# On the state-of-the-art of FinTech world and the initial approach of central banks

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**Abstract:** This paper aims to provide a state-of-the-art analysis about the FinTech and the cryptocurrencies phenomena. Given the focus of the central banks all over the world, we will discuss three main aspects: technology, economics and regulation. Technology seems to be the most important revolution brought by cryptocurrencies: it is employed for many purposes that depart from the original one of distributed ledger for storing transactions. The traditional financial intermediaries are trying to prevent the disruption of the current financial system by cooperating with the FinTech start-ups. Regarding the economic aspect, we deal with the comparison between what academia has been proposing for incorporating cryptocurrencies in the economy and what central banks and banks are doing. Regulation has mainly adopted a 'wait and see approach' and it is very fragmented around the globe. Regulation is mainly oriented in exploiting technology, acquiring the new name of RegTech.

**Keywords:** cryptocurrencies; blockchain; DLT technologies; FinTech; RegTech.

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# 1   Introduction

This paper aims to provide a holistic survey about the state-of-the-art of FinTech and cryptocurrencies phenomena. We decided to focus on three key aspects: technology, economics and regulation. These features synthesise the evolution and the impact on the real world of the FinTech phenomenon and are strongly relevant for central banks, as stated clearly by the Vice Director General of the Bank of Italy (Perrazzelli, 2021, 2020). Central banks are the competent authority for issuing regulation and for supervising financial markets, assets and payments system, which are directly affected by FinTech and cryptocurrencies. Moreover, the economic consequences of an alternative private form of money are strongly observed by the central banks given the eventual undermining of the control of the money supply (Benigno, 2019).

The born of finance together with technology (FinTech) is usually associated with the creation of Bitcoin in 2009 by the anonymous pseudonym of Satoshi Nakamoto. However, it is possible to consider FinTech or pre-FinTech era also years '80s and '90s. During these two decades, computers and internet had a pivotal role in revolutionazing financial markets and the banking system, whose euphoria lead to the dot-com bubble in 2001. The main innovations were in the way of providing current services, like transactions in electronic markets (NASDAQ), as well as creating new services, like electronic payments and e-commerce. At the end of '90s big companies like Amazon, e-Bay and PayPal begun their activities, without posing a real threat to the usual means of payments. The invention of Bitcoin is the main disruption for financial system and economics in general since Bitcoin claims to be an alternative private money against fiat money to allow peer to peer transactions. Bitcoin challenges the preminent role of money as a medium of exchange.

Bitcoin is the first cryptocurrency, where crypto refers to cryptography techniques employed to secure transactions and currency refers to the Bitcoin presumption of serving the three functions of money. The great innovation of Bitcoin is the use of blockchain technology to exclude third trusted intermediaries, thus limiting costs. Namely, blockchain allows the transferring of Bitcoin from one user to another without the intervention of an intermediary. The willingness of excluding the traditional financial architecture lies in the lack of trust in the system after the 2008 financial crisis of which intermediaries have been considered responsible. Bitcoin has progressively gained importance leading to the born of many other cryptocurrencies from one side and to the massive use of the blockchain technology for many other purposes on the other side. FinTech phenomenon became widespread.

After the first boom of Bitcoin price, which occurred in November 2013 when it reached the price of $395 leading to a profit of approximately 2,900% from the beginning of the same year, many other cryptocurrencies have followed. The most famous are Ethereum, Litecoin, and Ripple. Ethereum is considered more secure than Bitcoin because it employs a different kind of blockchain; the one who wants to enter the network has to respect certain guarantees (permissioned blockchain), while the one of Bitcoin is free (permissionless blockchain). Instead, Ripple is a cryptocurrency created by a single private company that targets banks for enabling cross-border transactions with lower costs. Litecoin is a soft version of Bitcoin that allows for small and micropayments and faster transactions. According to Coin Market Capitalization (2021), there are 3,600 cryptocurrencies exchanged on specific platforms whose total capitalisation is $1.91 trillions. At August 2021, Bitcoin price is $46,093.40 and it

dominates the 45.36% of the market.[1] Due to the extension of the cryptocurrencies phenomenon, the economic literature has been questioning mainly two aspects, how to price cryptocurrencies and whether they are suitable for monetary policy purposes, as we will discuss in Subsection 2.2.

Regarding the technological side, the most important innovation provided by Bitcoin is the blockchain technology, a safe way for storing transactions. Blockchain is a particular case of distributed ledger technology – DLT, and it is composed by blocks of information connected together by a unique hash function. Blocks are made by a list of transactions that are validated once a new Bitcoin is mined, namely when the cryptographic puzzle associated with each transaction has been solved. This procedure is called mining and represents one of the blockchain limits due to the computational power and energy needed. The blocks are decentralised in all the participants (nodes) to the chain and all the nodes compete against each other to be the first in solving the puzzle. Thanks to these characteristics, it is hard to hack or modify the content of a single block. The computational power needed to pass through one block and reach the target string is greater than the one needed for verifying the transactions, thus is almost unfeasible. According to Digieconomist (2020), at August 2021, the yearly consumption of electrical energy for mining new Bitcoin is around 146.22 TWh, comparable with the yearly electric consumption of Ukraine.[2]

The first version of the blockchain has been further developed and improved to be exploited for many other goals. Blockchain is suitable for tracking the supply chain from commodities firms to trade markets, for Robo advise algorithm, and for due diligence procedures. One of the main critiques moved against Bitcoin is that the anonymity of transactions may foster terrorism financing and money laundering. It is interesting to notice that the traditional financial system is embracing these new technologies to fight against the original purposes of Bitcoin, i.e., anonyminity and peer to peer transactions.

These aspects also arise many problems with regulation. Starting from 2013, the academia has been calling for a common regulation around the world for enabling an easier management of decentralisation (Plassaras, 2013). However, regulation is very fragmented: there are different approaches to currencies and exchanges and regulators are more oriented to discipline technologies.

The remainder of this paper is organised as follows: Section 2 contains a survey about regulatory, technological, economic and regulatory aspects, Section 3 makes a comparison of what the academia has called for the integration of cryptocurrencies in the economy and what central banks and private institutions are doing; Section 4 concludes.

## 2 Literature review

In this section, we will describe the current approaches to the management and developping of technologies, what academia suggests for the integration of cryptocurrencies in the economy and regulation.

### 2.1 Technology

As stated in Section 1, what fascinates most of the Bitcoin revolution since 2009 is its underlying technology: the blockchain. The blockchain was first invented by Haber and Stornetta (1991) to authenticate intellectual properties. Blockchain is a particular

kind of DLT, namely a "decentralised, shared, replicated, and synchronised record of transactions between contracting parties secured by cryptographic sealing" (Treleaven et al., 2017). Decentralisation is the warhorse of this technology, considered more secure thanks to the distribution of information in different nodes. Since nodes are not concentrated in a unique data centre, they are prevented from physical risk and hacking risk. Nowadays, Bitcoin blockchain is quite antiquated, but its introduction has opened the doors to further developments. Currently, there are three important blockchains with different characteristics for diverse purposes (Corda v Hyperldeger v Quorum v Ethereum v Bitcoin, 2019). These three are Ethereum Network, R3 Corda, and Hyperledger Fabric. Corda and Hyperledger Fabric are referred to an enterprise blockchain; they are private network, in which access is restricted to selected parties, and designed for business enterprise. Thus, in this case, participants are known and transactions are faster than Bitcoin or Ethereum network.

We can compare and contrast the three different blockchains:

- *Ethereum:* Ethereum network is based on a public[3], permissioned[4] blockchain. This is more flexible than the one of Bitcoin thanks to the featuring of smart contracts. A smart contract is a high-level programming language that makes contracts self-executing on a DLT when certain conditions occur. Smart contracts could automate laws. In the case of Ethereum, the smart contracts concern bytecode[5], whose computational cost is paid in Ether. One of the problems associated with this network is data privacy since information is replicated in all nodes.

- *Corda:* Corda has been created by R3, a consortium of technology companies. Corda is an enterprise blockchain specialised in data privacy by sharing transactions only on a need-to-know basis. It gains in performances thanks to linear horizontal scalability (i.e., the information is not replicated in each node). R3 is offering a set of blockchain services (BaaS) to major banks like Barclays, UBS, Unicredit, and Wells Fargo (Fanning and Centers, 2016).

- *Hyperledger Fabric:* The joint initiative between IBM and the Linux Foundation created this blockchain in 2015. The aim is to achieve data protection via channels that allow private and collective communication. The deployment of a network is a giant channel in which subsets for private communication can be created. However, the SWIFT banking cooperative finds significant operational challenges for the members (Hyperledger Project Charter, 2016).

Therefore, blockchain is suitable for different applications thanks to its flexibility and we refer to it as Blockchain 2.0 (Fanning and Centers, 2016). Nevertheless, the blockchain trilemma (Abadi and Brunnermeier, 2018), i.e., the incompatible simultaneous existence of correctness, decentralisation, and cost-efficiency, threatens its several potential applications. There is a huge debate surrounding the problems of blockchain, especially about its scalability and velocity in verifying transactions. A survey by Zhou et al. (2020) explains the potential solutions under exploration in order to improve scalability. Summirising there are two approaches: from one side, scholars are trying to modify the existing structure of blockchain by proposing two branches for increasing single block bit capacity: for example, block compression and block assignment problem for enabling short transactions. On the other side, different consensus strategies and new technologies arise: one is sharding, a technique based on partitioning the network into

different shards for increasing capacity, and the other one is directed acyclic graph (DAG). DAG exploits graphs theory: blocks act as vertices and they are linked together (one vertex links more than one) enabling more transactions.

We discuss now the different uses of the blockchain. Blockchain finds application in the circular economy. A report by PwC (Orlandi et al., 2019) shows that blockchain is now widely used for supply chain tracking, linking lots directly with commodities traders. However, banks and financial institutions are those investing more in this technology. According to Tapscott and Tapscott (2017), many banks are investing in blockchain technology for increasing the efficiency of back-office and due diligence procedures. A study by Santander (Belinky and Rennick, 2020) estimates that the potential savings derived by employing blockchain technology are around $20 billion per year, while the savings in consumer fees are about $16 billion a year. There are many aspects of the intermediaries' activities that can be automated and made more efficient thanks to blockchain, artificial intelligence (AI), and machine learning (AI and ML hereinafter). Anjum et al. (2017) report which technological standard should be expected for a massive usage of blockchain technology. Moreover, the International Organization for Standardization launched in 2017 a technical committee (TC307) on blockchain and DLT which has already issued 3 ISO Standards (ISO/TC 307 Blockchain and Distributed Ledger Technology, 2017).

**Figure 1** Basic schema of the P2P lending (see online version for colours)
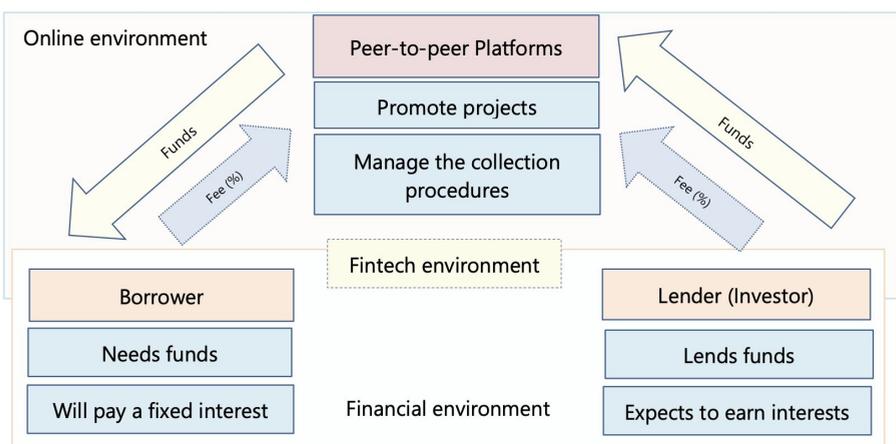


*Source:* BIS – FSI Insight 2020

As reported by Allen et al. (2020), one of the first advantages of using AI and ML is to reduce the time and costs of computing the credit scores. Thanks to the utilisation of new alternative big data, collected for example from social networks or banks account, the algorithm can obtain credit rating also for people who do not have a credit history. Croux et al. (2020) demonstrate that these algorithms can overcome the problem of asymmetric information, which is responsible for unexpected default. Berg et al. (2019) find that credit scores based on alternative data, such as the 'digital footprint', i.e., the track that we left online, perform better than traditional ones. These techniques contribute to enlarge the recipients of credit together with to the peer-to-peer – P2P, online lending platform (Jagtiani et al., 2018). Also, the credit rating evaluation with

AI/ML could improve credit pricing. Jagtiani and Lemieux (2019) compare the interest rate charged by LendingClub, an online personal lending platform adopting AI/ML technologies, with some traditional credit channels and found that the use of alternative data by LendingClub makes the credit cheaper. Figure 1 graphically explain how a P2P platform works. AI/ML techniques are also exploited in the insurance sector, known as InsurTech, for estimating insured risk thanks to big data.

Another important aspect of FinTech disruption is the integration between the traditional activities with the new services provided by the FinTech start-ups (for example PayPal and Nexi). As it is for online banking activities, which are complementary and not substitute for the standard bank ones, also FinTech facilities seem to support intermediaries' activities. Hornuf et al. (2020) observe that larger banks are more likely to integrate start-ups in their business model obtaining a significant positive response from the market. However, in the sector of investment advisors, algorithms seem to replace financial consultants. We talk in this case about Robo-advising. A Robo-advisor platform works by screening investor preferences, implementing a personalised investment strategy, and balancing it. One of the main advantages is that Robo-advisor is an unbiased consultant eventhough its characteristics do not meet the law standard requirements yet (Allen et al., 2020).

RegTech is another spill-over of the FinTech phenomenon. RegTech refers to the exploitation of the FinTech technologies for improving the monitoring, reporting and compliance operations (Arner et al., 2016; Zetzsche et al., 2017). As a consequence, RegTech is substituting the supervisory activity of men with algorithms. Up to now, the major financial institutions employ RegTech for compliance with anti-money laundering (AML) and know your customers tasks. Besides, blockchain and smart contracts are more suitable for screening activities. Parra-Moyano et al. (2019) proposes a system for the know your costumers assessment based on blockchain. He suggests that once a bank has performed the KYC procedure, it stores the results on the Corda network to avoid duplicated tasks, thus reducing the costs. Fanning and Centers (2016) argues that through smart contracts, it is possible to reduce the time of back-office procedure in case of debt syndication and derivates selling. Moreover, smart contracts make real-time delivery possible. We will discuss more extensively the RegTech in Subsection 2.3.

Furthermore, as stated in Section 1, one of the problem related to the massive usage of blockchain technology is the consumption of energy, which eventually implies waste of resources. According to Digieconomist (2020), the annualised Bitcoin Carbon Footprint is equal to the one of Israel.[6] Macchiavello and Siri (2020) highlight the necessity of facilitate the inclusion of green finance in the FinTech phenomenon. Demand for green investments has considerably grown, thus we should think about including ESG standard also in FinTech. FinTech technologies can implement data collection process for pricing environmental risks, measure and track sustainability criteria. Moreover, FinTech could balance the consumption of energy by financing green project through 'green crowdfunding platform'. As an example, Climatecoin in Switzerland serves as exchange for tokens representing carbon credits. The tokens can be used for investing in mitigation projects that compensate carbon emissions. SolarCoin rewards producers of solar energy with cryptocurrencies that can be traded. More innovative, Powerledger in Australia has created a blockchain-based P2P platform for the exchange of residents solar energy produced with peers. The green and sustainable finance seem to represent a promising future for FinTech if it wants to keep gaining competitiveness.

## 2.2 Economics

We deal now with the economic aspects of the FinTech disruption. Recall that we can identify the born of this phenomenon with the invention of Bitcoin, a private money that pretends to be an alternative to fiat money. Bitcoin innovations lie in the peer-to-peer transactions, in the low cost of transactions, in the anonymity, and in the absence of a third guaranteed party like an intermediary. The rally of Bitcoin price has stimulated the issuing of many other concurrent cryptocurrencies that go under the name of 'altcoins'.[7] Figure 2 depicts the main[8] cryptocurrencies price series where it is clear that all the minors follow the Bitcoin price behaviour (blue line, RHS scale). Also. Figure 3 shows the volume of exchange of the main cryptocurrencies as percentage of the cumulated volume. Following the dominance of Bitcoin, around 2018 the other cryptos progressively gained market shares.

**Figure 2** Price series of the main cryptocurrencies (see online version for colours)
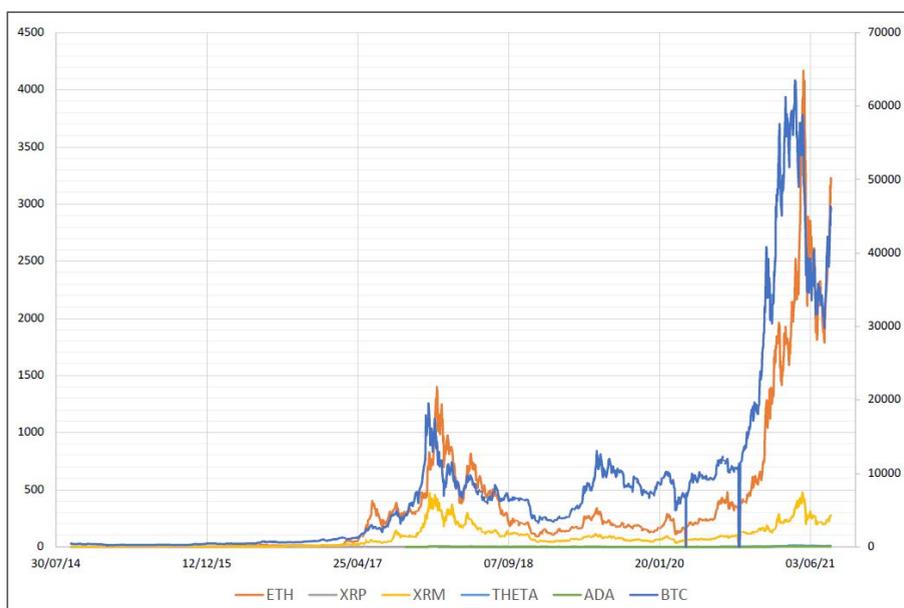


Notes: LHS: *ETH* – Ethereum, *XRP* – Ripple, *XRM* – Monero, *THETA* – Thether,
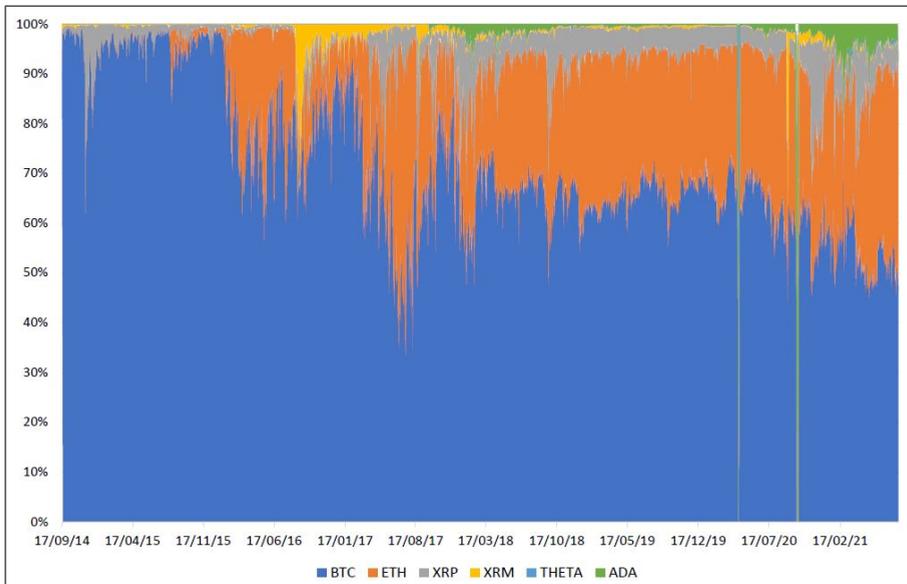     *ADA* – Cardano. RHS: *BTC* - Bitcoin.
       *Source:* Authors elaboration of CoinMarketCap data at 11 August 2021

Given that the 'altcoins' have been modelled after Bitcoin, they aim at being an improved version of the original cryptocurrency. As we state in Section 1, at August 2021, there are 3,600 cryptocurrencies exchanged on specific platforms whose total capitalisation $1.91 trillions. We briefly discuss the main features of the direct competitors of Bitcoin following (Garriga et al., 2020).

Ethereum (ETH) is a decentralised software platform that works with smart contracts and assigns a deterministic cost to the operations that create a transaction, i.e., transaction fee are remunerated in Ether. Ripple (XRP) is thought for banks' international transactions. Ripple's tokens are 'pre-mined' reducing computational power

and minimising latent costs. Litecoin (LTC) is a 'soft' version of Bitcoin, it shares the main features except for the faster transaction confirmation time. Tether (USDT) is one of the first cryptocurrencies that want to anchor the coin value to real currency for reducing volatility; it is a 'stablecoin'. Bitcoin Cash (BCH) is one of the earliest hard fork – a radical change in blockchain protocol – of the original Bitcoin. Monero (XMR) and ZCash (ZEC) are famous for having more guarantees on the anonymity and untraceability of transactions. A curios altcoin is Iota (MIOTA), a cryptocurrency based on a DAG called Tangle which purpose is to facilitate exchanges in the IoT world. Finally, another famous cryptocurrency that has still to be issued is Libra, Facebook stablecoin to whom we will dedicate a deeper analysis in Section 3.

**Figure 3**    Volume of exchange of the main cryptocurrencies (see online version for colours)



Notes: *BTC* – Bitcoin, *ETH* – Ethereum, *XRP* – Ripple, *XRM* – Monero,
       *THETA* – Thether, *ADA* – Cardano.
         *Source:*    Authors elaboration of CoinMarketCap data at 11 August 2021

The characteristic that all cryptocurrencies share is volatility. For this reason, the literature about cryptocurrencies is essentially split into two fronts: on one side, that we can call the financial, we have empirical investigations about predicting volatility and pricing currencies. On the other side, the economic one, academia questions whether cryptocurrencies could be integrated into the economic system and the implications for monetary policy.

The great volatility of cryptocurrencies rises the 'cryptocurrency trilemma' (Corbet et al., 2019), i.e., confidence in price stability is undermined by cyberattack, continuous attempts in regulation and potential bubble. The investigations about volatility permeate the financial literature, thus we will refer to the major empirical works. Blau (2018) assesses whether the volatility of Bitcoin price depends on speculative trading finding no relationship. Gkillas and Katsiampa (2018) introduce the value-at-risk (VaR hereinafter) model for studying the volatility of the first five capitalised cryptocurrencies. Peng

et al. (2018) extend the application of the VaR by trying to predict volatility with a support vector regression GARCH, using different GARCH specification, distributions, and skewness. Katsiampa (2019) further widens the GARCH with a diagonal BEKK model finding asymmetric effects of good and bad news. Ji et al. (2019) observe also asymmetric effect of volatility, more specifically negative returns accept more connectedness in the cryptocurrencies network. Ultimately, Catania et al. (2018) analyse long memory in the volatility process and asymmetric reactions through time-series. Jang and Lee (2017) instead exploit a Bayesian neural networks for price predictability by incorporating the underlying fundamentals of Bitcoin and volatility time series. At the edge of the empirical works on volatility, there is the paper by Mai et al. (2018). The authors try to link volatility to the information released on social media, eventhough the question has already been investigated.

After the first price peak of Bitcoin in 2013, scholars start to wonder which are the determinants of Bitcoin price and if the information released has to deal with it (Kristoufek, 2013, 2015; Ciaian et al., 2016). Following that, academia poses attention on the ability of cryptocurrencies to satisfy the efficient market hypothesis (EMH), i.e., prices reflect all the information available and assets trade at their fair value (Fama, 1960). Nadarajah and Chu (2017) and Brauneis and Mestel (2018) point out that the hypothesis is not satisfied due to volatility and that the higher the liquidity the higher price unpredictability. Eventually, we can affirm that given the instability of cryptocurrencies, thus the inability of preserving its value and transfer wealth to the furture, they are closer to financial assets than to money. Within this context, another kind of altcoin emerges: the stablecoin. A stablecoin is a cryptocurrency that lies on a price stabilisation mechanism that matches the price with another cryptocurrency less volatile. Tanaka et al. (2019) proposes various stabilisation mechanisms, showing that non-collateralised stablecoin is the simplest approach for including digital currency in the economy.

The presence of potential alternative and competitive money cannot be neglected. Many scholars produce a theoretical model for studying the relationship between fiat money and cryptocurrencies. The pioneering work is by Fernandez-Villaverde and Sanches (2016), who examine whether currency competition is feasible. Through a model of competition among privately issued fiat currencies and government money, they find that an equilibrium exists, but it is not the only one. One equilibrium is consistent with price stability in a competitive framework of currencies. Indeed, in the other equilibrium private money tends to disappear when introducing productive capital. Therefore, academia starts to question soon whether the central bank should issue a proper digital currency and how this would impact on banking system (Raskin and Yermack, 2016).

We first see the definition of central bank digital currency (CBDC) in Bordo and Levin (2017); in their paper, they find that a CBDC could overcome all the limits of a private cryptocurrency by fulfilling all the tasks of money and by being an account-based and interest-bearing activity fostering price stability. However, this poses another question in the debate around CBDC: whether the traditional bank could be subject more frequently to bank run phenomenon if people directly have a deposit at the central bank. Andolfatto (2018) develops a model in which a CBDC reduces the probability of bank run if the central bank compels banks to increase their deposit rates. Furthermore, Brunnermeier and Niepelt (2019) show that a CBDC does not undermine financial stability if it is accompanied by certain guarantees of the intervention of

monetary authority, especially in the role of lender of last resort. In this case, the CBDC would not represent a threat to financial stability but it will allow also helicopter money operation in case of distress, going beyond the incomplete pass-through problem. Keister and Sanches (2019) obtain similar results but at the cost of crowding out deposits. Also, Brunnermeier et al. (2019) find that in an economy in which digitalisation is the core characteristic, a CBDC would allow people to have a direct account at central bank making monetary policy more effective.

Moreover, a CBDC would improve the safety and efficiency of payments. Fernandez-Villaverde et al. (2020) confirms the previous results including in the model also commercial banks. Eventually, Asimakopoulos et al. (2019) inspect the effects of monetary policy intervention when we have two alternative currencies: one of the governments and one private. Their theoretical model (a Bayesian DSGE) highlights that an increase in private crypto-assets has a negative effect on output, which indeed can be offset by the intervention of monetary policy on the nominal interest rate. Nevertheless, the greatest threat in this kind of economy is represented by a technological shock that could affect cryptocurrency production and by contagion to central bank real balance. This recent paper shows that there are still concerns about the significant risks that digital currency can pose on the whole financial system.

## 2.3   Regulations

We investigate now how regulation tries to cope with the continuous evolving of the FinTech and cryptocurreny phenomena. The first attempt to regulate cryptocurrencies occurred in the USA in 2013 with the Financial Crimes Enforcement Network trying to prevent the use of Bitcoins for buying illegal items on the dark web. In 2013 the Silkroad scandal (Cheng, 2017) hit Bitcoin causing the first deep drop in price.

One of the first interventions calling for a homogenous regulation around the world about cryptocurrencies dates back to 2013 (Plassaras, 2013). The author suggests the intervention of the International Monetary Funds as a superior guarantor of common regulation. Specifically, the author emphasises the necessity of defending the stability of exchange rates between Bitcoin and other cryptocurrencies for preventing speculative attacks. Moreover, he auspicates the creation of a new Special Drawing Rights in the form of an alternative currency to provide a new source for reserve. However, the former Chair of the IMF Christine Lagarde clarifies the role of the institution, saying that single nations should intervene to protect the stability of the financial system and the IMF should serve as a place where exchanging ideas (Lagarde, 2018).

In recent years, law institutions underline the differences and the challenges for regulation regarding the FinTech phenomenon (William, 2018). After the 2008 financial crisis, the regulation was mainly focused on preventing systemic risk by dealing with 'too big to fail' institutions. Now the situation is the opposite, the FinTech ecosystem is plenty of small start-ups that may suffer problems of disclosure, vulnerability, and eventual fire sale in case of financial distress. For this reason, the law aims at fostering clarity in regulation in order to incentivise cooperation and limiting contagion. Reducing asymmetric information and pushing towards an international common regulation is essential for managing decentralisation.

We discuss now how much integrated is regulation around the world. A survey from the US Congress (Congress, 2018) stresses the fragmentation in regulation and the different approaches to cryptocurrencies and exchanges. Due to the fast-growing

cryptocurrencies markets, another source of uncertainty is represented by the great variety of terms for describing the FinTech products. In fact, the terminology varies across jurisdictions, i.e., in Germany, they refer to crypto-token, cyber currency in Italy and Lebanon, virtual commodity in Canada, China, and Taiwan. The common approach of many countries is to issue risk-advising notes for warning the public about the risk of trading cryptocurrencies, i.e., money laundering, terrorism financing, and frauds. Hence, laws aim to facilitate banks and financial institutions to conduct all the due-diligence requirements. Some countries directly ban any activities involving cryptocurrencies (Algeria, Bolivia, Morocco, etc.) while others ban crypto-activity but not investing in them, like China and Colombia. Another important foggy-area in regulation regards initial coin offering – ICO, i.e., a way of raising funds through cryptocurrencies in place of the traditional IPO. The main difference, other than the ICO lasts less than an IPO and it does not occur in a regulated market, concerns the medium of exchange (Bogusz et al., 2020). The ICO offers tokens instead of stocks. Usually, a token allows for receiving services, units of investments, or products from the start-up financed by cryptocurrencies. Howell et al. (2020) demonstrates that ICOs boost succesfull real outcome due to disclosure and credible commitment to the project. Nevertheless, regulation sometimes bans ICO (mainly China) some other it changes concerning the kind of token (New Zeland and The Netherlands). Finally, other jurisdictions do not recognise cryptocurrencies as legal tender but are fascinated by the promising technology opportunities and they are developing a friendly FinTech regulatory regime (i.e., Spain, Cyprus, and Luxemburg). We can briefly summarise the orientation to FinTech regulation in the most important areas (ComplyAdvantage, 2020).

Concerning the USA, in 2013 the Financial Crimes Enforcement Network (FinCEN) did not recognise cryptocurrencies to be legal tender but as money transmitters and properties (to be subject to taxation). The SEC has recognised cryptocurrencies as assets in 2018 and the FinCEN drafts a guideline in 2019 for gathering and sharing information of the exchangers. The future of US regulations moves towards ensuring effective consumer protection. Also the neighbour Canada does not consider cryptocurrencies as legal tender and exchangers are legal only if registered with FinTRAC after 1 June 2020. However, crypto in Canada has been taxed since 2013 and in 2017 the Canadian Securities Administrators (CSA) assimilate cryptocurrencies (only technically) to securities to extend to them the existing regulation. Furthermore, laws about Anti Money Laundering has been reinforced with amendments in 2019.

In Asia, there is a great disparity in treating cryptocurrencies among the 'open-team' Japan, Singapore, and the 'close-team' China, India. In Japan, both cryptocurrency and exchanges are legal, even if they must be registered with the Financial Service Agency. Japan is at the forefront in terms of regulation. In 2017 the government recognises Bitcoin and other cryptos as legal currencies and makes them subject to taxation as 'miscellaneous income'. Japan further changes the definition from virtual currency to crypto-assets in 2020 to ensure better protection to customers. Singapore is closer to the US and Canada for regulation: cryptocurrencies are not legal and exchanges have to be registered with the Monetary Authority of Singapore (MAS). MAS has always had a soft approach to FinTech regulation, but from 2020 is officially in charge of regulating authority. Moreover, even if cryptocurrencies are not legal tender, they are taxed as goods subject to VAT. The most important player for the 'close-team' is China, who officially bans Bitcoin transactions in 2013 and ICO in 2017. Nevertheless, the exchange of crypto assets using foreign platforms is allowed. Future steps in regulation

are obscure, what we only know is that the People's Bank of China accelerates its effort for introducing a Digital Yuan after the Facebook announcement of issuing its own cryptocurrency Libra.

Next, in Europe, regulation is even more fragmented. Again, in the UK cryptocurrencies are not regulated and exchanges are without the need for registration with the Financial Conduct Authority (FCA). In 2019, the UK adopts the Eurpean Directive 5AMLD (Fifth Anti Money Laundering Directive). However, its future application is uncertain due to Brexit. Switzerland, the other independent European nation, recognises as legal both cryptocurrencies and exchanges. Cryptocurrencies are considered as assets in order to be subject to wealth tax. The Swiss Financial Market Supervisory Authority (FINMA) is responsible for cryptocurrencies and ICO. In 2018 the FINMA issued a set of guidelines to adapt existing regulation to FinTech. In the rest of the EU cryptocurrencies are legal but exchange regulation varies across member states. Also, cryptocurrencies taxation is different, but cryptos usually fall under capital gains tax since 2015, when the European Court of Justice exempts cryptocurrencies from VAT. In 2020, the 5AML enters into force requiring exchanges to perform know your customer and client due diligence, which would become more stringent at the of 2020 with the 6AML. Table 1 provides a brief summary of the regulatory approaches across jurisdictions.

**Table 1**   Summary of regulation across jurisdictions

| Area | Supervisor | Legal tender | Exchanges | Taxed as |
|------|-----------|--------------|-----------|----------|
| USA | SEC and FinCEN | No | Legal | Assets |
| Canda | CSA and FinTRAC | No | Legal | Assets |
| Japan | FSA | Yes | Legal | Miscellaneous income |
| Singapore | MAS | No | Legal | Assets |
| China | PBC | No | Banned | |
| UK | FCA | No | Legal | Assets |
| EU | ESMA | No | Legal | Capital gain |

Finally, we can furthermore synthesise the approach to FinTech regulation following (Omarova, 2020).

- *Experimentation:* It consists of 'regulatory sandbox'. A regulatory sandbox is a sort of safe zone in which FinTech start-ups can move with discretion in order to achieve a gain in efficiency and facilitate consumer benefit. We can think of the current situation as a global financial sand-box.

- *Incorporation:* In this phase start-ups are endowed with a special license (the chart of FinTech) for proposing innovation. This is a particular strategy that seeks to augment the overall regulatory perimeter (think about AML, cybersecurity, customer).

- *Accomodation:* We talk about RegTech. RegTech is the union between regulation and technology and it aims at providing a technological and regulatory background in order to make more efficient and effective some burdensome procedures. Automating KYC/CDD through AI may reduce costs and make processes more efficient.[9]

Despite of the first regulation proposal about a global common regulation (Plassaras, 2013), we have analysed a heterogeneous panorama. However, there are some common aspects shared by all jurisdictions that can be summarised as:

- define the legal aspect of cryptocurrencies for taxing revenues

- protect users from cyber risk, frauds and illegal uses of cryptocurrencies

- discipline the use of technology for further financial and commercial services.

In the next Subsection 2.1 we will discuss the prominent role of technology in the revolution and the disruption of the financial system as we know it.

## 3  Central banks approach

In this section, we want to understand how far is theory from reality. Namely, given the academic ideas and suggestions about incorporating digital currency in the economy through CBDC, we wonder what central banks, or private consortium, are actually doing. The Federal Reserve is about to issue his digital currency called FedCoin (Lowe, 2020). The original proposal dates back to 2017 when Gupta et al. (2017) write a detailed paper on what kind of blockchain should FedCoin exploit highlighting all the potential advantages. They strongly believe that the Fed digital currency will be a complement of cash dollar, setting the exchange 1:1, with whom shares many features. Both cash and digital currency are directly issued by the central bank representing a liability, both can regulate transactions, also small, immediately and are available h24, they both guarantee anonymity. Furthermore, the idea of FedCoin brings back the Monetarist quantitative theory of money, advocating the direct control of the velocity of money circulation thus a more effective control on inflation. Also, if the Federal Reserve issues its own digital currency, this would imply that citizens would have a deposit directly at the central bank making the Monetarist monetary policy tool of the helicopter money feasible. It is argued that the helicopter money is more effective than a quantitative easing measure since provides liquidity directly to people and not to firms through banks. Moreover, if the FedCoin would bear interest, this would also solve the zero lower bound problem, having more interests to manovrate. However, also FedCoin could have some limits. Dodev (2018) points out that FedCoin could face a domestic Mundell-Fleming trilemma[10]: the FedCoin, peg 1:1 with cash dollar, would bring the possibility of true free convertibility between central bank money and commercial deposits. Like a foreign exchange market, people could profit from arbitrage opportunity making it problematic for the Fed to maintain the parity with commercial deposits. Besides, if the economy hits the ZLB, the Federal Reserve would lose the autonomy in setting the interest rate of FedCoin since it should also control interest rate on commercial deposits for avoiding bank run making the peg almost impossible to defend. Lowe (2020) does not share these concerns, believing that the FedCoin would replace cash dollar given all its advantages.

In Europe, the European central bank after four years of joint experimentation of DLTs with the Bank of Japan (ECB and BOJ, 2020) seems ready to launch a Digital Euro. Panetta (2020) illustrates that the Digital Euro will not an alternative, but support for cash. The launch is scheduled for mid-2021 and the Digital Euro would represent a liability for the Eurosystem. Also, the Digital Euro aims to enforce the transmission

mechanism of monetary policy through a direct account at the central bank with direct remuneration. The ECB beware of the potential increase in systemic risk due to the necessity of acquiring new assets against the digital liabilities and in case of bank run. The Digital Euro and the FedCoin share the same concerns as well as the potential ability to improve due diligence procedures.

Sweden has always been at the forefront of digital payments (Bergman, 2019) and it is now testing its own digital currency called E-Krona. The project started in 2017 and it is now at its fourth phase of the pilot (Riksbank, 2020). The goal is to issue E-Krona as complement of cash for reaching the part of the population marginalised out by cash. E-Krona relies on a DLT and, according to MIT (2020) the further purpose of the Swedish digital currency is to contain the risk of terrorism financing and fluctuations of the exchange rate. Similar to the Riksbank, the central bank of Bahamas has issued its own digital currency, which is the first CBDC, called 'Sand Dollar', in order to allow people leaving in one of the 700 coral islands in the Atlantic Ocean to buy goods (Sand Dollar, 2020).

Another major central bank that is rolling out a pilot test of digital currency is China. China accelerates the issuing of a Digital Yuan after the announcement by Facebook of issuing its own stablecoin. The Popular Bank of China launches a lottery for sampling people that will participate to first experimentation phase (Jonathan, 2020). In October 2020 China has issued 10 million of Digital Yuan ($1.5 million) to 50,000 people that can spend the digital currency in 3,389 designated restaurants and stores (Kawakami and Kawate, 2020). Chinese authorities are satisfied by this important step towards digitalisation and internationalisation, however, concerns about transparency and excessive centralisation arise, even from the Bank of Japan Governor. If transactions with the Digital Yuan will go cross border, then it can undermine the leader role of the dollar. Moreover, in 2018, the People's Bank of China introduced a centralised platform (NetsUnion) for the payment system. If the pilot project will succeed, Chinese authority could technically control every transaction. Table 2 provides a summary of the main CBDC projects around the world.

**Table 2**    Summary of regulation across jurisdictions

| Area | Launch | Characterisitics | Pros | Cons |
|---|---|---|---|---|
| FedCoin | Forthcoming | Complement of cash dollar | More effective inflation control; overcome the ZLB problem | Domestic Mundell-Fleming trilemma |
| Digital Euro | Forthcoming | Complement of cash euro | Enforcing trasmission mechanism of monetary policy | Increase in systemic risk |
| Digital Yuan | October 2020 | Substitute of cash yuan | Allow for cross-boarder transactions | It could susbtitute dollar; the Popular Bank of China could potentially control all transactions |
| E-Krona | Pilot project in progress | Complement of cash | Reaching all the population; fight against terrorism financing | Not declared |

Nevertheless, a private worldwide competitor could challenge the development of CBDC: Libra. In June 2019 Facebook announces the launch of its own cryptocurrency in partnership with many giants of payment systems such as PayPal, Visa, or Mastercard. In December 2020, the Libra Association issues a new white paper (Association, 2020) in which they take into account the critiques that have been moved against the original project and changes its name in 'Diem'. The first white paper (Association, 2019) present a new stablecoin, whose value is anchored to the dollar, that would bring digital payments worldwide by reducing transaction costs and augmenting security and scalability of the network through a new consensus method called byzantine fault tolerance. Many of the big original partners exit the project after the critiques raised by regulators. In the new white paper (Association, 2020), Libra Association proudly states that the changes to the project are due to an intensive collaboration with regulators, central banks, and other financial institutions. The greatest threat of authority lies in the eventual ability of Libra of making monetary policy ineffective if adopted as a substitute for fiat money. For this purpose, the association decides to anchor Libra values to a basket of four currency: dollar, euro, UK pound, and Singapore dollar. Moreover, they design also a program for being compliant with AML and combating financing terrorism (CFT) procedures as well as for ensuring participant safe identities and solid assets reserve. Libra wants essentially to bring competition in the payment systems by allowing private institutions to develop own networks.

## 4   Conclusions

This paper aims to provide a holistic literature review about the state-of-the-art of FinTech. We discuss the main three aspects that deal with FinTech: the technological development, the economic perspective of adopting new centralised bank digital currency (CBDC) against altcoins, and, finally, the regulatory one. In Subsection 2.1 we discuss the evolutionary steps of technology and how the original disruption of the financial system is turning in inclusion of FinTech services. We present the main three blockchain platforms and all the usages, going from computing credit scores to Robo-advising. We introduce the concept of RegTech, namely the attempt to automise the due diligence procedure through smart contracts. In Subsection 2.2 we deal with the genesis of the altcoins, with the empirical analysis proposed on one side for predicting volatility and with the theoretical model for simulating economy with two concurrent currencies from the other side. Results are different whether they consider a CBCD or private digital currency. Subsection 2.3 inspects the regulatory evolution, from the very first attempts towards the current approach in FinTech regulation. We compare the different approaches across the world and we notice that regulators are interested in defining the legal nature of cryptocurrencies for including them in the taxation regime as well as a regulating technology for all its potential applications, including illicit purposes. Section 3 wants to highlights what central banks and private institutions are actually doing notice that they quite cope with academia.

What emerges from this survey is that FinTech is a very fascinating phenomenon but it is still quite unexplored. Its potentiality is still under experimentation as well as its risks that are still under investigation. Regulators mainly adopt a wait and see approach. Also, it is interesting to notice that the government digital currencies that are emerging, as well as the usage of FinTech technology, have the opposite goals of

the original Bitcoin idea. Bitcoin wants to overcome third trusted parties, while central banks are issuing their digital currencies to guarantee the value and use it as a tool for monetary policy, going beyond the peer-to-peer transactions. Bitcoin ensures anonymity in transactions, bur now blockchain technology and smart contracts are exploited for tracking movements and prevent operations of terrorism financing and AML.

Finally, we can conclude that altcoins do not represent a threat for the economic system since they are essentially speculative assets. The phenomenon to which we should pay attention is stablecoin. For example, a stablecoin like Diem, which is linked to a worldwide social network that already has data about private life and preferences could become a monopolist in all the sectors by also adding financial transactions. Moreover, even if Diem enlarges the basket of currency to which is anchored, this does not solve the problem of the inefficacy of monetary policy in the opinion of the authors and as sustained by Benigno (2019). Many countries in Africa or Lebanon or Argentina looks for dollar for using a currency with higher purchasing power, but, monetary supremacy is still guaranteed. With Diem, people could totally abandon the use of national currency posing a serious threat to economic stability and to authorities. A speech of the Governor of the Bank of Italy at Bank of International Settlment (Visco, 2021) points out that "[...] new forms of money could make it easier to engage in anti-competitive behaviour; exacerbate exclusion and inequality; foster economic volatility; facilitate criminal activity; and even undermine the effectiveness of macroeconomic policy." quoting the opening of the foreword to a book titled *The Future of Money*, published in 2002 (The Future of Money, 2002).

Besides, the evolution of FinTech sector together with its enormous consumption of energy cannot be underestimated given the increasing sensibility to green topic. Thus, the integration of private money in the economic and social system represents a serious challenge as the whole evolution of the FinTech phenomenon.

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**Notes**

1    https://coinmarketcap.com (accessed 11 August 2021).

2    https://digiconomist.net/bitcoin-energy-consumption/ (accessed 11 August 2021).

3    Open-source, all the participants can modify and improve the system.

4    Permissioned means that the participants to the network have to satisfy certain guarantees before entering the blockchain, while Bitcoin network is 'permissionless': everybody can join it.

5    Intermediate language between machine code and programming code. It serves for describing the actions of a smart contract.

6    https://digiconomist.net/bitcoin-energy-consumption/ (accessed 11 August 2021).

7    In December 2017 Bitcoin price peaked at almost $20,000 and around $63,500 in April 2021.

8    According to CoinMarketCap rank.

9    Given the relevant role of technology in the RegTech discussion, we will provide more details in Subsection 2.1.

10   In an open economy, the Mundell-Fleming trilemma states that is unfeasible to achieve free capital flow, fixed exchange rate and sovereign monetary policy simultaneously.