Blockchain, FinTechs and their relevance for international financial institutions

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Abstract

The purpose of this working paper is to provide a primer on financial technology and on Blockchain, while shading light on the impact they may have on the financial industry. FinTechs, the financial technology and innovation that competes with traditional financial methods in the delivery of financial services, has the potential to improve the reach of financial services to the broader public and facilitate the creation of a credit record, especially in the developing world. Some Blockchain applications like cryptocurrencies, could be problematic as cryptocurrencies cannot substitute traditional money due to the high risk of debasement, luck of trust and high inefficiencies relating to the high cost in electricity and human effort required to clear cryptocurrency transactions. Cryptocurrencies' high volatility renders it a poor means of payment and store of value, while resembling a fraudulent investment operation. Yet, other Blockchain applications, like Blockchain securities, could facilitate the functioning of an International Financial Institutions (IFI) due to the volume of securities they issue as Blockchain securities enable an almost instantaneous trade confirmation, affirmation, allocation and settlement and reconciliations are superfluous releasing collateral to be used for other purposes in the market. IFIs could promote awareness and understanding about Blockchain technology among different IFI services and launch Blockchain labs in order to pilot projects that can improve governance and social outcomes in the developing world. Financial inclusion, at the core of IFI's mandate, could be enhanced by investing into FinTechs who facilitate access to payment systems. IFIs could also ponder the development of Blockchain software aimed at improving transparency and efficiency in public resources that finance development projects. IFIs could promote Blockchain applications in several sectors like agricultural lending where Blockchain technology is used in the supply chain in order to improve transparency and efficiency in agricultural and commodity production. Other sectors include transport and logistics and even energy distribution. IFIs could benefit by utilizing FinTechs' knowhow in the analysis of big data in order to understand better the investment gaps and the financing needs of prospective clients. Finally, FinTechs' knowhow could be used by IFIs in order to streamline their internal processes concerning credit underwriting and risk management.

Introduction

In the past few years, words like FinTechs, TechFins, Blockchain and cryptocurrencies went from being used by only a few experts in the field to words that are used daily. The development in the financial technology infrastructure enabled by the technological breakthroughs in the last decades triggered a fast-paced and technology-driven financial environment.

Millennials, a generation born 1981–2000 and more than 84 million strong in the US alone, use technology, collaboration and entrepreneurship to create, transform and reconstruct entire industries. As consumers, their expectations are radically different than any generation before them. With millennials projected to surpass baby boomers as the world's largest generation, their demand for financial services changes, too. Traditional banks are often despised by millennials since they are considered as a source of tradition and inefficiencies. According to a recent study, the four largest banks are among the least loved brands by millennials and 71% of millennials would rather visit the dentist than their banks.[1]

Banks evolved from a closed model, where there is a close relation between customers and banks to an open one, where customer data are shared is accelerating the use of financial technologies, too. Customers provided financial institutions with a wealth of data from demographic information relating to age, residence, employer and family to financial information on personal assets, wealth, income and expenses. These data can be used in order to gain behavioural insights and propose financial products to match better client needs. The new General Data Protection Regulation (GDPR) adopted in May 2018 and the revised Payment Service Directive (PSD2) in the European Union are based on the premise that individuals own their personal data and are responsible how they are used and with whom it is shared. It is FinTechs among other third party providers that facilitate this transformation to open banking possible by creating new product prepositions to customers, using their personal data. Third party interfaces whereby customers manage their finances and switch providers via a single application may decline market share and the primary customer relationship to traditional banks.

In this paper we provide a primer on these new technologies and their implications for the financial sector. Additionally, we elaborate on possible applications for IFIs and their clients. The paper is organized as follows: It starts by describing the impact that FinTechs and TechFins can have in the financial sector. It then explains what is Blockchain and its different applications with a particular focus on Cryptocurrencies. In the following section it elaborates on the potential impact that these new technologies could have for financial inclusion. It then lists the potential risks and challenges from these new technologies. Finally, we illustrate potential applications for IFIs and their clients.

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[1] https://www.bbva.com/wp-content/uploads/2015/08/millenials.pdf

Disrupting the financial sector: FinTechs

Banks profitability is under pressure as evident in the industry's Return on Equity (ROE) which is between 8% and 10% and remains below banks' cost of equity of 10%. Moreover, banks' shares trade at low multiples with price/book ratio near historic lows for developed and emerging economies nearing 1 and masking investors' concerns over bank future profitability. Weak profitability implies a significant pressure on global banking revenue margins due to low yields, changes in customer expectations, legacy issues and rising competition. Financial technology firms or FinTechs fuel competition either as aggregators, redefining the interface between traditional banks and customers; innovators, using the existing technology platforms and bringing innovative customer relationship and sales approaches or disruptors, offering a better experience for a targeted customer group.

FinTechs refer to the firms that implement innovative technology that competes with traditional financial methods in the delivery of financial services. Using smartphones for mobile banking, investing services and cryptocurrencies are manifestations of FinTech aiming at improving the reach of financial services to the broader public. There is a sustainable upward trend in the number of FinTechs. FinTechs attracted over USD13.1bn in venture capital-backed investments in 2016, about five times more than investments four years earlier, reinforcing the belief that FinTechs will disrupt banks (Ernst & Young (2017)). An essential part of FinTechs is open banking. The latter uses open source technology in order to enable third party developers to build applications and services around financial institutions and improve financial transparency for account holders. In open banking, data is shared through Application Programming Interfaces (API) between two or more unaffiliated parties to deliver enhanced capabilities to the marketplace. APIs existed for decades (Brodsky L. and L. Oakes (2017)) but have been used for sharing information rather than transferring monetary balances. For example to connect developers to Visa and Mastercard payment networks. What is different today, though, is that APIs are used to transfer money balances. In a bid to promote the development and use of innovative online and mobile payments through open banking, the European Parliament adopted a revised Payment Services Directive (PSD2) in 2015. PSD2 and the General Data Protection regulation in the EU, Open Banking in the UK and the development of commercial banking aggregator models in the US are giving more control to customers over their data.

The adoption rate of FinTech services varies significantly across 20 markets ranging from a share of FinTech users of 13% of the digitally active population in Belgium and Luxembourg to 69% in China and 52% in India (Figure 1). With 50% of the population having used at least one FinTech service in the **money transfers and payments** (online foreign exchange; pay via cryptocurrency; overseas remittances; non-banks to transfer money; mobile phone payment at checkout; online digital only banks without branches) category, it is the most popular category among FinTech users (Ernst & Young (2017)). **Insurance** (car insurance using telematics; insurance premium comparison sites and activity based health insurance) is the second most popular with 24% of the FinTech users having used a FinTech service. **Savings and investments** (Peer-to-peer platforms for high-interest investments; Investments in equity crowdfunding platforms; and rewards crowdfunding platforms; Online investment advice and investment; management; Online stockbroking and Spreadbetting) follow with 20%; **borrowing** (Borrowing using peer to peer platforms and borrowing using on-line short-term loan providers) with 10% and **financial planning** (Online budgeting and financial planning tools) with 10%.

Figure 1
Share of FinTech users in the digitally active population
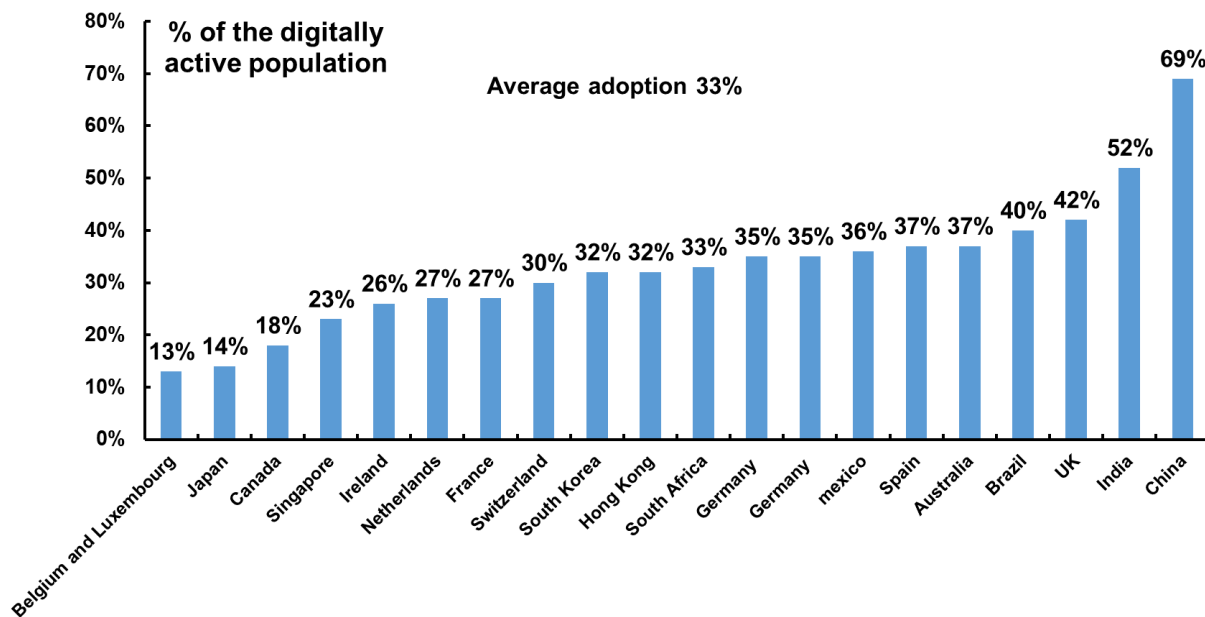

Source: Ernst & Young

A decade ago, sending money via international wire transfers included paying transfer and foreign exchange fees, while funds' recipients were receiving the funds in their account a week later. Bills were paid by handing cash or writing physical checks that required three to five working days to clear. Today, transactions are handled fast with services like TransferWise, that charge a fee 78% lower than incumbents and shorten the time from the time a money is sent to the time is received. Apps like Venmo or Apple Pay Cash replaced the need to write physical checks to friends to cover a dinner bill, while paychecks are automatically deposited into accounts and funds are available on the same day.

Historically, banks originated and held loans in their balance sheet until maturity. This originate-to-hold banking business model has been replaced by the originate-to-distribute model where banks distribute the loans they originate. The rise in collateralized loan obligations before the great financial crisis, for example, fueled the demand for corporate loans and motivated banks to distribute larger portions of the loans they originated. Securitization of mortgages is another example of originate-to-distribute model whereby banks securitize mortgages in order to improve the banks' liquidity. With this model banks limited the growth of their balance sheets but maintained an important role in the origination of loans and contributed to the role of nonbank financial intermediaries.

Of the two legs in the originate-to-distribute model, distribution does not require regulatory capital. According to McKinsey (McKinsey (2017)), distribution contributes 65% to banks' total after tax profits versus 35% from origination, while the return on equity related to distribution equals 20% compared to 4.4% for origination. Distribution's larger profitability potential and low regulatory capital requirement make it the prime focus for non-bank digital attackers like FinTechs. Advanced analytics, machine learning and the drop in the computing cost from USD 100 per gigaflop in 2003 to USD 0.08 in 2016 have helped the digitalization drive. APIs, currently at the forefront of the revised PSD2 have helped to create new digital services and broaden the scope of digitalization.

Retail banking business was the first to be explored by FinTechs as the latter attempted to build banking products like toys in order to remove the negative utility that customers experience when applying, for example, for a mortgage. With their simplicity and more user friendly interfaces of their digital banking applications, FinTechs managed to increase digital usage and the time a client spends in a digital banking platform. By increasing interaction with a client the likelihood of selling more products to a client increases, resulting into higher revenues. Indeed, higher digital usage correlates highly positively with customer's loyalty measured by the net promoter score (Figure 2).[2] Customers who become promoters of a bank's product stay longer with their bank, while more products cost less to serve and recommend the bank to other people.

Figure 2
Net promoter score given by US mass affluent/affluent customers

Net promoter score given by US mass affluent/affluent customers
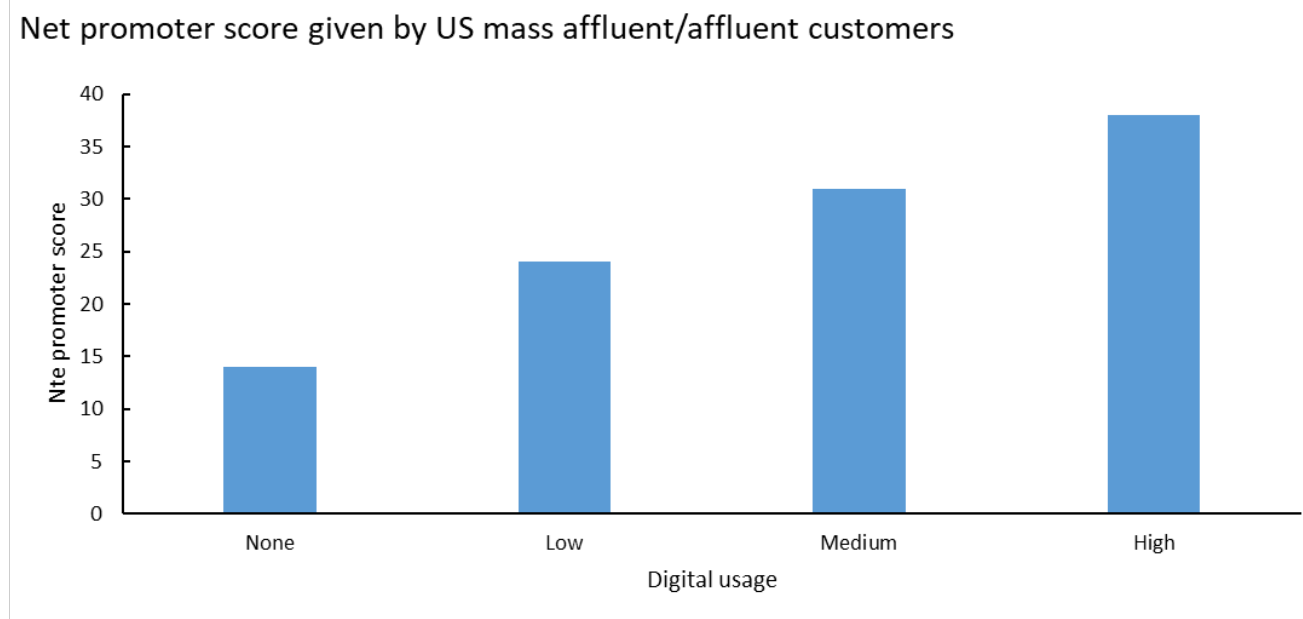
Source: Bain Research Now (2013)

Due to FinTechs, brand awareness for banks among customers erodes as banks lose physical access to customers since clients do not have to visit physically a bank branch for a banking service, while clients choose different banking services from different banking service providers instead of opting for a single bank for all banking needs. Unbundling and disintermediation caused by FinTechs, accelerated the erosion in customer loyalty to financial institutions that started in the 1990s with the advent of monolines. The latter specialized in only one industry, product or service, such as credit card issuance, mortgages or whole life insurance. FinTechs have accelerated the erosion in customer loyalty. Also, online comparison of banking products, for example mortgage interest rates, has resulted into a commoditization where banks cannot differentiate from the competition, further obscuring bank brand awareness among clients.

FinTechs do not have a large power to topple banks as most FinTechs are small startups that are concentrating on peer-to-peer lending (P2P) lending and crowdfunding, areas not covered by banks. Also, banks hold long relationships with their clients that FinTechs are difficult to achieve overnight.

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[2] The score ranges from -100 to 100 and proxies the willingness of customers to recommend a company's product or service to others.

Moreover, safety of data is more guaranteed and the cybersecurity risk is smaller for banks than small FinTechs. It is mostly banks' retail business affected by FinTechs as this is where more synergies with FinTechs could be realized (P2P and crowdfunding for project financing already in use). Banks' corporate business is less affected given that it still requires a physical interaction and a close client relationship, while a more demanding due diligence is needed.

Financial services' value chain includes three key elements (Oliver Wyman (2016)), namely:

The back office, responsible for record keeping; policy administration; collections; claims processing; and transaction processing

The financial product provision, which includes the approval decision; product design; capital, balance sheet and risk taking; risk management and payment services

The customer platform, which incorporates marketing; advisory; product range management; onboarding and AML checks and research

Banks are already using the same digital technology that FinTechs are using in industrializing their back office. Industrializing banking operations by automating repeatable tasks and using Artificial Intelligence (AI) in order to improve efficiency, security, accuracy and release resources for other more value added activities. HSBC, for example, is using IBM's AI technology to process documents related to the processing international trade transactions. An average trade transaction requires 65 data fields to be extracted from 15 different documents, with 40 pages to be reviewed. Using IMB's optical character recognition and robotics technology, HSBC's Global Trade and Receivables Finance is automating the review of documents and sending them automatically to the bank's transaction processing systems. The Royal Bank of Scotland is also working with IBM in piloting a robot that will answer customer questions and pass requests on to the right agents, while Sweden's SEB bank became the first bank to use IPsoft's cognitive technology for customer services.

By leveraging Blockchain technology, correspondent banking changes, too. JP Morgan, Royal Bank of Canada and Australia and New Zealand Banking Group Limited, announced the launch of the Interbank Information Network (IIN). The new initiative will use Blockchain technology to minimize friction in the global payments process. IIN will allow payments to reach beneficiaries faster with fewer steps and better security, while reducing the number of participants currently needed to respond to compliance and other data-related inquiries that delay payments. The IIN platform is built on top of JP Morgan's private Quorom Blockchain and allows JPMorgan to exchange information with other banks to address compliance issues in certain cross-border payments.

Moreover financial institutions integrate FinTechs by outsourcing to them part of their activities in the financial value chain. For example, significant compliance costs due to emerging regulation (derivative post-trade and collateral management – EMIR, MiFID II and Dodd-Frank) are forcing asset managers to outsource significant portions of their middle office. Most parts of their back office activities, like custody and fund administration, has traditionally been outsourced by asset managers to providers based on specific needs.

Instead of competing with FinTechs, banks have opted to incorporate FinTechs in the various phases in the banking value creation chain in a setting where financial services are turning modular. Modular financial services refer to the move from a large one-stop shop to a variety of firms competing at

different points in the value chain. Customers buy financial services through distribution platforms separate from product providers where many more firms are supplying services, while providers themselves buy services from a range of specialists rather than operating all their activities in-house. Banks acquired directly or indirectly FinTechs by organizing venture capital funding for them; offering incubator services to FinTech startups entering the beginning stages of building their company and offering accelerator services to existing FinTech companies with an idea and business model in place advancing their growth and acquiring FinTechs via Mergers and Acquisitions. Banks' emphasis is more on cooperating with FinTechs rather than competing with them. A good example is BNP Paribas who has not only purchased 95% of so-called 'new bank' Compte Nickel but has also launched an investment fund to invest indirectly in FinTech firms via venture capital funds.

FinTechs enabled traditional banking activities rather than topping traditional banks, but platforms disrupt traditional banks. Platforms bridge the value chains of different industries in order to improve customers' convenience and experience, increase clients' appetite for more services and reduce operation cost. Amazon, for example, is an electronic commerce and cloud computing company that started as an online bookstore and later diversified into SME lending and factoring among others. Similarly, Alibaba is a large conglomerate that offers e-commerce, retail, Internet, AI and technology services. It also provides consumer-to-consumer, business-to-consumer and business-to-business sales services via web portals, as well as electronic payment services, shopping search engines and cloud computing services. Offering a superior customer experience after analyzing customer behaviors from past transactions, platforms challenge banks by keeping the client in the platform for longer and increasing the probability of cross-selling products among which banking products. Amazon has spent USD22.6bn on research and investment in 2017 twice the amount spent by Apple and Microsoft combined. The amount compares to JP Morgan's technology spending of close to USD 10bn signaling that platforms have the capacity to maintain the technological edge over banks and remain a threat to traditional banks.

Banks need to address the digital threat represented by platforms and mitigate the digital disruption that they represent. If banks do not adjust their business model to the digital disruption, they will risk their return on equity to drop to 5.2% by 2025. If they do adjust, they will manage to sustain their return on equity and marginally improve it to 9.3% (Figure 3). Banks will manage to survive the

Figure 3
Global banking return on equity

Global banking return on equity
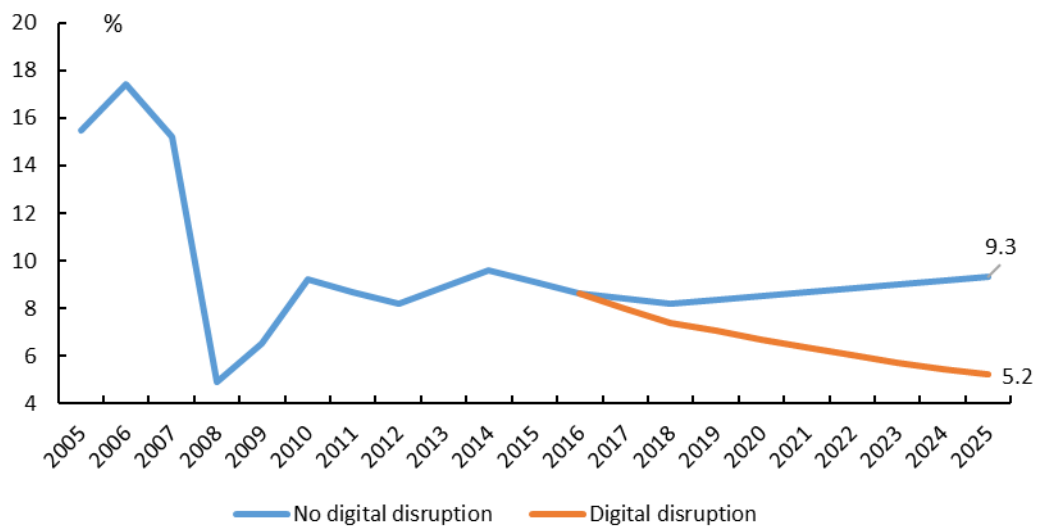
Source: McKinsey & Company

digital disruption as long as customers trust them, banks monetize the gold mine of data they sit on and capitalize on the regulatory experience banks have and is essential when operating in the financial industry. In order to survive the digital competitions, banks have already utilizing the same technology their digital foes are using like cloud computing, open APIs and shared digital techs. Cloud computing accelerates the time-to-market of new products while it reduces the IT cost and burden.

APIs are getaways to a server that includes anything a company or bank wants to share. An API calls the shared server and redeem the data asked. Data may include transaction data on clients, pieces of code, software or services that a bank owns and sees value in sharing. APIs power applications benefiting the clients by allowing flexibility to access multiple apps seamlessly between devices, use social profiles to interact with third-party apps and more. For example, PayStats API offered by BBVA, offers anonymized and aggregated statistical data from millions of transactions performed with BBVA cards and any other cards in BBVA POS terminals, creating a virtual map comprised of consumers' habits, demographics and origins. With this information, updated on a weekly basis, a BBVA client purchasing the API is able to gain knowledge and value for its business. A sandbox dataset is available, with mock data, to test freely the API capabilities. APIs is the vehicle by which banks share their customer data in anticipation of the PSD2.

As an increasing number of tasks and operations of daily life move online, digital ecosystems controlled by large global technology firms, the so called "Big tech" firms such as: Alphabet , Facebook, Apple and Ant Financial Services Group, are expanding rapidly. Provision of retail financial services in these non-bank ecosystems is well underway mostly in Asia and in other emerging markets elsewhere, affecting incumbent banks, insurers, asset managers and brokers.

Big tech firms are formidable competitors in retail financial services given their large user bases, delivery of seamless user experience, long-term focus and significant capital resources. Further

expanding into financial services would align with strategies to increase the scope and appeal of their digital platforms. By increasing user engagement, it would also enable these firms to capture valuable data and boost revenues. In several surveys (such as the one performed by EBA in July 2018), retail banks are increasingly mentioning this firms as their bigger competitors not in the distant future but already in the short term.

On the ongoing debate it is important to distinguish between the so called FinTechs and TechFins. Loosely speaking, TechFins refer to companies handling, managing and processing the increasingly available amount of information for business decisions be it related with marketing or financial markets. The more commonly used name for this new field is "Big data". Most records and observations are now captured electronically by devices connected to the internet. This, in principle, allows businesses to access a broad range of relevant data in real time. This ranges from online purchases of items that can be used to assess macro variables like inflation or GDP growth but also more micro variables like the number of customers visiting a given store and credit card transactions that can give real time sales estimates. Also, satellite imaging can assess agricultural yields or activity of oil rigs. Finally, the combination of this data can now be used to forecast future trends, ranging from economic growth to consumption (allowing for directed marketing campaigns) and even to credit risk.

Tracking the global capacity of analog and digital technologies from 1986 to 2007 (with update to 2014) the world's technological capacity to store information has increased from 2.6 exabytes to 4.6 zettabytes (1 zettabyte = 10^{21} bytes = 1000 exabytes) between 1980 and 2014 (Figure 4). The world's technological per-capita capacity to store information has roughly doubled every 40 months since the 1980s. Moreover, the availability of cheap and numerous information-sensing Internet of things devices such as mobile devices, aerial (remote sensing), software logs, cameras, microphones, radio-frequency identification (RFID) readers and wireless sensor networks has facilitated the creation of big data.

Figure 4
World capacity to store information

World's technological capacity to store information
(in optimally compressed bytes)
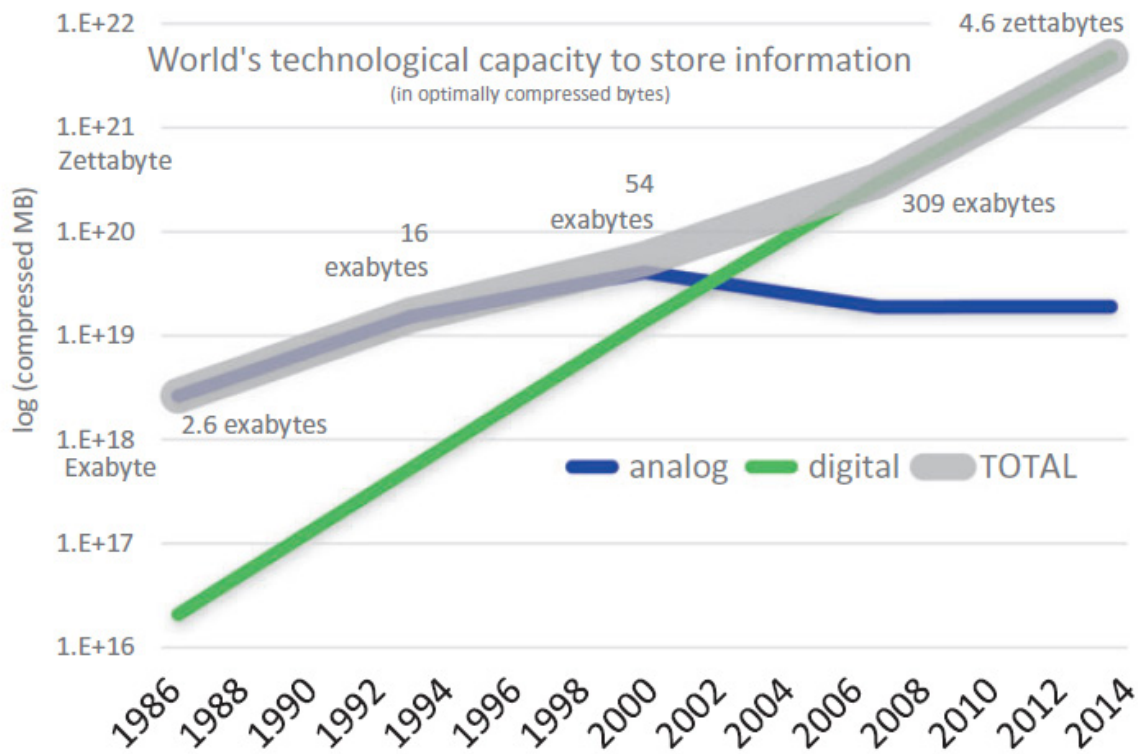
Source: Hilbert Martin (2017)

With terabytes of data and continuous editing of content from user, Wikipedia the well-known online encyclopedia, provides a case of big data management. The chromogram in Figure 5 illustrates the editing activity of the robot Pearle, administrator in Wikipedia, the well-known online encyclopedia over a given period. The aim is to investigate the time allocation and editing patterns of participants in peer production. The chromogram displays very long textual sequences through a simple color-coding scheme that describe a set of characteristic editing patterns.

Figure 5
Big data management example: Wikipedia
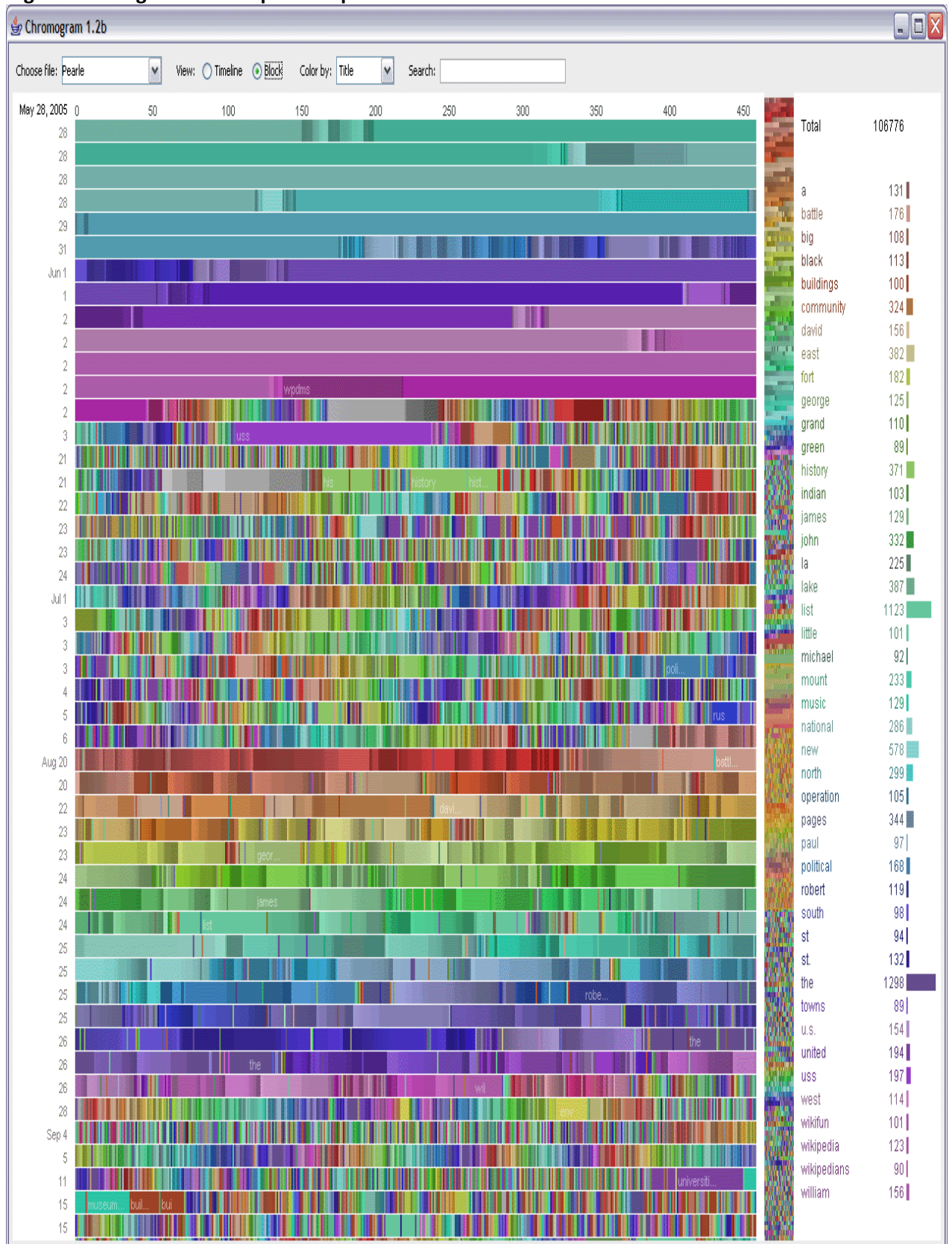
Source: Visualization of all editing activity by user "Pearle" on Wikipedia (Pearle is a robot). To find out more about this project, see "Visualizing Activity on Wikipedia with Chromograms". Proceedings of INTERACT. 2007

Having big sets of data is not entirely new. However, in the past data were only available at low frequency (on a monthly, quarterly or even yearly basis). Given the amount of data that is now available, in theory it is possible to have near real time macro or sector/company specific data not available from traditional data sources. In practice, useful data are not readily available and one needs to purchase, organize and analyze alternative datasets in order to extract usable signals.

There are two main components in Big Data: acquiring the data, and using the appropriate and methods to analyze it. Big datasets are usually larger in volume, frequency and variability as compared to traditional datasets. Alternative datasets include data generated by individuals (social media posts, product reviews, search trends, etc.), data generated by business processes (company exhaust data, commercial transaction, credit card data, etc.) and data generated by sensors (satellite image data, foot and car traffic, ship locations, etc.). In most cases these datasets need a level of analysis before they can be used. Methods to analyze big and alternative datasets include traditional statistics, and therefore are not new, but also include methods more flexible and adaptive: the so-called Machine Learning - that (loosely) consists in allow for a progressive improvement of analysis and forecasting without being explicitly programmed.

There are important pros and cons that come with the big data. On the positive side, big data can make banking services more useful and viable to a population that cannot access it, while banks can monetize the gold mine of data they are sitting on. Consider the way a company like Netflix mines its consumer data and gets to the consumers. By observing the series and films a Netflix viewer is watching, Netflix algorithms recognize viewing patterns that enable Netflix to get to know its clients very well. In doing so, Netflix creates unique films and series that it knows beforehand that its viewers will consume instead of providing content with the hope that it will be consumed. This virtuous cycle of observation, pattern recognition and personalized recommendations, helps Netflix to create value. Banks do the same. By collecting data on client behaviour, locations and purchasing patterns using Internet of Things ecosystems, financial institutions could be able to send clients tailored investment offerings. This could prove to be a less intrusive and more 'socially responsible' method to investing and would help make automated portfolio management a reality. Geolocation of a customer's assets is already used by banks in order to enable banks to pinpoint the likelihood of a fraudulent event. For example, HSBC has collaborated with SAS Fraud Management to harness Big Data and internet of things and detect fraudulent behaviour in ATM transactions. Big data analysis allows financial organizations to discover compliance anomalies and risks like incorrect transaction data before they turn into wider business issues.

Big data disadvantages include technical and non-technical factors. On the technical side, big data are not necessarily representative of the whole population (Mayer-Schönberger and Cukier (2013)) as not all members of the population use social media or any other internet-based sources of big data. Also, big data often contain few variables, while extracting any meaningful value requires linkage to other data which may not be available for all the big data observation points (Groves (2006)). The likelihood of finding a statistical model with a significant in sample fit increases significantly with a large date set, but its out of sample performance may be questionable. Moreover, the estimated coefficients of any statistical model using big data are subject to the assumption that the consumer preferences that applied when the data were collected are still valid which may not be the case at the time of the estimation. On the non-technical side, a key issue with big data is the protection of integrity,

confidentiality and privacy of data. Bake data make ultrasensitive personal financial information far more distributed, and therefore easier to steal.

Blockchain

Traditional databases have been used as central data repositories in order to store transaction data. Contracts, transactions and their records are the core of our political economy. Blockchain implements the so-called Distributed Ledger Technology (DLT) – as opposed to a Centralised Ledger Techonology - referring to the protocols and supporting infrastructure that enable computers in different locations to propose and validate transactions and update records simultaneously across a network (Figure 1). Supermarket chains, for example, with branches across a given country or several countries need to maintain consistency across the different copies of the ledger. A master copy of the ledger is updated timely and shared with all the network participants. In contrast, DLT enables copies of the ledger to be shared across multiple locations (Goldman Sachs (2016)) and in a decentralized manner without requiring a trusted central authority (Figure 6). The information contained in each transaction included in Blockchain consists a block of transaction details like the seller, the buyer, the price, the contract terms and other relevant details. Subsequently, each copy of the database saved in different locations, called node, validates the transaction. The validation performed by the entire network of nodes is consensus-based and done via encryption by pairing the common transaction details with the unique signature of two or more transaction parties. A transaction is valid only if the end-result of the encoding performed by each node is identical across nodes. Once a transaction is validated, it is added to the chain of prior transactions that have been previously validated resulting into a chain of blocks called Blockchain. The only person who can amend a block is the one who owns it via a private key that they have. When there are changes to an individual block, the entire Blockchain is updated and synced in real time.

Figure 6
Distributed ledger system
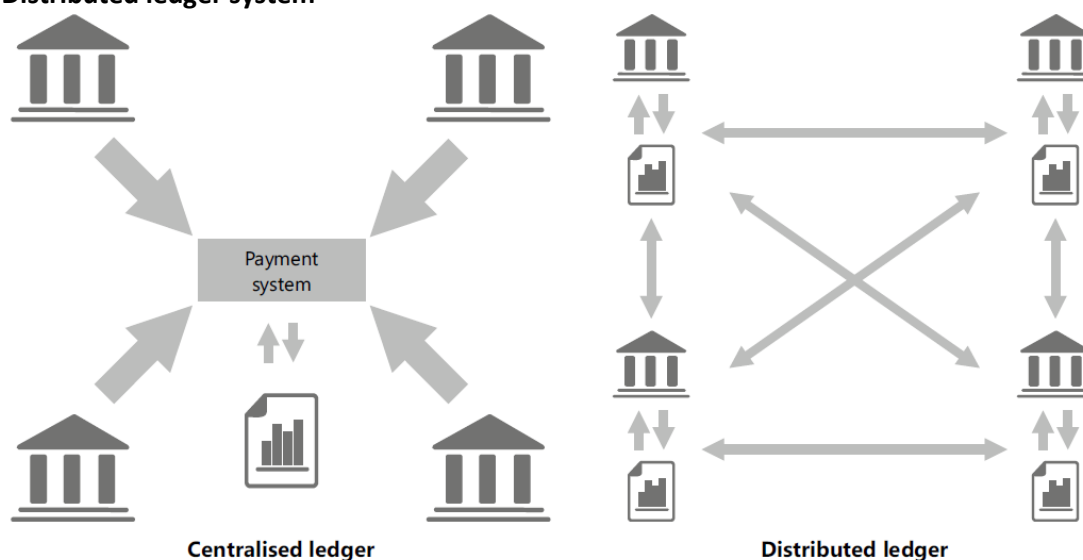
Source: Santander InnoVentures (2015)

Blockchain technology is based on the following five principles (Lansiti and Lakhani (2017)):

Distributed database: Each party on a Blockchain has access to the entire database and its complete history. No single party controls the data or the information. Every party can verify the records of its transaction partners directly, without an intermediary.

Peer-to-peer transmission: communication occurs directly between peers instead of through a central node

Transparency with pseudonimity: Every transaction and its associated value are visible to anyone with access to the system. Each node, or user, on a Blockchain has a unique 30-plus-character alphanumeric address that identifies it. Users can choose to remain anonymous or provide proof of their identity to others. Transactions occur between Blockchain addresses.

Irreversibility of records: Once a transaction is entered in the database and the accounts are updated, the records cannot be altered, because they are linked to every transaction record that came before them (hence the term "chain"). Various computational algorithms and approaches are deployed to ensure that the recording on the database is permanent, chronologically ordered, and available to all others on the network.

Computational logic: The digital nature of the ledger means that Blockchain transactions can be tied to computational logic and in essence programmed. So users can set up algorithms and rules that automatically trigger transactions between nodes.

Blokchain is a self-auditing ecosystem of a digital value as it reconciles every transaction that happens in short time intervals. Information in Blockchain is not stored in a single location, implying that the records it keeps are public and verifiable. There is not a centralized version of this information for a hacker to corrupt, while it is hosted by many computers simultaneously. The computer resources of most blockchains are significant, because it is not just one computer but many. For example, the Bitcoin Blockchain harnesses anywhere between 10 and 100 times as much computing power compared to all of Googles's serving farms put together.

Potential uses of Blockchain technology include:[3]

Smart contracts: Distributed ledgers enable the coding of simple contracts that will execute when specified conditions are met;

The sharing economy: Blockchain can enhance the sharing economy manifested by Uber and AirBnB without intermediaries. For example, call a transportation car without Uber's intermediation;

Crowdfunding: Blockchain is aiding in creating crowd sourced venture capital funds;

Governance: Blockchain could enhance transparency in elections by making the results fully transparent and publicly accessible;

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[3] https://blockgeeks.com/guides/what-is-blockchain-technology/

Supply chain auditing: Consumers increasingly want to know that the ethical claims companies make about their products are real. Blockchain could help consumers to verify that the background story of each product is real though the timestamping of a date and location;

File storage: Spreading data throughout the network protects files from being hacked or lost;

Protection of intellectual property: Blockchain eliminates the risk of file copying and redistribution of creative works online by enabling smart contracts that protect copyright;

Internet of Things: Blockchain-enhanced smart contracts make the automation of remote systems management possible enabling data exchanges between object and mechanisms;

Neighbourhood Microgrids: Blockchain technology enables the buying and selling of the renewable energy generated by neighborhood microgrids;

Identity management: Distributed ledgers offer enhanced methods for proving who you are, along with the possibility to digitize personal documents. Having a secure identity will also be important for online interactions — for instance, in the sharing economy;

AML and KYC: Regulation is requiring financial institutions to perform a labour intensive multi-step process for each new customer along the lines of Anti-Money Laundering (AML) that could had been more cost effective and less laborious under Blockchain. Similarly Knowing your customer (KYC) costs could be reduced through cross-institution client verification, and at the same time increase monitoring and analysis effectiveness;

Data management: Credit growth in several developing countries is impeded by the lack of a credit record. Performing transactions supported by Blockchain establishes a credit record and could facilitate financial inclusion;

Land title registration: Property titles are prone to fraud in several developing countries, while several lack a land registry, deterring foreign investment. As a distributed ledger technology, Blockchain enhances credibility in land title registration, and

Stock trading: Stock transactions executed peer-to-peer do not require a central clearinghouse to settle a transactions resulting into a more efficient and faster execution of asset transactions.

Blockchain applications

Crypto currencies

Bitcoin pioneered the Blockchain technology in 2009. Bitcoin is a completely digital money payment system in a consensus network. There is not a central authority or middlemen as it is a peer-to-peer payment network powered by its users. Bitcoin is the first implementation of the cryptocurrency concept or money that uses cryptography to control its creation and transactions rather than a central authority. Other cryptocurrencies exist as well, but Bitcoin is the strongest cryptocurrency in terms of market capitalization and share in transactions. Bitcoin's share in the transactions materialized in 2016 stood at 84% followed by the Ethereum with 14% of transactions. More than 40% of the total cryptocurrency market capitalization is dominated by Bitcoin, with other cryptocurrencies are either clones of bitcoin and other cryptocurrencies or have different parameterization with regards to block time, supply and issuance scheme and show little to no innovation.

Bitcoin is nothing more than a mobile app or a computer software that provides a Bitcoin wallet and allows a user to make and receive payments in Bitcoins from others in the same Bitcoin network. The latter shares a public ledger that includes all the transactions, digitally signed and verifiable, enabling users to have full control over sending bitcoins from their own Bitcoin addresses. The common public ledger is maintained by the Blockchain technology. All is needed is a wallet application,[4] either on a computer or a smartphone, where the recipient's address and the payment amount are entered, without having a merchant account. One acquires Bitcoins as a payment for goods or services; Bitcoin exchanges where Bitcoins are bought in exchange for other currencies; exchange Bitcoins with someone nearby or earn bitcoins as a payment for the creation of new Bitcoins. Bitcoins can be used in the same way credit cards and online banking networks are used to pay online and in physical stores just like any other form of money and it can be exchanged in physical form such as the Denarium coins.[5]

Bitcoin's advantages include:[6]

Payment freedom: able to send and receive bitcoins anywhere in the world at any time, irrespective of bank holidays.

Fee choice: there is not a fee to receive Bitcoins, while most wallets let you control how large a fee to pay when spending. In general, transactions fees are substantially lower than fees charged by traditional payment network operators, and fees are not based on the amount transferred, but generally on the transaction size measured in bytes. This means that a multi-million dollar transaction can be processed for the same fee as a single dollar.

Fewer risks for merchants: merchants can expand to new markets where credit cards are not available and fraud rates are high, while they are protected from losses due to fraud as Bitcoin transactions are secure and do not contain customers' sensitive information.

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[4] A digital wallet refers to an electronic device that allows an individual to make electronic transactions, purchase items online with a computer or using a smartphone to purchase something in store and store driver's license, health card, loyalty cards, boarding passes and other identification documents.
[5] https://denarium.com/
[6] https://bitcoin.org/en/faq#what-is-bitcoin

Security and control: As they are based in Blockchain, Bitcoins are very diffilcult to hack. Users are in control of their transactions, with merchants unable to force unwanted or unnoticed charges as can happen with other payment methods.

Transparent and neutral: Bitcoin is neutral, transparent and predictable as all the information regarding the Bitcoin money supply is publicly available, usable and verifiable in real time on the Blockchain.

The combined Bitcoin market capitalization or the market price multiplied by the number of existing currency units has increased more than nine-times to USD 275bn in April 2018 from USD 28bn in April 2017. There has been a large drop in the market capitalization since the beginning of 2018 when several Japan-based cryptocurrency exchanges lost USD 530mn of virtual coins to hackers in one of the biggest ever thefts of digital money. Trading volumes by national currencies reveals that there are significant variations among the most widely supported currencies (Figure 7).

Figure 7

Bitcoin exchange trading volume share by national currency


Source: https://data.bitcoinity.org/
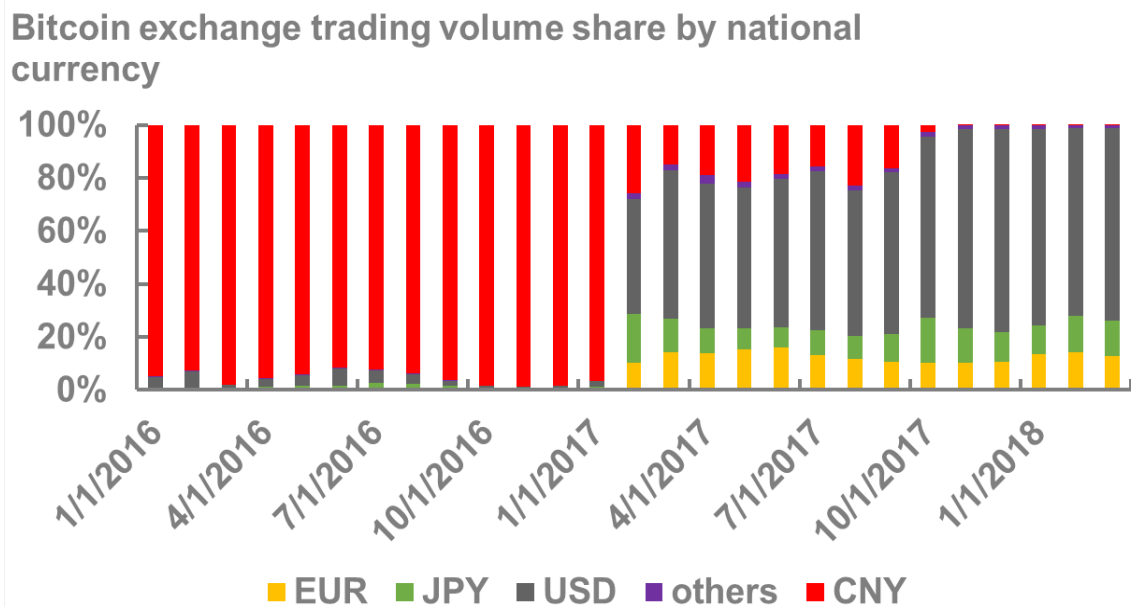
The US dollar (USD) is the most widely supported national currency, followed by the Euro (EUR). While reported trading in the Chinese Renminbi (CNY) appeared to represent an often significant majority of global bitcoin trading volumes before 2017 ranging from 50% to 90%, it plummeted in early 2017 after the tightening of regulation by the People's Bank of China. Yet, the combined market value of all cryptocurrencies is less than half of Facebook's equity and 1/25th the market value of gold signaling the still weak cryptocurrency penetration in the population. According to the International Telecommunication Union, about 50% of the world population is using internet currently, while the number of Blockchain wallet users is not higher than 0.5% of the world population. In terms of user penetration, Bitcoin is where internet was in 1994 (Figure 8). Just as email enabled bilateral electronic messaging, bitcoin enables bilateral electronic financial transactions, while the development and maintenance of Blockchain is open, distributed and share like the internet. The mix of few users ready to use cryptocurrency, the lack of trust in cryptocurrency and Blockchains from a security perspective

and the lack of underlying infrastructure for the construction of decentralized applications, make many cryptocurrency projects to suffer for the same reasons online retailers in 1994 failed. That is because they were launched before there was sufficient user adoption and infrastructure to support their success.

Bitcoin's price is determined by supply and demand factors. Given that new Bitcoins are created at a predictable and declining rate, demand for Bitcoins has to change at the same pace in order to keep Bitcoin prices stable. Given that the size of the Bitcoin market is relatively small, it does not take significant amounts of money to move Bitcoin prices up or down, resulting into market volatility. Volatility has increased significantly after the January 2018 of the Bitcoin exchanges in Japan signaling uncertainty by market participants over the regulatory framework governing Bitcoin exchanges and its potential impact to Bitcoin demand.

Figure 8
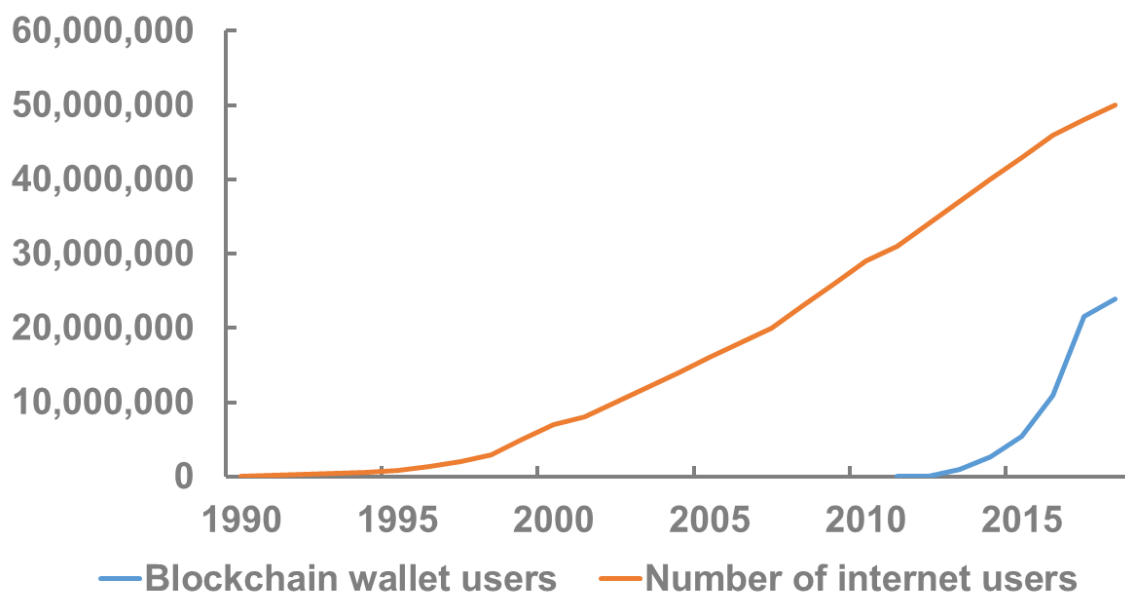
Source: https://blockchain.info/en/charts/my-wallet-n-users?timespan=all and International Telecommunication Union

Cryptocurrencies versus central bank-issued money

According to Sir John Hicks, "money is what money does" (Hicks (1979)). It is a unit of account, store of value and means of payments. Money is a special version of an IOU as everyone trusts that it will be accepted by others in exchange for goods and services. According to the BIS (Bech and Garratt (2017)), the supply side of money has four properties:

**Issuer:** it can be the central bank or other

Form: money can be physical or electronic

Accessibility: it refers to the ability of money and can be limited or wide

Transfer mechanism: transactions may occur either directly between the payer and the payee in a peer-to-peer manner without a central intermediary or with a central intermediary

The various types of money can be characterized according to the four properties resulting into the taxonomy of money illustrated by the money flower chart (Figure 9). For example cash, is issued by the central bank, it is not electronic, it is available to everyone and it is peer-to-peer. Bank deposits are not the liability of the central bank but the commercial bank that holds them, it can be electronic, it is available to most people (with the exception of capital controls) and it is not peer-to-peer as it requires the involvement of at least the depositor's bank. Bitcoin is not issued by the central bank, it is widely accessible, it is electronic and it is used into peer-to-peer transactions.

Figure 9
The money flower
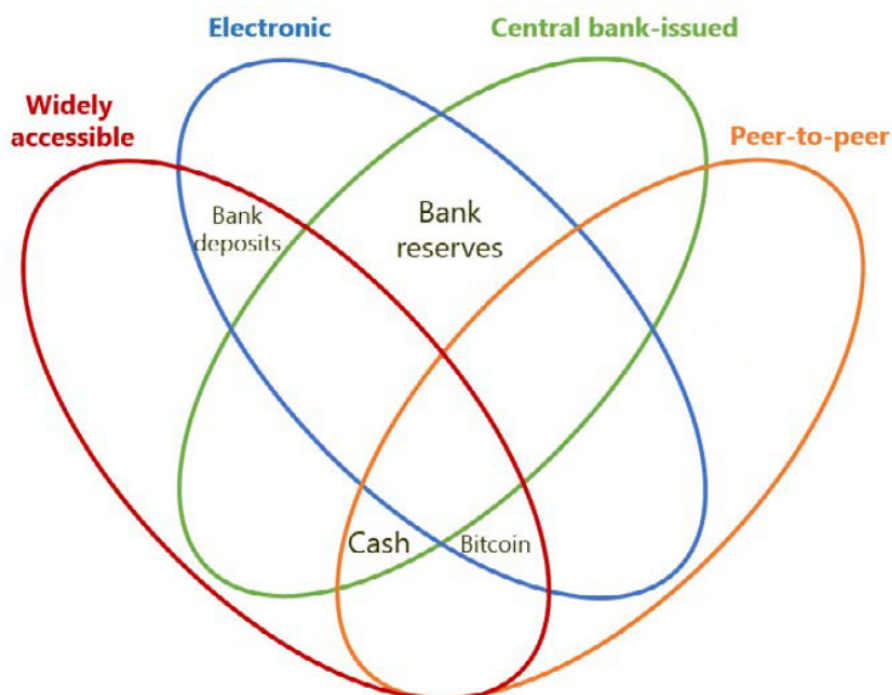
Source: Bank for International Settlements

Differences between crypto and fiat currencies include:

Decentralization: No single institution controls the bitcoin network. It is maintained by a group of volunteer coders and run by an open network of dedicated computers spread across the world. As such it attracts individuals and groups that are uncomfortable with the control exercised by banks and government institutions transaction controls;

Limited supply: fiat currencies like dollars, euros and yens are available in unlimited supplies as central banks can issue as many as they want, while new Bitcoins are created at a diminishing rate until a maximum of 21mn has been reached;

Pseudonymity: absent a central validator of a transaction, users do not have to identify themselves when sending or receiving Bitcoin payments. In electronic money payments and for reasons of anti-money laundering and other legislation, though, senders of electronic money payments have to be identified;

Immutability: Bitcoin transactions cannot be reversed in contrast to fiat transactions. An hour after a Bitcoin transactions recorded on the network, it cannot be modified, and

Divisibility: Bitcoin enables micro-transactions otherwise impossible with the traditional electronic money as its smallest unit is called satoshi and equals one hundred millionth of a bitcoin.

Despite the fact that Bitcoin shares the four properties in the money taxonomy with traditional money, Bitcoin and other types of cryptocurrency cannot substitute traditional money due to the following three flaws (Carstens (2018)):

Debasement: debasement lowers the intrinsic value of the coinage so that more coins can be made with the same quantity of precious metal so that the intrinsic value of coins does not eventually rise above their face value. Inflation rises after a currency debasement, resulting into a loss of purchasing power. Bitcoin is prone to debasement as developers clone Bitcoin's software and release it with a new name after possibly adding a few new features or tinkering with the algorithms' parameters. These spin-offs are called Bitcoin forks and can dilute the value of existing Bitcoins to the extent such cryptocurrencies do not have any economic value at all. Last year alone, 19 Bitcoin forks came out, including Bitcoin Cash, Bitcoin Gold and Bitcoin Diamond. In contrast, the purchasing power of the central bank issued currency is stabilized by the central bank that issues it by amending its supply.

Trust: The key to a stable currency is trust and trust "takes years to build, seconds to break and forever to repair". Unlike consumer or durable goods, central bank issued money does not have any consumption or utility value. The value of a currency, then, relies on the central bank that issues it, while the credit quality and integrity of a central bank is reflected in the value of its currency.

Figure 10

### Bitcoin price volatility (90-day rolling)
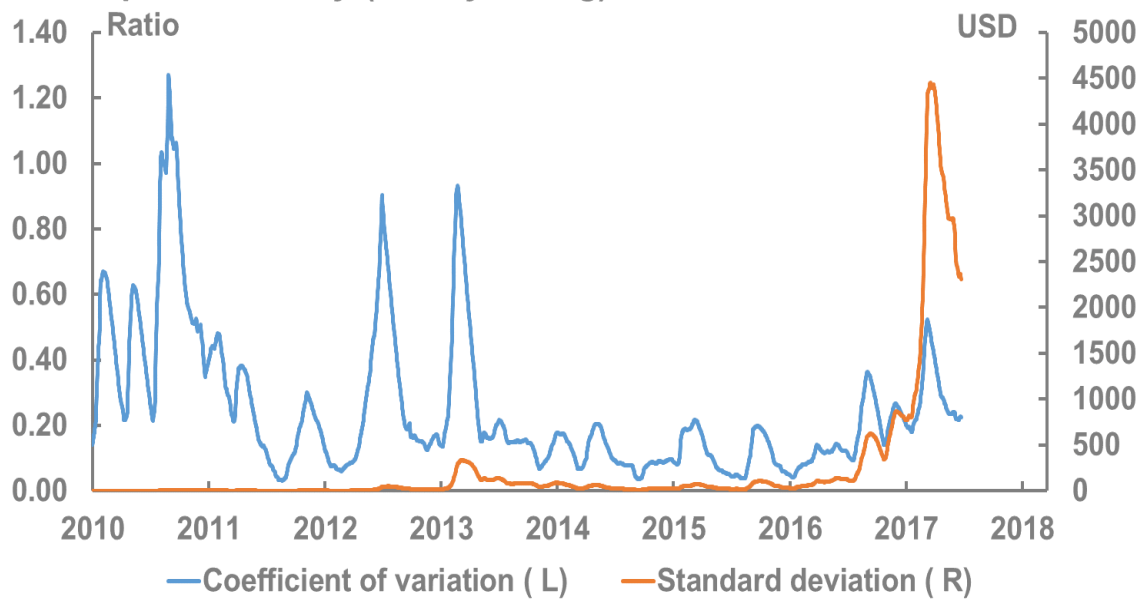
Source: https://data.bitcoinity.org
Note: coefficient of variation is the ratio of standard deviation to the arithmetic mean of a variable

Moreover, the central bank issued money is anchored to the real economy as in the euro's case, for example, the Eurosystem takes collateral from its monetary policy counterparties as a "deposit" for providing euro currency. Cryptocurrencies lack that anchor to the real economy and no one has to redeem them, while their governance is opaque. There are anecdotal evidence that in a major cryptocurrency conference the registration fee could be paid only by conventional money rather than bitcoins (Krugman (2018)). Simultaneously, their value is very volatile (Figure 10) exposing Bitcoin users to a significant market risk. Dismissing the short-term price spikes before mid-2013 as part of phasing in a new currency, subsequent sharp movements cast doubts in the use of cryptocurrencies as a store of value. Low Bitcoin daily trading volumes add to its volatility resulting into a significant transaction cost. With a typical daily dollar trading volume at the tune of USD 30-35bn at the New York Stock Exchange, Bitcoin's trading volume has never exceeded USD 6bn a day (Figure 11) and is currently below USD 1bn.

Figure 11
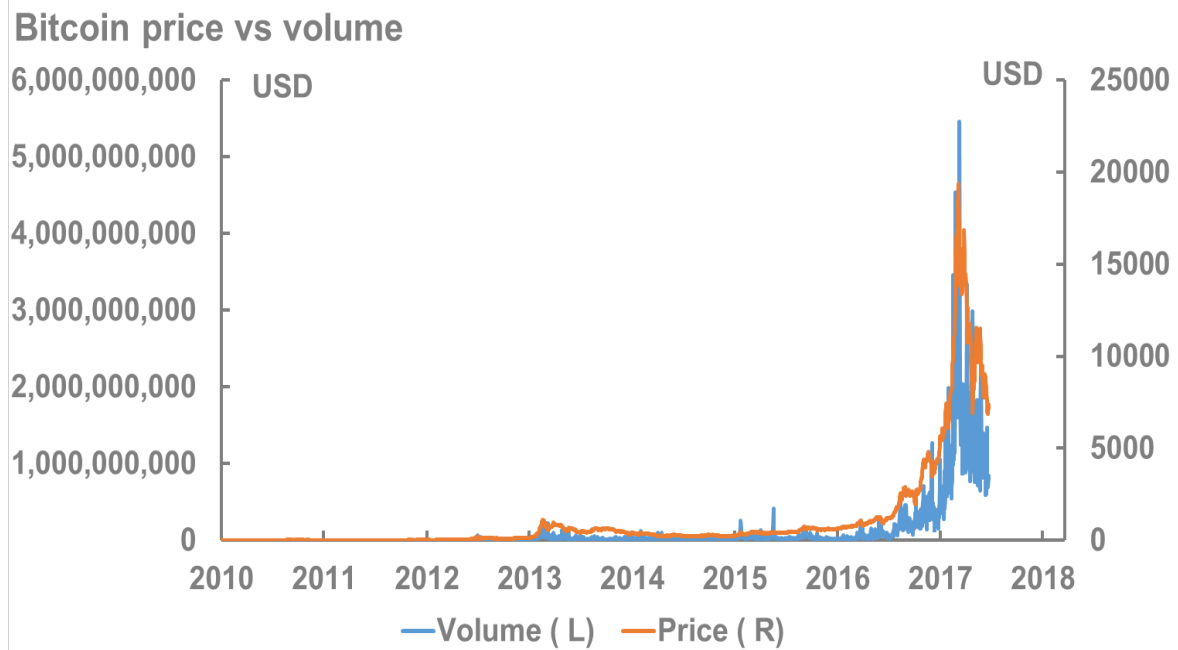
Inefficiency: Bitcoin's high volatility renders it a poor means of payment and store of value. Very few people use it for payments or as a unit of account. Its volatile nature has brought forward the idea that it is a Ponzi scheme.[7] Yet, it qualifies (Kaushik Basu (2014)) as a "naturally occurring Ponzi scheme" (Shiller (2000)). Early investors make a lot of money as new investors are drawn in, pulling in more investors. The process can go on for years before a trigger event that could be market fatigue or a regulation initiative ends abruptly the market rally. Moreover, running the Blockhain technology that supports cryptocurrencies is environmentally costly as it requires a significant electricity consumption. For instance, Digiconomist.net, a platform that provides in-depth analysis, opinions and discussions with regard to Bitcoin and other cryptocurrencies, has estimated that the average electricity that the Bitcoin network requires to clear one transaction is 555,000 times higher than that required by VISA.

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[7] Ponzi scheme is a fraudulent investment operation where the operator fabricates reports and generates returns for older investors through revenues paid by new investors.

Payment systems

At first sight, DLT can simplify reconciliation processes in payment systems and support complex work-sharing value added chains. DLT has the potential to facilitate transactions and their clearing as it allows transactions to be carried out directly, peer-to-peer, without intermediaries. The Bank of Canada and the Bank of England have analysed the potential and limitations of the DLT in the context of large-value payment systems (e.g., systems that serve a similar function as Fedwire in the United States or TARGET in the euro area). Both concluded that such technology is currently not sufficiently mature to be deployed in large-value payment systems (The Bank of England (2017) and Gaetz and Wilkins (2017)).

There are three main weaknesses in the use of DLT in large-value payment systems:

- First, the existing legal framework requires participants to be identifiable. As virtual currencies change hands between virtual participants, Bitcoins never leave the Bitcoin Blockchain and they have no reference to the real economy until they are exchanged for real currency outside the Blockchain. At that point there has to be a trustworthy outside third party to verify the existence of the assets, credibility and identity of the counterparties. Only then real transactions can be conducted.
- Second, transacting counterparties in large-value payment systems need to protect the privacy around transactions which is incompatible with some versions of decentralized digital ledgers that operate under an assumption that everything is publicly observable at a certain level.
- Third, transactions have to be settled with finality and not approximately. Large-value payment systems are supervised and regulated and have been deemed systemic. They are subject to international standards know as Principles for Financial Market Infrastructures (Bank for International Settlements (2012)), adopted into the domestic law. One of the principles is referring to settlement finality. The latter is a statutory, regulatory and contractual construct referring to the moment in time when one party is deemed to have discharged an obligation or to have transferred an asset or financial instrument to another party, irrevocably and unconditionally, despite the insolvency or entrance into bankruptcy of either party (Liao (2017)). DLTs are characterized only by a probabilistic finality of settlements where a transaction is cleared if a consensus of Blockchain participants calculates the same outcomes with respect to transactional sets and ledger states, an outcome called proof-of-work. Settlement finality in this setting is only probabilistic and approximate in the sense that it is unlikely that all Blockchain participants will reach to the same proof-of-work.

It takes ten minutes on average to add batches of Bitcoin transaction data to the relevant Blockchain resulting into lags that can be exploited by malevolent Blockchain participants. Through rapid transactions before a Blockchain is updated, malevolent participants can double-spend Bitcoins, undermining Blockchain's security for payments. Also, there is the persistent risk that transaction records maintained in a specific Blockchain could be erased if a majority of participants decides to cast aside that authoritative Blockchainrefuting the argument that Blockchain is a secure way of record keeping (Böhme, Christin, Edelman and Moore (2015)).

The technical capacity of the Bitcoin network to settle a large number of transaction is at its infancy given the long time and the large amount of energy that its consensus mechanisms require. The cost

of transaction settling is further augmented by the substantial additional data transfers required. For comparison purposes, the Bitcoin network settles roughly 350,000 transactions worldwide every day, and given its current configuration, appears to be running at almost full capacity. The German payment system alone, meanwhile, processes more than 75 million transactions on average every business day, according to the data for 2016 (Thiele (2017)).

Applications of Fintechs and Blockchain for Financial Inclusion

There is a significant financial exclusion in the developing world: out of 590 million adults in Sub-Saharan Africa (SSA), for example, 350 million do not have access to an account at a bank or with another type of financial institution. Financial exclusion is significant among women, young people and people living in rural areas. Building brick-and-mortar branches in low-population density areas by traditional banks is typically not economically viable. Financial exclusion refers to either lack of a current account or lack of access to other basic financial services, including savings accounts, loans and insurance products. With only 34% of adults formally banked, there is the potential for the development of financial services in Africa to meet the needs of the unbanked.

FinTechs and Telecommunication companies fill the gap through mobile money services. They provide a solution to the lack of infrastructure via mobile banking and agent banking. Agent banking includes a financial service provider engaging third parties – including shops, service stations and post offices – to deliver financial services on their behalf. In practice, when the end-user is several kilometres away from the nearest bank branch, being able to conduct a financial transaction in a shop is extremely convenient.

About half of the improvement in financial inclusion is due to the expansion of the traditional banking sector, the other half to that of mobile accounts. Countries share their experience with digital financial inclusion with regulators and commercial banks through the Alliance for Financial Inclusion (AFI) platform.

The degree and nature of financial inclusion challenges vary significantly from country to country and call for tailored financial inclusion strategies. Specifically, most countries have seen a rise on both accounts but mobile phone subscriptions do not necessarily translate into mobile money transactions. According to IFC, there are about 400mn SMEs with unmatched credit needs. About half of these are from developing markets, representing 175-220mn SMEs in developing countries with unmatched credit needs of USD 2.1-2.6tr. Of these, it is estimated that 81mn SMEs are based in SSA, with an outstanding credit gap of USD 132bn. SMEs are confronted with a significant credit risk that traditional banks are not willing to shoulder fully, while the cost of serving SMEs by banks is high given SMEs' small average size of transactions and corresponding revenue per account.

This gap represents a major credit opportunity for FinTechs, non-bank SME lenders and banks to explore as transactional and alternative data can help to address the SME financing conundrum. The SME Finance Forum is working with its FinTech members to see how they can partner with banks to apply technological innovation to boost financial access for women entrepreneurs. FinTechs have the capacity to improve financial inclusion of world travelers, expats, immigrants or refugees by offering borderless accounts for expat banking and allowing customers to receive money in one country and pay out in another immediately. International transfer fees are avoided as well as currency exchange fees. Originally targeting Spanish expats living in the US, BBVA's Denizen bank is offering global

accounts designed to eliminate the cost, uncertainty and impediments to cross border banking. There are no fx fees for these accounts and no bank-owned ATM fee debit card, while a mobile app is used for on-the-go money management. The technology behind Denizen plugs into partner banks APIs, allowing the solution to work in numerous countries, including those where BBVA does not currently have a presence.

Trust in digital financial services can be enhanced by paying attention to financial risks and the take-up of digital financial services at the bottom of the pyramid, boosted by ensuring that regulation safeguards the interests and rights of the poorest end-users. Biometrics can address many of the issues associated with the lack or unreliability of identity mechanisms while digital footprints can be used as a source of credit referencing. As a corollary, regulators need to ensure that digital identities are not abused. Regulatory supervision for data management, i.e. the collection, storage and protection of data, must be provided. The issues of identity protection and cybersecurity are critical.

There are four institutional models (European Investment Bank (2017)) that rely on alternative data streams for SME lending. The first are SME marketplace lenders. These non-bank digital lenders originate SMEs loans via platforms connecting SME borrowers to their own balance sheet or to third party investors. Their use of alternative SME data allows them to increase the pool of eligible SMEs and to simplify, speed up and lower the cost of SME credit. The second model is provided by global digital corporates who leverage their proprietary big data to offer SME finance. The third is mobile database lending platforms (e.g. Saficom, CBA's M-Shwari, Sanctuary, KCB's M-PESA, and Zuna in Zambia), which use mobile and mobile e-money services transaction history to score the creditworthiness of first-time borrowers. The fourth model is supply-chain finance platforms, which are becoming increasingly common in SSA. GoFinance in Tanzania, for instance, analyses the supply-chain structure as well as sales and delivery data within a given supply chain to provide financial solutions for SMEs. They can lend as much as USD 30k to SMEs, utilising alternative data to manage risk. Existing bank players have also launched their own database platforms, including Kenya's Equity Bank and Airtel's Equitel.

Applications for the IFIs and development institutions

Without being exhaustive, the section provides a list of potential applications for the IFIs and development institutions. Promoting awareness and understanding about Blockchain technology among IFIs and development institutions is important in order to benefit from private sector experience on Blockchain applications. The World Bank is perhaps the leading example in that regard. In recognizing the transformative potential of distributed ledger technology and Blockchain, World Bank launched in 2017 a Blockchain lab in order to pilot projects that can improve governance and social outcomes in the developing world.[8] The aim of the lab is to operate as a forum for learning, experimentation, and collaboration on Blockchain while promoting cooperation between internal and external participants on Blockchain use cases significant for World Bank's mandate. Through Requests for Information, the World Bank is identifying parties that want to work on Blockchain applications pertinent for World Bank's development challenges, while ultimately incubating and scaling the results of this experimentation to the greater benefit of the organization.[9]

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[8] http://www.fao.org/in-action/agronoticias/detail/en/c/903647/
[9] http://www.worldbank.org/en/about/corporate-procurement/business-opportunities/administrative-procurement/distributed-ledger-technology-or-blockchain-services

Also, the KFW is studying how to apply Blockchain to its programs. Germany's development has developed a Blockchain software, called TruBudget, aimed at improving transparency and efficiency in public resources that finance development projects. It uses a distributed ledger to provide access to records of budgetary spending on social infrastructure projects from payment to procurement, contracting and implementation of a project. Leveraging on this software, KfW and the Brazilian Economic and Social Development Bank (BNDES), approved a memorandum of understanding where KfW will allow BNDES to use the TruBudget software repository and do a pilot of it on the Amazon Fund, which makes non-reimbursable financial operations and has KfW as one of its donors.

IFIs could experiment with Blockchain technology by using it in the issuance of securities. The Blockchain technology designed for bitcoins differs to that designed for financial services in several ways. First, the Blockchain for financial services would be a permissioned system with only authorized participants. The Blockchain for cryptocurrencies, in contrast, is an open system where all contribute to the validation process. Also, Blochain transactions in cryptocurrencies are immutable, implying that once settled they cannot be modified or revoked. Immutability is unsuitable for securities markets as cancelling transactions is needed in the event of operational errors.

New securities are issued into the asset ledger by the issuer and the origination of a new issuer is captured digitally. Subsequently the issuer approaches an investment bank to perform the due diligence, assist on asset types, prepare the Term Sheet, help to raise funds, appoint the lead manager and form the banking syndicate of underwriters and distributors of the new security offering. The lead manager assists in the origination, issuance of securities, book building and allocation processes. The lead manager and the syndicate members have a single view on a Blockchain platform of the Master Book which includes bids and orders from prospective investors with the price and quantities of the security required. In this way, the security issuer can view in real time the list of investors and their positions. In the traditional securities issuance process, each of the network of issuers, syndicate members and investors maintains a different record of the transaction dictating a continuous reconciliation process. In a Blockchain security, mandatory corporate events like dividend and coupon payments, stock splits etc can be converted into smart contracts that would be auto executed if specific timestamps and conditions were met.

Blockchain in securities markets enables more efficient post-trade processes as Blockchain enables an almost instantaneous trade confirmation, affirmation and allocation, with settlement and reconciliation being superfluous. Shortening the time necessary to settle a transaction reduces counterparty risk and the need to post collateral in order to compensate counterparty risk and subsequently, releases collateral to be used for other purposes in the market.[10] More collateral implies lower liquidity constraints as there are assets or funds immediately available at times of stress. The Blockchain record application, would enable multiple market participants accessing a unique, accurate and verifiable ledger in real time, while regulators could be granted special access rights to consult or retrieve data stored on Blockchain ledgers. The distributed and shared nature of the system could facilitate the recovery of both data and processes in the case of an attack (assuming that not all the nodes are corrupted simultaneously). This could reduce the need for costly recovery plans. Sophisticated encryption techniques could also provide an additional layer of protection to pools of

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[10] https://www.esma.europa.eu/system/files_force/library/dlt_report_-_esma50-1121423017-285.pdf

information stored on DLT compared to existing systems. Costs relating to clearance, settlement, custody, register and notary services could be lower with Blockchain technology as well as costs for compliance and risk monitoring. Ultimately, moving security issuance to Blockchain could cut costs and speed up trading for both bond issuers and investors.

The World Bank, which issues between USD50 billion and USD60 billion annually in bonds to fund sustainable development in emerging economies, issued in August 2018 a two-year Blockchain bond equal to USD73mn called Blockchain Operated New Debt Instrument (Bond-i).[11] The latter is designed to improve the efficiency of automated financing for countries with extreme poverty. The Commonwealth Bank of Australia (CBA) is the sole arranger of the bond priced to yield a 2.251% return. Bondi was be issued and managed on a private Blockchain operated by the World Bank in Washington and the CBA, in Sydney. The computing infrastructure will run on Microsoft's Azure cloud platform. Microsoft has already validated Ethereum's "capabilities, security and scale" for the bond issuance. Before that, in the private sector, the German automaker Daimler used Blockchain technology to issue a type of German bond in a pilot project in 2017.[12] Through LBBW, Daimler launched a EUR100mn 1-year corporate Schuldschein within which savings banks (Kreissparkasse) Esslingen-Nürtingen, Ludwigsburg and Ostalb as well as LBBW acted as lenders. The entire transaction — from the origination, distribution, allocation and execution of the Schuldschein loan agreement to the confirmation of repayment and of interest payments — was digitally carried out via blockchain technology in cooperation with the IT subsidiaries TSS (Daimler) and Targens (LBBW). The city government of Berkeley, California, is also exploring the use of Blockchain technology to issue municipal bonds.

Blockchain benefits for securities markets can be realized only when a critical mass of market participants adopts the technology. For this to happen concrete and compelling business cases are needed. Issuers and investors of Blockchain securities will need to agree on a governance framework that provides relevant safeguards to the users of the technology and their clients. The management of potential privacy issues is an important consideration. Finally, regulatory and legal issues need careful consideration.

Verifying the "green bond" status and monitoring the use of proceeds by issuers of green bonds are tasks performed by second opinion or third party assurance providers like accountancy firms and research agencies. The fee for these services is high, deterring small green bond issuers, while there is a variety of classification criteria resulting into uncertainty of the green bond classification among prospective investors. Standardizing the criteria could lower the cost and effort of verification. IFIs could pioneer Blockchain Green bonds that could enable them to reassure Green bond investors where their money is spent for Green projects. Blockchain Green bonds could eliminate the need for second opinion or third party assurance providers as Green bond investors and issuers in the dedicated Blockchain node can communicate in real time. To that end, the cost for post-trade processes would significantly decline while the overall investors' trust to the asset class would improve resulting into an even deeper market.

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[11] https://www.worldbank.org/en/news/press-release/2018/08/23/world-bank-prices-first-global-blockchain-bond-raising-a110-million

[12] https://www.daimler.com/investors/refinancing/blockchain.html

There are other Blockchain applications outside the financial sector. This could include sectors like, agricultural lending where Blockchain technology is used in the supply chain Blockchain technology can improve transparency and efficiency of the supply chain in agricultural and commodity production. Specifically, the agricultural supply chain is fragmented and dependent on personal acquaintances of a counter-party before a farmer can trust them to do business. By allowing P2P transactions of commodities mapped on a Blockchain ledger where transactions are verifiable, untampered and transparent, trust is forged between farmers and other market participants without the need of a middleman to broker trust. Hence, cost efficiency, transparency and soundness of the market improves. Other sectors include transport and logistics and even energy distribution.

Other Blockchain applications pertinent to the operations performed by IFIs include: **smart contracts** where distributed ledgers enable the coding of simple contracts that are executed when specified conditions are met; **crowdfunding among like-minded multilateral international financial institutions** in order to create crowd sourced venture capital funds that could be used for the indirect financing operations of the EIB; **data and file storage and protection of intellectual property** as Blockchain eliminates the risk of file copying and redistribution of creative works online while spreading data through a Blockchain network protects files from being hacked or lost; **identity management**, especially for Technical Assistance projects as Blockchain technology offers enhanced methods of identification along with the possibility of digitizing personal records and **AML and KYC** as Blockchain technology could potentially reduce cost in time, money and human effort in performing the laborious Anti-Money Laundering (AML) and Knowing Your Customer (KYC) analysis and monitoring by cross-institution client verification. IFIs could benefit by utilizing the technology of both FinTechs and TechFins in the analysis of big data in order to better understand the investment gaps and the financing needs of prospective clients. Moreover, FinTechs' knowhow could be used in order to streamline its internal processes with regards to credit underwriting and risk management. Finally, IFIs could enhance financial inclusion by investing into FinTech/TecFin firms who facilitate access to payment systems.

The applications of Blockchain and Fintechs to IFIs could be even wider than the examples mentioned above. In the future, as the technological change progresses so will the new applications to IFIs.

Risks and challenges
FinTechs
Along the benefits, FinTechs have the potential to undermine financial stability and the provision of critical financial services. According to the Financial Stability Board (FSB), FinTechs may undermine financial stability directly or indirectly by triggering a disintermediation of regulated entities that are providing FinTech services (Financial Stability Board (2017)). There are two broad risk types that FinTechs may encounter namely financial and operational risk.

Financial risk includes potentially mismatches of maturity and liquidity and leverage. Maturity mismatches is relevant for Fintechs with lending as their main activity. It is realized when investors sell their loans before maturity if other investors are willing to buy them or if there is a sell-out option of fixed term accounts for a fee. Liquidity mismatch is possible if FinTechs do not hold client monies that could be invested in liquid assets such as bank deposits or government bonds and perform a liquidity transformation. Leverage is an issue for FinTechs only when they borrow funds in order to

finance temporary holdings of bonds and equity issuance or when they use their own balance sheet to fund loans.

Like all businesses, Fintechs are subject to operational risk that may rise from information systems, human error, management failures and external influences. Governance/process control risks may emerge for Fintechs if the latter are third parties offering services to regulated financial institutions and they are not subject to the same level of oversight or scrutiny of their governance and business processes to which regulated financial institutions are. Greater use of technology and digital solutions expand the range and number of entry points cyber hackers might target. Some FinTech activities may spread data across a larger number of institutions, for example, via increased use of digital wallets and e-aggregators making more likely a cyber-attack of a weak link in the system of connected financial institutions. Reliance to third parties could increase via Fintechs resulting into a legal/regulatory risk if these third parties are not traditional financial institutions and are not covered by existing legislation, legal and regulatory frameworks. The more central these third parties are in linking together multiple systemically important institutions or markets the more likely it is an operation risk experienced by these third parties to turn into a systemic risk for the financial system.

Norms regulating FinTech firms are necessary in order to reduce operational and reputational risks for those that decide to acquire or partner with FinTechs. These norms establish minimum public financial reporting and know-your-customer requirements, anti-money laundering controls and capital levels for financial technology institutions. Specific maximum lending and investment limits for crowdfunders and maximum daily and monthly transfers for tech enabled payment platforms are dictated by the regulation on Fintechs. Finally crowdfunders need to develop business continuity plans to deal with potential operational contingencies and ITFs will need to have compliance officers and establish control committees to review risk methodologies. However, these investments will come at a significant cost, which will limit these companies' financial capacity, and consequently their ability to undercut banks. At the same time, the regulations will create a more level playing field between fintechs and banks, which will reduce opportunities for regulatory arbitrage.

The majority of jurisdictions (20 out of 27) surveyed by FSB have already taken some measures to respond to FinTechs. Within jurisdictions, the scale of changes or planned changes varied substantially, from a new Draft Law in Mexico and eight new sets of rules or opinions in China, to more minor amendments to existing rules or law in Korea, the EU, Switzerland, Turkey and Russia. Policy objectives most commonly include consumer protection, market integrity, and financial inclusion as well as promoting innovation or competition. Many changes focus on crowdfunding / FinTech credit, virtual currencies, payments, cybersecurity, or in some cases specific technologies (e.g. big data, cloud computing). The most common model used by the competent jurisdictions in order to guide innovation and experimentation is the "regulatory sandbox," where new products or services can be tested in a (controlled) environment. This is used by the Australia, Canada, Hong Kong, Korea, Netherlands, Singapore and the UK. Another model involves innovation hubs that support firms to address the regulatory requirements, like the FinTech Support Desk in Japan, the Fintech Center in Korea, or hubs in Brazil and France. Finally, some jurisdictions have accelerator or partnership arrangements between innovators, incumbent firms and/or public sector authorities to 'accelerate' growth or develop use cases.

Blockchain and Cryptocurrencies

These risks to the financial system are spread through a number of different areas. The main and more pressing concerns relate to financial integrity due to the anonymous nature of payments made with virtual currencies and include: i) anti-money laundering/combating the financing of terrorism (AML/CFT), ii)consumer protection, iii) tax evasion, and the regulation of capital movements.

There have been already some early examples of websites and suppliers that were serving as intermediaries to illicit payments and were closed by the authorities.[13] Concerns about financial stability, or the implications for monetary policy stemming from the use of virtual currencies are are less immediate but require a continuing analysis and monitoring. The use of virtual currencies is so far limited but as their use increases the impact on monetary policy and on its transmission will increase. The growing interest in blockchain technology, independent from any virtual currency scheme, a priori raises fewer policy concerns, because its technology is used in a closed system administered (in principle) by regulated financial institutions.

Authorities should provide a level playing field to all market participants (banks and non-banks), while at the same time fostering innovative, secure and competitive markets. In this context, this means, among other things, ensuring that the same high standards that money transfer and payment service providers have to meet are also met by FinTechs (including Bitcoin). It also means ensuring that legitimate banking and payment services are only offered to those businesses that meet these high standards.

Central Banks and regulators may also intervene to ensure financial stability. To date, cryptocurrencies' are small . However, if authorities do not act pre-emptively, they could become more interconnected with the main financial system and become a threat to financial stability (as illustrated in Figure 3).

Finally, another priority is linked with the cross border and country coordination. Which is even more important than in the past. These new applications and technologies are not confined to the traditional borders. Most companies "born local but act global" meaning that they can easily bypass legislation leading to global implications even if the majority of the regulators are proactively monitoring their activities. This is even more the case for virtual currencies as they are not limited by any borders and their attractiveness only depend on their use as means of payment.

Concluding remarks

The purpose of this policy paper was to shed light on the disruption it triggers to the financial industry and provide a primer on the Blockchain technology and its applications. Blockchain refers to the protocols and supporting infrastructure that enable computers in different locations to propose and validate transactions and update records simultaneously across a network.

Financial technology (FinTech) refers to the technology and innovation that competes with traditional financial methods in the delivery of financial services. Using smartphones for mobile banking, investing services and cryptocurrencies are manifestations of FinTech aiming at improving the reach of financial services to the broader public and facilitate the creation of a credit record. TechFins, instead, relate

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[13] The most notorious case was "Silk Road", a market for illegal goods such as drugs and arms that was closed by the US authorities in 2013.

to the use of increasingly available amount of information to business decisions be it related with marketing or financial markets. The more commonly used name for this new field is "Big data". Most records and observations are now captured electronically by devices connected to the internet enabling businesses to access a broad range of relevant data in real time.

With a significant rate of financial exclusion in the developing world, FinTechs and Telcos fill the gap through mobile money services. They provide a solution to the lack of infrastructure via mobile banking and agent banking. The degree and nature of financial inclusion challenges vary significantly from country to country and call for tailored financial inclusion strategies. SMEs around the world are confronted with unmatched credit needs as traditional banks are not willing to shoulder fully the high credit risk involved, while the cost of serving SMEs by banks is high given SMEs' small average size of transactions and corresponding revenue per account. This gap represents a major credit opportunity for FinTechs, non-bank SME lenders and banks to explore as transactional and alternative data can help to address the SME financing conundrum.

Cryptocurrencies' application of Blockchain technology is problematic, according to the analysis, as cryptocurrencies cannot substitute traditional money due to the high risk of debasement, luck of trust and high inefficiencies relating to the high cost in electricity and human effort required to clear cryptocurrency transactions. Importantly, Cryptocurrencies' high volatility renders it a poor means of payment and store of values, while resembling a fraudulent investment operation.

The rapid expansion in Blockchain and financial technologies, has led to a fast spreading of their potential benefits but has so far left unaddressed the risks that they could imply. Risks include anti-money laundering/combating the financing of terrorism, consumer protection, tax evasion, and the regulation of capital movements. This technological expansion outpaced the actual regulatory measures taken dictating that more regulation and cross-country coordination is needed.

As a traditional lenders, IFIs could benefit by utilizing the technology of both FinTechs and TechFins in the analysis of big data in order to better understand the investment gaps and the financing needs of prospective clients. Moreover, FinTechs' knowhow could be used by IFIs in order to streamline its internal processes with regards to credit underwriting and risk management. Finally, IFIs could enhance financial inclusion by investing into FinTech/TechFin firms who facilitate access to payment systems. In addition, Blockchain technology has several applications that could facilitate the working of an IFI with Blockchain securities being the most pertinent one given IFIs' issuance volumes.

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