher, 2017)

participants from any computer of the participants, being the file stored on the users' machine.

Taking the example of cryptocurrencies, the miners are the ones offering computer processing power, and therefore representing the nodes. The miners have the duty of verifying transactions that are outside of the network and adding them to the blockchain.

1.3   Blockchain 1.0, 2.0 and 3.0

Blockchain disruptive force may be broken down into three phases: Blockchain 1.0, 2.0 and 3.0.

Blockchain 1.0 regards the utilization of blockchain as cryptocurrency, blockchain 2.0 is about smart contracts and blockchain 3.0 is about the adoption of blockchain across industries.

The following time table shows how the blockchain will be implemented across the years. The different kind of blockchains we just saw are different and at the same time each one of them is the evolution of the previous one. That means that for smart contracts to be fully implemented, we need cryptocurrencies to reach full maturity.

Image 1.3: Disrupting financial services, capital markets and beyond
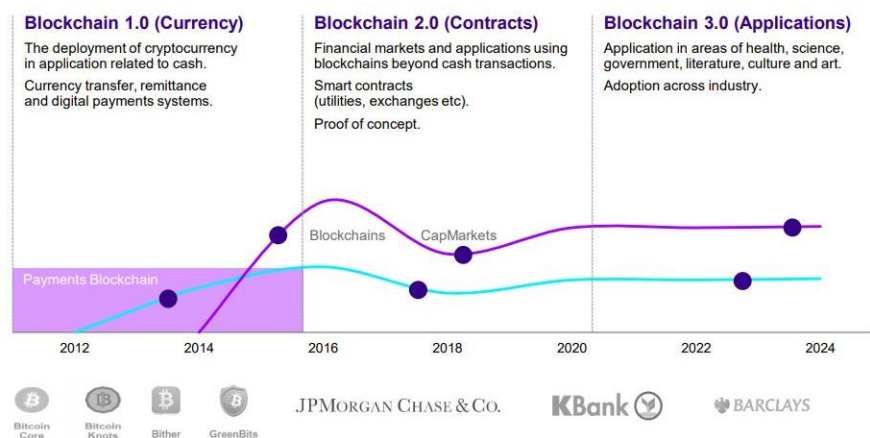
Source: Accenture research, 2017

1.3.1 Block chain 1.0: cryptocurrencies

In the previous paragraphs I've already talked about cryptocurrencies, the purpose of the following one is to get into the details. A simple definition of cryptocurrency is the following: digital or virtual currency that uses cryptography for security.[5]

"A cryptocurrency is a token on a distributed consensus ledger (DCL) that represents a medium of exchange and a unit of account. A cryptocurrency can be obtained, stored, accessed and transacted electronically. It facilitates peer-to-peer exchange without necessarily going through a third-party intermediary[6]."

Transactions made by cryptocurrencies are registered on the blockchain, while the identity of the players stays anonymous and they are known only by their virtual addresses. The disruptive power of cryptocurrencies lays on the fact that they can be issued without the involvement of a central bank or any other traditional player. Nowadays banks own all the money in circulation with the exception of cash owned by individuals; cryptocurrencies conversely are owned by the owner of the keys.

The main characteristic of cryptocurrencies is the cryptographic hash function which converts a transaction into a hash value. *"Hash values can be thought of as fingerprints for files. The contents of a file are processed through a cryptographic algorithm, and a unique numerical value – the hash value - is produced that identifies the contents of the file. If the contents are modified in any way, the value of the hash will also change significantly[7]"*. Important attributes of cryptographic hash functions are:

- Deterministic: a particular message will always return the same hash value

- Quick: a function is quick to compute

- One way: it is infeasible to reverse engineer a message from its hash value

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[5] Investopedia

[6] *The (R)evolution of money, Blockchain Empowered Digital Currencies* (Accenture consulting, 2017)

[7] *Hash values* (trendmicro)

- Avalanche effect: a minor change to the input message would cause a major change to the hash value, so much that the new hash would appear unrelated to the old hash value.

When talking about cryptocurrencies we refer indifferently to Bitcoin, Altcoins and crypto-tokens. As seen before, cryptocurrencies have been born with Bitcoin which has set itself as standard among other cryptocurrencies and it has been the first distributed and decentralized cryptocurrency. Altogether crypto-coins different from Bitcoin are known as Altcoins and they differ according to their protocol source. Bitcoin-derived Blockchain are created by altering the underlying codes on the Bitcoin's open sourced protocol and the most famous example of it are Litecoins. There are also altcoins with their own blockchain and protocol supporting their native currencies; examples of this kind of altcoins are Ripple (XRP) and Ethereum. Both types of Altcoins register the transactions related to their native coins on their own independent blockchain.

Crypto-tokens operate on top of another blockchain and they represent a particular asset or utility. Tokens give to the owner the control over a specified amount of digital resources and the possibility of transfer that control to a third party in exchange for cryptocurrencies. Examples of digital resources that can be stored in a token are utilities, assets or even other cryptocurrencies. Since they operate on top of another blockchain, tokens are not created from scratches and they don't need to modify codes from an existing protocol, like Bitcoin-derived blockchain, or to create a new blockchain, like Native Blockchain.

ICOs (Initial Coin Offerings) are used by cryptocurrency ventures to create and distribute cryptocurrencies to the public and raise funds. With the ICO (Initial Coin Offer) a start-up offers some new crypto-coins or crypto-tokens in exchange for Bitcoin or altcoin in general. It is possible to equalize ICOs to IPOs since the release of the tokens or coins is integrated into the project, making tokens equivalent to shares and securities.

1.3.2 Blockchain 2.0: smart contracts

Focusing on blockchain 2.0, a possible definition of smart contracts is the following: event driven contracts whose terms and conditions are written into lines of codes running on a blockchain network. In other words, a smart contract works on an *if-then* premise. The contract will be executed only if an event will occur: the property of an asset will be transferred only when the payment is received. Furthermore, the all process is witnessed by a multitude of validators and therefore theoretically faultless.

The implementation of smart contracts at different levels and in different areas will be able to:

      - reduce settlement times,

      - lower contract costs, since validators are rewarded by the activity of mining which is less costly than paying any legal/notary fees,

      - eliminate risks of fraud,

      - increase security by preventing contract changes,

      - increase auditability of contracts by legal and compliance

      - eliminate reconciliation costs.

The logic behind the smart contract is that the asset is transferred into a program *"and the program runs this code and at some point it automatically validates a condition and it automatically determines whether the asset should go to one person or back to the other person, or whether it should be immediately refunded to the person who sent it or some combination thereof"*[8].

Smart contracts may be defined as computer programs that cryptograph contracts among participants and that can be settled in cryptocurrency. This could be either useful for cutting contract costs and for regulating aspects that are not yet regulated or for dealing with parties that have no juridical system.

It is possible to use smart contracts for all kinds of situations such as financial derivatives, financial services, legal processes, property law and many others.

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[8] Buterin at DC Blockchain Summit in Washington, D.C.

1.3.3 Blockchain 3.0: applications

The blockchain technology allows for a decentralized interaction among multiple participants around the world. This feature is able to rewrite not only payments and financial services but potentially all the industries. Blockchain model is not only more efficient but it could also play an important role in reaching greater equality and in empowering users.

Blockchain might be able to transform the value chain thanks to its characteristics of traceability and immateriality. Taking the example of auto manufacturing value chain, we will analyze how it'd change in every phase:

1.A vehicle id is assigned at each vehicle in the production phase. This allows to know exactly at which phase of the production the vehicle is and what is going to happen next.

2.Once the vehicle is sold to the final client its ownership is transferred automatically and the change of ownership is logged in the blockchain, meaning that titles are no longer needed.

3.Every time a check, a reparation or a substitution is made to the vehicle, it is added to the vehicle information and available on the blockchain. This aspect is important both for the user, which is able to check the eventual repairs or substitutions, therefore reducing the risk of fraud, and for the mechanic who is able to better understand a vehicle maintenance history.

4.When the vehicle is resold, the new owner is able to check the vehicle maintenance history, providing greater transparency and reducing information asymmetry.

Blockchain 3.0 doesn't refer only to value chain disruption, this term refers to all the possible applications of blockchain in different industries such as Government, health, science, literacy, art and culture.

An important scope that the blockchain may serve, within both the government and the health industries, is the digital identity verification. By combining blockchain with the biometrics system it would be possible for anyone to be recognizable anywhere without the need for paper documentation. Digital

identity verification would eliminate all the problems related to losing the physical id and it would reduce identity thefts since it requires biometrics. Having a reliable digital identity would allow for concentrating all the information in a single account, meaning that it would be possible to have access to bank account, social media, mail, clinical history and so on with only one profile. The final user would be able to control which information to share and with whom, by doing so the privacy of the final user would be protected at a higher level. To better understand what just stated it's useful to think at the example of voting. Instead of giving the id which contains multiple data, digital identity would allow us to show the only information we want to provide: the right of voting. Furthermore, digital identity would be useful for health purposes, in the case of an accident doctors would have access to the clinical history of the patient having available blood type, allergies, previous surgical operations and all the information needed to have a better understanding of the patient.

For what it concerns the art industry, blockchain technology is able to confirm the authenticity of an artwork and its rightful owner.

1.4   Types of blockchain

It is possible to identify mainly four types of blockchain based on two criteria. We can distinguish between public and private blockchain according to the possibility for anyone to have free access or not to the chain. Moreover, if there is an authority which controls what kind of transactions are allowed we are in presence of a permissioned blockchain, otherwise we have a permissionless blockchain.

The following matrix tries to give a better understanding of the concepts:

Matrix 1.1: Different types of blockchain
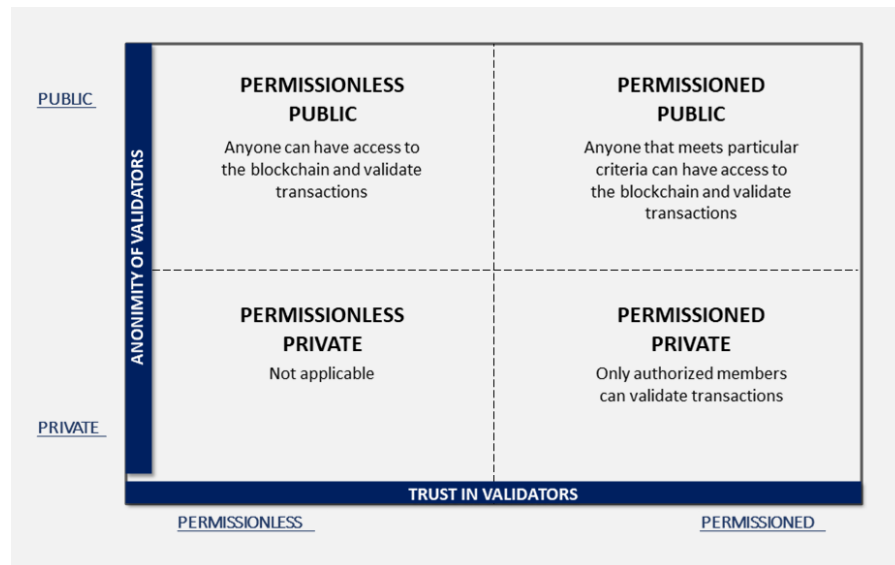
Source: own elaboration based on Accenture Research

Starting from the top left quarter it is possible to define four types of blockchain, resulting from the combinations of the criteria listed above:

- **Permissionless and public blockchains**, as the words say, don't require any permission to the actors in order to join the network. In this configuration any participant can read and write the chain, and at the same time become a miner helping to validate the network and getting rewarded for it. Participants only need a computer to mine and only the proof of work is needed. This structure is out of government control because the identity of the miners is unknown and therefore the trust in validators is low. Permissionless blockchains ensure that anyone can validate a transaction and check the regularity of the chain consequently increasing transparency. On one side this procedure enables parties to develop trust on the system, it lowers transaction costs, it works as deterrent for hackers (since it is more profitable to work for the system as miner than trying to hack it) and it increases speed in the verification process. On the other side as the community grows so the complexity verification does. That implies that more computational power is needed while the activity of mining becomes less remunerative (because of the increased energy consumption).

- **Permissioned and public blockchains** are restricted networks and in order to join the network permission is required. Anyone that meets particular criteria can join the network. Trust level in the validator is high and proof of stake is requested.

- In **permissioned and private blockchains** validators need to be authorized and trust in validators needs to be high. In this case there is a centralized authority who controls who is allowed to enter the network, it decides the set of rules for participating the network, the mining rights and rewards.

Permissioned blockchains are suitable for corporations, banks and payment infrastructures. In this case a set of rules gives the possibility to authorized actors to grant and control the access and the authorization of transactions and it also gives them the right to add and modify transactions. These kinds of blockchain are able to combine the typical properties of the distributed ledger (transparency, immutability and security) with the need for control over the regularity of transactions demanded by banks, public administration and corporations.

1.5   *Proof of work vs proof of stake*

Since we have seen that public blockchains require proof of work or stake, accordingly if they are permissionless or permissioned, it's useful to analyze the similarities and the differences between them. Proof of work and proof of stake are both consensus mechanisms used to validate the information that are added to the ledger. Proof of work (PoW) is the consensus mechanism introduced by Nakamoto and it is the one used by Bitcoin and the other major cryptocurrencies. The main goal of PoW protocol is to avoid any possible cyber-attack: the mining process is such that trying to hack it, would require more power and it would be costlier than participate to the system and get rewarded for the mining activity. In the PoW mechanism the first miners who solve the hash functions get rewarded for it with the creation of a portion of Bitcoin (or crypto-coins in general). This process doesn't require any particular skills by the miners, but it requires brute force to solve the

hash functions and therefore a large computational power is needed. Furthermore, the network automatically and periodically increases the difficulty, requiring more

Image 1.4: Proof of Work vs Proof of Stake: analysis of the differences
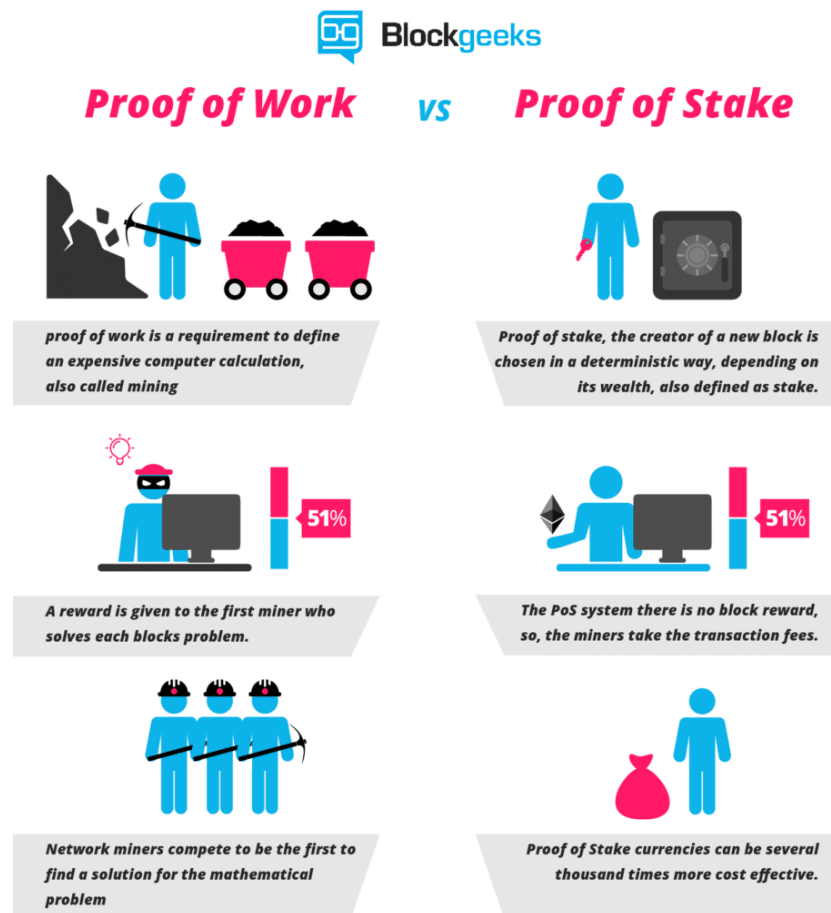
Source: Blockgeeks[9]

calculations to solve the function and consequently a greater computational power. The final outcome of this process is that in the long run mining will result in great energy consumption and that has raised multiple problems related to efficiency and environmental concerns. Those considerations have led players such as Ethereum to consider other alternatives such as the Proof of stake (PoS) protocol. PoS, being

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[9] *Proof of Work vs Proof of Stake: Basic Mining Guide* (Blockgeeks)

a consensus mechanism, aims at validating transactions and reach distributed consensus just like PoW. What is different with this mechanism is the process: the validators are chosen in a deterministic way based on their stake. The number of stakes hold by the players becomes nevralgic in this model since the greater the number of stakes a node has, the lower are the probability for him to violate the system. The participants with the greater wealth are selected to validate blocks and add them in the blockchain. Altogether with the nodes with the greater wealth, also participants with a lower stake are selected. At the end of the validation process miners (often defined forgers when referring to PoS) are not rewarded with new coined crypto-coin, but they are paid with transaction fees. As anticipated this method helps achieving a greener and cheaper distributed form of consensus. Besides environmental concerns there are two main problems with the PoW model: the high costs of electricity, which is being paid in fiat currencies, leads to a downward pressure on the crypto-currency value; participants that can afford greater computational power will gain a significant portion of crypto-currency, resulting in the failure of the decentralization sought by the distributed ledger system.

Currently Ethereum is developing a new proof of stake protocol called Casper, planning to switch from the actual PoW consensus method. The number of the forgers (miners) won't be limited and anyone can join the pool, regardless of how many participants there are. In order to regulate the number of validators interest rates will be cut in the case of many participant, conversely if the validating pool will have few participants, rewards will be increased. The Casper protocol imposes forgers to submit deposits to participate which they might lose if they try to violate the system.

1.6   Governments' worldwide interest on blockchain

Blockchain technology has attracted the interest of many countries that are currently studying its application in different fields, starting from cryptocurrencies and ICOs. Those studies have the goal of exploring the different applications of

blockchain on areas such as taxation, healthcare, property transfer rights and privacy and security issues.

Governments worldwide have been commissioning studies on blockchain trying to impose themselves as leaders of the most discussed technology of the moment.

The **European Commission** has put together 22 countries[10] that have signed a Declaration on the foundation of a European Blockchain Partnership. This cooperation aims at sharing information, experience and expertise to constitute a bundle of EU-wide blockchain applications across the Digital Single Market. In February 2018 the European Commission constituted the EU Blockchain Observatory and Forum which stated a budget of € 300 million to ensure that Europe position itself among the major players on this topic. Mariya Gabriel, Commissioner for Digital Economy and Society, has affirmed, regarding the signing of the Declaration:

"In the future, all public services will use blockchain technology. Blockchain is a great opportunity for Europe and Member States to rethink their information systems, to promote user trust and the protection of personal data, to help create new business opportunities and to establish new areas of leadership, benefiting citizens, public services and companies. The Partnership launched today enables Member States to work together with the European Commission to turn the enormous potential of blockchain technology into better services for citizens"[11].

Within the EU members, **Estonia** has been distinguishing itself for being an early bird on adopting blockchain technology and it has been studying the "hash-linked time-stamping" (as they used to refer to it before the word blockchain was coined) before Satoshi's white paper on Bitcoin became public. The country is analyzing the possible usages of distributed ledgers for national purposes such as health care, legislation, id verification and many others. Estonia's main focus nowadays is on the implementation of the e-Residency program which aims at

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[10] List of countries signatories of the Declaration: Austria, Belgium, Bulgaria, Czech Republic, Estonia, Finland, France, Germany, Ireland, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, UK.

Other countries, Members of the EU and of the European Economic Area are invited to join the European Blockchain Partnership. *Source: European Commission*

[11] *European countries join Blockchain Partnership* (European commission, 2018)

boosting foreign investments in the country by offering, as the government web site states, *"e-Residency, a government issued digital identity that empowers entrepreneurs around the world to set up and run a location-independent business[12]"*. The benefits that this model and the government want to achieve, are the following:

- Establish a company online: meaning that it'd be possible for everyone and from anywhere in the world to start a company which is completely online based. That implies that a local director is no longer needed.

- Manage remotely: with the usage of smart contracts, private keys, encryption and being all the data available on the network, the entrepreneur won't need to be physically present on the territory. It is now possible to sign and authenticate documents anywhere and at the same time managing and declaring taxes online.

- Achieve location independence: based on the reasons listed above. The entrepreneur will be free to operate from anywhere in the world and it won't need to re-establish his company after moving abroad.

Estonia, within the e-Residency program, is currently considering launching its own cryptocurrency: the Estcoin. That would be the first national cryptocurrency to be coined and the European Central Bank has already raised its concerns. Mario Draghi has stated that none of the European countries can introduce its own currency but Kaspar Korjus, which oversees the e-Residency program, is studying three different models for introducing the cryptocurrency.

The first model wants the value of the Estcoin to be linked to the Euro value, like a derivative, but that doesn't help reducing the ECB concerns. An alternative model wants to use the Estcoin as a reward for helping to build the e-Residency, and therefore create an Estcoin community, but it is not clear what those coins would buy and how. Finally, the third model wants to use Estcoin as coins available only to pay taxes and fines. Thanks to its low taxation and for being base of many, **Switzerland** has been home of the Crypto Valley Association (CVA). The no profit association was formed to support and attract blockchain organizations. In 2014 in

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[12] Source: Republic of Estonia, e-residency website

Zug it has been installed the first Bitcoin ATM and in the same year Ethereum foundation was established. As the official website states, "*The Ethereum Foundation's mission is to promote and support Ethereum platform and base layer research, development and education to bring decentralized protocols and tools to the world that empower developers to produce next generation decentralized applications (dapps), and together build a more globally accessible, more free and more trustworthy Internet. (...). Ethereum is a decentralized platform that runs smart contracts: applications that run exactly as programmed without any possibility of downtime, censorship, fraud or third-party interference. These apps run on a custom built blockchain, an enormously powerful shared global infrastructure that can move value around and represent the ownership of property. This enables developers to create markets, store registries of debts or promises, move funds in accordance with instructions given long in the past (like a will or a futures contract) and many other things that have not been invented yet, all without a middleman or counterparty risk*" [13]. At the beginning of 2018, Switzerland's Economic Minister, Johann Schneider-Ammann, has expressed the national intent of making Switzerland a Crypto Nation. The Swiss national regulator, FINMA, has published the ICO guidelines, the first of its kind, with the purpose of offering a guidance to companies and startups.

The **United States** lead the list of the countries involved in studying the different applications of blockchain. The US governments, in collaboration with each other as with corporations and educational institutions, have been studying the implementation of distributed ledger technology in different fields such as: financial management, smart contracts, patents, visas, passports, supply chain management and many others.

"*The General Services Administration (GSA[14]) Emerging Citizen Technology Office launched the US Federal Blockchain program for federal agencies and US*

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[13] Source: Ethereum website, foundation

[14] Independent agency of the United States government. GSA provides workplaces by constructing, managing, and preserving government buildings and by leasing and managing commercial real estate. GSA's acquisition solutions offer private sector professional services, equipment, supplies, and IT to government organizations and the military. GSA also promotes management best practices and efficient government operations through the development of governmentwide policies. Source: GSA website

businesses that are interested in exploring Blockchain technology and its implementation within the US government. So far, GSA has used Blockchain to automate and speed up contracts review for its FASt Lane program[15]"[16].

The treasury Department is studying the application of blockchain for supply chain management and it has started initiatives to combat money laundering and terrorism financing. The Deputy secretary Sullivan has stated: *Blockchain has the potential to become a transformative technology of our lifetime. It is increasing its footprint in our daily lives every day and is expected to play a major role in trade, business, healthcare management, and finance, and we hope at the State Department as well. We are quite confident of that. Through Blockchain we can track movements of goods in the shipping industry; we can verify someone's ID; we can safely transfer money and payments across borders in real time. It's no wonder that Blockchain technology, a market that could grow to more than $40 billion by 2022 according to at least one estimate, has captured the attention of governments and international organizations worldwide[17].* In general, United States are exploring the application of blockchain on birth registries, state records, ID systems, national defense and more.

The **United Arab Emirates** are playing an important role on shaping the future of Blockchain. Dubai aims at becoming the first blockchain-based government. By 2020, the emirate wants all visa applications, bill payments and license renewals, which account for over 100 million documents each year, to be transacted digitally using blockchain[18]. It has been estimated by Smart Dubai that blockchain implementation will save more than 25 million man-hours and $1.5 billion per year. Furthermore, Dubai plans on opening its blockchain platform to partners in Europe, North America and Asia in order to simplify passport check and visas concessions.

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[15] The FASt Lane program ensures our government customer agencies have quicker access to emerging technologies and innovative suppliers. With FASt Lane, suppliers get shorter processing times. Source: GSA website

[16] "*US Government Implements Blockchain Programs to Improve Transparency and Efficiency*" (Selva Ozelli, 2018)

[17] Source: U.S. Department of state Website

[18] "*Dubai Sets Its Sights On Becoming The World's First Blockchain-Powered Government*" (Suparna Dutt D'Cunha, 2017)

Canada, being home to the inventor of Ethereum blockchain, Vitalik Buterin, is one of the most important innovating player on implementing blockchain. As the official website says *Ethereum is a decentralized platform that runs smart contracts: applications that run exactly as programmed without any possibility of downtime, censorship, fraud or third-party interference*[19]. The Government of Canada, together with Ethereum and Catena Blockchain Suite, is running a pilot project to explore the possible applications of public blockchain in managing government grants and contributions. "*The trial for the pilot project will be spearheaded by the NRC via the Industrial Research Assistance Program (NRC IRAP), an organization which operates as the Canadian government's premier research and development organization. An Ethereum blockchain-compatible software service called Catena Blockchain Suite, built by Bitaccess, is the platform upon which the government database rests*"[20]. Furthermore, in Canada there is one of the most important organization in the world, The Blockchain Research Institute, studying real world applications for blockchain technology.

Singapore is currently exploring blockchain applications to improve financial access and inclusion for Southeast Asian Countries. A project started by the Monetary Authority of Singapore, in partnership with R3, has developed software prototypes for decentralized interbank payment and settlements. Singapore's minister of finance talking about blockchain stated *"In particular, we will support digital innovations like fintech. For example, the underlying distributed ledger technology presents us with many opportunities for cheap and secure transactions. This can promote financial inclusion for underserved and underbanked segments in ASEAN*[21]" (Association of Southeast Asian Nations).

Japan is Bitcoin's hearth and more in general it has been leading the legalization of smart contracts, blockchain and cryptocurrencies. Japan has been the first country to regulate and legitimize cryptocurrencies and it is home of the largest Bitcoin exchange, Bitflyer. Midori Kanemitsu, Bitflyer's CFO, affirmed:

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[19] Source: Ethereum Website
[20] *Canada Leverages Ethereum Blockchain For Public Transparency Of Government Grants* (Jeremy Nation, 2018)
[21] *Singapore Plans Blockchain Push to Boost Financial Inclusion* (Wolfie Zhao, 2018)

"Effectively, Japan is the first and only country that has a proper legal system regulating cryptocurrency trading. That's a big deal. Before the law regulating cryptocurrencies, people worried what would happen to their money if an exchange were to go bust.[22]"

That has helped the proliferation of cryptocurrencies and it has supported investments on Blockchain application studies. Besides regulating cryptocurrencies, the government and the financial institutions are working on an ID platform, based on distributed ledger technology, which will enable banks to share consumers' information with each other. At the same time this platform will enable consumers to share their personal data to financial institutions and multiple banks. That means that a consumer, who has a bank account at one of the platform's institution, will be able to open a bank account at another institution by simply verifying his identity biometrically and therefore avoiding to physically present all the documentation needed.

The **Australian** government has been financing studies about blockchain applications on government services. In particular the government has allotted AU$700,000 to its Digital Transformation Agency with the goal of moving government services into the digital era. The main focus is once again on virtual id verification which would allow users for a better experience within the government services. The Australian government is also financing a blockchain powered smart-utilities project. This project aims at studying *"how cities can use blockchain technology and data analytics to integrate distributed energy and water systems[23]"* according to Power Ledger[24], which is collaborating at the project.

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[22] *Japan Claims Global Leadership in Cryptocurrency Space* (Komfie Manalo, 2018)
[23] *The woman powering the energy industry on the blockchain* (Samantha Yap, 2018)
[24] Power Ledger (POWR) is an Australian blockchain-based cryptocurrency and energy trading platform that allows for decentralized selling and buying of renewable energy

1.7   How it began: lights and shadows on the blockchain

As mention at the beginning of this work, the blockchain as we know it today sees light for the first time in 2008 with the pamphlet on Bitcoin of Satoshi Nakamoto which becomes reality on January the third 2009 when the first Bitcoin was created.

Earlier attempts of creating a web currency may be tracked down back to 1982 when David Chaum proposed his idea of electronic money in a paper called *Blind Signatures for Untraceable Payments*. His ideas of using cryptography to create an automated payment system led him to launch in 1990 DigiCash which represents the first attempt of creating a digital currency. In 1998 the company created by Chaum declared bankruptcy, at the time the idea of a digital currency running on the internet wasn't in vogue, being the e-commerce market not fully mature yet. Nonetheless Chaum's work inspired other projects based on creating digital cash protected by crypto algorithms such as Hashcash proposed in 1997 by Adam Back or B-Money created by Wei Dai in 1998.

Even though those projects never took off they set the basis for Satoshi Nakamoto to create Bitcoin. The reason why the accounting system created by Nakamoto managed to succeed has to be found on the historical background. Back in the '90s people had great trust in the financial system so the idea of an alternative one just seemed unnecessary and illegitimate. The financial crisis of 2008, started with the collapse of Lehman Brothers, represented a great opportunity for Bitcoin to spread worldwide. The largest bankruptcy in the history of the fourth largest U.S. investment bank has led customers to lose trust in the banking system and to welcome new disruptive alternatives such as cryptocurrencies.

At its beginning Bitcoin was a small reality sustained by few idealists and cypherpunks who saw in blockchain technology a way to overturn the actual financial system and give the power back to the most. The first Bitcoin transaction ever done is between Satoshi Nakamoto and Hal Finney on January 2009. Hal was a cypherpunk and he has been fascinated by the cryptotechnology way before Bitcoin came to life. Referring to Chaum's work in 1992 Hal writes in Cypherpunks Mailing List *"It seemed so obvious to me, here we are faced with the problems of*

loss of privacy, creeping computerization, massive databases, more centralization - and Chaum offers a completely different direction to go in, one which puts power into the hands of individuals rather than governments and corporations. The computer can be used as a tool to liberate and protect people, rather than to control them."[25]

Hal Finney is also known for contributing writing the code underlying the Bitcoin platform and for exchanging multiple mails with Satashi Nakamoto. Because of its proximity to the father of Bitcoin, Finney has been accused to be the real Satoshi Nakamoto and to have used the identity of his neighbor Dorian Nakamoto to conceal his own identity.

On February 2010 the first Bitcoin exchange website is launched, which becomes operative starting from March the 17th and on May Laszlo Hanyecz buys two pizzas for 10.000 Bitcoins, being the first exchange ever recorded of a good for Bitcoins. At the time Laszlo purchased those pizza for 10.000 Bitcoins, when its value was close to zero, nowadays the same amount is worth somewhere around $70.000.000.

From the end of 2009 to the end of 2010 the value of Bitcoins increased from $0,00076 to $0,30 recording a growth of 400%.

In July 2010 Jed McCaleb uses his website created to trade Magic cards, Mtgox, to exchange Bitcoins. In March 2011, after the website grew exponentially, McCaleb decided to sell the company to Mark Karpelès and few months later a hacker attack made the website Bitcoin price drop to $0,1. The breach lasted few minutes, but it was enough time for the hacker to get in control of a large number of Bitcoins. At the time of the attack a Bitcoin was worth somewhere around $1 but by the end of the year it touched $5,42. By 2014 Mtgox managed 70% of all Bitcoin transactions worldwide when it started filing for bankruptcy. In February 2014 indeed Karpelès stated that 850.000 Bitcoins were stolen from Mtgox, of which 100.000 owned by the company. One month later Mtgox declared to have found an old wallet worth 200.000 Bitcoin, reducing the missing Bitcoins to 650.000. In 2016

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[25] *Nakamoto's Neighbor: My Hunt For Bitcoin's Creator Led To A Paralyzed Crypto Genius* (Andy Greenberg, 2014)

Karpelès was arrested by Japanese authorities with the charges of fraud and embezzlement.

Coming back to McCaleb, after selling Mtgox he developed what is today known as the Ripple protocol and in 2014 together with Joyce Kim he developed the Stellar protocol with the purpose of enabling cross border payments for both digital and fiat currencies.

Among the first enthusiast adopters of Bitcoin the name of Charles Shrem is one of the biggest one. Charles started buying Bitcoin back when he was in college but ended up losing them when the platform he was using crashed. Thanks to the collaboration with Gareth Nelson, Shrem opened in 2011 BitInstant, a blockchain based marketplace which provided users with Bitcoin within few seconds from the purchase. By 2013 BitInstant processed 30% of all Bitcoin transactions attracting numerous investors among whom the Winklevoss twins who invested in 2013 $1.5 million in the startup. BitInstant was shut down in 2014, being its CEO Shrem charged with money laundering. BitInstant gave users the opportunity of exchanging Bitcoin for dollars and vice versa and because of that it has been involved in the Silk Road scandal. Silk Road was a dark web market place where any kind of commerce was possible. The platform created by Ross Ulbricht in February 2011 used Bitcoin to buy online drugs, weapons and any other illegal good, taking advantage of the anonymity of the payments guaranteed by cryptocurrencies. Shrem has been accused of conducting business with Robert Faiella who used Shrem's platform to buy Bitcoins and then buying drugs in Silk Road with them.

The birth of Silk Road in 2011 together with the Bitcoin theft at Mtgox have caused a reputational damage to the Bitcoin community. For this reason, on September 27, 2012 Gavin Andresen, Charlie Shrem, Mark Karpelès, Peter Vessenes, Roger Ver, and Patrick Murck founded the Bitcoin foundation with the following mission:

"The Bitcoin Foundation coordinates the efforts of the members of the Bitcoin community, helping to create awareness of the benefits of Bitcoin, how to use it and

its related technology requirements, for technologists, regulators, the media and everyone else globally"[26].

Having talked about Shrem and Karpelès and their misdoing, it is fair to spend few words over the other founders of the Bitcoin Foundation. Starting from Gavin Andersen he was appointed by Satoshi Nakamoto as lead developer for the software Bitcoin Core, which constitutes the backbone of Bitcoin.

Peter Vessenes was the first Executive director and Chairman of Bitcoin foundation, today he is the CEO of CoinLab, a venture-backed company with the purpose of spreading the use of cryptocurrencies. Roger Ver is currently involved in many Bitcoin related projects and in 2017, together with other developers who wanted to increase Bitcoin's cap of 21 million and contrary to costlier transaction fees coming from an always larger network, created BitcoinCash a spin off, called hard fork, of Bitcoin. Finally, Patrick Murck was the general counsel of the foundation and today he is the president of BitGive foundation, a nonprofit organization which raise Bitcoin donations for charitable causes.

Another important event in Bitcoin history is when Nick Spanos and Andrew Martin in the late 2013 found the Bitcoin Center NYC, the first physical Bitcoin exchange. The center had the role of promoting the use of cryptocurrencies and worked as a hub for developing new blockchain applications.

2013 has been a profitable year for Bitcoin which by the end of the year reaches the value of $1.205. The boost was driven mostly by Karpelès manipulating the algorithm to bid up the price, but also political tensions helped Bitcoin to break the value of $1.000. The Cyprus bail-in in March 2013 together with the Greek crisis and the devaluation of the Yen have exposed the fragility of the banking system and have boost further the confidence in a decentralized system not controlled by banks.

In 2014 Gavin Andersen steps down as Bitcoin Lead Developer, that together with the already mentioned arrest of Charles Shrem and the scandal of Mtgox, have brought the authorities in New York to propose in July the BitLicence, with the purpose of regulate virtual currency businesses. All those events caused the Bitcoin to drop to the value of $318 by the end of 2014. By looking at Bitcoin chart and

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[26] Source: The Bitcoin foundation manifesto

analyzing its peaks, it is possible to track down the effects of the events described above.

Graph 1.1: Bitcoin value chart August 2010 – December 2014
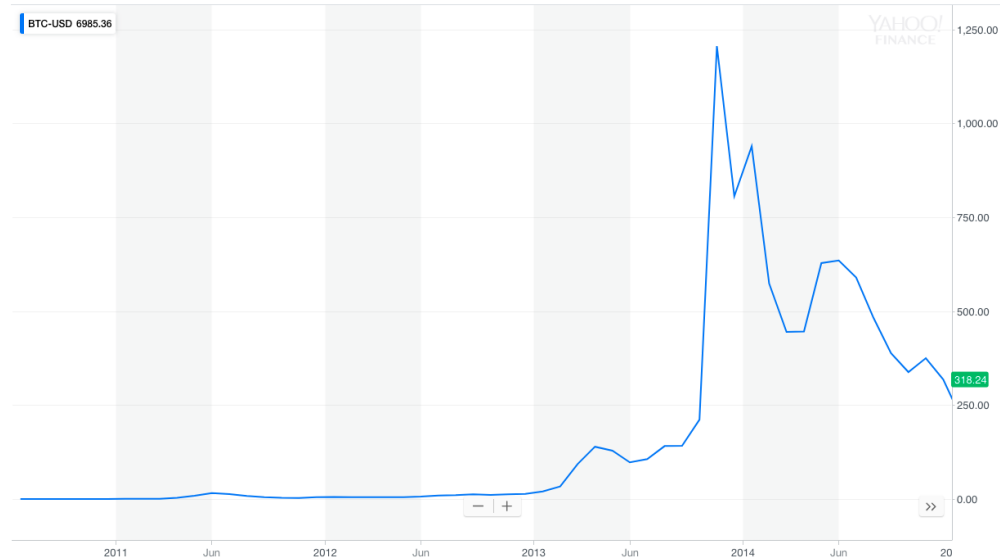
Source: Yahoo Finance

As we can see from the graph, Bitcoin value was close to 0$ till 2013, when it touches its highest value on November of the same year. In 2014 all the scandals related to the Bitcoin world drove its value down to somewhere around $320.

January 2015 starts with bad news for the Bitcoin community: Bistamp, one of the biggest Bitcoin exchange has been hacked and $5 million worth Bitcoin have been stolen from it. Even though the loss hasn't impacted significantly the trading platform, the reputational damage coming from it was way more severe for Bitstamp.

On June, the BitLicence is released by Benjamin Lawsky, superintendent of New York State Department of Financial Services. The license caused many companies to ban New York based customers and to abandon that market. In October the Winklevoss twins release Gemini, a US based Bitcoin exchange, totally compliant with the set of rules defined by Lawsky, which served both individual and institutional investors. At the end of the same month, an event which helped boosting the value of Bitcoins was the declaration of the EU court of justice which established that virtual currencies are not subject to VAT. The EU court also

classified the virtual currencies as currencies, contrary to what happened in the USA where the US regulator classified them as commodities. By the end of the year Bitcoin value is $435, starting its recovery from the drop of the previous year.

2016 is the year in which Bitcoin is back on track and it almost touches back the value of $1.000. Looking at the international scenario, the Cabinet in Japan recognizes virtual currencies as money and in South Africa, the largest online marketplace opens his doors to Bitcoin payments.

In the summer of 2016 the price of Bitcoin almost doubled, this peak was mostly due to investors' concerns on Brexit which resulted in considering Bitcoin as a safe place where to store money.

In August Bitfinex, one of the biggest Bitcoin exchange, has been hacked and $70 million worth Bitcoin are stolen, causing the Bitcoin to drop once again.

The second raise of Bitcoin started in November is a consequence of Trump's election, in times of uncertainty investors refuge their money in investments called safe heaven, for their characteristic of retaining their value. The fact that investors moved to Bitcoins in times of uncertainty such as Brexit and Trump's election helped giving legitimacy to virtual currencies and caused the Bitcoin to jump high.

Graph 1.2: Bitcoin value chart January 2015 – December 2016
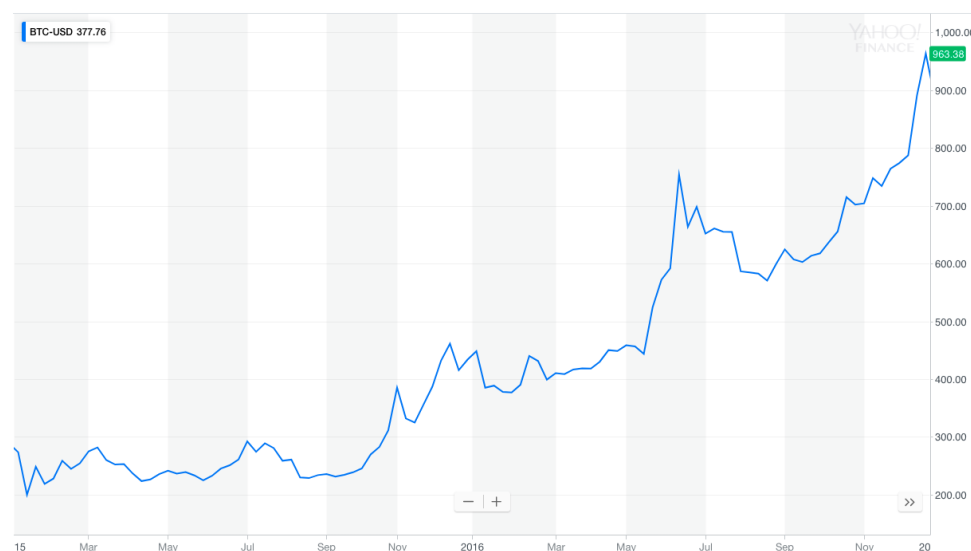
Source: Yahoo Finance

January 2017 starts with Bitcoin breaking once again the cap of $1.000 for the first time in three years. Financial regulators worldwide start legitimating cryptocurrencies, in April Japan recognizes Bitcoin as legal tender and Russian authorities affirm that Bitcoin and other cryptocurrencies will be legal in the country from 2018 and in Norway Skandiabanken, the largest online bank, integrates Bitcoin accounts and recognizes it as a payment system.

After Bitcoin having collected approvals from various regulators worldwide, Jamie Dimon, CEO at JPMorgan, during a speech at a financial services conference defined Bitcoin a fraud. In addition to that he said that he would fire in a second any JPM trader who traded Bitcoin because *"Its against the rules, its stupid, its dangerous"*[27]. Those words coming from JPMorgan CEO, together with China taking officially distance from the cryptocurrency, drove the value of Bitcoin down. In the same days indeed, the Chinese regulator was banning companies from raising money through ICOs and shutting down all the cryptocurrency exchanges. Nonetheless 2017 has set an all-time record for Bitcoin which jumped to a $20.000 value by the end of the year. The reasons behind this growth are multiple, but a large impact probably derives from media influence which contributed inflating the cryptocurrency. On December 2017, Cboe Global Markets Inc (CBOE.O) and CME Group Inc (CME.O), which is the world's largest futures exchange, launched their own Bitcoin futures contracts. This event had two primary effects: it legitimized Bitcoin at old school investors' eyes, which saw the cryptocurrency as a fraud, and it also attracted institutional money. As we can see from the graph below, the announcement of launching Bitcoin futures had the effect of doubling the value of Bitcoin within few days. Immediately after CME and CBOE launch their products the value of Bitcoin starts falling, this evidence seems to suggest that institutional investors were stocking up Bitcoin before the launch to sell them right after for speculating purposes and manipulating the market. The entity and the speed of the market downturns happened in March and May 2018 appear to be a replication of the first market manipulation but with a weaker impact. By operating

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[27] *JP Morgan CEO Jamie Dimon: I'd Fire Trader "In a Second" for Trading Bitcoin* (Rob Wile, 2017)

those adjustments indeed large investors may have reduced the quantity of Bitcoins in their possess.

Another important event happening in 2018 is the ban on cryptocurrencies advertisements coming from Facebook, Google and Twitter. The reason behind this decision is related to the severe presence of fraudulent ads on those site with the intent of protecting consumers from frauds.

As for the previous years also 2018 sees the happening of hacker attacks stealing bitcoin from cryptocurrency trading platforms: in April Coinsecure, one of the largest Bitcoin trading platform in India, has been hacked and $3 million worth Bitcoins are stolen; in June South Corean exchange CoinRail has been hacked recording losses for $40 million.

The most important news of 2018 however comes from Goldman Sachs deciding to open the first Bitcoin trading operation at a Wall Street bank. The project of the bank consists in creating a virtual currency, whose value is linked to the Bitcoin, to trade with clients Bitcoin related contracts.

Graph 1.3: Bitcoin value chart January 2017 – August 2018
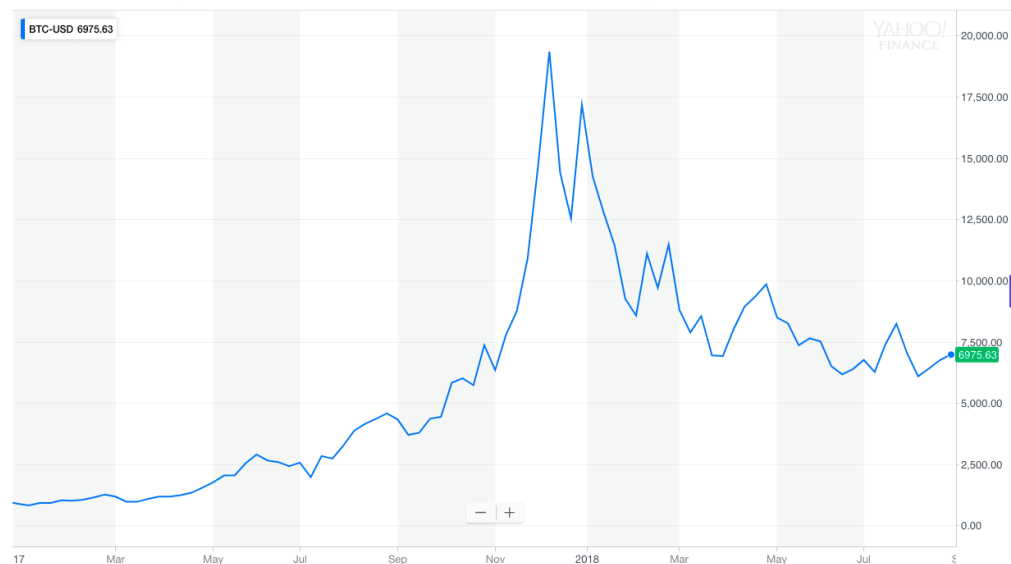
Source: Yahoo Finance

2. The impact of blockchain on the banking industry

2.1 Overview of the Italian banking environment

The European banking sector, and in particular the Italian one, has been seriously affected by the financial crisis of 2007. In order to better understand how the industry has been affected, it is useful to focus on the drivers of bank profitability:

▪ **Net interest margins:** the money lending, which represents the core business for banks, has lost profitability mainly because of low interest rates and low commissions. Interest rates have been kept low by the ECB in the aftermath of the crisis with the purpose of mitigating the credit crunch (the reduction of credit disbursements to families and businesses). In addition to that the ECB's Quantitative Easing program lowered the interest rates even further. The QE consists in lowering interest rates by buying assets from commercial banks with the goal of supporting growth and reach an inflation level close to 2%. Coming to the commissions' side they have been lowered mainly because of intra banks competition and treat of new entrants in the credit industry different from banks. The events just described contributed diminishing the net interest margin and so the banks' profitability.

▪ **Non-performing exposures:** Besides of low interest rates one of the main issues for European banks is represented by the massive presence of non-performing loans on their balance sheet. NPL are loans that banks do not expect to be repaid. In order to avoid actors to misinterpret the concept of NPL, the EBA provided a definition of Non-Performing Exposures. "Non-performing exposures are those that satisfy either or both of the following criteria:

1. material exposures which are more than 90 days past-due;

2. the debtor is assessed as unlikely to pay its credit obligations in full without realization of collateral, regardless of the existence of any past-due amount or of the number of days past due.

Therefore, the definition of NPE is based on the *past-due criterion* and the *unlikely-to-pay* criterion." [28]

The problem with NPL is double sided. On one side they effect banks' profitability restricting their ability to make new loans to individuals and businesses. On the other side they impact the society as a whole: banks can spread their crisis all over the economy influencing employment and growth. In the Euro Area in 2016 around 6.2% of the total loan amount was represented by NPL, accounting for €880 billion; nowadays NPL account for 5.15% of the total loan amount[29].

In Italy *"Credit risk is improving. The flow of new non-performing loans (NPLs) has been decreasing since 2014. It is now about 2 per cent of total loans, below the pre-crisis average. Banks are also selling very large amounts of NPLs on the market: €30 billion in 2017 alone, while more than €25 billion are expected to be sold in the first half of 2018. This represents a sharp increase from annual sales recorded in the previous five years (about €5 billion on average). As a result of these trends, the NPL stock is diminishing at a remarkable pace. Including the sales that will be completed in the next few months, by mid-2018 the volume of NPLs net of provisions will amount to less than €140 billion, almost one third below the peak of 2015. The net NPL ratio will stand at 7.8 per cent, against 10.8 per cent in 2015"*[30].
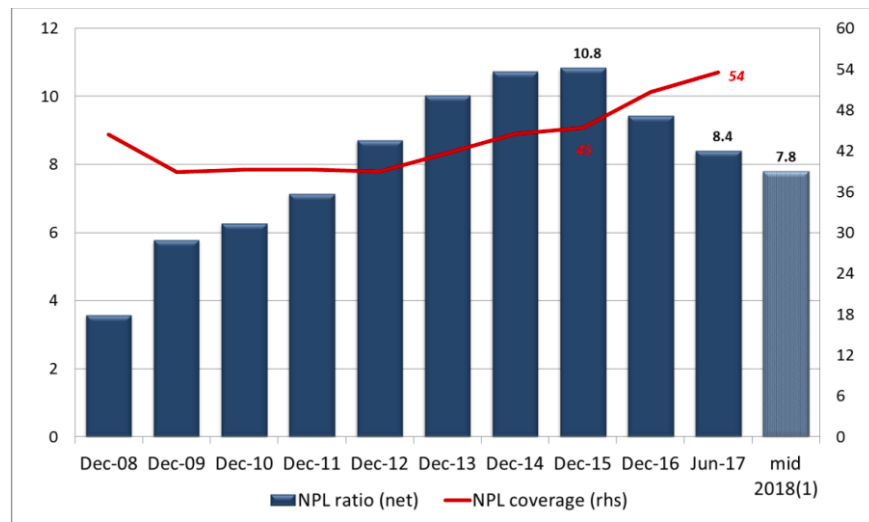
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[28] *Non-performing loans* (European Central Bank, Banking Supervision, 2017)
[29] See above (28)
[30] *Italian Banks: where they stand and the challenges ahead*, Remarks by Fabio Panetta Deputy Governor of the Bank of Italy

Graph 2.1: Net non-performing loan ratio and coverage ratio
(percentage of outstanding loans)

(1) Expected mid-2018 data are calculated considering September 2017 data for banking groups and June 2017 for stand-alone banks. NPL disposal by MPS (expected by mid-2018) is also taken into account.

Source: Banca d'Italia[31]

▪ **Cost to income:** the cost to income average ratio for leading Italian banks has grown from 50% in 2007 to around 70% nowadays. That happened both because of net interest margin reduction and increase in technology costs. In order to face the competition of technologically advanced players, banks had to adapt their informatics system and do investments in the IT area.

▪ **Regulation:** the high level of NPL in Italy has brought new regulatory impositions. The ECB has imposed measures aimed at reinforcing the solidity of banks. Those measures consist in increasing a bank's liquidity by imposing the detention of particular assets and reducing exposure by limiting risky assets. The counter part of those measures is a reduction on profitability.

According to this situation in Italy banks have followed a trend consisting in contracting the direct fund raising in favor of indirect fund raising. Another dominant trend in the Italian banking environment to boost profitability is the contraction of the costs related to personnel and administrative expenses. This

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[31] See above (30)

expenses' decrease is mostly due to the closure of bank branches and to planned staff exits. From 2009 to 2016, almost 4.000 branches closed in Italy and the voluntary retirement engaged around 40.000 resources. Furthermore, within 2019 the five major banks (Intesa, Unicredit, Mps, Banco Popolare and Ubi) are planning to close an additional 3.000 branches and an additional amount of 25.000 employees will take part to the voluntary retirement program.

2.2   *Bank's revenues*

In order to better understand how the blockchain could impact the traditional banking system, it is useful to examine how revenues and costs are generated.

Banks' revenues can be classified in two macro areas according on how they are generated: net interest income and non-interest income. The sum of those two areas gives us the total revenue which, on average, is composed for 56% by net interest income and for 44% by non-interest income.

When referring to interest income, we are mainly talking about revenues arising from lending activity, in this case banks use the resources collected from direct fund raising to grant loans and exploit the net interests' difference. With non-interest income we refer to commissions and fees for banking services, most of them arising from indirect fund raising and in particular from commissions on assets under management.

The difference between the interests paid and the interests earned is called spread and it represents the net interest income, accounting for 56% of bank revenues as affirmed before.

Lending still represents the primary banking activity despite the problems that the banking industry is facing with regards to money lending.

Banks offer different types of credit according to the scope of the loan and in particular they are: consumer loans, repair loans, housing loans and credit card. We can distinguish between two main forms of credit: unsecured and secured credit. Among the first type we have credit card and small unsecured loans while secured credits are the ones that require a collateral such us mortgage loans and personal

contract plan credit agreements. The main risk for the banks on issuing a credit is the credit risk, which consist in the possibility of borrowers not repaying the debt or repaying it partially. For this reason, banks tend to require collaterals, insurances and grant loans according to the credit scores of the counterparties. This process involves the participation of multiple actors which creates costs and inefficiencies related to the interactions of multiple actors. Furthermore, it lengthens the time for granting a loan and creates transparency and asymmetry problems due to the fact that clients don't know their credit score. Among the multiple actors participating the lending process the Consumer Reporting Agencies deserve some considerations. A Consumer Reporting Agency is a company which collects and provides information about the individuals' creditworthiness. Its job consists in collecting debtors' information and not in assigning a credit score. Consumer Reporting Agencies sell the collected information to credit bureau which then generate a credit report. The data included in the credit report are the following:

- Personal information: including both generic information such as name, age and address but also current employment and employment history;

- Credit accounts: that's the main icon of the credit report, it includes history payments, current balance, credit limit, the opening account date and all the information related to past or current credit accounts;

- Collection items: they show on your credit report in the case of unpaid debts;

- Public records: in case a judgement has been entered against an unpaid debt;

- Inquiries: they occur when a client is applying for different form of financing. They can be soft, and not influencing the credit report, or hard, which may lower an individual's credit score.

The outcome of the credit result is the credit score, which is assigned to assess individuals' likelihood to repay a debt. The credit report and the score are available both for lenders and individuals, but it is not a common practice for individuals to do that. Therefore, on one side credit bureau helps lenders reducing information

asymmetry providing a better understanding of clients' solvability. On the other side creates asymmetry on the individuals' side not knowing their scores.

Banks, according to clients' credit score, decide whether to grant a loan or not. The same credit score is fundamental when deciding which is the maximum amount the bank is willing to grant and the size of the interests.

Regarding the non-interest income, banks in the aftermath of the credit crisis have been focusing on this segment aimed at exploiting different sources of income and trying to offset the decreasing revenues of lending, coming from low interest rates. With non-interest income we refer to revenues derived mostly from fees and other activities outside the core activity of lending. These fees are originated by payment services, gains and losses from the sale of loans and securities, cards' fees, annual fees and many others. In addition to those, of great impacts are also the sale of insurance products, financial planning services, annuities and brokerage services.

Coming to the costs' side, the cost of funds is for sure the most important for banks since it represents the interest rate paid on the deposits. The lower this voice is the greater the returns are. The primary source of funds for banks are saving and checking accounts, which altogether are known as core deposits. This kind of deposits are payable on demand and therefore banks pay low or none interest rates on them. Additional sources of funds are: wholesale deposits, shareholder equity and debt issuance.

Summing up what stated above we can define a bank as an institution which grant the following functions:

- Storing value for privates and businesses by offering bank accounts, debit cards and safety deposit boxes;
- Lending loans to the public;
- Offering payment services;
- Offering investment opportunities;
- Insuring;

Alongside with each of these functions it's possible to identify many cross critical problems financial institutions have to deal with. Identity verification is one of those: in order to obtain a loan, a bank account or any other service a person id need to be validated. This process takes time and involve lots of paper work but

most importantly prevent 340 million people worldwide to open a bank account. According to the Worldbank[32] indeed a fifth of the unbanked adults don't have access to banks because of identity verification related problems. Furthermore, the 2017 Global Findex research highlights that the first reason why unbanked adults don't open a bank account is because they have too little money. Currently financial services don't make room for micropayments or microcredit, being unprofitable and consequently leaving almost unserved poor country. This discrepancy is evident when considering that in developed countries 94% of adults are banked, while this percentage shrinks to 63% in developing countries.

Another important issue is related with cost and time inefficiencies. In a world where everything is instantaneous, settling payments or trading positions or granting loans still requires a lot of time and fees. This process involves many costs related to working hours, regulatory compliance requirements, manual checklist processes, legal advisory, litigation costs, inventory costs, cost of paper and many others.

Moreover, the current system exposes parties to many financial risks and in particular to credit risk and operational risks such as fraud, human errors and accounting mistakes.

2.3   How blockchain could disrupt banking

As highlighted by the analysis of the banking environment, banks are facing a decrease in profitability and for this reason the banks' interest on blockchain is raising. As a matter of fact, this new technology will enable banks to run faster and more accurate payments, reduce transactions' costs, errors and exceptions while obtaining faster settlement and seek for new revenue opportunity.

When referring to banks, the most popular idea on how to implement the distributed ledger is through private and permissioned blockchain since they reach multiple advantages:

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[32] *Measuring Financial Inclusion and the Fintech Revolution* (Asli Demirgüç-Kunt, Leora Klapper, Dorothe Singer, Saniya Ansar, Jake Hess, 2018)

- This type of blockchain permits to specified and authorized parties to verify, and in certain case to modify, transactions.

- Costs related to verifying transactions are kept low, since it uses a proof of stake protocol which doesn't involve rising energy costs.

- Regulators can easily monitor the transactions.

- A cyber-attack is unluckily to happen because the parties are trusted and authorized by the central authority.

By following the scheme proposed before to identify the functions performed by the bank, I will try to analyze how the blockchain may disrupt them.

2.3.1 Storing value

Privates and businesses open bank accounts in order to benefit of financial services and to collect savings. Money are collected in bank accounts for several reasons, the first one being that it's safer keeping money on a bank account than physically holding cash. Keeping cash may expose to many risks such as losing money, being robbed and being victim of an accident, which destroys your money. In addition to that cash is subject to inflation and doesn't produce any interest contrary to what happens with storing money in bank accounts.

Banks normally require a minimum amount to open a bank account and charge customers with fees for the provision of it. Among them there are maintenance fees, withdrawal fees and account statement copy fees.

With the introduction of blockchain bank accounts may become outdated. Blockchain gives its users the possibility of "storing" crypto-coins directly on the distributed ledger. To be more precise what is being stored is the record of a transaction and not the crypto-coin itself. As explained before the transfer of funds consists in changing the ownership of a crypto-currency to a specific address. This generates a private key known only to the owner which, in combination with the public key, is able to track the transaction and therefore demonstrate the ownership and the availability of the crypto-coins. Each transaction generates a public key that in turn has a corresponding private key.

Image 2.1: Cryptography and transactions
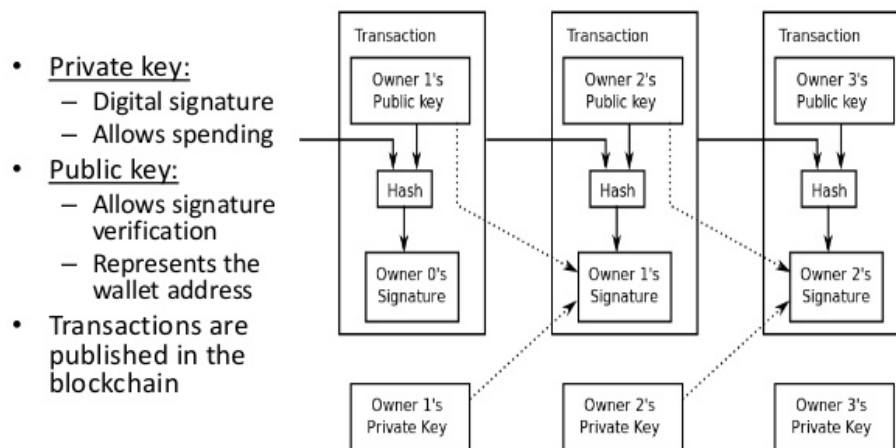
Source: Pinterest, blockchain[33]

That means that we have to keep as many private keys as it is the number of transactions we have done. In order to keep record of all the transactions exist crypto-currency wallets.

A crypto-currency wallet is a *"software program that stores private and public keys and interacts with various blockchain to enable users to send and receive digital currency and monitor their balance"[34]*.

We can distinguish among different types of crypto-wallets which are presented from the riskier to the safer:

- Online wallet: they are managed by third parties and are stored on the cloud, making the wallet available from any device.

- Mobile wallet: they have a friendly interface and they run on mobile apps, meaning that is possible to have access to the keys everywhere.

- Desktop wallet: it can be downloaded on a single personal computer which is the only device able to access the private keys stored in it.

- Hardware wallet: they are stored offline on hardware such as a USB

- Paper wallet: simply consisting in printing the public and private keys of each transactions.

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[33] Source: Pinterest
[34] *Cryptocurrency Wallet Guide: A Step-By-Step Tutorial* (Ameer Rosic, 2017)

Given the characteristics just described above, it's clear why those digital wallets may represent a threat to existing bank accounts. First of all, they respond to the same needs: storing value and keeping it safe from the possibility of losing it or being robbed. Furthermore, the only way for someone to steal your finances is to have access to the private keys, that are only know to the owner. That implies that fraud risks such as cloning cards or hacking a bank account are no longer in place, yet it exists the possibility of saving credentials on fake e-wallets that are being created with the purpose of stealing private keys.

Nowadays banks are considered to be the most secure place where to store money, and therefore people store their savings in them because of that trust. The recent financial crisis has weakened people trust on the banking system. Blockchain is based on cryptographic proof instead of trust, making the role of banks as trusted parties obsolete. An additional reason, and probably the most important one, for final customers to switch from bank accounts to crypto-wallets is the significant reduction of costs and fees. First of all, since the system is built on multiple nodes (personal computers) spread worldwide, the costs of creating and maintaining the system is distributed and close to zero, moreover the validation process requires very low fees allowing for micropayments. This statement has a very strong implication: blockchain and crypto-wallets are able to grant access to financial services to all those unbanked adults that don't have enough money to open a bank account and that are concentrated in developing countries. Blockchain would have therefore a powerful social impact, helping for example people who live abroad sending money home without paying high transaction fees to intermediaries such as Western Union.

2.3.2 Lending

Lending represents the core activity for banks and it consists in financing both privates and businesses.

The implementation of distributed ledger would radically change lending in each aspect. Starting from the basis, we have seen that each financing valuation

starts with the analysis of the client creditworthiness which takes times, waste resources and it involves multiple parties.

The first step in the creditworthiness assessment is the identity verification. We have already seen how digital id verification would slim the overall process by providing individuals with verified digital id.

As well as with id data, individuals would have a profile on a platform with a digital credit score determined by history payments, meaning that credit score agencies are no longer needed. The first consequence is that fees are significant lower as well as the time for lenders to grant a loan. Furthermore, this process helps developing disclosure: individuals are able to control which information to share and with whom, always knowing their credit score and being able to monitor it and taking actions to improve it.

Blockchain has opened and enriched the world of P2P lending which may have the strength to push banks out of the game. The expression P2P lending stands for Peer-To-Peer lending and it indicates the procedure with which individuals borrow and lend money each other without the need for an intermediary. In this way privates and businesses have access to credit without having to apply for one through banks.

Lenders can access to individual profiles and check their credit score in order to choose whether to disburse the loan or not at a predetermined interest rate. Investors may decide to either finance the all amount or a part of it, the remaining part would be financed by multiple investors. This structure permits investors to have higher returns than the ones they would get from a saving accounts. At the same time, it gives credit access to borrowers who would get excluded by banks and lower interest rates for borrowers with good history payments.

Another characteristic of P2P lending platforms is that it helps dissolving geographical borders and differences in interesting rates among countries. Being virtually accessible to anyone everywhere, P2P lending represents a global solution which would increase competition among lenders. The increased competition leads to a decrease in interest rates resulting in cheaper transactions. Being signed through smart contracts, P2P lending would also eliminate the need for paper-based documents. An additional benefit of this configuration is that financial risks would

be reduced and in particular fraud risk, thanks to blockchain intrinsic features of traceability

The main result of P2P lending is increasing efficiency deriving from: lower processing time, lower fees, lower interest rates, elimination of physical documents and reduction of financial risk.

For what it concerns personal loans, SALT is among the first lending blockchain platforms. The acronym stands for Secured Automated Lending Technology, and it is a platform which grant loans using digital assets as collaterals. What's radically new in SALT is that borrowers' creditworthiness is not assessed on their credit score but on their collateral. To better understand how the overall process works, it is useful proceed by steps:
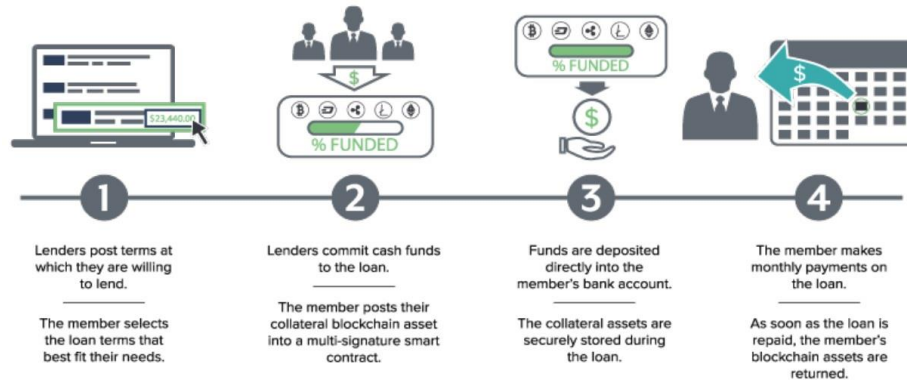
- Lenders post the conditions at which they are willing to lend money, while borrowers choose among all the conditions that fit the best their needs.
- Lenders commit cash funds to the loan while borrowers' assets are verified
- Once the assets are verified and accepted, parties are requested to sign a loan agreement through a smart contract.
- As for traditional lending the borrower is committed to realize payments periodically
- At the end of the contract the collateral is given back to the borrower.

In the case of a missing payment, a portion of the collateral is liquidated to compensate the lenders.

SALT gives the opportunity to obtain loans in fiat currency by giving digital assets as collaterals and it does that by applying more convenient rates than traditional players and by storing contracts and collaterals in a more secure way, thanks to the utilization of smart contracts.

The following scheme helps understanding how SALT works:

Image 2.2: Analysis of SALT lending process

	1	2	3	4
	Lenders post terms at which they are willing to lend.	Lenders commit cash funds to the loan.	Funds are deposited directly into the member's bank account.	The member makes monthly payments on the loan.
	The member selects the loan terms that best fit their needs.	The member posts their collateral blockchain asset into a multi-signature smart contract.	The collateral assets are securely stored during the loan.	As soon as the loan is repaid, the member's blockchain assets are returned.

Source: SALT [35]

2.3.3 Payments

When it comes to payments banks have traditionally played a fundamental role consisting in validating transactions. Nowadays the only occasion in which a third party is not needed during a transaction is when the seller and the buyer meet physically, the buyer pay by cash and the object of the transaction is physically handled by the seller to the buyer. Even through this way both parties are subject to multiple risks: the seller may not own the right of alienating the good, the good sold or the cash used by the buyer might be stolen or counterfeited. Aside from cash, any other form of payment consists in an order from an individual to move money from his bank account to another one. As for the cash payment, any transactions consist of two moments: the delivery of good or service and the transfer of funds. We refer to this process as system of payments which is described by the ECB as follows:

"(...) the term "payment system" refers to the complete set of instruments, intermediaries, rules, procedures, processes and interbank funds transfer systems which facilitate the circulation of money in a country or currency area. In this sense, a payment system comprises three main elements or processes:

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[35] Source: Salt Website

1. payment instruments, which are a means of authorising and submitting a payment (i.e. the means by which the payer gives its bank authorization for funds to be transferred or the means by which the payee gives its bank instructions for funds to be collected from the payer);

2. processing (including clearing), which involves the payment instruction being exchanged between the banks (and accounts) concerned;

3. a means of settlement for the relevant banks (i.e. the payer's bank has to compensate the payee's bank, either bilaterally or through accounts that the two banks hold with a third-party settlement agent).

It also relies on institutions that provide payment accounts, instruments and services to customers (including consumers, businesses and public administrations) and on organisations that operate payment, clearing and settlement services (such as interbank funds transfer systems). There are also market arrangements in place, such as standards, conventions and contracts for the production, pricing and use of the various payment instruments and services, as well as arrangements for consultation and cooperation within the industry and with other stakeholders. Finally, a payment system needs to be underpinned by a sound legal basis. This includes laws, standards, rules and procedures laid down by legislators, courts, regulators, system operators and central bank overseers[36].

Basically, it is possible to think the payment system as a process which starts with choosing a payment instrument and giving instructions to the bank to process the payment. The sending bank has to check the validity of the payment and the availability of the funds and before the payment is transferred from the sender to the recipient bank it still has to go through several steps and intermediaries. Furthermore, each step requires settlement and reconciliation which requires time and increases transaction fees.

It is clear that the current payment system is full of inefficiencies and it has room for consistent improvements such as reducing settlement days, eliminating third party processing fees, eliminate counterparty risk and reduce reconciliation costs. At the current state, payments systems are based on third party

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[36] *The payment system: Payments, securities and derivatives and the role of the Eurosystem (*European Central Bank report, Tom Kokkola, 2010)

intermediaries, implying high processing fees and high settlement times. The function of intermediaries is acting as trusted third parties allowing the other actors to transact without knowing each other. With blockchain, payments wouldn't require third parties since trust is no longer needed, resulting in lower fees and shorter settlement times.

To better understand the differences in terms of time and cost savings, the following scheme represents a useful tool.

Image 2.3: The Blockchain bank model
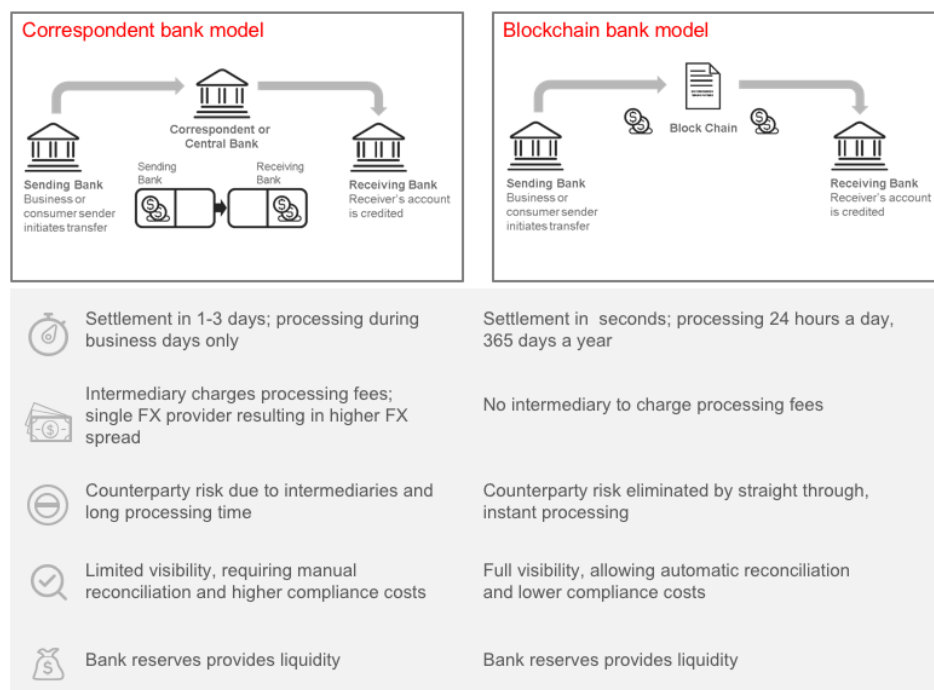
Source: Accenture research

According to the scheme described above, the lack of need for intermediaries will lower fees and rates across products and services and banks will be able to cut costs for tracking and managing their financial transactions and at the same time reduce or avoid duplication and reconciliation.

From a customer-oriented point of view the implementation of such a model is able to benefit the society as a whole. Today if the cost of the transaction is greater than the benefit which arises from it, the transaction doesn't take place. In developing countries transactions are often lower than the costs of operating them,

which leaves a consistent part of the society without the possibility of operating micro-payments. The implementation of blockchain technology opens to a new market for micro-payments since the transaction costs are close to zero.

When talking about the disruption of the payment system deriving from blockchain applications, two companies deserve to be mentioned: Ripple and R3.

Starting with Ripple, as we've seen in the first part of this work, it's a digital currency (XRP) and at the same time it's an open payment network which uses its own currency. Ripple aims at connecting different payment systems together allowing the transfer of any fiat currency or cryptocurrency. The startup created in San Francisco by Larsen and McCaleb has obtained funds by many banks such as Santander, Unicredit, Credit Agricole and many others. The main reason why banks are interested in Ripple payment network is because it allows for fast and cheap cross-border transactions. Today in order to make payments in foreign currencies, banks hold accounts with other banks globally. Those accounts are known as Nostro and Vostro account and their goal is to facilitate transactions and settlement between foreign currencies. In order to maintain a Nostro account, banks need to allocate them resources which can't be used for more profitable operations. According to Ripple website *"Banks join RippleNet to process cross-border payments in real time with end-to-end tracking and certainty. Banks can expand payments offerings into new markets that are otherwise too difficult or expensive to reach"*[37].

R3 fintech as Ripple aims at reducing inefficiencies in the international payments, but the way they are operating it is totally different from any other blockchain. R3 adopted a consortium-based ownership model and it's focused on solutions for financial institution. As their official website states *"R3 is an enterprise blockchain software firm working with a broad ecosystem of more than 200 members and partners across multiple industries from both the private and public sectors to develop on Corda, our open-source blockchain platform, and Corda Enterprise, a commercial version for enterprise usage"*[38].

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[37] Source: Ripple Website
[38] Source: R3 Website

The platform is running on a distributed ledger technology and it has been designed to meet banks' needs. Corda is intended to be a "Global Logical Ledger", meaning that all the parties involved in a transaction can access, manage and record the agreements without sharing information with other parties. In Corda Platform only authorized actors can control and validate transactions. In this way R3 is able to meet the needs of a regulated environment such as banking, avoiding sharing sensible data. Smart contracts are utilized to legally bind all the parties involved in a transaction and the immutability of blockchain eliminates the need for a dispute. Besides of the parties involved, only authorized parties can have access to the transaction data such as regulators. Another important feature of Corda is being an open source platform which gives the opportunity to new service providers to access the platform and compete with each other.

2.3.4 Investments and trading

Blockchain technologies play an important role also in trade finance. Today trade finance involves multiple actors: importers and exporters, banks and financiers, insurers and export credit agencies, and service providers. This process implies paper-based document exchange, causing delays, and it involves spending a lot of time on coordination and transaction execution. The paper-based document process within the fallibility of human activity are the main causes of the need for internal control and compliance, for the same reason fraud incidents' and regulatory fines' risks are high. In a blockchain integrated system this process would be different. First of all, the whole process would be paperless and there would be a single pool of documents related to a transaction. Furthermore, transactions would be multi-signed in different times on a decentralized basis and then collected in a single transaction, without need for redundancy of signatures and documents. In this way the time for coordination and transaction execution would be significantly reduced. The absence of any single point of failure, typical of blockchain, would reduce the risk for fraud. Being all the transactions recorded and available, risk of

regulatory fines would be reduced as well since smart contracts guarantee that the documents are originated from correct entity.

Crypto-technology has already impacted the trading world. On May 2015th NASDAQ announced a trading platform based on open asset protocol. During a press release the CEO of NASDAQ, Bob Greifeld, affirmed the necessity of simplifying the model of share issuing:

"We are excited about the potential impact of this new endeavor with Chain on the transaction process. This Nasdaq Private Market project aims to simplify the overwhelming challenges private companies face with manual ledger record-keeping. As blockchain technology continues to redefine not only how the exchange sector operates, but the global financial economy as a whole, Nasdaq aims to be at the center of this watershed development."[39]

The fully-electronic, distributed ledger-style solution is intended to increase the accuracy of record-keeping, which will complement a cloud-based equity management solution that enables private companies to manage their cap table and stock plan more efficiently. The new system is able to settle positions immediately through the decentralized network of nodes, thanks to distributed technology the asset will be automatically transferred as result of bid and offer match. Furthermore the settlement is instantaneous and asset ownership transfer becomes public and immediately available eliminating counterparty risk.

The following scheme highlights the impact of blockchain on trade finance as it is today:

Image 2.3: Trade finance using crypto-technology
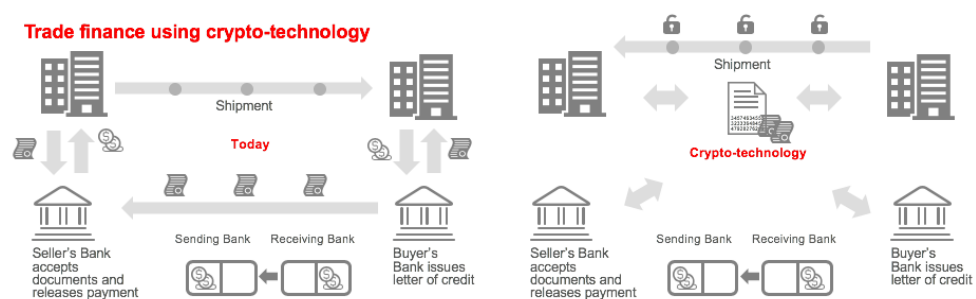
Source: Accenture research

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[39] *Nasdaq and chain to partner on blockchain technology initiative* (Nasdaq press release, 2015)

When talking about blockchain and trading few words must be spent on Coinbase. It is the largest U.S. Bitcoin marketplace and it also exchanges other cryptocurrencies such as Ethereum and Litecoin with fiat currency. Coinbase developed a cryptocurrency wallet which is available in 190 countries and it offers trading services in 32 countries worldwide. Besides of cryptocurrencies, Coinbase also offers API to develop apps that help spreading cryptocurrencies as form of payment.

2.3.5 Insuring

Coming to the insurance industry, characteristics of blockchain such as having access to digitalized personal data, prevention of fraud and a new way to process claims may have a strong impact on the industry.

When customers enter in an insurance contract, the first problem they find themselves dealing with is the collection of data. Since the premium is calculated on the characteristics of the insured party, the insurer makes sure that all the information is valid, authentic and complete. This process is particularly time consuming and it weights mostly on the insured party, since he has to collect all the data if he wants to enter the contract. With a blockchain integrated system, customers would have all their sensible information always available on their digital id. Not only the information would be easier to collect but they would also be more reliable and harder to falsify. Furthermore, from a customer oriented pointed of view, the premium paid would be fairer resulting in lower premium for customers who deserve it. This system would also facilitate the switch from an insurer to another one increasing competition and reducing premium rates, switching provider would be costless for the insured and all his information would be easily transferred, being stored in the chain. Tradle, which has been nominated in 2017 as European Blockchain company of the year, is building a network for storing Know Your Customer data (KYC) in order to lower cost of collecting those data and to speed up the customer journey. According to this model once customers'

data are stored by one of the participant to the network, they become available to the overall network without the need for further verifications.

Smart contracts can also address the problem of trust between insurer and insured. Insurers find themselves dealing with frauds, while insured have to deal with complicated contracts full of exceptions and not always clear to the final customer. Smart contracts ensure transparency between the parties and are able to ensure that only valid claims are paid. Working on an *if-then* premise, smart contracts are able to automate obligations when the conditions agreed in the contract are met. Axa has developed an insurance product which exploits this feature and it named it Fizzy.

Fizzy is a parametric insurance thought to simplify the reimbursements in the case of flight delays which runs on Ethereum blockchain platform. By submitting an insurance policy with Fizzy, passengers are asked to provide the basic flight information: flight number and date of flight. Before submitting the client is aware of the amount which would receive in the case of a delay greater than two hours. Reimbursements are processed automatically without need for refund request and funds are transferred to the customer account within few minutes. The immutability of smart contracts ensures customers that their contract cannot be modified by Fizzy in any case after it has been signed. Furthermore, Fizzy promises to refund customers in any case, independently from the reason of the delay.

Safeshare is an insurtech start-up based in London and it is the first blockchain insurance. Its core business consists in offering insurance solutions for the sharing economy and it is underwritten by Lloyds Bank. The British start-up has partnered with Vrumi, an online market place which gives householders the opportunity of lending their rooms as studios. Thanks to this partnership, Safeshare has developed a new insurance product with the goal of insuring householders against possible damages coming from tenants.

The insurtech industry is among the ones that will benefit the most from blockchain application. According to a study published by Juniper research with the title *"Fintech Futures: Market Disruption Leading Innovators and Emerging Opportunities 2016-2021"* the insurtech platforms will reach globally $235 billion by 2021.

2.3.6   How blockchain is already impacting the Italian financial environment

At a global level the financial technology, better known as FinTech, is an emerging industry which includes all the companies involved in innovating and reinventing the financial environment through the application of new technologies such as artificial intelligence and blockchain.

This segment has obtained lots of attention lately, being the first time for financial institutions such as banks and insurers that they find themselves competing with external players. Financial institutions seem to understand the threat represented by Fintech and they have begun a process of Fintegration, which consists in acquiring, financing and striking partnerships with Fintech startups.

It has been estimated that blockchain startups will raise over $1.3 billion in 2018 worldwide[40] surpassing of more than 30% the amount raised in 2017 as shown in the graph below:

Graph 2.2: Worldwide Venture Investment in Blockchain and Blockchain Adjacent startups by year
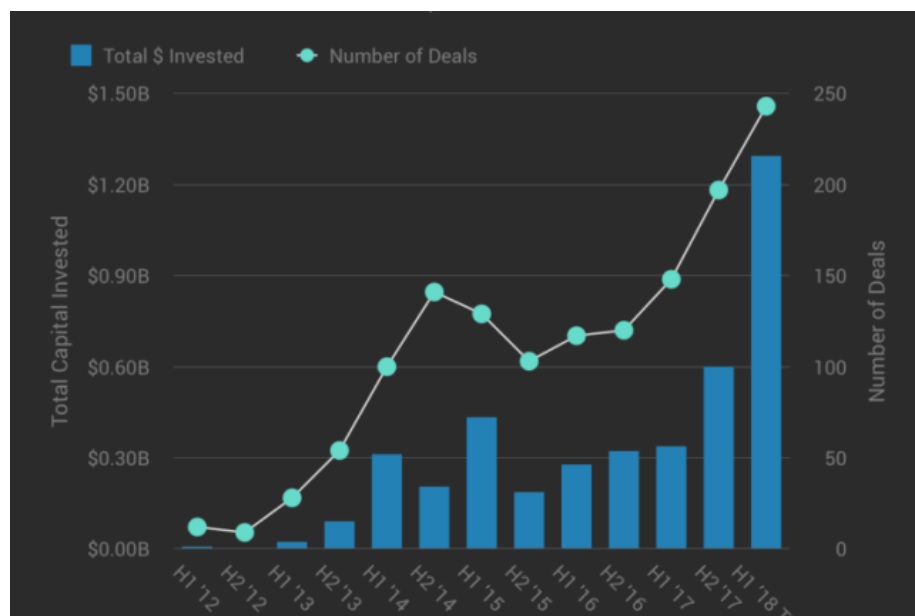
Source: Crunchbase[41]

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[40] *With at least $1.3 billion invested globally in 2018, VC funding for blockchain blows past 2017 totals* (Jason Rowley, 2018)
[41] See above (40)

Shifting the focus to the Italian environment, an analysis conducted by Net Consulting and PwC[42] has highlighted that 8% of the Italian FinTech runs on Blockchain platforms. The raise of interest on Blockchain technology in Italy comes primarily by banks' concerns to find themselves out of the market. The lack of a competitive and fertile startup environment in Italy has given banks the opportunity to finance and study this technology and therefore reaching a dominant position instead of being victims of it. According to a survey conducted by PwC [43], in Italy 85% of the banks surveyed has affirmed that they have planned blockchain projects starting from 2020. The main attention is focused on distributed ledger application on payments, trade finance and digital identity. ABI (Associazione Bancaria Italiana) is currently coordinating a blockchain project through AbiLab. So far already 14 banks have joined the project, which is studying the application of blockchain in interbank payments with the goal of pursuing the benefits proper of the blockchain: transparency, instant settlement and immutability of the information recorded. According to ABI website[44] the network has identified as working platform Corda (developed by R3) in order to comply with the high regulated Italian banking system.

As mentioned before, the interest in blockchain in Italy is raising and so it is the number of startups exploring this new technology. Among them all few of them have distinguished themselves:

- Conio: it's an e-wallet with a friendly interface which stores Bitcoin, but it also gives the possibility of buying and selling them within few seconds by sending and receiving money directly into a bank account.

- Bitboat is an app which allows users to buy the principal currencies in cash through a PostePay refill.

- InBitcoin is the first Italian company dedicated to offer services related to Bitcoin. This startup has helped developing a network of operators willing to accept Bitcoin as a form of payment.

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[42] *Le aziende del Fintech in Italia 2017* (analysis conducted by Net Consulting and PwC, 2018)
[43] *Ridisegno dei confini: crescente influenza delle FinTech sui Servizi Finanziari. Global FinTech Survey 2017 e confronti col mercato Italiano* (PWC research, 2018)
[44] *Banche italiane avviano sperimentazione blockchain (ABI, 2018)*

- UniquID is a startup committed in preserving the id and the data of personal devices through the immutability of the blockchain.

- Similarly to UniquID, Everledger's goal is to guarantee the property of goods but in this case it's referred to valuable goods such as diamonds. Everledger exploits the blockchain technology to guarantee the authenticity and the traceability of goods.

- Spidchain is engaged in elaborating blockchain solutions to develop a digital identity platform.

- Eidoo is a multicurrency wallet helping users to manage assets on the blockchain

- Aidcoin tracks donations to non-profit organizations

- Friendz is an app that helps social media influencers and big brands to get in contact. Friendz helps social media influencers to get paid and gives to brands the opportunity of sponsoring themselves.

- Xriba is an accounting protocol with the purpose of bringing transparency to cryptocurrency companies.

In 2018 thanks to the ICOs four startups (Eidoo, Aidcoin, Friendz and Xriba) alone have raised $70 million mostly coming from outside of Italy.

3. Webank: a case study on how blockchain can impact mortgages

3.1 The mortgage industry in Italy

In the aftermath of the financial crisis the disposable income of Italian families between 2008 and 2014 diminished of ten percent in real terms[45]. That, together with the credit crunch started in 2010, have interrupted a long period of expansion of the mortgage industry in Italy. According to a study conducted by Banca d'Italia[46], in the three years previous the financial crisis the number of mortgages granted grew at a path of 8,5% a year, while from 2008 to 2011 it decreased of 9,1% a year. As we can see from the graph below the decrease was more severe in the following years, from 2007 to 2013 the overall size of the mortgage market shrunk from €63 billion to €21 billion. In the following years the market started its recovery, almost doubling its size from 2014 to 2015 when the total amount of mortgages granted hit €41 billion.

Graph 3.1: Cash amount supplied by banks to households (2007-2017)
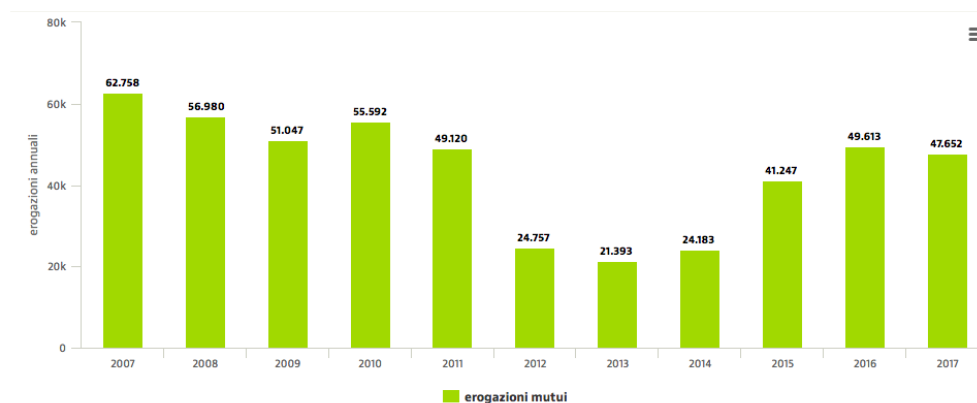

Source: 2018 Banca d'Italia

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[45] *Questioni di Economia e Finanza: Il sostegno finanziario della rete familiare durante la crisi* (Laura Bartiloro e Cristiana Rampazzi, 2015)
[46] *La crisi e le famiglie italiane: un'analisi microeconomica dei contratti di mutuo* (Roberto Felici, Elisabetta Manzoli e Raffaella Pico, 2012)

This boost was due to positive macro-economic trends and to the expansionary monetary policy adopted by the ECB which helped increasing demand for mortgages by driving down the long-term interest rates. As shown in the graph indeed, Italy long term interest rates have been moving from 6% of 2012 to somewhere around 2% nowadays.

Graph 3.2: Italy long term interest rate
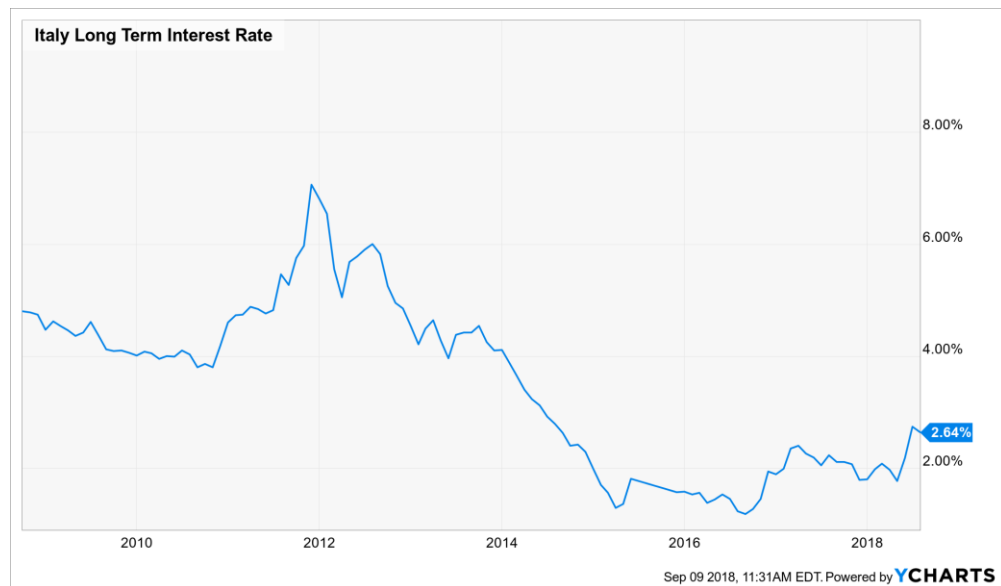
Source: YCharts, 2018

From a bank point of view, all of that implies that the mortgage industry is not as profitable as it used to be. Banks, which in Italy disburse 90% of home loans, deal with a reduced size market and at the same time earn lower interest rates.

Furthermore, the mortgage system in general is full of inefficiencies and the legal environment surrounding it put banks at risk of getting fines and wasting valuable resources on compliance. It has been estimated that the six largest traditional mortgage lenders worldwide paid $110 billion alone in fines since the credit crisis, accounting for 90.000 of paperwork hours[47].

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[47] Accenture research

Coming to the cost side, loan production costs have more than doubled since the credit crisis and they now account for around $7.000 per loan[48], including sales and fulfillment expenses.

Moreover, besides monetary costs, the disbursement is costly also on a timing base. Closing time for refinancing is about 54 days and the time to purchase held at 48 days in the mortgage industry[49].

3.2 Requesting a home loan in Italy

The process of getting a mortgage in Italy it's a long and complicated process and it involves multiple actors. This process might slightly vary from bank to bank, but it's possible to identify 7 common steps: preliminary investigation, investigation, deliberation, real estate evaluation, notary's report, notary deed and disbursement of the loan.

The first step for requesting a home loan is the **preliminary investigation**. During this phase, the bank analyzes the feasibility of the mortgage by asking the applicant basic information and by running his data on a database able to give back his credit scoring. If this step is concluded with a positive result, the bank proceeds with the **investigation**. The purpose of this step is verifying the client's credit scoring. The process starts with the subscription of the mortgage application which requires the applicant to present the following documents:

- Personal ID
- Fiscal code
- The certificate of residence
- The certificate of family status
- The CUD Model (if an employee) or the Single Model (if self-employed)
- The service certificate (if an employee)
- A copy of the pay slip (if an employee) or a copy of the account statements (if self-employed).

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[48] Accenture research
[49] Accenture research

These documents are necessary for the bank in order to assess the economic conditions of the loan. This phase has the goal of conducting a proper creditworthiness assessment in respect to the finality of the financing. At the end of this process the bank reaches the pre-deliberation which determines the maximum amount the bank is willing to lend to the client.

Within the process of investigation of a mortgage we can identify three kinds of analysis:

1. Identity analysis: with the scope of verifying the reliability of the applicant and of all the people involved in the mortgage. Delayed or missed payments are checked to determine client's repayment behavior.

2. Income analysis: it is done to assess applicant's ability to repay the debt for the whole duration of the loan. The bank verifies if after repaying his installment, the client is still able to dispose of a good part of his income. During this phase are also considered the forecasts over client's career and it's taken into consideration the possibility of him losing his job or getting a promotion.

3. Real estate analysis: the bank checks all the document related to the property object of the home loan and if its value is coherent with what stated by the applicant. The real estate evaluation will have to officially confirm what stated in the documents.

If all the previous steps end up positively, the bank proceeds with the **deliberation** with which it formally commits itself to make available the amount requested.

During the **real estate evaluation**, the bank appoints an expert to run the inspection of the property guaranteed by the mortgage. The property must be consistent within the purpose of the loan and the expert controls the regularity of the acquisition. At the end of this phase the expert determines the value of the property and if it is suitable with the amount requested it proceeds with the next phase. With the **notary's report** the bank checks the ownership and legitimacy of the property by requiring the R.N.P. (Preliminary Notary Report) to the client. With the R.N.P. the notary identifies the house object of the mortgage and verifies all the previous transcriptions within the last 20 years. Once the R.N.P. is handled to the

bank, the last one must verify its content. Normally the stipulation of the contract happens within 5 to six days with the **notary deed**. The stipulation indeed is conducted at the presence of a notary who proceeds registering the purchase agreement and the transcription of the new owner of the house. Finally, after the notary and all the taxes related to the contract stipulation are paid, the bank proceeds with the **disbursement of the loan**.

Image 3.1: Disbursement of a home loan in Italy

PRELIMINARY INVESTIGATION
Analyzing feasibility of the mortgage

INVESTIGATION
Verifying client's credit scoring

DELIBERATION
Bank's commitment to disburse the loan

REAL ESTATE EVALUATION
Inspection of the property

NOTARY'S REPORT
Checking ownership and legitimacy of the property

NOTARY DEED
Stipulation of the contract

DISBURSEMENT OF THE LOAN
Funds' transferring

Source: own elaboration

The process described above normally takes an average of fifty/sixty days to be concluded. The process of investigation of the mortgage takes thirty days and it takes between twenty to thirty days for the bank to grant the loan after the legal evaluation is concluded.

Coming to the cost side there are several fees and charges that must be considered when taking out a mortgage. The first cost icon to be taken into account is the interest paid on the financing, which is usually linked to the EURIRS in the case of a fixed rate and to the EURIBOR if it is a variable rate. In addition to that, banks add the value of the spread. Besides principal and interests there are several expenses, which may be summarized as follows:

- the costs of preliminary investigation: it can be a fixed amount between 180€ and 300€ or a percentage of the financed amount between 0,1% and 0,5%;

- appraisal fees: between 100€ and 300€;

- notary fees: they may vary from region to region but it's reasonable to consider a range between 2.000€ and 3.000€;

- the substitute tax: it amounts to 0.25% of the mortgage unless the loan concerns the purchase, construction or renovation of the second home, in this case the tax is increased to 2%;

- insurance costs: it is mandatory, and its value depends on the amount and on the duration of the mortgage. It is appropriate to consider a monthly premium between 30€ and 60€.

- Payment expenses: around 2€ for each payment.

The following tab summarizes costs and fees of an average home loan in Italy, on a mortgage of 150.000 € to be repaid in 25 years. From the tab it has been excluded the interest expenses since the focus is understanding the costs related to the process of disbursing a home loan.

Tab 3.1: Costs and fees of a home loan (excluding interest expenses)

AVERAGE COSTS AND FEES OF A HOME LOAN	min (€)	max (€)
Costs of preliminary investigation	180	300
Appraisal fees	100	300
Notary fees	2.000	3.000
Substitute tax (on a loan of 150.000€)	375	2.000
Insurance costs (30€/60€ a month)	9.000	18.000
Payment expenses (2€ a month)	300	300
TOT	11955	23.900

Source: own elaboration

3.3 Disbursement of a home loan at Webank

In the last months I've been working at BancoBPM with Accenture, which gave me the opportunity of getting to know and better understanding how a bank works. BancoBPM is the fourth Italian banking group and it is born on January the first by the merger between BPM and Banco Popolare. In order to serve those clients who prefer to have a remote relationship with the bank, BancoBPM uses Webank as its online channel. Webank offers online all the traditional services offered by a bank including trading platforms and the financing of a mortgage.

Focusing the attention on the mortgage process, the official website promotes to grant the loan in 4 steps[50]:

1. Calculating the installment online and sending the request
2. Getting in contact with a specialist and sending the requested documents
3. Receiving the result of the investigation within few days
4. Getting an appointment at the notary for the contract stipulation.

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[50] Source: Webank Website

To request a mortgage via Webank, the applicant needs to have a Webank account. After he opens an account he can proceed with the simulation of the installment and at the end of it, he can send the mortgage request. The client is therefore contacted by a specialist and within 5 days from the request he must send all the documentation regarding: his identity, his income and the real estate. The investigation may take up to 72 days from the day the applicant has presented all the documentation requested. The following tab summarizes the main expenses of a home loan of 150.000€ repayable in 25 years. In this scenario, as in the previous one, interests' expenses are not taken into account as non-relevant for the conducted analysis.

Tab 3.2: Costs and fees of a home loan at Webank (excluding interest expenses)

COSTS AND FEES OF A HOME LOAN WITH WEBANK	min (€)
Costs of preliminary investigation	-
Appraisal fees	-
Notary fees	*2.000 - 3.000*
Substitute tax (on a loan of 150.000€)	*375*
Insurance costs	-
Payment expenses	-
TOT	***2.375 - 3.375***

Source: own elaboration

As seen, Webank as an online bank manages to reach a good level of costs' efficiency and it reduces to the minimum the contacts with client avoiding useless waste of time. Nonetheless the process, as we saw it, is profoundly time consuming, taking up to 77 days to disburse the loan and still paper based.

3.4 How blockchain can improve the mortgage process

The current mortgage process, as already seen, is full of inefficiencies causing long processing time and high intermediary costs for clients. Blockchain and smart contracts combined may disrupt the mortgage industry and make it more efficient. By allocating all elements of the home loan chain in a distributed ledger, the process has the potential of becoming a secure and fast end-to-end solution.

The first process which might be simplified is the identification. Nowadays personal data are released and stored by different actors (city halls, hospitals, banks, employers and many others). This situation may cause problems of different nature. Some personal information may be hacked, identities stolen and, at a lower level, cause delays.

Before applying for a mortgage, people are asked to collect a number of documents which are in possess of different actors. Thanks to the blockchain all the individuals' personal information would be already available for usage, previous owner authorization. Being those information part of an encrypted code, only the owner may grant access to it and control what third parties could see.

Synechron, which is a *"digital, business consulting & technology services providers firm"*[51]*,* has developed a *"blockchain mortgage lending application which automates mortgage initiation, execution and servicing for lenders, buyers and their appointed representatives"*[52].

According to their analysis, Blockchain is able to improve the mortgage process mainly in four areas:

- Data transfer: by enabling secure identification and sharing data
- Automation: by creating the automatic meeting between offer and demand for mortgages
- Payment efficiency: by eliminating intermediaries, payments will be executed in a faster and cheaper way
- Asset title transfer: by allowing the immediate transfer of the property ownership.

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[51] Source: Synechron Website
[52] See above (51)

Image 3.2: How the blockchain could transform the current mortgage value chain
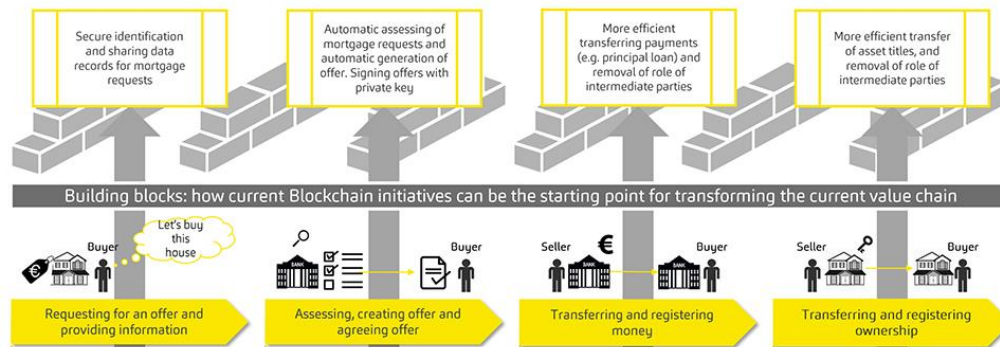
Source: Synechron 2018

Currently the mortgage process involves a multitude of parties among which there are: the buyer, the lender, the insurer, the notary and many others. Each party needs to validate data and transmit progresses to the other party. That's not only costly and time consuming, each step indeed represents a single point of failure and a possibility for fraud. Furthermore, if a change occurs it must be confirmed by all the parties once again. All of that happens because *"each one of these parties has its own processes, databases, ledgers, record-keeping and documentation systems to gather and store that information, and it needs to be checked and rechecked by all parties any time a change occurs to ensure all parties remain in agreement. With blockchain, also known as Distributed Ledger Technology (DLT), all parties can have access to different stages of the transaction in real-time, and all share the same view of the transaction but are limited to seeing only the parts which they need to in order to make their contribution."*[53]

Coming to the implementation of smart contracts, they could make transactions, or part of them, automatically executable. Within the mortgage process, smart contracts could be executed between parties simultaneously and becoming binding only when all the criteria are met.

Having said that and having analyzed the characteristics of blockchain, it is possible to design a hypothetical mortgage process running on a blockchain technology based integrated system.

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[53] *How blockchain can improve the mortgage process* (Mortgage Finance Gazette, 2017)

After identifying the property, the applicant could request for pre-approval for a home loan. Pre-approval would be instantaneous since all the basic information of the applicant would be already available. The application can now be sent online and broadcasted to every third parties involved in the process. Each party is now able to verify the data given by the client which become already available for usage. What just stated implies that even before the amount is made available by a lender, an insurer may generate his offer based on the information available on the client's block. After all the parties generate their offer a loan offer contract is generated and it can be signed by the client with a private key. When the contract is signed the amount is made available to the client to finalize the purchase and the property title is automatically transferred to the new owner. The all process may take around 5 days to be fully implemented, instead of around 60 days that are needed with the current system.

The following process cycle summarizes the steps needed to request a mortgage in a fully integrated blockchain system. To be operative this system would need the parties to share a common network in which client's id information, banks' and insurers' data are stored in a single blockchain

Image 3.3: The mortgage process cycle in a blockchain system
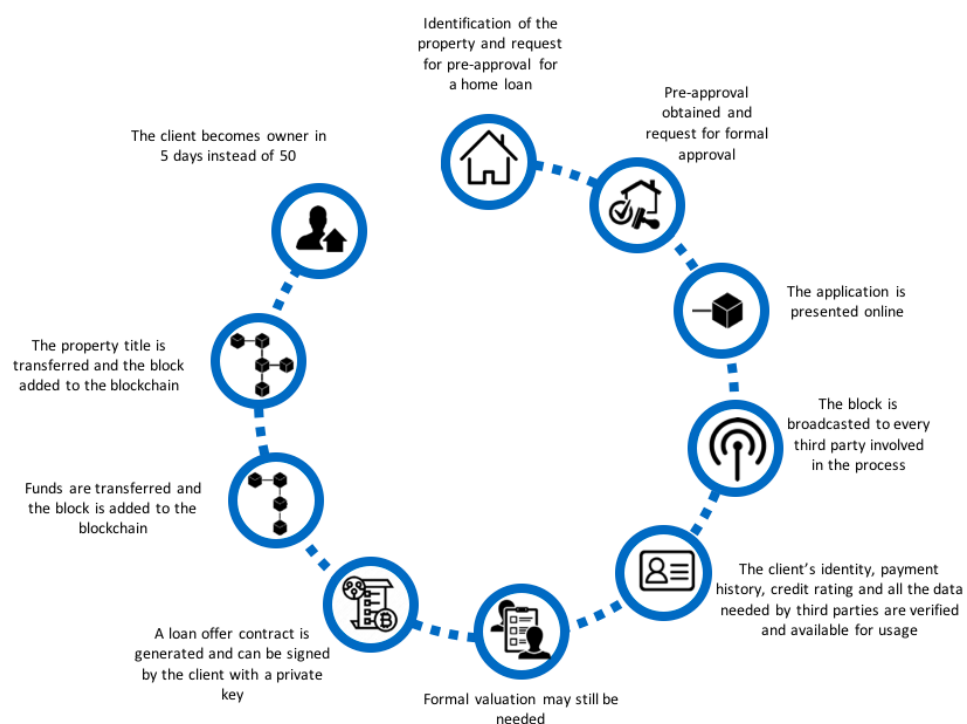
By comparing the process described above with the one adopted by Webank, it's clear that it doesn't constitute a cost improvement for the client but it does save him a lot of time wasting. From the bank's point of view, on the contrary, it may help achieving cost efficiency. The current model indeed is paper-based and it requires many working hours, with blockchain those steps would be automatized and the all documentation would be stored digitally.

The blockchain constitutes a process improvement able to help reducing costs for the banks. In a period in which banks struggle to improve their revenues, blockchain may help them to achieve better results by cutting costs and reducing opportunities for frauds and fines.

4. Conclusions

Blockchain today is subject of fears, suspicions and prejudices for two reasons essentially: the close connection with the cryptocurrencies (which has caused the public opinion to link blockchain with the circulation of unofficial currency) and the delay with which, with respect to its rapid development, regulatory policies are being launched. For this reason, an international economist such as Joseph Stiglitz (but he is not the only one) does not imagine a possible future for the blockchain. In his opinion, in fact, the cryptocurrencies will soon be put under pressure by the regulatory authorities, the same authorities that the blockchain aims at substituting.

What concerns Stiglitz in the first place is the lack of transparency of cryptocurrencies such as Bitcoin which has put them on a collision course with governments and banking authorities all over the world. In his vision it is paradoxical that while the world is fighting on a political and social level to achieve acceptable levels of transparency, in the great and powerful banking world, there is a parallel planet based on that "secrecy" that has been greatly reduced in the traditional banking world. The fact that the blockchain is a public ledger of records is not enough to guarantee access to the data, the secrecy characteristics allowed by the blockchain have indeed attracted the criminal organizations and will attract them even more in the future.

"You cannot have a means of payment that is based on secrecy when you're trying to create a transparent banking system (…) If you open up a hole like bitcoin, then all the nefarious activity will go through that hole, and no government can allow that[54]."

But Blockchain goes way beyond its link with the cryptocurrencies. There are still several unexplored fields in which the blockchain will, in the future, give a considerable boost to the development of new activities. What frightens the most is the capillarization of the network that allows the widespread sharing of databases, in a historical moment in which the management and possession of the databases proved to be a source of income with unprecedented earning capacity. It will not be

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[54] *"Stiglitz, Roubini and Rogoff lead joint attack on bitcoin"* (Joseph Stiglitz for Financial News London, article by By Chris Newlands 2018)

useless to remember the recent scandal of the Cambridge Analytica company that, in the occasion of the American elections of 2016, has stolen personal data of 50 million American citizens to send a political advertisement calibrated on the profile stolen from the largest social network in the world. The ones that holds and trades databases, don't look favorably at the very idea of blockchain because it represents a loss of concrete and current power.

It is understood, therefore, that the new reality of the blockchain calls into question some basic principles on which the social organization of the whole industrialized and developed world is founded. On the other hand, although the system we are talking about is fundamentally linked to cryptocurrencies, we know that it has potentialities that are easy to extend to many other areas of social life, capable of affecting social interactions, being them economic-financial or of any other nature.

Another clarification is needed. The blockchain is born as an alternative to the regulatory system of banks. From the point of view of those who invented and made the blockchain grow, the discussions and concerns mentioned above regarding the need to regulate the system have neither value nor meaning. In other words, the requests for privacy and the search for transparency have proved to be necessary in the official banking world in the face of illegal or simply illicit drifts that for decades have allowed the bankers enormous and often unjustified gains. Here the "political" weight of the existence of blockchain emerges. The technological possibility of being able to manage encrypted data directly from the network participants (democratic instance) who verify, approve, record all the blocks with all the data of each transaction on all the nodes, constitutes the most sensational attack on the centrality of the banks and their power of conditioning government policies. No control action remains in the hands of banks once the blockchain shifts the centrality of data files from their hands to the widespread network and thus offers a concrete solution to the issue of corruption that weighs heavily on the vote of confidence that users assign to those who manage their money. Especially considering, in light of the scandals already mentioned, that once spread, all information is present on all nodes and therefore becomes unmodifiable (technically would require the approval of the majority of nodes of the network, but

still would not change the history of that same information). Blockchain, therefore, is not just a system, it is not just a new technology, it is a new "paradigm" of information management, it guarantees immutability over time because it is able to certify the complete history of all data and all transactions related to each transaction.

What we are seeing today, in other words, is a change in the fundamental modeling of economic and financial events and a clash between the holders of the old banking model (which, so far, has had the universal consensus of users and operators), and the proponents of new blockchain model (extending its network of consents and sharing).

The theme of the blockchain, therefore, is not so much linked to cryptocurrencies as erroneously believed. The recent statement by ECB President Mario Draghi, who has issued a warning to the banks on cryptocurrencies, should be read - according to the supporters of the blockchain - as an attempt to discredit the nascent alternative. In his speech before the European Parliament in Strasbourg, during the presentation of the Report on the economic conditions of the euro area, Draghi stressed that the Frankfurt Institute does not currently detect a systemically significant detention of cryptocurrencies among European banks, despite there is a growing public interest. But since the launch of bitcoin futures in the US could further boost the spread of cryptocurrencies in bank portfolios, including in Europe, Draghi pointed out that the time has come to take a closer look at the phenomenon. All this interest would actually be a way to curb the blockchain itself, associating it with cryptocurrencies and cloaking it of that halo of high-risk assets and high volatility that determines the shipwreck of every product that circulates within the international financial community. The true aim, therefore, would not be to protect neither banks nor account holders from speculative risks linked to cryptocurrencies, but to prevent the blockchain from developing as an alternative and highly competitive system for the management of databases, for the storage of information on users and on consumers.

From what has been said so far, it is understood that blockchain is a complex contemporary phenomenon that will have potentials for disrupting the whole

financial system and impacting the world as we know it today, just as the Internet did in the 90's.

Blockchain can guarantee the traceability of every data recorded in it and this characteristic finds his utility in a number of fields from foodborne outbreaks to digital identity. The distributed technology indeed will totally change the way we interact and trade: the need for reducing uncertainty will no longer be satisfied by third parties such as banks and corporations but by the technology itself. Thanks to blockchain we'll manage to track back the exact origin of food and in the case of a food outbreak, identify and isolate the source of it. When buying something on the internet customers will no longer need an intermediary such a PayPal to guarantee their transactions and smart contracts will be able to secure that the deal is executed correctly. Digital identity will become possible, implying that we could demonstrate our identity everywhere without the need for paper document and drastically reducing (or eliminating) the possibility for identity theft. Blockchain technology would also be capable of storing and securing digital votes and by combining that with digital identity recognition we can imagine a world where everyone is able to vote from anywhere, being that the maximum expression of democracy. The list of blockchain possible applications could keep going, all sharing the characteristic of ensuring complete privacy and control of all data to all users being at the same time accessible to the public.

I agree with the many who think that a blockchain technology-based world is a more democratic one, it's a world where centralization of information is excluded by definition and the trustworthiness of the information is guaranteed. Because of this, what I see in blockchain is a powerful tool to further boost the supply chain management of any technology related sector. The financial sector will particularly be impacted by it and banks, in my opinion, will soon have to decide if embracing this new technology or being put out of the market by it. As we've seen with the mortgage disbursement process, blockchain is above all a business process improvement able to achieve a higher quality level of services both for customers and providers. Bankarization of third world countries will become easily implementable meaning that more resources will flow into those countries helping to boost their economy. Actually, I think that through blockchain we, as humans,

have the opportunity of setting new foundation for our economic and social systems.

Even though for blockchain to be implemented it will take probably many years, I believe we are about to enter a new era whose implications today are not fully disclosed but whose basic principles have the goal of pursuing a more equalitarian system.

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Summary

This work examines the phenomenon of the Blockchain. Technically it is a database that records and stores transactions on a widespread network. Two preliminary clarifications are needed: the database, as a repository of information, is decentralized and the management of its content is peer-to-peer. Thanks to these characteristics blockchain can be defined as a simple public register for the management of data related to transactions stored in blocks that make up the chain, that is the network. In other words, in order to have a practical image of what blockchain is, it is possible to think of it as a google document. With blockchain is possible, for everyone participating the network, to access the document and editing it. Everybody has documentation of what has changed and what hasn't changed, but none of the participants has the power of changing what another participant recorded in it. The only way a transaction can be "reversed" is by tracking back the original block and create a link to a new one which specifies that anything that is on that block must be referred to the updated one.

When talking about blockchain the main issue is defining what this technology is. Many people tend to confuse it with Bitcoin since it has been born with it. Bitcoin is a digital currency which uses encryption to generate digital cash and to verify the transfer of funds. The blockchain is the underlying technology used to create Bitcoins, or cryptocurrencies in general.

It's possible to define the blockchain as a reliable transaction cloud containing a distributed ledger of transactions, repeated in an identical copy, in multiple nodes.

The blockchain technology allows for a decentralized interaction among multiple participants around the world. This feature is able to rewrite not only payments and financial services but potentially all the industries. Blockchain model is not only more efficient but it could also play an important role in reaching greater equality and in empowering users.

Blockchain disruptive force may indeed be broken down into three phases: Blockchain 1.0, 2.0 and 3.0: Blockchain 1.0 regards the utilization of blockchain as

cryptocurrency, blockchain 2.0 is about smart contracts and blockchain 3.0 is about the adoption of blockchain across industries.

Cryptocurrency may be defined as digital or virtual cash that uses cryptography for security. Transactions made by cryptocurrencies are registered on the blockchain, while the identity of the players stays anonymous and they are known only by their virtual addresses. The disruptive power of cryptocurrencies lays on the fact that they can be issued without the involvement of a central bank or any other traditional player.

Coming to the smart contracts they are event driven contracts whose terms and conditions are written into lines of codes running on a blockchain network. In other words, a smart contract works on an *if-then* premise. The contract will be executed only if an event will occur: the property of an asset will be transferred only when the payment is received. Furthermore, the all process is witnessed by a multitude of validators and therefore theoretically faultless.

Blockchain might be able to transform the value chain thanks to its characteristics of traceability and immateriality, but with the term "Blockchain 3.0" we don't refer only to value chain disruption, this term refers to all the possible applications of blockchain in different industries such as Government, health, science, literacy, art and culture.

After having distinguished the different phases of blockchain, it is possible to identify the different types of it. We can distinguish between public and private blockchain according to the possibility for anyone to have free access or not to the chain. Moreover, if there is an authority which controls what kind of transactions are allowed we are in presence of a permissioned blockchain, otherwise we have a permissionless blockchain.

The purpose of this work is understanding how this new technology will impact the banking system. Banks, as today, are facing a decrease in profitability and for this reason the banks' interest on blockchain is raising. As a matter of fact, this new technology will enable banks to run faster and more accurate payments, reduce transactions' costs, errors and exceptions while obtaining faster settlement and seek for new revenue opportunity.

Blockchain has the potential for disrupting the banking system within all its core activities: storing value, lending money, executing payments and offering investments and insuring products.

Blockchain gives its users the possibility of "**storing**" crypto-coins directly on the distributed ledger which may cause bank accounts to become outdated. To be more precise what is being stored is the record of a transaction and not the crypto-coin itself. The transfer of funds consists in changing the ownership of a crypto-currency to a specific address. This generates a private key known only to the owner which, in combination with the public key, is able to track the transaction and therefore demonstrate the ownership and the availability of the crypto-coins. y.

Lending represents the core activity for banks and it consists in financing both privates and businesses. The implementation of distributed ledger would radically change lending in each aspect. Each financing valuation starts with the analysis of the client creditworthiness which takes times, waste resources and it involves multiple parties. In a blockchain implemented system, individuals would have a profile on a platform with a digital credit score determined by history payments, meaning that credit score agencies are no longer needed. The first consequence is that fees are significant lower as well as the time for lenders to grant a loan. Blockchain has opened and enriched the world of P2P lending which may have the strength to push banks out of the game. The expression P2P lending stands for Peer-To-Peer lending and it indicates the procedure with which individuals borrow and lend money each other without the need for an intermediary. In this way privates and businesses have access to credit without having to apply for one through banks. Lenders can access to individual profiles and check their credit score to choose whether to disburse the loan or not at a predetermined interest rate. Investors may decide to either finance the all amount or a part of it, the remaining part would be financed by multiple investors. This structure permits investors to have higher returns than the ones they would get from a saving accounts. At the same time, it gives credit access to borrowers who would get excluded by banks and lower interest rates for borrowers with good history payments.

Another characteristic of P2P lending platforms is that it helps dissolving geographical borders and differences in interesting rates among countries. Being

virtually accessible to anyone everywhere, P2P lending represents a global solution which would increase competition among lenders. The increased competition leads to a decrease in interest rates resulting in cheaper transactions. Being signed through smart contracts, P2P lending would also eliminate the need for paper-based documents. An additional benefit of this configuration is that financial risks would be reduced and in particular fraud risk, thanks to blockchain intrinsic features of traceability.

Coming to the **payments** systems, they are currently based on third party intermediaries, implying high processing fees and high settlement times. The function of intermediaries is acting as trusted third parties allowing the other actors to transact without knowing each other. With blockchain, payments wouldn't require third parties since trust is no longer needed, resulting in lower fees and shorter settlement times. The lack of need for intermediaries will lower fees and rates across products and services and banks will be able to cut costs for tracking and managing their financial transactions and at the same time reduce or avoid duplication and reconciliation.

Blockchain technologies play an important role also in **trade finance**. Today trade finance involves multiple actors: importers and exporters, banks and financiers, insurers and export credit agencies, and service providers. This process implies paper-based document exchange, causing delays, and it involves spending a lot of time on coordination and transaction execution. The paper-based document process within the fallibility of human activity are the main causes of the need for internal control and compliance, for the same reason fraud incidents' and regulatory fines' risks are high. In a blockchain integrated system this process would be different. First of all, the whole process would be paperless and there would be a single pool of documents related to a transaction. Furthermore, transactions would be multi-signed in different times on a decentralized basis and then collected in a single transaction, without need for redundancy of signatures and documents. In this way the time for coordination and transaction execution would be significantly reduced. The absence of any single point of failure, typical of blockchain, would reduce the risk for fraud. Being all the transactions recorded and available, risk of regulatory fines would be reduced as well since smart contracts guarantee that the

documents are originated from correct entity. Coming to the **insurance** industry, characteristics of blockchain such as having access to digitalized personal data, prevention of fraud and a new way to process claims may have a strong impact on the industry.

When customers enter in an insurance contract, the first problem they find themselves dealing with is the collection of data. Since the premium is calculated on the characteristics of the insured party, the insurer makes sure that all the information is valid, authentic and complete. This process is particularly time consuming and it weights mostly on the insured party, since he has to collect all the data if he wants to enter the contract. With a blockchain integrated system, customers would have all their sensible information always available on their digital id. Not only the information would be easier to collect but they would also be more reliable and harder to falsify. Furthermore, from a customer oriented pointed of view, the premium paid would be fairer resulting in lower premium for customers who deserve it. This system would also facilitate the switch from an insurer to another one increasing competition and reducing premium rates, switching provider would be costless for the insured and all his information would be easily transferred, being stored in the chain.

In the last chapter the analysis focuses on how the mortgage process could be disrupted by blockchain technology. In doing that I've analyzed the process of disbursing a home loan at Webank which is the online channel utilized by BancoBPM to offer online services including trading platforms and the financing of a mortgage. From the analysis it results that Webank manages to reach a good level of costs' efficiency and it reduces to the minimum the contacts with client avoiding useless waste of time; nonetheless the process is profoundly time consuming. Blockchain and smart contracts combined may disrupt the mortgage industry and make it more efficient. By allocating all elements of the home loan chain in a distributed ledger, the process has the potential of becoming a secure and fast end-to-end solution. In the end of the chapter I propose an alternative process of disbursing a home loan based on the blockchain. The outcome of this analysis is that designed process doesn't constitute a cost improvement for the client, but it does save him a lot of time wasting. From the bank's point of view, on the contrary,

it may help achieving cost efficiency. The current model indeed is paper-based and it requires many working hours, with blockchain those steps would be automatized and the all documentation would be stored digitally.

The blockchain constitutes a process improvement able to help reducing costs for the banks. In a period in which banks struggle to improve their revenues, blockchain may help them to achieve better results by cutting costs and reducing opportunities for frauds and fines.

Blockchain today is subject of fears, suspicions and prejudices for two reasons essentially: the close connection with the cryptocurrencies (which has caused the public opinion to link blockchain with the circulation of unofficial currency) and the delay with which, with respect to its rapid development, regulatory policies are being launched. For this reason, an international economist such as Joseph Stiglitz (but he is not the only one) does not imagine a possible future for the blockchain. In his opinion, in fact, the cryptocurrencies will soon be put under pressure by the regulatory authorities, the same authorities that the blockchain aims at substituting.

What concerns Stiglitz in the first place is the lack of transparency of cryptocurrencies such as Bitcoin which has put them on a collision course with governments and banking authorities all over the world. In his vision it is paradoxical that while the world is fighting on a political and social level to achieve acceptable levels of transparency, in the great and powerful banking world, there is a parallel planet based on that "secrecy" that has been greatly reduced in the traditional banking world. The fact that the blockchain is a public ledger of records is not enough to guarantee access to the data, the secrecy characteristics allowed by the blockchain have indeed attracted the criminal organizations and will attract them even more in the future.

"You cannot have a means of payment that is based on secrecy when you're trying to create a transparent banking system (…) If you open up a hole like bitcoin, then all the nefarious activity will go through that hole, and no government can allow that."[55]

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[55] Joseph Stiglitz for Financial News London, article by By Chris Newlands: "*Stiglitz, Roubini and Rogoff lead joint attack on bitcoin*" (July 2018)

But Blockchain goes way beyond its link with the cryptocurrencies. There are still several unexplored fields in which the blockchain will, in the future, give a considerable boost to the development of new activities. What frightens the most is the capillarization of the network that allows the widespread sharing of databases, in a historical moment in which the management and possession of the databases proved to be a source of income with unprecedented earning capacity. It will not be useless to remember the recent scandal of the Cambridge Analytica company that, in the occasion of the American elections of 2016, has stolen personal data of 50 million American citizens to send a political advertisement calibrated on the profile stolen from the largest social network in the world. The ones that holds and trades databases, don't look favorably at the very idea of blockchain because it represents a loss of concrete and current power.

It is understood, therefore, that the new reality of the blockchain calls into question some basic principles on which the social organization of the whole industrialized and developed world is founded. On the other hand, although the system we are talking about is fundamentally linked to cryptocurrencies, we know that it has potentialities that are easy to extend to many other areas of social life, capable of affecting social interactions, being them economic-financial or of any other nature.

Another clarification is needed. The blockchain is born as an alternative to the regulatory system of banks. From the point of view of those who invented and made the blockchain grow, the discussions and concerns mentioned above regarding the need to regulate the system have neither value nor meaning. In other words, the requests for privacy and the search for transparency have proved to be necessary in the official banking world in the face of illegal or simply illicit drifts that for decades have allowed the bankers enormous and often unjustified gains. Here the "political" weight of the existence of blockchain emerges. The technological possibility of being able to manage encrypted data directly from the network participants (democratic instance) who verify, approve, record all the blocks with all the data of each transaction on all the nodes, constitutes the most sensational attack on the centrality of the banks and their power of conditioning government policies. No control action remains in the hands of banks once the blockchain shifts

the centrality of data files from their hands to the widespread network and thus offers a concrete solution to the issue of corruption that weighs heavily on the vote of confidence that users assign to those who manage their money. Especially considering, in light of the scandals already mentioned, that once spread, all information is present on all nodes and therefore becomes unmodifiable (technically would require the approval of the majority of nodes of the network, but still would not change the history of that same information). Blockchain, therefore, is not just a system, it is not just a new technology, it is a new "paradigm" of information management, it guarantees immutability over time because it is able to certify the complete history of all data and all transactions related to each transaction.

What we are seeing today, in other words, is a change in the fundamental modeling of economic and financial events and a clash between the holders of the old banking model (which, so far, has had the universal consensus of users and operators), and the proponents of new blockchain model (extending its network of consents and sharing).

The theme of the blockchain, therefore, is not so much linked to cryptocurrencies as erroneously believed. The recent statement by ECB President Mario Draghi, who has issued a warning to the banks on cryptocurrencies, should be read - according to the supporters of the blockchain - as an attempt to discredit the nascent alternative. In his speech before the European Parliament in Strasbourg, during the presentation of the Report on the economic conditions of the euro area, Draghi stressed that the Frankfurt Institute does not currently detect a systemically significant detention of cryptocurrencies among European banks, despite there is a growing public interest. But since the launch of bitcoin futures in the US could further boost the spread of cryptocurrencies in bank portfolios, including in Europe, Draghi pointed out that the time has come to take a closer look at the phenomenon. All this interest would actually be a way to curb the blockchain itself, associating it with cryptocurrencies and cloaking it of that halo of high-risk assets and high volatility that determines the shipwreck of every product that circulates within the international financial community. The true aim, therefore, would not be to protect neither banks nor account holders from speculative risks linked to cryptocurrencies,

but to prevent the blockchain from developing as an alternative and highly competitive system for the management of databases, for the storage of information on users and on consumers.

From what has been said so far, it is understood that blockchain is a complex contemporary phenomenon that will have potentials for disrupting the whole financial system and impacting the world as we know it today, just as the Internet did in the 90's.

Blockchain can guarantee the traceability of every data recorded in it and this characteristic finds his utility in a number of fields from foodborne outbreaks to digital identity. The distributed technology indeed will totally change the way we interact and trade: the need for reducing uncertainty will no longer be satisfied by third parties such as banks and corporations but by the technology itself. Thanks to blockchain we'll manage to track back the exact origin of food and in the case of a food outbreak, identify and isolate the source of it. When buying something on the internet customers will no longer need an intermediary such a PayPal to guarantee their transactions and smart contracts will be able to secure that the deal is executed correctly. Digital identity will become possible, implying that we could demonstrate our identity everywhere without the need for paper document and drastically reducing (or eliminating) the possibility for identity theft. Blockchain technology would also be capable of storing and securing digital votes and by combining that with digital identity recognition we can imagine a world where everyone is able to vote from anywhere, being that the maximum expression of democracy. The list of blockchain possible applications could keep going, all sharing the characteristic of ensuring complete privacy and control of all data to all users being at the same time accessible to the public.

I agree with the many who think that a blockchain technology-based world is a more democratic one, it's a world where centralization of information is excluded by definition and the trustworthiness of the information is guaranteed. Because of this, what I see in blockchain is a powerful tool to further boost the supply chain management of any technology related sector. The financial sector will particularly be impacted by it and banks, in my opinion, will soon have to decide if embracing this new technology or being put out of the market by it. As we've seen with the

mortgage disbursement process, blockchain is above all a business process improvement able to achieve a higher quality level of services both for customers and providers. Bankarization of third world countries will become easily implementable meaning that more resources will flow into those countries helping to boost their economy. Actually, I think that through blockchain we, as humans, have the opportunity of setting new foundation for our economic and social systems.

Even though for blockchain to be implemented it will take probably many years, I believe we are about to enter a new era whose implications today are not fully disclosed but whose basic principles have the goal of pursuing a more equalitarian system.