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# FINANCIAL DIGITALIZATION: RISK OR OPPORTUNITY

Rui Manuel Ferreira Esteves

*Master* in Monetary and Financial Economics

Supervisor:
Ph.D. Diptes Chandrakante Prabhudas Bhimjee,
Invited Assistant Professor,
Iscte Business School,
Iscte – Instituto Universitário de Lisboa

October, 2021

CIÊNCIAS SOCIAIS
E HUMANAS

Department of Political Economy

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*"It is well enough that people of the nation do not understand our banking and monetary system, for if they did, I believe there would be a revolution before tomorrow morning."*

Henry Ford, 1930s.
(Ford Motor Company's founder and chief developer
of the assembly line technique of mass production.)

*"Banking is necessary, banks are not."*

Bill Gates, 1994.
(Microsoft Corporation's co-founder.)

# Acknowledgements

This Dissertation is the result of a challenging academic path, especially during a pandemic event that swept around the world, disrupting all human activity and taking place during almost the entire Master's program. Even so, this Master's degree was an enriching journey that has helped to build stronger and deeper foundations of scientific knowledge. So I would like to show my gratitude for the valuable contribution and encouragement provided by my Dissertation Supervisor, Professor Diptes Bhimjee, and I also wish to thank all ISCTE Faculty for providing me with the tools I need to thrive in the dynamic world of Monetary and Financial Economics, especially Professor Sérgio Lagoa for his availability and guidance throughout the entire duration of the Master's course.

I would like to thank my Course Colleagues for the moments of fellowship and in particular the colleagues I worked with directly in various group assignments during the course, Patrícia André and João Nunes.

Last but not least, many thanks to my Parents (Ana Ferreira and Manuel Esteves), who are always there, supporting and giving me strength to pursue my dreams, especially in the most difficult times.

Thank you all!

# Resumo

O crescente desenvolvimento tecnológico está a dar origem à digitalização da economia, que se alastra a todas as indústrias, incluindo a financeira, trazendo consigo riscos e oportunidades, e afetando todos os intervenientes. Esta mudança vem acompanhada de alterações no pensamento socioeconómico, e na colaboração entre os agentes económicos, juntando-se assim a economia digital à economia colaborativa, incluindo a desmaterialização e desintermediação financeiras.

Procurando-se obter uma análise mais quantitativa sobre a disrupção da digitalização financeira nos vários atores do sistema financeiro, com um foco na Europa e no investimento, chegou-se à conclusão que ainda é relativamente prematuro apresentar conclusões definitivas sobre os riscos e as oportunidades da digitalização financeira; no entanto, algumas conclusões foram obtidas, tais como, não ter sido observada uma ligação direta entre a prevalência de FinTechs e o baixo desenvolvimento económico em jurisdições na Europa. Foram encontrados *clusters* especializados em áreas de inovação financeira em alguns países Europeus, em que a regulação e a legislação desempenham papéis importantes nesta especialização. As áreas financeiras mais relevantes nesta disrupção, são pela seguinte ordem decrescente, os pagamentos, os investimentos, e o financiamento por crédito. Os criptos-ativos demonstraram elevada volatilidade, não podendo ser considerados como ativos de refúgio e de reserva de valor, incluindo as 'stablecoins', que revelaram não serem estáveis e falharem em serem representações digitais fiéis dos ativos financeiros tradicionais. Concluindo-se que ainda não podem ser considerados como substitutos de moedas fiduciárias e de outros ativos financeiros. Por isso, também se conclui que o investimento em cripto-ativos é altamente especulativo.

Palavras-chave: Inovação digital, inovação financeira, FinTech, regulação
Classificação JEL: G2, O3

# Abstract

The growing technological development is giving rise to the digitalization of the economy, which spreads to all industries, including the financial industry, bringing with it risks and opportunities, and affecting all stakeholders. This change is accompanied by shifts in socio-economic thinking, collaboration between economic agents, thus joining the digital economy to the collaborative economy, including financial dematerialization and disintermediation.

In an attempt to obtain a more quantitative analysis about the financial digitalization disruption in the various actors of the financial system, with a focus on Europe and investment, it was concluded that it is still relatively premature to have definitive conclusions about the risks and opportunities of the financial digitalization, however, some conclusions were reached, such as, a direct link between the prevalence of FinTechs and the low economic development in jurisdictions in Europe was not observed. Specialized clusters in areas of financial innovation have been found in some European countries, where regulation and legislation play important roles in this specialization. The most relevant financial areas in this disruption are in the following descending order, payments, investments and credit financing. Crypto-assets showed high volatility, and could not be considered as safe haven and store of value assets, including 'stablecoins', which proved not to be stable enough and fail to be faithful digital representations of traditional financial assets. This leads to the conclusion that they cannot yet be considered as substitutes for fiat currencies and other financial assets. Therefore, a conclusion must be drawn that investment in crypto-assets is highly speculative.

Keywords: Digital innovation, financial innovation, FinTech, regulation
JEL classification: G2, O3

# Index

# List of Tables

# List of Figures

# List of Annexes

# Glossary of Acronyms

| | |
|---|---|
| AEs | Advanced economies |
| AI | Artificial intelligence |
| AML | Anti-money laundering |
| API | Application programming interface |
| ATM | Automated teller machine |
| AUM | Assets under management |
| B2B | Business-to-business |
| B2B2X | Business-to-business-to-any |
| B2C | Business-to-consumer |
| BankingTech | Banking technology (company) (technology-based banking company) |
| BCBS | Basel Committee on Banking Supervision |
| BD | Big data |
| BigTech | Big information technology (company) (Mega market capitalization company) |
| BIS | Bank for International Settlements |
| BTC | Bitcoin (unofficial code) (used in the Bitcoin blockchain) |
| CBDC | Central Bank digital currency |
| CEU | Council of the European Union |
| CFD | Contract for difference |
| CFT | Combating the financing of terrorism |
| CH | Switzerland (ISO 3166-1 alpha-2 code) |
| CHF | Swiss franc (ISO 4217 code) |
| CNY | Chinese yuan (ISO 4217 code) |
| CPMI | Committee on Payments and Market Infrastructures, BIS |
| DCA | Digital currency area |
| DE | Germany (ISO 3166-1 alpha-2 code) |
| DLT | Distributed ledger technology |
| DTCC | The Depository Trust & Clearing Corporation |
| EC | European Commission |
| ECB | European Central Bank |
| ECCB | Eastern Caribbean Central Bank |
| EEA | European Economic Area |
| EFTA | European Free Trade Association |
| EMDE | Emerging market and developing economy |
| EMI | Electronic money institution (‘E-money institution’) |

| | |
|---|---|
| EP | European Parliament |
| ESG | Environmental, social and governance |
| ETF | Exchange-traded fund |
| ETH | Ether (unofficial code) (used in the Ethereum blockchain) |
| ETN | Exchange-traded note |
| ETP | Exchange-traded product |
| EU | European Union |
| EUR | Euro (ISO 4217 code) |
| FCA | Financial Conduct Authority |
| FinTech | Financial technology (company) (technology-based financial company) |
| FSB | Financial Stability Board |
| G10 | Group of Ten |
| G7 | Group of Seven |
| GB | United Kingdom (ISO 3166-1 alpha-2 code) |
| GBP | (United Kingdom) Pound sterling (ISO 4217 code) |
| GDP | Gross domestic product |
| GDPR | General Data Protection Regulation |
| GFC | Global financial crisis (2007-2009) |
| ICO | Initial coin offering |
| InsurTech | Insurance technology (company) (technology-based insurance company) |
| IOSCO | International Organization of Securities Commissions |
| IoT | Internet of things |
| ISIN | International Securities Identification Number (ISO 6166) |
| ISO | International Organization for Standardization |
| IT | Information technology |
| JE | Jersey (ISO 3166-1 alpha-2 code) |
| JPY | Japanese yen (ISO 4217 code) |
| KYC | Know your customer |
| LBR | Diem (formerly known as Libra) |
| Lhs | Left hand side |
| LI | Liechtenstein (ISO 3166-1 alpha-2 code) |
| MC | Markets Committee |
| MiCA | Markets in Crypto-assets Regulation |
| MiFID | Markets in Financial Instruments Directive |
| ML | Machine learning |
| MMF | Money market fund |
| NBER | National Bureau of Economic Research |

| | |
|---|---|
| NFT | Non-fungible token |
| NPL | Non-performing loan |
| OCA | Optimal currency area |
| OECD | Organisation for Economic Co-operation and Development |
| P2P | Peer-to-peer |
| PoW | Proof-of-work |
| PPP | Purchasing power parity |
| PropTech | Property technology (company) (technology-based property company) |
| PSD | Payment Services Directive |
| RegTech | Regulatory technology (company) (technology-based regulatory company) |
| Rhs | Right hand side |
| SE | Sweden (ISO 3166-1 alpha-2 code) |
| SEK | Swedish krona (ISO 4217 code) |
| SME | Small and medium-sized enterprise |
| STO | Security token offering |
| SupTech | Supervisory technology (company) (technology-based supervisory company) |
| SWIFT | Society for Worldwide Interbank Financial Telecommunication |
| UK | United Kingdom |
| US | United States (of America) |
| USD | United States dollar (ISO 4217 code) |
| VASP | Virtual Asset Service Providers |
| WealthTech | Wealth technology (company) (technology-based wealth management company) |
| XAMS | Euronext Amsterdam (Market Identifier Code (MIC), ISO 10383 code) |
| XBRN | BX Swiss (Market Identifier Code (MIC), ISO 10383 code) |
| XDUS | Boerse Duesseldorf (Market Identifier Code (MIC), ISO 10383 code) |
| XETR | Deutsche Boerse Xetra (Market Identifier Code (MIC), ISO 10383 code) |
| XNGM | Nordic Growth Market (Market Identifier Code (MIC), ISO 10383 code) |
| XPAR | Euronext Paris (Market Identifier Code (MIC), ISO 10383 code) |
| XSTO | Nasdaq Stockholm (Market Identifier Code (MIC), ISO 10383 code) |
| XSTU | Boerse Stuttgart (Market Identifier Code (MIC), ISO 10383 code) |
| XSWX | SIX Swiss Exchange (Market Identifier Code (MIC), ISO 10383 code) |
| XWBO | Wiener Boerse (Market Identifier Code (MIC), ISO 10383 code) |
| YTD | Year-to-date |

# Introduction

The digitalization of the economy is not a recent phenomenon, but this trend has been accelerating since the 1970s with the fast development in computer science including computer networks such as the internet. This has opened a new world of opportunities creating a new parallel reality to the real world, a digital universe, where only the human imagination is the limit, causing a growing dematerialization of the economy and society, and bringing about challenges to the contemporary world. This growing digitalization gave rise to the so-called digital economy, from which the financial sector was not indifferent.

The dematerialization of the economy spread to the financial system, where incumbents looked for new ways to reduce costs, create more efficient processes, offer better financial products, and increase customer loyalty through a better user experience.

Technological evolution has also shaped new consumption habits, changing the paradigm of financial services provided, both who can use them and how to access them, being associated with a new form of socio-economic thinking, the collaborative economy[1]. This has brought greater disintermediation in various sectors, linking consumers to each other in peer-to-peer relationships, including in the financial sector, both in payments, as in financing (non-bank lending and crowdfunding), data and transaction records (DLT), among others, being able to relegate the incumbents to a secondary role.

The business model of creating technology companies, or start-ups, financed by venture capital and private equity firms caused a rapid growth of new companies with high disruptive potential in various industries, including finance, sometimes not giving enough time for the incumbents and regulators to adjust to paradigm shifts. Allied to the multinational and increasingly global nature of these companies, the incumbent not only began to face stiff competition from new technology-based companies born in national territory, but also from companies from all over the world.

Technology has also started to cause disintermediation in Central Banks, first indirectly through the disintermediation of banks and then directly through the creation of crypto-assets that propose to be alternative forms of payment, putting not only the stability of the financial system at stake, but also monetary policy and sovereignty.

Financial innovations could affect the ability of Central Banks to implement their monetary policies effectively and maintain financial stability. As an increasing part of financial transactions is accounted for outside traditional banking, this brings new challenges for measuring monetary aggregates, in addition to bringing more questions to the stability of the financial system, due to the growth of shadow banking[2].

Also for financial market supervisors, new challenges are added with the design and implementation of innovative financial products, new forms of financing and investment, and trading platforms for the same.

[1] For more on collaborative economy, see Petropoulos and Bruegel (2017).

[2] 'Shadow banking' refers to the financial institutions that don't receive deposits and that aren't subject to the traditional banking regulation (FSB, 2015).

Finally, the entry of new players from other sectors cannot be overlooked, such as BigTechs[3] that control large amounts of data that can be used to monetize and leverage their penetration in the financial sector and the legal restrictions of the GDPR[4].

From this ecosystem, the general research question was born, Financial Digitalization: Risk or Opportunity, as the existing literature has a narrow view on financial digitalization. The intention is to address the topic in a more aggregated way so that it could observe all those involved in this transformation of the financial system, from the challengers that are technologically disrupting the financial industry to the financial regulators that seek to regulate financial innovation, thus including the financial consumers who have an increasingly participatory role in the financial sector and the incumbents who follow technological evolution and try to adapt to these changes. Accordingly, four research sub-questions are formulated, each one about each financial system actor, for the challengers, Where are the main areas of digital disruption in the financial system; for the consumer side, What is the impact of the digitalization of financial services on consumers; at the incumbent level, How can financial digitalization affect the financial system; and finally on the regulators' point of view, What challenges will regulators face with the digital economy. All these research sub-questions will form the square base that converges to answer the general research question, but these questions are not 'tight' questions that only analyze one vertex, as they are interconnected with each other, since the actions of the interveners affect the entire base, that is, the financial system with all its actors. One player's behavior influences others.

This ambitious quest is somewhat constrained, mainly related to the data availability and the ongoing occurrence of rapid transformations brought about by technology, by the stakeholders of the financial system, and the dynamics of the financial markets. The existing literature is also mostly theoretical, based on some specific themes of the digitalization of the financial system. This has brought an opportunity to disrupt scientific knowledge about financial digitalization, giving rise to new paths in research on the subject.

Based on what previous authors researched about the sub-themes related to financial digitalization, the following is worth highlighting: the possibility of technology creating greater financial inclusion and increase economic development, especially in EMDEs; cost reduction in the financial industry; efficiency gains in processes; creation of new financial products and improvement of existing ones; an improved supervision and forward looking of the financial system by the regulators. But this can also bring associated risks, such as, data privacy; data security; technological discontinuity of financial services; increased interconnectivity between the parties; potential conflicts of interest; money laundering and terrorist financing risks; fraud and cyber attacks; greater financial risks; putting into question the financial stability and transmission channels of monetary policy. The possession of large amounts of proprietary information held by BigTechs can create an economic moat that makes them information oligopolists, excluding other

[3] BigTechs firms are large information technology companies and include: Alibaba, Amazon, Apple, Baidu, eBay, Facebook, Google, Microsoft, Tencent (FSB, 2019c).

[4] Officially known as Regulation (EU) 2016/679. For more about GDPR, see EP and CEU (2016).

participants in the financial system from data sources, thus reducing competition in the financial industry. Crypto-assets carry some of the risks mentioned above, but it also poses other challenges for Central Banks, such as monetary sovereignty, however CBDC could improve the transmissibility of monetary policies but could also create an exclusion of banks from the financial system.

This Dissertation seeks to bring new contributions to the existing scientific knowledge, in addition to an aggregation of themes about all participants in the financial digitalization mentioned above, it is also to provide a more quantitative and financial view, including from the investment side. For example, the stability of 'stablecoins', their 1:1 parity for the USD, the tracking error, among other ideas. One of the authors/documents cited, Hernández de Cos (2019), mentions that the stability of 'stablecoins' has yet to be tested, therefore, the existing idea of analyzing the stability of these assets is reinforced. As the existing quantitative information on financial digitalization is scarce and dispersed, this brought the opportunity to create an aggregation and cross the data in order to obtain new results and seek to find conclusions about the evolution of this event in the financial system and its impacts on its stakeholders.

This Dissertation is a case study that will use a quantitative (i.e., statistical) methodology with data collected from several sources and from several time periods, with several statistical data types (cross-sectional data; panel data; and time series), using various economic and financial ratios, such as returns, volatility, tracking error, correlations, among others. Due to the nature of the subject under study and the availability of data, it was decided to subdivide the analysis into six case exhibits, each one analyzing an aspect of financial digitalization, but which will affect all those involved in the financial system and with these case exhibits complementing each other and providing an increasingly granular analysis of previous case exhibits. From a macroeconomic study of the financial system in Europe to a more detailed analysis of financial assets (e.g. as crypto-assets), passing through challengers, consumers, incumbents and regulators, trying to observe the particularities of each one.

This Dissertation is quite innovative and goes a step further in expanding existing scientific knowledge, in order to find new ways to observe the subject giving a more quantitative and more focused view on Europe, seen from a more financial angle and linked to investment. This thus covers some of the observed gaps in the existing literature to which no answers are found in the literature.

The structure of the Dissertation is divided as follows, the first chapter covers an extensive and comprehensive theoretical framework and review of the existing literature, starting with a characterization of financial digital disruption with a brief historical summary about financial technology, innovative technologies and actors of financial disruption, followed by the characterization of the financial digital disruption in consumers, incumbents and regulation, with a more thorough review of the various aspects related to regulation. In the second chapter, the research methodology and data referring to the six case exhibits of this Dissertation are aptly described. The third chapter covers the presentation and analysis of the results obtained. Finally, the conclusion chapter, the conclusions of the various case exhibits and an aggregating conclusion, as well as the obtained answers for the questions posed, ending with the limitations found during the completion of this Dissertation and suggestions for future investigations.

# 1. Theoretical Framework and Literature Review

The present literature review maps the existing theory of the research topics under study, focusing on the stipulated research questions, from the perspective of challengers, incumbents, consumers, and regulators. That is, the literature review and the theoretical framework will be divided into these four pillars, seeking to characterize these four market participants.

## 1.1. Characterization of Financial Digital Disruption

### 1.1.1. Brief history on financial technology

Technology has been present in finance for over 150 years, with the "FinTech 1.0" wave marked by the conclusion of the first transatlantic telegraph cable in 1866, marking the first steps in the global trend to digitalize finance. The next stage of financial disruption happened in 1967 with the appearance of the ATM and bank cards[5] ("FinTech 2.0"). The third and actual stage ("FinTech 3.0") may have been accelerated by Moore's law[6], which essentially stipulates the increasing processing power of computers, mobile phones and other electronic devices, and the widespread use of the internet in the 1990s. Another important technology emerged in 2008 as a "P2P electronic cash system", popularly known as Bitcoin, and prompted the first use of a blockchain, or DLT (Hernández de Cos, 2019; Nakamoto, 2008).

The dematerialization of physical securities, from paper-form securities to electronic "book-entry" securities that started in the late 1960s in the US, has helped exchanges and other participants to lighten the burden of the administrative and settlement procedures associated with the paper certificates[7], making it: (i) more cost-efficient; (ii) diminishing the settlement days from T+5 to the actual T+2 (since 2017); and (iii) more secure and reliable (DTCC, 2020).

Other relevant landmarks in financial technology include the development of Nasdaq as the world's first fully electronic stock market (without a physical trading floor) in 1971. This was followed by the creation of SWIFT in 1973, a new worldwide financial messaging service with a communications network for financial institutions using computers; and a common language (data standardization) for international financial messaging, that revolutionized the way financial institutions share information about financial transactions, such as making payments or settling trades, making the cross-border transfers worldwide more efficient than the previous technology used by banks (the Telex technology). These two financial technological disruptions bought about lower costs, as well as faster, more reliable and secured transactions (Nasdaq, 2021; SWIFT, 2021).

[5] For more on the historic development of the bank card, see Wonglimpiyarat (2004).

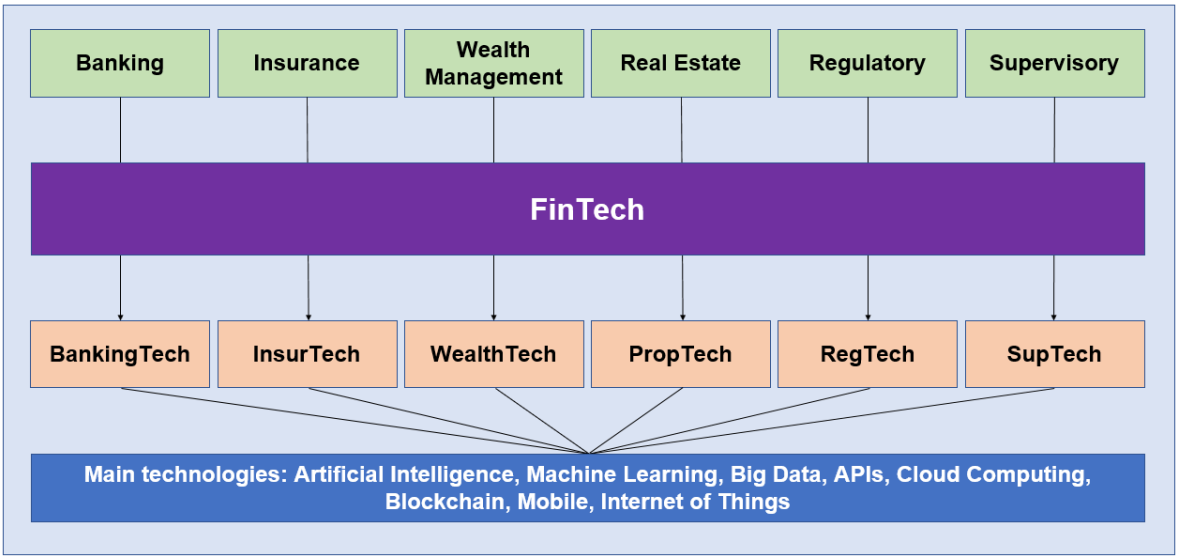
[6] Moore's law is an observation that forecasts the doubling of the number of transistors on integrated circuits (microprocessors) every two years. First introduced in 1965, as doubling every year, the law was further revised in 1975 to doubling every two years. For more on Moore's law, see Moore (1965).

[7] By 1967, 10 million shares per day were traded on average, in Wall Street, but three months later, this statistic grew to 20 million shares a day (DTCC, 2020).

### 1.1.2. Innovative technologies

The use of AI (bots, automation, algorithms) and data applications (BD analysis, ML, predictive modeling) is increasing in several industries, including in the financial industry. Financial institutions are increasingly adopting novel technologies for credit quality assessment, pricing and marketing credit and insurance contracts, and client interaction automation. Asset management firms, broker-dealers and other financial firms are using it to achieve better returns and risk management, as well as to have a more efficient trade execution. These technologies are also used to improve the regulatory compliance, supervision and monitoring of illegal activities, such as KYC/AML, by regulated institutions and authorities. Other technological developments have also contributed to the digitalization in finance, such as the innovations in infrastructures (cloud computing[8], open source and APIs), DLT (blockchain and smart contracts), IoT, mobile technology, security (customer identification and authentication) (FSB, 2017b; BCBS, 2017). Each of the main financial related sub-sectors has a specialized field of technology connected to it under the generic umbrella term of FinTech (Figure 1.1).

**Figure 1.1** – Classification of technologies by financial sub-sectors




Source: Author.

The use of APIs gives access to functionalities, as it allows the access to financial services by third parties. More specifically, with open banking, open APIs allow data portability between financial institutions, much like the interaction between banks and the payment service providers (BIS, 2019).

Satoshi Nakamoto's Bitcoin proposal[9] bought several developments, including a decentralized payment system, based on P2P electronic cryptographic transactions registered on a distributed ledger (blockchain). Further development is made with the introduction of smart contracts, a digital transaction

[8] For more on cloud computing, see Annex A.1.
[9] For more details on Satoshi Nakamoto's Bitcoin proposal, see Nakamoto (2008).

protocol with automated execution according to the terms of a contract[10]. This led to, Ethereum's proposal in 2013, and the first crypto-asset with smart contract functionality (Nakamoto, 2008; Buterin, 2013).

Presently, there is no international standardized accepted taxonomy of crypto-assets, however there are simplified categorizations to classify existing crypto-assets. The crypto-assets can be classified by the fungibility, the fungible tokens, such as: (i) payment tokens (e.g. Bitcoin and Ether) that serves as a means of exchange; (ii) utility tokens that grants permissions to use software features, rights to join a community, and rights to participate in product development; (iii) security tokens or rights relating to financial assets (e.g. stocks, bonds and funds), with expected return and traded with reference to an underlying asset; and (iv) non-fungible tokens or NFTs, tokens that use the Ethereum blockchain to store data and serve as a certification, proving property rights (including copyright) and trading ownership to unique assets, like for example, art; music; or any other form of intellectual property; collectibles; and real estate (IOSCO, 2020; Lambert, Liebau and Roosenboom, 2020; OECD, 2020; OECD, 2021).

Inside the sub-category of payment tokens, there are some initiatives that seek to reduce the volatility of these crypto-assets, such the 'stablecoins', which are defined as crypto-assets with its value pegged to an underlying asset or basket of assets, such as: (i) fiat currencies (e.g. USD and EUR); (ii) commodities (e.g. gold, other precious metals or oil); (iii) crypto-assets (e.g. BTC and ETH); and (iv) reference alternative units (e.g. real estate, averaged inflation rate of the G10 countries or a Consumer Price Index, and index of prices of diamonds) (Annex A.2), with or without collateral[11] (Annex A.3) (Kriwoluzky and Kim, 2019; Bullmann, Klemm and Pinna, 2019; Lyons and Viswanath-Natraj, 2020).

Facebook and a consortium of other companies proposed a 'stablecoin' - Libra (renamed to Diem) -, initially a multi-currency coin pegged to a basket of stable fiat-currencies (e.g. USD, EUR and GBP) and backed by a basket of currencies and very short-term government securities. This was implemented in order to control for price volatility, while subsequently also adding single-currency 'stablecoins' pegged to individual fiat-currencies (Annex A.4) (Libra Association, 2020; Arner, Auer and Frost, 2020).

This tokenization of assets that constitutes the digital representation of real (physical) assets on DLTs or the issue of traditional asset classes in tokenized form, which includes the security tokens (e.g. stocks and bonds)[12]; 'stablecoins' or asset-referenced tokens (e.g. gold and fiat currencies); and the NFTs (e.g. art and real estate), are considered as one of the most promising applications of DLTs in financial markets. The asset tokenization with DLTs and smart contracts could bring a series of benefits, namely, (i) efficiency gains with the automation and disintermediation; (ii) higher transparency; (iii) better liquidity and tradability of assets; (iv) faster and a potential more efficient clearing and settlement; (v) fractional ownership that could bring lower investment barrier, promoting financial inclusion; and (vi) better access to SMEs funding through ICOs with utility tokens or equity/debt tokenized issuance in the form of security

[10] FSB (2017a: p. 34) defines smart contracts as "Programmable distributed applications that can trigger financial flows or changes of ownership if specific events occur".

[11] Algorithmic 'stablecoins' are an example of non-collateralized 'stablecoins' (OECD, 2020).

[12] The World Bank launched in 2018, the first legally binding bond using DLTs, (on a private, permissioned blockchain and with smart contracts for the automation of payments) (OECD, 2020).

tokens (STOs). Tokenization can be seen as a replacement of a previous digital technology (the centralized electronic security depositories) with a cryptography dematerialization on decentralized ledger networks. A widespread adoption of asset tokenization can endanger financial stability and monetary policies, with the disintermediation of the financial system, volatility and liquidity of the associated markets, especially in periods of extreme financial stress. Moreover, there are also operational risks driven by: (i) technology including cyber risks; (ii) governance risks including AML/CFT and "51% attacks"[13]; (iii) digital identification; (iv) data privacy and protection; and (v) legal status of smart contracts, and all constitute issues that are raising concerns within the regulatory community and related authorities (OECD, 2020).

Financial services are already using decentralized technologies, payments and settlements (e.g. foreign exchange platforms); trade finance, due to a lack of established infrastructure for information verification between participants (e.g. finance and freight logistics); capital markets with the tokenization of securities; and lending, online lending platforms doing credit scoring and making lending decisions (FSB, 2019b).

### 1.1.3. Financial disruption actors

The main players in financial digitalization are the FinTechs, financial services firms driven by technological innovation that "could result in new business models, applications, processes or products with an associated material effect on financial markets and institutions and the provision of financial services" (FSB, 2017b: p. 35). The BigTechs[14], large information technology companies providing financial services, the SupTechs, companies that provide supervisory technology used by regulatory, supervisory and oversight authorities and the RegTechs, technologies that enable regulatory compliance by regulated institutions are all part of this FinTech universe (FSB, 2019a; FSB, 2020)[15].

BigTechs are sometimes considered a subsector of FinTechs, as the former are technological companies that provide digital services and have expanded to financial services as a diversification strategy and as a complement to their main activities. They have generally started with payments, proceeding with loans, passing through insurance, savings and investment (Annex A.5), in a cross-selling strategy to boost the baseline business model, while FinTechs exclusively provide financial services. The adoption of these services is more pronounced in economies where the financial system has higher rents and is less developed, taking advantage of the existence of inefficiencies in the financial system, such as banking regulation (regulatory costs), legacy bank IT systems, organizational inefficiencies resulting from bank diversification (diversification costs) and banks' internal culture (agency costs) (Frost et al., 2019; Philippon, 2016; Stulz, 2019).

[13] "51% attacks" could happen if a majority of the network or participants holding more than 50% of outstanding tokens, decides to make any transactions they want or make changes in the protocol or develop a separate network (OECD, 2020).

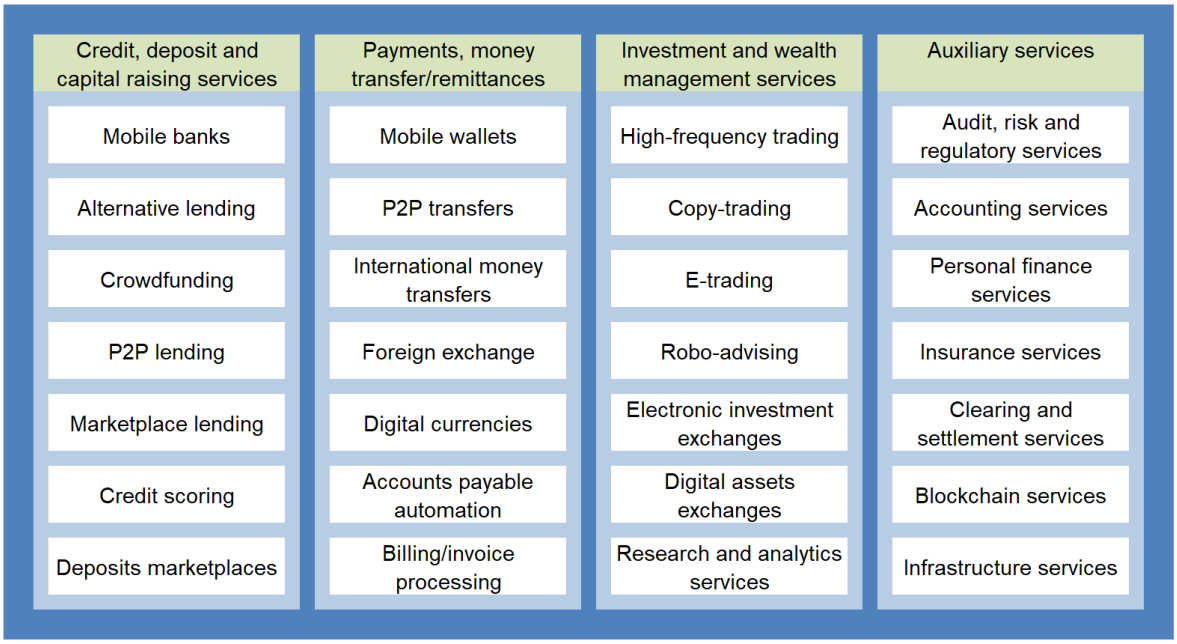
[14] BigTech firms includes: Alibaba, Amazon, Apple, Baidu, eBay, Facebook, Google, Microsoft, Tencent (FSB, 2019c).

[15] Some authors make clear distinctions between the several types of financial digital companies, such as FinTechs and BigTechs, but others include all in the FinTechs label. In this study, a distinction will be made when necessary.

Due to the intensive use of technology by the BigTechs, they share some characteristics with FinTechs, such as economies of scale with lower marginal costs than incumbents, having lower profit margins, and the use of AI and BD (high data sources). These economies of scale, and the use of AI and BD, are largest in BigTechs due to their size, volume of transactions, and information. BigTechs have specific characteristics, as they obtain economics of networks generated by the success of their baseline businesses, such as e-commerce, instant messaging, social networks, advertising and search engines, *etc.*, with some BigTechs combining several of these areas and including the financial area (Annex A.6), thus obtaining economies of scope, which contribute to a greatest source of private information that incumbents, which FinTechs do not have access to. BigTechs have the advantage of being able to finance their activities in the financial area through other business areas. While BigTechs have the ability to compete with banks in several banking areas instead of challenging banks in certain niche markets such as FinTechs, due to the BigTechs' unique advantages, such as the high amounts of exclusive information that BigTechs have, and thanks to their lesser dependence on the incumbent banks (unlike FinTechs), with BigTechs being the biggest threat to the future of banks than FinTechs are (Frost et al., 2019; Stulz, 2019).

The disruptors have entered every field of finance, in payments, credit, deposits, alternative lending, wealth management, insurance, capital markets, real estate, and auxiliary financial services. These disruptors offer solutions in several business models, such as B2B, B2C, B2B2X and P2P (Figure 1.2) (FSB, 2019a).

**Figure 1.2** – Financial innovative services




Sources: BCBS (2017); FSB (2017a); CB Insights (2020).

The granting of credit by FinTechs is typically more expensive compared to shadow banks[16], but their processes are faster without necessarily increasing the risk of loans. Thanks to new technologies and new sources of information, the algorithms' predictive power is considered to be superior to the traditional methods used, improving the granting of credit, including to people who had been excluded by the financial system (Philippon, 2019).

FinTechs' activities are still considered to be of small dimension comparatively with the size of the entire financial system, being considered niche market activities. In some economies they have already reached an important degree of relevance, while in other geographies they are limited to some market segments, but in certain economies they have already become the main areas of financial services. In China for example, the mobile payments provided by BigTechs represent 16% of GDP, but in the US they represent less than 1% of GDP (Annex A.7). Credit FinTechs originate in the US around 8% of new mortgage loans in 2016 and 38% of personal credit in 2018, while in credit to SMEs in the US and the UK, these platforms granted respectively the equivalent of 15.1% and 6.3% of the SMEs loans granted by banks. Overall, the global volume of new credit originated by FinTechs and BigTechs has been demonstrating steady growth between 2013 and 2017, yet it still represents less than 1% of total credit outstanding (Annex A.8). China is the jurisdiction with the largest weight of loans originated by these companies (Annex A.9). In asset management (WealthTech) and in the insurance sector (InsurTech), there is an increase in the presence of FinTech companies, although syndicated loans, derivatives markets, and clearing and settlement services continue with low penetration (Frost, 2020).

## 1.2. Characterization of Financial Digital Disruption in Consumers

There are 1.7 billion adults without access to bank accounts in all economies regardless of the latter's degree of development, together with a high number of mobile phone users, which helps to explain the growth in the adoption of FinTechs. These firms contribute to the expansion of financial services, greater competition, and greater financial inclusion, especially in economies with less financial inclusion, thus being able to contribute to greater economic growth. Empirical evidence suggests that there is a positive relationship between GDP per capita growth and credit granted by BigTechs mainly in economies with less developed or less competitive financial systems or with less rigid regulatory regimes and in regions with less access to banking services (Frost et al., 2019; Frost, 2020).

In EMDEs, where the financial systems are less developed and regulation is less restrictive, the BigTechs are more prevalent than in AEs, as around 48% of the EMDEs eligible population has a bank account (Annex A.10), but almost two-thirds of those unbanked own a mobile phone. In comparison, 82% of the unbanked Chinese population owns a smartphone. This availability of mobile phones gives an opportunity to BigTechs and FinTechs to penetrate the financial services industry directly (Annex A.11).

[16] 'Shadow banking' refers to the financial institutions that don't receive deposits and that aren't subject to the traditional banking regulation (FSB, 2015).

The success of mobile money payments[17], especially in EMDEs (Annex A.12) leads to mobile microcredit that helps SMEs and informal workers to have access to credit for their business improvement (FSB, 2019c; Sahay et al., 2020).

FinTechs and BigTechs help to reduce geographical barriers between consumers and financial services providers, which allows people and SMEs to obtain credit assessments and thus be able to obtain credit, facilitating money remittances and cross-border payments more cheaply and fast, even for the most remote locations. BigTechs are able to collect transaction information by offering innovative payment services to financial consumers without access to them, which can later be used for granting credit, eliminating some of the barriers that exist in traditional financial services, such as lack of documentation and asymmetry of information. Simultaneously, this increases the volume of payments and generates greater business volume by the online merchants who resort to loans given by BigTechs. A positive economic/financial externality arises in some deficient economies in payment infrastructures, as BigTechs are forced to develop these infrastructures in order to expand themselves, thus contributing to greater financial inclusion of the community (Frost et al., 2019; Frost, 2020).

With the use of AI, ML, and BD, BigTechs are also able to grant credit to people who had previously been excluded by banking and may also reduce human prejudice in granting credit, but at the same time it may decrease the effectiveness of policies aimed at granting credit to disadvantaged minorities. While technology has the potential to be a force against discrimination and can remove human discretion in decisions, technology has been changing the way in which discrimination in financial services manifests itself, moving from human discretion to the development and implementation of algorithms, the opacity and complexity of the parameters in the algorithms, and the fact that these and the databases are proprietary. The added use of ML with the existing information can also perpetuate discrimination (Frost et al., 2019; Philippon, 2019; Morse and Pence, 2020).

Technology may also help to democratize access to financial services, with lower fixed costs, which allows lower minimum investment and commissions in the wealth management market (robo-adivising), making credit more accessible to formerly excluded consumers; moreover, it may improve information on financial products and services and thus make access to information more equitable, however, it may not reduce inequality in all groups. Some consumers have more access and more literacy with technology than others (thus reinforcing exclusion), which is aggravated by a more targeted advertising and digital information, with different prices and conditions that consumers with less access or digital literacy do not obtain. Some algorithms use consumers' digital footprint to classify them, while consumers with less digital presence may have worse access to financial services. The technology may represent a gap for some, however the algorithms can help to reduce the disparity between the general population and the disadvantaged classes in terms of interest rates on credit, which can also contribute to an improvement in

[17] In Zimbabwe, cash transactions have been effectively replaced by mobile payments (Sahay et al., 2020).

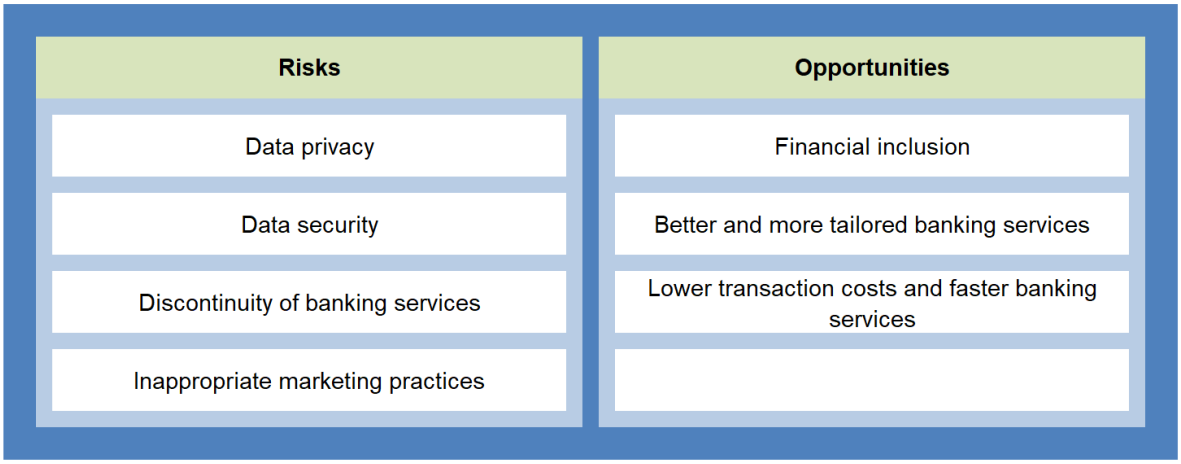
choices and competition, as well as greater financial inclusion fueled by increased use of mobile phones and broadband connections (Philippon, 2019; Morse and Pence, 2020).

The digitalization in finance is increasing financial inclusion and contributing to a higher GDP growth, including closing gender gaps, but there are several barriers to digital financial inclusion, the resources accessibility (e.g. mobile phones or computers and internet connection); cultural and social norms; and digital and financial literacy, especially for women (Sahay et al., 2020).

The collaborative loan financing model helps to obtain credit, but carries risks, in addition to both the credit risk and the liquidity risk for investors who finance these loans (Braggion et al., 2020).

Other risks and opportunities from the digitalization in finance could also emerge for consumers (Figure 1.3).

**Figure 1.3** – Risks and opportunities for consumers




Source: BCBS (2017).

## 1.3. Characterization of Financial Digital Disruption in Incumbents

Philippon (2016) observes that the current financial services remain expensive and inefficient, with a greater regulatory weight both in terms of costs and in complexity, as this sector has been concentrating and reducing competition in this market, thus contributing to an "industry with excessive rents and poor overall efficiency" (Philippon, 2016: p. 10).

The US commercial banks that had intensively adopted IT before the GFC suffered less from increasing NPLs during the crisis, as they were able to overcome that crisis more efficiently, due in part by a better screening of borrowers during the loan origination process. During the GFC, the high-IT adopters provided more credit than the low-IT adopters. The technology contributed to a better management of credit delinquency during the GFC, and the FinTechs and BigTechs can also benefit the financial system in the future, although is yet to be tested in a subsequent large systemic crisis, although the credit share originated by the new technological firms is still small in most countries. (Pierri and Timmer, 2020).

Credit FinTechs are regarded as substitutes to banks, for customers, who certain banks chose not to serve during regulatory and credit supply shocks, both in consumer credit and in home loans. Regulatory restrictions on incumbents lead banks to contract in some of their activities, voids that have been occupied by FinTechs. Also the smaller network of bank branches and their reduction caused this banking service gap to be filled by credit FinTechs. In markets with high concentration and little banking competition, credit FinTechs are able to penetrate thanks to their lower fixed costs resulting from intensive technological adoption, as well as in more challenging markets, such as low-income consumers and economies in greater difficulty. FinTechs are also complementary in consumer credit due to the small size of the loans they grant, an advantage that FinTechs obtain due to their lower fixed costs; in consumer credit this advantage in costs is more visible than in mortgage loans, because fixed costs represent a reduced share in the total capital borrowed in real estate credit, mitigating the competitive advantage of the platforms, although their customers tend to be the same customers that banks accept, who have nevertheless better credit quality (Buchak et al., 2018; Tang, 2019; Jagtiani and Lemieux, 2018).

With the inclusion of the younger population in the active life and their appetite for technology, this financial consumer segment will be more receptive to access FinTechs credit services than traditional banking services (Jagtiani and Lemieux, 2018).

In several countries, banks are typically the center of the financial system, in addition to credit, custody and monetary payments, they also provide asset management, insurance and other services. With the growth of an economy based on technological platforms, banks may lose relevance, since payments will be the focus of platforms, while other financial services will be secondary. That is, P2P transactions typically remove the need for financial intermediation (Brunnermeier, James and Landau, 2019).

Several scenarios are possible for incumbent banks. BCBS (2017) forecasts five scenarios for the incumbent banks, namely the: (i) “better bank”, with the incumbents modernizing their legacy IT systems and digitalizing their procedures; (ii) “new bank”, new banks digitally created that replace the incumbent banks; (iii) “distributed bank”, modular financial services provided by the incumbents with collaboration between banks, FinTechs and BigTechs as joint ventures; (iv) “relegated bank”, where the banks become commoditized service providers to front-end FinTechs and BigTechs customer platforms; and the (v) “disintermediated bank”, the incumbents loose relevance, as decentralized networks take the banks out of system with more direct contact between parties, such as P2P transactions.

In AEs, BigTechs generally complement or work in partnership the financial incumbents (e.g. issuing branded credit cards and underwriting insurance policies for the BigTechs), whereas in EMDEs the BigTechs tend to serve as competitors to the incumbents, possibly due to financial market structure and the financial development that is generally greater in AEs (92% with bank accounts in 2017) than in EMDEs (with only 48%) (FSB, 2019c).

FinTechs don’t seem to pose a serious competitive threat to the financial incumbents in more mature financial market segments, due to their small size (e.g. small customer base and less access to low-cost funding), the opposite of BigTechs. FinTechs’ nature appears to be high complementary and cooperative

with the incumbents. Although there are exemptions, whereby some FinTechs have penetrated in credit and payments segments, the FinTech loan origination is growing fast yet it is still small in comparison to the total outstanding credit in most jurisdictions. BigTechs' large customer base and economics of networks, including huge amounts of proprietary data, strong financial position with cross-subsidization, and low-cost capital, make it more of a competitive threat to traditional financial incumbents than FinTechs (FSB, 2019a).

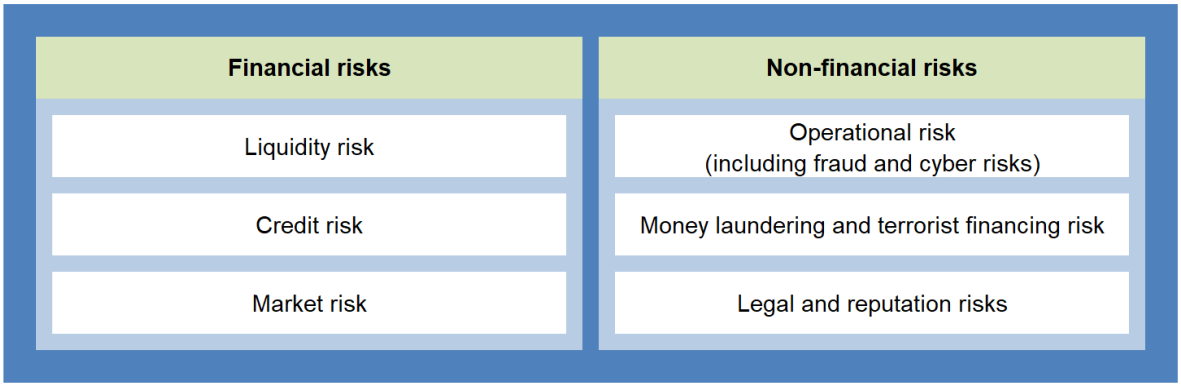
The actual financial digitalization presents a number of risks and opportunities for the banking system (Figure 1.4).

**Figure 1.4** – Risks and opportunities for incumbent banks


Source: BCBS (2017).

Crypto-assets pose specific risks for banks, such as:

**Figure 1.5** – Crypto-assets' risks for banks




Source: BCBS (2019).

## 1.4. Characterization of Financial Digital Disruption in Regulation

Innovation in finance has bought some new challenges, especially to the regulators and supervisors, in several fields, namely: competition; financial stability; monetary security; consumer and investor protection; and privacy (Annex A.13). These questions are herein addressed in several sub-topics.

### 1.4.1. The role of regulation in the appearance of shadow banking

Regulation plays an important role in FinTechs and BigTechs, because the existence of a somewhat uncoordinated and unbalanced regulation over them creates a competitive advantage over incumbents, and this advantage has been amplified by increasing regulation under the traditional financial/banking system since the GFC. This is in essence the nature of existing regulatory arbitrage processes. The various regulatory changes have led to changes in mortgage lending practices by banks, namely through the Basel III regulatory framework with stricter capital controls, which typically caused a reduction in mortgage lending by banks. Since non-monetary financial institutions or shadow banking are not subject to these regulations, this helps to fill the void left by banks, especially in more regulated segments and geographic areas, such as low-income geographies and/or minority populations. The increasing regulatory burden has provoked the growth of shadow banking that allow the provision of banking services without being subject to regulation costs, a fact which has coincided with the change from the physical presence to the digital presence of the financial intermediaries. There is a significant increase in the granting of mortgage loans by shadow banking in the US, from around 30% of market share in 2007 to 50% in 2015, and in particular in mortgage loans of lesser credit quality, with a 75% share in 2015. The credit FinTechs represent 25% of the credit granted by shadow banking in 2015 (3% of the market share of real estate credit in 2007 to 12% in 2015). In the US mortgage market, around 60% of shadow banking is due to regulation and about 30% is attributable to technology through the use of digital means in the loan origination, with shadow banking having achieved greater growth in more demanding regulatory environments (Philippon, 2016; Stulz, 2019; Jagtiani and Lemieux, 2018; Buchak et al. 2018)[18].

Due to the nature of BigTechs, its core business resides in information technology and consulting, but they are expanding to the financial services, although they lack banking licenses. Their customers' money in their accounts is typically put in money market funds, a component of shadow banking, and thus a concern to financial regulation. In China, the Alipay's Yu'ebao money market fund became the world's largest MMF within five years, with AUM over 1 trillion CNY (150 billion USD) and about 350 million customers. Although the total MMF AUM at the end-2018 in China offered by the BigTechs amounted to 2.4 trillion CNY (360 billion USD), this amount represents about 1% of bank deposits or 8% of wealth management products. (Annex A.14) (BIS, 2019; FSB, 2015).

[18] A more detailed and thorough description of shadow banking activities is available in FSB (2015).

### 1.4.2. Competition in digital finance

The growing digitalization has led to BigTechs becoming systemically important information intermediaries, raising concerns about their power with regard to their users' data. Furthermore, if BigTechs have associated payments and digital currencies, these platforms can become information oligopolists, making it difficult for banks to access certain information so that they can assess the creditworthiness of their customers. BigTechs could be able to create their own banks and thus have more market power and exclude incumbent banks from data sources (Brunnermeier, James and Landau, 2019).

The open banking legislation, like the EU's PSD2[19], allowing data portability across financial services, banks, FinTechs, and BigTechs, can contribute to a higher competition in the financial services industry, including in the data competition (BIS, 2019).

The effects of BigTechs' economics of networks, from their wide range of business, like e-commerce, social media, payments, etc. (Annex A.15), should help to create a greater economic moat against other competitors, which can lead to a high concentration in some segments and cause a greater involvement of BigTechs' customers with them. This constitutes a strong re-payment incentive for customers who obtain credit, so these customers can continue to have access to the services provided by BigTechs that hold greater market power. In China, the mobile payments market is dominated by two BigTechs with a combined 94% market share (Frost et al., 2019; FSB, 2019a).

In India, in order to avoid potential conflicts of interest and anticompetitive practices, the main e-commerce platforms are prohibited from selling on their websites, goods and services provided by related companies (BIS, 2019).

The EU, US and Chinese competition authorities have ongoing investigations for assessing possible anticompetitive conducts of the BigTechs (Banjo, 2020; Chen and Liu, 2020).

An interest-bearing CBDC for the retail segment might improve competition in the banking system, pushing commercial banks to be more competitive in the interest rates offered to their banking customers. The absence of competition from CBDC would make the payment system quasi-monopolistic towards the private digital money issuers, the FinTechs and BigTechs (Bordo and Levin, 2017).

### 1.4.3. Financial stability in digital finance

FSB (2017a) identifies three priority areas for financial stability implications from the technological innovation in financial services, namely: (i) macrofinancial risks; (ii) cyber risks; and (iii) the operational risk from third-party service providers. If FinTechs or BigTechs reach a large size, they may be systemically relevant, existing a moral hazard and potential excessive risk taking. BigTechs as providers of technological services to financial incumbents and at the same time competitors may represent a potential conflict of interest. In addition, it may create a high risk that operational failures in the IT systems or that cyber events (cyber espionage, cyber

[19] Officially known as Directive (EU) 2015/2366. For more detailed information about PSD2, see EP and CEU (2015).

terrorism/cyber sabotage, cyber crime)[20] in BigTech's infrastructures could spread with the operational interconnectivity between FinTechs, BigTechs and financial incumbents through technological services that could be a transmission channel of shocks between markets leading to a systemic crisis in the financial system (Frost, 2020; Frost et al., 2019).

The use of AI and ML could bring new and unknown forms of interconnectedness between financial markets and institutions, with for example, the use by several institutions of related data that were not previously employed. The opacity, the lack of audit, and the widespread use of AI and ML models could nevertheless pose a macro-level risk with unintended results. Also AI and ML could create data privacy, biased data and cyber security concerns (FSB, 2017b).

According to FSB (2018: p. 1), crypto-assets "do not pose a material risk to global financial stability at this time" but they identify the need to create policies about consumer and investor protection, market integrity protocols, AML/CFT regulation and supervision, the prevention of tax evasion, the circumvention of capital controls, implementation of international sanctions and the illegal securities offerings.

### 1.4.4. The technology's opportunities for regulation

Although technology has brought new challenges for regulated institutions and authorities, with large amounts and diversity of data, AI, and new infrastructures (cloud computing and APIs), it is also providing an opportunity to regulated institutions and authorities. Both the SupTech and RegTech offer the means to scrutinize the financial system and to comply with financial regulations that could contribute to the financial stability goal. The SupTech could improve the regulators' ability to oversight, surveillance and analysis on a real-time dimension, in order to support forward looking stances and supervision. The RegTech could help the regulated institutions improve the procedure of regulatory prerequisites (fraud detection; AML/CFT; KYC, identity and verification; risk assessment and management; and stress testing) and regulatory reporting (risk reporting; microprudential reporting; macroprudential reporting; and recently also including ESG reporting), and improve existing regulatory risk management procedures. Both SupTech and RegTech thus enhance the efficiency and effectiveness of regulators, reducing the regulatory costs, improving timeliness of information and strengthening cyber security (FSB, 2020).

### 1.4.5. Digital money

Money has taken several forms during mankind's history, from commodity money (e.g. grain, metals and cowries shells) to paper money, and now electronic money[21]. Several kinds of electronic money or digital money exists, and virtual currencies[22] associated to digital ecosystems (e.g. electronic games), private crypto-assets (e.g. payment tokens, including 'stablecoins') could fit under this umbrella, but the latter are

[20] For more on cyber security, see Morag (2014).
[21] For more on the history of money, see Ferguson (2009).
[22] Virtual currency is defined as "a type of unregulated, digital money, which is issued and usually controlled by its developers, and used and accepted among the members of a specific virtual community" (ECB, 2012: p. 5).

often categorized as a separate subdivision of digital money (Annex A.16)[23]. Bank deposits and mobile money are accessible privately issued forms of digital money, where money is held on digital accounts of the bank or service provider. Digital money isn't entirely an innovation for Central Banks, as Central Banks already provide it through reserves or settlement account balances held by banks and other financial institutions at the Central Bank, and known as wholesale[24] digital money. The innovation will be for general purpose variant, or retail variant[25], used by the consumers, deposited currency accounts, a digital form of retail deposits issued by Central Banks are almost nonexistent, the exception being, 'Dinero electrónico', a mobile payment service provided by Ecuador's Central Bank (Annex A.18). With the appearance and diffusion of a CBDC, such distinction could be less important, as CBDC could be used by both segments. (Bech and Garratt, 2017; CPMI and MC, 2018).

Digital currencies as privately issued electronic units of money, aren't a recent phenomenon, as the idea of digital money with cryptographic and privacy features was actually introduced in 1982, and later revisited in 2008. Digital currencies started to appear in the 1990s, with several electronic money initiatives that ultimately failed, including commodity-backed digital currencies with clients' funds in reserve as gold, silver, platinum, or palladium, which could be exchanged via digital certificates and fiat-backed digital currencies based on the value of the backing currency, like the USD and EUR (Chaum, 1982; Nakamoto, 2008; Clark, 1998; Jackson, 2013; Mullan, 2016).

These early digital currencies had the same regulatory risks (e.g. KYC/AML and lack of a regulation framework) as the actual crypto-assets[26], as any online centralized system, the digital currencies' platforms has cyber security risks, as well as the market risk associated with the underlying asset in the commodity-based digital currencies (Foley, 2013; e-gold, 2007; Mullan, 2016).

Bitcoin is often regarded as a speculative asset without intrinsic value and with extreme price volatility (Annex A.19) that makes it difficult to be priced, as well as being considered as a unit of account, although representing a poor store of value and means of exchange. The Bitcoin market lacks depth, it is concentrated and opaque, being subject to market manipulation with pump and dump schemes. It also presents risks related to cyber security and financial crime, especially with cyber attacks (hacks and thefts) (Annex A.20), financial fraud (Ponzi schemes, exit scams), and money laundering. As a reference, in 2019, the illicit activity involving crypto-assets represented a 4.5 billion USD loss (Annex A.21). Crypto-assets are also used by countries to evade international sanctions (North Korea, Iran, and Venezuela)[27]. In addition, Bitcoin's PoW scheme is very energy-intensive process, consuming more energy than certain

[23] An updated version can be seen at Annex A.17.

[24] The wholesale segment in payments, are large-value and high-priority transactions, usually done by commercial banks and other financial institutions (e.g. interbank transfers) (CPMI and MC, 2018).

[25] The retail segment in payments are characterized as lower-value transaction (e.g. card payments and credit transfers) (CPMI and MC, 2018).

[26] Commonly known as 'crypto-currencies', they are defined as crypto-assets by financial authorities (FSB, 2018; BCBS, 2019). According to the BCBS (2019, online), "is of the view that such assets do not reliably provide the standard functions of money and are unsafe to rely on as a medium of exchange or store of value. Crypto-assets are not legal tender, and are not backed by any government or public authority."

[27] For more on crypto-assets crime, security and evasion of international sanctions, see CipherTrace (2020).

countries, thus also bearing an ESG risk due to its carbon footprint (Carstens, 2021; FCA, 2020a; Shanaev et al., 2018).

The 'stablecoins' (e.g. Tether, USD Coin, Dai) have seen their market capitalizations steadily growing, although their price fluctuates against the USD (Annex A.22)[28]. The so-called 'stablecoins' are considered more credible than Bitcoin and other non-backed crypto-assets in matters of price volatility. However there are concerns about their price fluctuations especially if they are backed by high risk and opaque assets. This is especially relevant in stress periods, when the runs on 'stablecoins' could originate selloffs of the backed assets and could provoke negative spillovers on all segments of the global financial system. Other concern includes governance issues in which a private issuer may have strong incentives to deviate for maintaining its own currency asset backing as shown by historical evidence, simply because there is a temptation to invest in riskier assets to pursue higher returns (Annex A.23)[29]. On the other hand, 'stablecoins' maintain the same risks as other crypto-assets, like cyber and other operational risks; AML/CFT financial integrity; data protection; consumer and investor protection; legal and tax compliance. Notwithstanding, 'stablecoins' do have the potential to be a less volatile digital monetary instrument on distributed network but lacks regulation, although it provides Central Banks with the opportunity to innovate their monetary policies (Arner, Auer and Frost, 2020; Adachi et al., 2020; G7 Working Group, 2019; Carstens, 2021).

Crypto-assets do not compete with banks, but with the currencies issued by Central Banks (Stulz, 2019). The role of government in public money is questioned since at least Adam Smith's "Wealth of Nations", with criticism about the debasement of metal coinage by public authorities, eroding their intrinsic value, and opposing a Central Bank, advocating for free banking. In fact, the free banking debate was revisited by Hayek two centuries thereafter, in 1976, referring to the need to end the national governments' monopoly in currency issuance, and allowing private money issuance (e.g. banks) to foment competition for acceptance, with the stability in value as the decisive factor (Smith, 1776; Hayek, 1976).

Brunnermeier, James and Landau (2019) foresee a disruption in the functions of money (store of value, medium of exchange, and unit of account), with the possibility of currency specialization in certain functions, and currency differentiation with various associated functions such as information collection, privacy, and network services. According to these authors, Hayek (1976) suggested that total competition between private currencies, mainly as a store of value, would be the alternative for the mismanagement of public money, but for Brunnermeier, James and Landau (2019), this Hayek theory brought about unresolved issues, such as the difficulty of establishing a system with several currencies that had all the functions of the currency, mainly the unit of account. Hayek's competition for private currencies, according to Brunnermeier, James and Landau (2019), suffers from a central problem, the unit of account, which originates strong network externalities, which with private currencies are less 'connected'. Digital networks will allow overcoming the problem of reduced network externalities for private currencies, due to the creation of economic and social ecosystems, with information about the currency and its use, lower

[28] For more on pegging mechanisms across 'stablecoins', see Lyons and Viswanath-Natraj (2020).
[29] For more on a historical example about 'stablecoins', see Frost, Shin and Wierts (2020).

switching costs will allow greater use of the currency, and a separation of the currency functions. Digital networks may increase currency cross-border circulation and the number of users. The reorganization of currency functions, in addition to creating differentiated currencies, helps the creation of more fragmented consumer preferences about the currency, and may discourage interoperability between platforms, which may thus contribute to the creation of barriers and a reduction of competition mainly on large platforms (Brunnermeier, James and Landau, 2019).

The diversity of platform services could lead to the development of closed systems. The size of the platforms will lead to greater and more complex data collection processes that will allow far greater growth, and the platform may create exit barriers, such as exit costs or the lack of interoperability with other platforms. Further digitalization of the economy associated with a dematerialization of the currency could cause the disappearance of physical money, with payments being able to focus between social and economic platforms, in exchange for banks, and could weaken the transmission channels of monetary policy. The creation of national digital currencies (CBDC) may be necessary for countries to maintain their monetary independence. The existence of a public currency helps to discipline and maintain stability in the banking sector. CBDC will also be able to contribute to the elimination of information asymmetries related to private currencies and currencies with imperfect liquidity conditions. The CDBC will be able to provide a direct channel between the Central Bank and other economic agents, changing the way how monetary policy flows through the economy. However, it will be necessary to maintain interoperability with the largest platforms to maintain the CBDC's attraction to the public (Brunnermeier, James and Landau, 2019).

The digital use of the currency may give rise to a "digital currency area" (DCA) that link the currency to digital platforms to the detriment of specific countries, mainly in countries with smaller or unstable economies. Leaving countries vulnerable to digital dollarization, where platform currencies overlap with national currencies. While in an optimal currency area, there is an issuing entity with the ability to manage shocks and distribute risk among its participants, in a DCA there may not be access to tools sufficiently capable of supporting private digital currency. The power to define their own monetary policy may create an agency problem, with platforms wanting to pursue their interests at the expense of clients' interests. In the banking system, the Central Bank plays the role of lender of last resort to financial institutions, providing liquidity whenever necessary, however on platforms it is not certain that this can happen (Brunnermeier, James and Landau, 2019).

A greater use of a digital currency could become a unit of account of synthetic international currency, which is used for international trade, being able to dethrone the international trade prices denominated in currencies such as USD, in which the US shocks or monetary policies spread to all international trade, and so the adoption of this synthetic international currency may reduce global correlations *vis-à-vis* certain economies, especially if this synthetic currency is based on a basket of official currencies (Brunnermeier, James and Landau, 2019).

A CBDC has opportunities and risks for the financial system, including banks, as a CBDC issuance could divert banks' customer deposits to direct deposits on the Central Bank, especially in times of stress,

making the deposits a less reliable source of funding to commercial banks and affecting not only the financial stability but also the efficiency of financial intermediation. On the other hand, a CBDC can give a direct channel to the Central Bank to apply its monetary policies. The CDBC could facilitate a better intervention by Central Banks, an interest-bearing CBDC could serve as the main tool for conducting monetary policy, a CBDC indexed to an aggregate price index could offer a more efficient tool to control inflation, contributing to a greater macroeconomic stability, and thus making obsolete the need for an "inflation buffer", like the 2% goal targeted by some Central Banks, or to use alternative monetary tools (e.g. quantitative easing or credit subsidies). By adjusting the interest rate, Central Banks can incentive or disincentive consumption to control inflation or to foster greater economic growth. In adverse economic periods, the CBDC could help deliver more efficiently the money provided by fiscal stimulus, by depositing directly into the CBDC accounts, especially those of lower-income households. Cash reduces the Central Bank's ability to deploy negative nominal interest rates, because cash is a zero lower bound financial asset, making cash an appealing store of value that can in extreme situations provoke bank-runs in a high scale (a disintermediation into cash), such as the US bank panics of the 1930s. The issuance of CBDC could affect the way *seigniorage* is distributed between commercial banks and the Central Bank, as the CBDC reduces the costs related to physical money (e.g. production, logistics), increasing *seigniorage*, creating the incentive to move it from banks to the Central Bank. Currencies commonly used in international transactions, would also be affected by speculation and flight to safety movements, so a CBDC could also be impacted by these shocks. Nevertheless, there are no known effects on the exchange rates and other asset prices, as well as on interest rates (CPMI and MC, 2018; Bordo and Levin, 2017).

Several CBDC initiatives are being develop around the world, with the retail CBDC template being more advanced in jurisdictions with the largest informal economies. These projects are intended to be a digital complement, instead of an attempt to replace cash. Central Banks are increasingly considering the adoption of "Hybrid" or "Intermediated" architectures, where although the CBDC functions as cash in a direct claim on the Central Bank, there are nevertheless private entities that have the contact with the customers. "Direct" models are being considered by a few countries, where the Central Banks manage some or all customer-facing of payments. Actually, no Central Bank reports show the "Synthetic" or "Indirect" CBDC designs being pursued. The project infrastructures tend to be based on DLT, instead of a conventional infrastructure, with an account identification access, not allowing the token-based anonymity. At present, The Bahamas is the first jurisdiction (since 20$^{th}$ October 2020) to implement a live retail CBDC, the Sand Dollar, a digital version of the Bahamian dollar, issued by the Central Bank of The Bahamas through authorized financial institutions. The ECCB on March 25$^{th}$, 2021 announced the launch of its retail CBDC, the DCash, a digital version of the Eastern Caribbean dollar issued by the ECCB, marking the first use of a CBDC by a monetary union, the Eastern Caribbean Currency Union. It should also be noted that these CBDC's are both digital versions of currencies pegged to USD. Other CBDC projects, like the digital yuan issued by the People's Bank of China and the e-krona (digital Swedish krona) issued by the Riksbank, have pilot trials in real-world selected environments (Annex A.24). In Sweden, the physical cash in

circulation has been dropping over the last two decades, with many commercial spaces not accepting cash and some bank branches no longer providing or collecting cash (Annex A.25) (Auer, Cornelli and Frost, 2020; Sand Dollar, 2021; ECCB, 2021; Bech and Garratt, 2017).

The COVID-19 pandemic outbreak since the end of 2019 has led to fears of contagion through physical money accelerating a trend towards the use of contactless cards and digital payments (Annex A.26) (Arner, Auer and Frost, 2020).

### 1.4.6. Legal and regulatory framework on the tokenization of finance

The EU considers that tokenized equities and bonds, known as security tokens, qualify as financial instruments under MiFID II[30]. Other jurisdictions, like the US and the UK, also consider the security tokens as subject to the same traditional securities market legislation. For the crypto-assets that do not qualify as financial instruments, such as under EU's MiFID II, the EC propose a new regulation for the crypto-assets, the MiCA[31], that will create a new unified set of rules for all the EU Member States in three categories of crypto-assets, (i) the asset-referenced tokens ('stablecoins' referring to the value of: a basket of fiat currencies that are legal tender; one or a basket of commodities; one or a basket of crypto-assets; or a combination of that assets); (ii) the e-money tokens (crypto-assets referring to a fiat currency considered as legal tender, and to be used as a means of exchange), both categories of crypto-assets with the purpose to maintain a stable value; and (iii) the crypto-assets outside the previous categories (e.g. 'utility tokens') (Annex A.27) (OECD, 2021).

### 1.4.7. Consumer and investor protection in digital finance

Since the high valuations of some crypto-assets in 2017, the interest of investors and financial institutions have increased, further encouraging financial innovation with the development of crypto-asset trading platforms; crypto-asset derivative markets; and crypto-asset funds and trusts (including ETNs). The high price volatility; the unreliable valuation of the crypto-assets by the retail consumers due to the crypto-assets' absence of intrinsic value (Annex A.28); the associated cyber security risks and the existence of market abuse; and the retail consumers' illiteracy, have raised concerns in regulators, such as FCA, which decided to banned the sale, marketing, and distribution of crypto-assets derivatives (CFDs, options and futures) and crypto-asset ETNs (or crypto ETNs) to retail consumers, with the objective of protecting retail consumers, estimating a 53 million GBP savings for the retail consumers from that ban (FSB, 2018; FCA, 2020a; FCA, 2020c).

A recent survey about crypto-assets and education of retail investors made by IOSCO C8 members has found that "more than 50 percent believe that crypto-assets pose a threat to investors for various reasons" (IOSCO, 2020: p. 4). Thus greatly urging the need for financial education about crypto-assets.

[30] Officially known as Directive 2014/65/EU. For more about MiFID II, see EP and CEU (2014).
[31] For more about MiCA, see EC (2020).

### 1.4.8. Data protection and privacy in digital finance

The FinTechs and especially the BigTechs are able to collect a myriad of data from their customers, sometimes in opaque ways. Concerns about the amount and type of data collected has raised awareness[32], and authorities around the world started to enacted data privacy laws since 2018, the GDPR[33] from the EU, beyond others, tried to address these concerns, by requiring customer consent to share its personal data. The PSD2, the EU's open banking legislation, allows the portability of the bank customer data with customer consent, to third parties or competitors, and this allows data to be shared, although with some restrictions to the type of data and institutions (BIS, 2019). Recently, China has also proposed a greater oversight on the data collected by Chinese BigTechs, starting with the biggest e-commerce and payment platforms (Chen, 2021).

[32] In 2019, Bundeskartellamt, the German competition authority, banned Facebook from aggregating user data from different sources (of their group, WhatsApp and Instagram) (BIS, 2019).

[33] Officially known as Regulation (EU) 2016/679. For more about GDPR, see EP and CEU (2016).

# 2. Research Methodology and Data

In the research methodology chapter, the research questions and the research methodology with the necessary data relevant to this Dissertation are discussed.

## 2.1. Goals and Research Questions

As mentioned before, this Dissertation addresses whether the financial digitalization poses risks or opportunities for market participants, challengers, incumbents, consumers and regulators. For that goal, several research sub-questions are specifically addressed to each of these participants, in order to answer the main research question. The research questions are the following:

**General research question:**

Financial Digitalization: Risk or Opportunity?

**Research sub-questions:**

a) Where are the main areas of digital disruption in the financial system?
b) What is the impact of the digitalization of financial services on consumers?
c) How can financial digitalization affect the financial system?
d) What challenges will regulators face with the digital economy?

These questions assess several levels as seen in the literature review above, with a prevalent theoretical scope and without robust quantitative detail. However it should be pointed out that there is a lack of detailed data related to FinTechs' and BigTechs' activities, including their impact on the economy and society, and the existing disaggregated and unstructured information around finance digitalization. So the research in this field is typically quite limited to the availability of data.

## 2.2. Research Methodology

The digitalization of finance is a phenomenon currently taking place, with some of their actors being young and small companies, having little corporate history and being mostly private companies. This makes the data collection and subsequent use a challenging task. Notwithstanding, the methodology to be used in this Dissertation will have a quantitative approach to contribute to a more quantitative study of the subject and bring more detail about the technological evolution in finance. For that, data will be collected from diversified sources and treated to fulfill the goals of this Dissertation. As the research questions are broad questions that have a high degree of interconnectedness among them, the quantitative data collected and analyzed could answer multiple questions more universally, although limited to the said data availability. This Dissertation has the ambitious goal to aggregate several research subjects that were previously studied

separately and mainly in a theoretical way, so this Dissertation critically analyses new variables and data in a new and different perspective. The statistical methods include cross-sectional data collected at a particular point of time; panel data with a multi-dimensional data collection; and time series with observations at various points in time.

The hypotheses to be posed include:

Is it confirmed that FinTechs tend to emerge in developing economies and in economies underserved by financial services, as suggested by several authors reviewed above? Will this be the case in Europe? (These hypotheses will be put forward for analysis in case exhibit #1.)

Was payments the area of greatest preference for consumers or is it credit? Will US consumers be more receptive to FinTechs services than European consumers? (They will be analyzed in case exhibit #2.)

Will personal or corporate financing be more prevalent? Will the least developed economies and those least served by financial services be the ones with the greatest number of crowdfunding platforms? (These hypotheses will be studied in case exhibit #3.)

On continental Europe's largest crowdfunding platform, will personal credit be the most prevalent? Are credit needs increasingly being financed by non-bank lenders? (The hypotheses will be tested in case exhibit #4.)

Is regulation a preponderant factor in financial innovation, namely in crypto-assets and in Europe? Is European regulation more responsive than British regulation? (In case exhibit #5, these hypotheses will be addressed.)

Could Bitcoin be considered as a safe haven asset like gold? Can Bitcoin be considered a store of value? Are Bitcoin-linked instruments perfect substitutes for Bitcoin investments? Are the 'stablecoins' really stable and perfectly follow their reference assets? The 'stablecoin' with reference to USD, Tether (USD) is a perfect substitute for USD and maintains its 1:1 parity with USD? Will investing in crypto-assets and related financial instruments have better risk-adjusted returns than more traditional assets, such as investing in the S&P 500? (These hypotheses will be addressed in case exhibit #6)

## 2.3. Data

As previously mentioned the data on this subject are disaggregated and unstructured, due to a dynamic and constant evolving environment, proprietary data, a reduced history of some of the companies and complexity of financial instruments, forcing the data collection to be collected from several sources. The data analyzed includes, proprietary data from the FinTechs (eToro and Mintos); data from financial institutions (21Shares; CoinShares; ETC Group; FiCAS; HANetf; Iconic Holding; SEBA Bank; VanEck; WisdomTree and World Bank); third-party data from crypto-data firms (CoinGecko and CoinMarketCap), financial databases (Investing.com), investment research companies (Morningstar), data and information services firms (Business of Apps; P2P Market Data; TheBanks.eu), and from statistical offices (Eurostat). Due to the nature of the data, several case exhibits are built namely the following:

**Case exhibit #1**

This case exhibit's goal is to analyze the relation between the economy's development and the existence of banks and challengers in EEA[34] plus Switzerland and United Kingdom (EEA+2). For that purpose, the following variables about those economies were chosen: the GDP at purchasing power parity[35] in millions EUR, and the population, both for 2019, from the Eurostat; the number of banks currently operating and recently closed, the number of EMIs[36] also currently operating and recently closed, all collected on May 25th, 2021, from TheBanks.eu; the number of equity crowdfunding and P2P lending platforms on May 25th, 2021 from the P2P Market Data; and account ownership (% of population ages 15+) for the years of 2011, 2014 and 2017 from Demirgüç-Kunt et al. (2018). All collected data except the data from Demirgüç-Kunt et al. (2018) is cross-sectional data that were extracted on May 25th, 2021 and the panel data is extracted from Demirgüç-Kunt et al. (2018).

Several ratios are computed, such as the GDP at PPP per capita in EUR, the number of people served by several financial institutions, the currently operating banks, the operating EMIs, the investing crowdfunding platforms (the sum of the equity crowdfunding platforms plus the P2P lending platforms), dividing the population each economy had in 2019 by all the previous mentioned variables. An 'Innovation Indicator' is created, defined by the sum of the investing crowdfunding platforms plus the EMIs currently operating for each country, and with this indicator the population served by the 'Innovation Indicator' was also created. The ratio of the number of EMIs per banks currently operating in each jurisdiction and the banks' 'Unsuccess Rate' measured by the percentage of the number of recently closed banks in relation to the total of the existing banks are also computed.

It should be observed that data availability for specific dates or economies is lacking, thus limiting not helping a more in-depth analysis.

**Case exhibit #2**

After a macroeconomic analysis in the previous case exhibit, we conduct a more microeconomic analysis with the objective of studying the areas where FinTechs have more prevalence and at the same time to enquire about their consumers' preferences. We compute the number of total registered users in millions from the largest FinTechs in their segment and geographic areas in the time horizon from 2016 to 2020, such as, Mintos, the largest crowdfunding platform in the continental Europe by funding volume with data collected through proprietary data; eToro, the largest social trading platform, with proprietary data; the following data was retrieved from Business of Apps about: Revolut, the largest digital challenger bank in Europe including UK by AUM (it also offers trading services); Robinhood, the largest US commission-free stock trading platform by AUM; Coinbase, the US largest crypto-assets trading platform by AUM; PayPal,

[34] The EEA Member States are: the 27 EU Member States (Austria; Belgium; Bulgaria; Croatia; Cyprus; Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Ireland; Italy; Latvia; Lithuania; Luxembourg; Malta; Netherlands; Poland; Portugal; Romania; Slovakia; Slovenia; Spain; and Sweden) and the three EFTA Member States (Iceland; Liechtenstein; and Norway).

[35] The GDP at purchasing power parity measures the total value of all final goods and services produced during a specific time period adjusted for the inflation, exchange rate and other national variables.

[36] For more about the EMIs, see EP and CEU (2009).

the largest online payment platform by total assets; Venmo (a PayPal subsidiary) and Cash App (a Square subsidiary) are two of the largest US mobile payment services, with Cash App also offering trading services.

Mintos is a Latvian-based marketplace lending platform that allows non-bank lenders to have liquidity to lend more as they sell claim rights for loan receivables they previously made to investors at lower interest rates earning the interest rate spread. Mintos offers loans granted by loan originators from Europe, Asia, Africa and Latin America and accept investors from all over the world (Mintos, 2021). According to P2P Market Data (2021), Mintos is the leader in the crowdfunding space, with a total of 6.41 billion EUR in financed loans up to April 30th, 2021, although the P2P Market Data database is somewhat incomplete. In case exhibit #3, the crowdfunding ecosystem and in case exhibit #4, a more granular analysis on Mintos is addressed more thoroughly.

eToro was born in Israel as foreign exchange trading platform that evolved into a CFDs, crypto-assets, stocks and ETFs trading platform that allows investors to invest independently or by coping other investors transactions, a trend known as social trading[37]. It became the largest social trading platform, according to eToro (2021a). eToro offers its services in several countries, including in Europe, US, Asia, and Oceania.

Revolut is an app-based challenger bank, initially created in UK, offering payment services with multi-currency accounts and debit cards, currency exchange, personal insurance, crypto-assets, commodities, and stocks trading. Revolut has customers in Europe, US and Asia (Revolut, 2021). According to TheBanks.eu (2021), Revolut Ltd was the UK EMI market leader with 15.02% market share and 2.63 billion GBP of customer assets in 2019 and Revolut Payments UAB, the Revolut company for EU residents migrated from Revolut Ltd due to Brexit, was the Lithuanian EMI market leader with 2.59 billion EUR of customer funds in 2020, both companies offering banking and trading services. Revolut is the largest digital challenger bank in Europe (including the UK) by registered users according to Business of Apps (2021c).

Robinhood is an app-based brokerage services company and the largest US commission-free stock trading platform by AUM according to Business of Apps (2021c), offering trading services in stocks, ETFs, options, crypto-assets, and gold, it's recognized as a user-friendly and gamified trading platform that aims to democratize the investment process. Robinhood only operates in the US (Robinhood, 2021).

Coinbase is an US publicly listed crypto-assets exchange (Nasdaq: COIN) that is at the moment the US largest crypto-assets trading platform by AUM (Bull, 2021; Business of Apps, 2021b). It offers easy access to crypto-assets trading for inexperienced investors and constitutes a cross-border platform (Coinbase 2021).

PayPal, founded in the US is a payments services ecosystem that offers digital payments services through a multitude of forms and providing B2B and B2C services. With its subsidiary, Venmo, it also provides P2P mobile payments. Paypal is a public listed company (Nasdaq: PYPL) and according to

[37] FSB (2017a: p. 34) defines social trading as "A range of trading platforms that allow users to compare trading strategies or copy the trading strategy of other investors. The latter is often referred to as "copy trading" or "mirror investing"".

Finextra (2021), it is the largest payment platform with more than over 54 billion USD in total assets as of February 2021, the equivalent of almost 60% of the top ten non-bank lenders' total assets combined. Paypal provides its services globally (Paypal, 2021).

Venmo is an US mobile payment service and a PayPal subsidiary, and offers P2P mobile payment services, deposits, and debit and credit cards to customers located in US (Venmo, 2021). Venmo and Cash App are currently two of the largest US mobile payment services by registered users (Business of Apps, 2021c).

Cash App is an US mobile payment service owned by Square, Inc. that provides P2P mobile payment services, deposits, debit cards, stocks and Bitcoin trading services to customers in US, and only payments services in UK (Cash App, 2021).

Data limitations in this case exhibit are observed in the life cycle status of the analyzed companies, as well as in the geographies where they operate, as some are cross-border companies, while some have more implementation in US and others more in Europe, but expanding to other geographies.

**Case exhibit #3**

In this case exhibit, a more detailed analysis on the crowdfunding space is addressed, with cross-sectional data collected at May 20th, 2021 from P2P Market Data (2021) referring to 85 alternative investment online platforms by funding volumes in millions EUR updated at April 30th, 2021. This database includes several types of crowdfunding platforms, equity-based and debt-based crowdfunding platforms in various models, real estate crowdfunding, P2P and marketplace lending. With platforms specialized in one type of financing, or with a more diversified approach, such as equity and/or debt financing (e.g. corporate finance, such as startups/SMEs, or real estate crowdfunding), or in one type of financed loans, or various types of financed loans. These loans were originated and financed directly on the platforms or financing loans that were already granted by the loan originators, usually by non-bank lenders. This database includes crowdfunding platforms from Europe, North America, and Latin America. The P2P Market Data doesn't list all existing equity-based and debt-based crowdfunding platforms, such as those from the US (e.g. LendingClub or Prosper Marketplace) and from the UK (e.g. Funding Circle or Zopa).

One important data limitation in this case exhibit is data availability, e.g. small number of US and UK platforms, especially the oldest and largest ones mentioned above, in addition to the lack of platforms in Asia-Pacific[38] and Africa, as well as the small number of Latin-American platforms presented.

**Case exhibit #4**

Following the study of the alternative investment online platforms, a more granular analysis of the market leader by funding volume in continental Europe, Mintos, is conducted. Mintos is a Latvian marketplace lending platform that offers funding for several types of loans, short-term loans (also known as payday loans); personal loans (long term loans); car loans (including car leasing); mortgage loans; business loans; agriculture loans; pawnbroking loans; and invoice financing (also known as factoring), granted on several

[38] In recent years, China closed the majority of its P2P lending platforms, from about 6000 at its peak to 29 platforms (Bloomberg News, 2020).

countries in Europe, Asia, Africa and Latin America[39]. Panel data for the each loan type outstanding and by region of origination in EUR, in December 31st of each year since the first year of operation of Mintos, from 2015 to 2020 is collected, with the objective to see which loan type and regions are dominant and consequently what are the credit needs. Was also collected the total funding on this platform, both the cumulative funding per year and the annual funding in millions EUR, from Mintos' inception in 2015 until the end of 2020. This is done in order to observe the evolution of private credit financing. All this data are collected from proprietary data originated from Mintos (Mintos 2021).

Although proprietary data since inception is used, Mintos is a young company with six years of existence and the firm doesn't provide data on loans outstanding by country of origination for all periods of time, limiting a deeper analysis.

**Case exhibit #5**

This Dissertation wouldn't be complete if the crypto-assets and regulation weren't analyzed, so for that purpose cross-sectional data about the crypto ETNs (also known as crypto ETPs)[40] listings in the European stock exchanges up to June 30th, 2021, was collected. The data was collected from several sources, from the investment research provider Morningstar and ETPs issuers (21Shares; CoinShares; ETC Group; FiCAS; HANetf; Iconic Holding; SEBA Bank; VanEck; and WisdomTree).

The only observed limitations were the data fragmentation and the constant expanding European crypto ETP space, with new listings of the existing ETPs and the creation of new crypto ETPs.

**Case exhibit #6**

In this last case exhibit, the performance of a series of assets is analyzed, including the S&P 500 index, the CBOE Volatility Index (VIX) and the EUR/USD pair as benchmarks for the Bitcoin in USD (BTC/USD), the relationships between the 'stablecoins' and its reference assets, especially between Tether USD and USD. The performance of a crypto ETPs (21Shares Bitcoin ETP (ABTC)) that intends to track BTC/USD is also analyzed. The relationship between Bitcoin and various currencies is the focus of attention in order to find out whether the quote currencies play any role in Bitcoin valuation. Time series data of these instruments is collected from different sources, with daily frequency, denominated in various currencies, and for the maximum time horizon available (Table 2.1). As crypto-assets are traded every day of the year but traditional assets are not traded on weekends and holidays, data collection comprises daily data for the S&P 500 trading days since April 29th, 2013, the first available data for Bitcoin, and for other crypto-assets since their first available data.

[39] Mintos offers loans originated in Europe (Albania; Armenia; Belarus; Bosnia and Herzegovina; Bulgaria; Czech Republic; Denmark; Estonia; Finland; Georgia; Kazakhstan; Kosovo; Latvia; Lithuania; Moldova; North Macedonia; Poland; Romania; Russian Federation; Spain; Sweden; Turkey; Ukraine; United Kingdom; Uzbekistan); Asia (China; Indonesia; Mongolia; Philippines; and Vietnam); Africa (Botswana; Kenya; Namibia; South Africa; and Zambia); and Latin America (Colombia; and Mexico) (Mintos, 2021).

[40] ETNs or exchange-traded notes, are exchange-traded debt securities, part of the ETPs family, that are linked to the performance of an underlying asset, that includes indexes, basket of assets or a single asset, made of stocks; bonds; funds; or crypto-assets. The ETNs could be collateralized (physical assets) or uncollateralized. The ETNs could use a physically backed replication method or synthetic replication method (e.g. swaps with or without collateral) to be able to offer the underlying asset performance (Börse Frankfurt, 2021).

**Table 2.1** – Case exhibit #6: Variables

| Type | Name | Currency | Underlying | Start Date | End Date | Source |
|---|---|---|---|---|---|---|
| Index | S&P 500 (SPX) | USD | | 29-04-2013 | 31-05-2021 | [1] |
| Index | CBOE Volatility Index (VIX) | USD | S&P 500 | 29-04-2013 | 31-05-2021 | [1] |
| ETF | SPDR Gold Shares (GLD) | USD | Gold | 29-04-2013 | 31-05-2021 | [1] |
| ETP (ETN) | 21Shares Bitcoin ETP (ABTC) | USD | Bitcoin | 08-03-2019 | 31-05-2021 | [1] |
| Currency | USD/EUR - US Dollar Euro | EUR | | 29-04-2013 | 31-05-2021 | [1] |
| Currency | EUR/USD - Euro US Dollar | USD | | 29-04-2013 | 31-05-2021 | [1] |
| Commodity | XAU/USD - Gold Spot US Dollar | USD | | 29-04-2013 | 31-05-2021 | [1] |
| Crypto-asset | BTC/USD - Bitcoin US Dollar | USD | | 29-04-2013 | 31-05-2021 | [2] |
| Crypto-asset | BTC/EUR - Bitcoin Euro | EUR | | 29-04-2013 | 31-05-2021 | [2] |
| Crypto-asset | BTC/JPY - Bitcoin Japanese Yen | JPY | | 29-04-2013 | 31-05-2021 | [2] |
| Crypto-asset | BTC/GBP - Bitcoin British Pound | GBP | | 29-04-2013 | 31-05-2021 | [2] |
| Crypto-asset | PAXG/USD - PAX Gold US Dollar | USD | Gold | 26-09-2019 | 31-05-2021 | [2] |
| Crypto-asset | WBTC/USD - Wrapped Bitcoin US Dollar | USD | Bitcoin | 30-01-2019 | 31-05-2021 | [2] |
| Crypto-asset | USDT/USD - Tether US Dollar | USD | USD | 02-03-2015 | 31-05-2021 | [3] |
| Crypto-asset | USDT/EUR - Tether Euro | EUR | USD | 02-03-2015 | 31-05-2021 | [3] |

Notes: S&P 500 (SPX) and CBOE Volatility Index (VIX) are US indexes; SPDR Gold Shares (GLD) is listed in the NYSE Arca; 21Shares Bitcoin ETP (ABTC) is listed in the SIX Swiss Exchange. The following crypto-assets are asset-backed tokens ('stablecoins'): PAXG/USD; WBTC/USD; USDT/USD; USDT/EUR.
Sources: [1] Investing.com; [2] CoinMarketCap; [3] CoinGecko.

The analysis included the computation of various indicators over different time periods, YTD (from January 1st, 2021 to May 31st, 2021); one, three, and six months; one, two, three and five years; and data since April 29th, 2013. The indicators studied include: cumulative returns; annualized returns; volatility (standard deviation); risk-adjusted returns (annualized returns divided by their volatility); tracking error (standard deviation of the difference between the asset and its reference); and the correlations of all instruments, with all indicators computed based on logarithmic returns.

Data limitations include the lack of all crypto-assets' historical data and the short existence of crypto-assets.

# 3. Research Findings and Discussion

The case exhibit #1 (Annex B.1-B.2) shows that the economies with higher development are the ones that are more served by banks, adjusted to their population, namely Liechtenstein, Luxembourg, Malta, Cyprus, and Switzerland (Annex B.3), with four of these economies being the same four with better population-EMIs ratio, and with Switzerland being replaced by Lithuania on the top five jurisdictions with less people per EMIs (Annex B.4). Where investing crowdfunding platforms, Switzerland and Cyprus are still present as two of the economies with a higher number of investing crowdfunding platforms relative to their population, but the three Baltic countries are the top three with less people served per investment crowdfunding platforms (Annex B.5). In the aggregated 'Innovation Indicator', Liechtenstein, Luxembourg, Malta, and Cyprus continue to appear as the economies with a higher presence of FinTechs, but Lithuania is the outsider due to its high number of EMIs relative to its population (Annex B.6). The EMIs per banks ratio shows that Lithuania has a strong presence of EMIs, reaching almost four times the number of banks in Lithuania, although the UK has a great number of operating banks, it also have a relevant number of EMIs, the highest in absolute terms on EEA+2, the rest of the jurisdictions being Malta, Cyprus, and Liechtenstein (Annex B.7). When considering the banks' 'Unsuccess rate', the only economy present mentioned on the above tables is Latvia (Annex B.8).

The computed results don't fully corroborate the similar results of the reviewed literature, as there isn't any evidence that FinTechs are more prevalent in unbanked economies and in the EMDEs than on the economies best served by banks and developed economies. Lithuania has an economy with a predisposition for technological innovation and at the same time shows a population with less access to financial services (account ownership) when compared with other jurisdictions with higher financial innovation. Bank closures don't seem to be a catalyst to the appearance of more FinTechs on the respective countries, with the exemption of Latvia with a high number of closed banks and a high number of operating P2P lending platforms, denoting perhaps some credit needs in that country. Some jurisdictions are recurrent, especially with less population per banks, EMIs, and per 'Innovation Indicator' ratios, and including the high EMIs per banks ratio, such as Liechtenstein, Luxembourg, Malta, and Cyprus, which could suggest external factors to attract banks and FinTechs, such as a more friendly tax environment[41]; the same for the Baltic countries, especially Lithuania and Latvia that show a possible greater opening for financial innovation[42].

[41] Tax Justice Network identifies Liechtenstein, Luxembourg, Malta, and Cyprus as corporate tax heavens (Tax Justice Network, 2019).

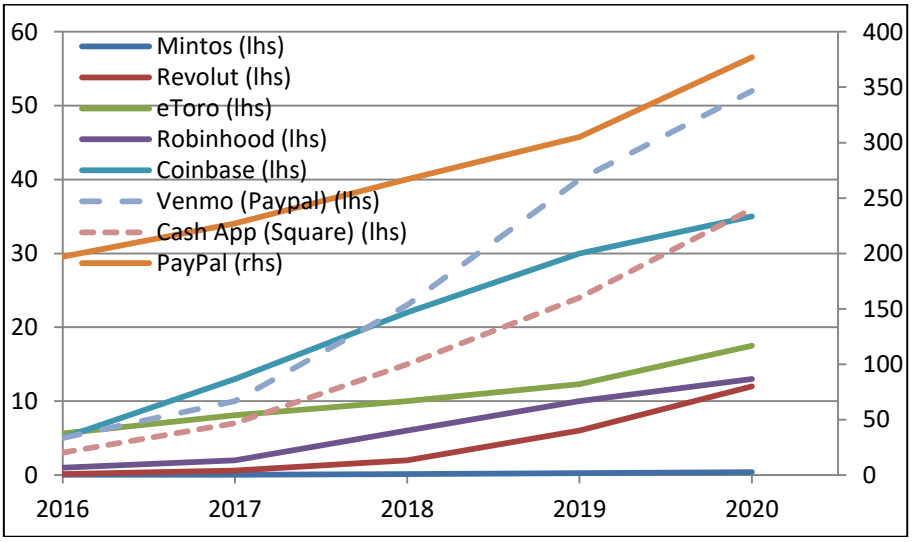
[42] Lithuania through the Bank of Lithuania has created a FinTech-friendly regulatory environment, e.g. a regulatory sandbox for FinTech development; faster and less expensive FinTech licensing; and access to the national payment system (CENTROlink) for the payments institutions and EMIs (Lietuvos Bankas, 2019). The presence of P2P lending platforms in Latvia was fostered by the absence of regulation on them, with the Latvian Financial and Capital Market Commission (FCMC) working towards the regulation of the P2P lending platforms (Labs of Latvia, 2020). Estonia has demonstrated openness to technological innovation by conducting a series of e-government initiatives, like the e-Residency program to attract foreign entrepreneurs, with government-issued digital identity and status to facilitate the creation of Estonia-domiciled new businesses with the remote management possibility (Republic of Estonia e-Residency, 2021).

Also noteworthy, the UK has the highest number in absolute terms of EMIs in EEA+2, possibly due to the British financial regulator position in terms of financial innovation[43].

Taking into account the age of FinTechs analyzed in case exhibit #2 (Annex B.9), it is important to observe that payments are the area with more registered users, followed by the trading services sector (including securities, derivatives, and crypto-assets trading), and in the end the lending service providers. This suggests that payments are more relevant to the financial services consumers than trading and loan financing. It also shows that there are more consumers in US FinTechs than in the European counterparts, which demonstrates that US consumers are more receptive to financial innovation that FinTechs bring, than European consumers (Figure 3.1).

**Figure 3.1** – FinTechs: Total registered users, 2016 – 2020

(Ratio: millions people)



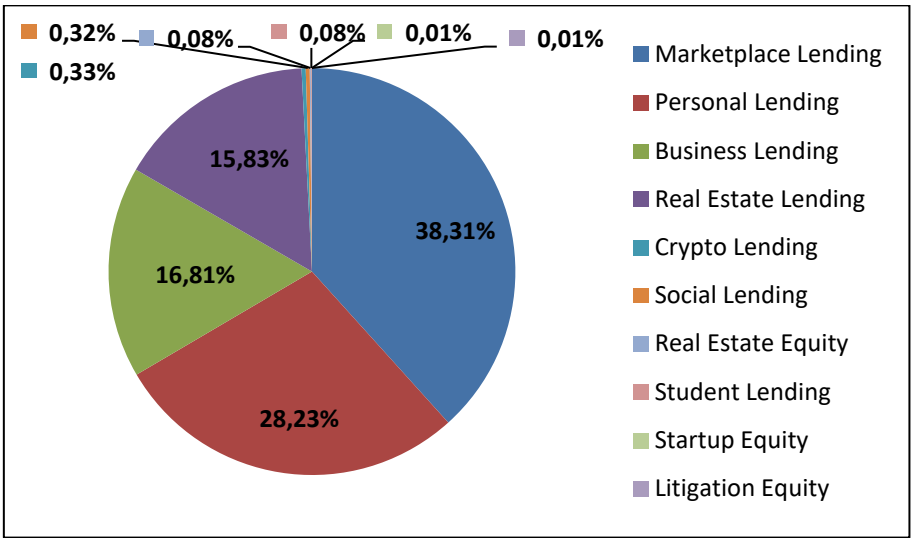

Sources: Business of Apps (2021a; 2021b; 2021c), eToro (2021), Mintos (2021).

According to the results obtained in the case exhibit #3 (Annex B.10-B.11) it is possible to observe that marketplace lending (a model that loan originators sell claim rights for loan receivables they previously granted to investors), and personal lending or the traditional P2P lending model for unsecured personal loans (when borrowers and lenders meet in an online platform to make the lending transactions), represent nearly two-thirds of the total funding for platforms on the P2P Market Data (Figure 3.2).

[43] The FCA has several initiatives to encourage financial innovation, including a regulatory sandbox, direct support and advice (FCA, 2021).

**Figure 3.2** – Investment crowdfunding: Platforms funding, 30-04-2021

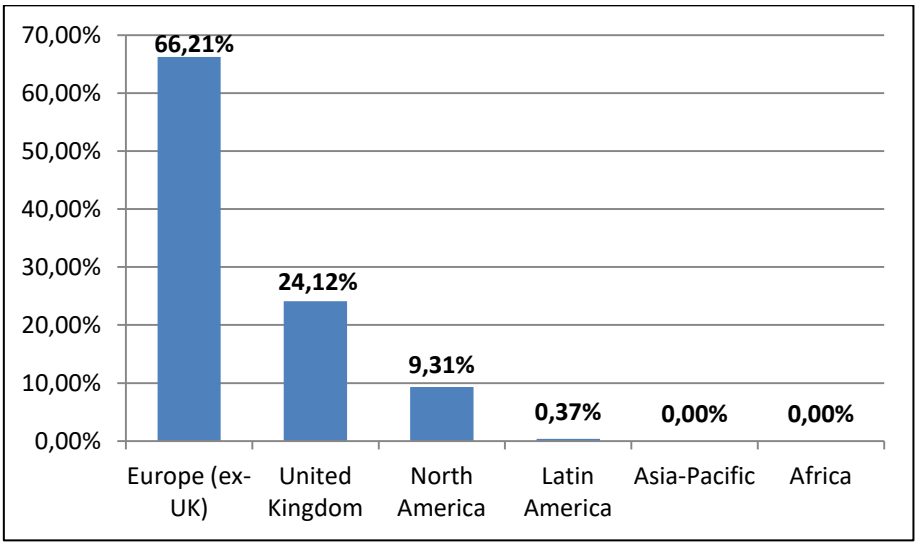
(Ratio: %)




As previously mentioned the database is incomplete, so the data collected shows a prevalence of Europe (ex-UK) funding volume (Figure 3.3). The Baltic region[44] represents almost 46% of the funding volume within Europe including the UK (Figure 3.4). From a total of 85 platforms in P2P Market Data funding volume database, the Baltic region has 27 investment crowdfunding platforms, Mintos being the leader by funding volume with a total of 6.41 billion EUR in financed loans up to April 30th, 2021. The higher relevance of the Baltic region in the investment crowdfunding area was also previously observed in case exhibit #1.

**Figure 3.3** – Investment crowdfunding: Geographic dispersion, 30-04-2021

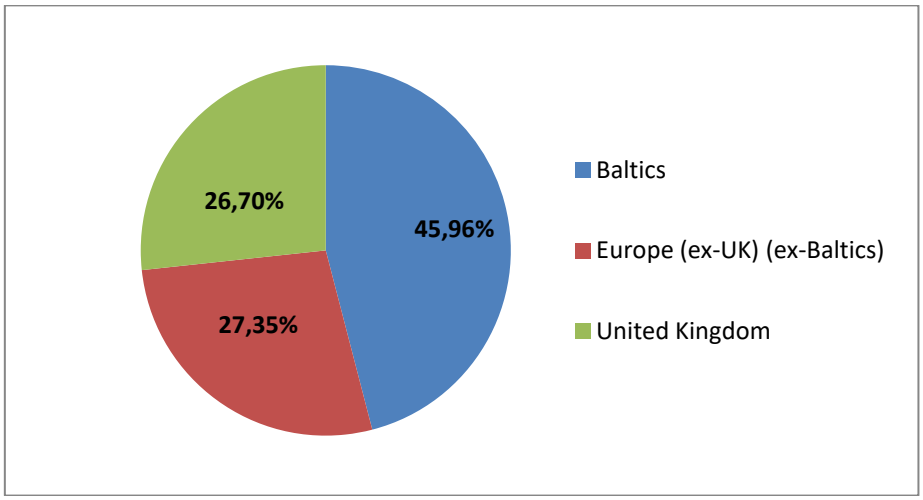
(Ratio: %)




[44] The Baltic region includes Estonia, Latvia, and Lithuania.

**Figure 3.4** – Investment crowdfunding: Europe, 30-04-2021

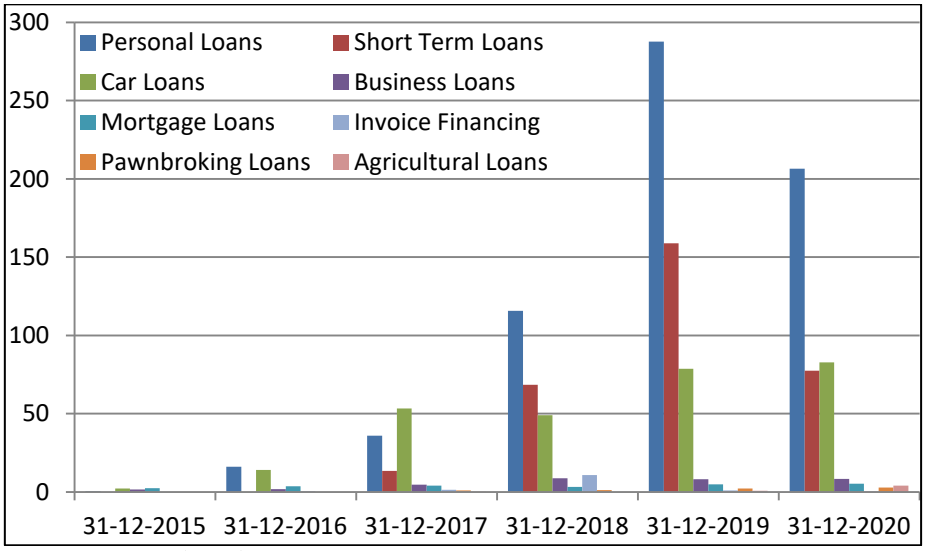
(Ratio: %)




The case exhibit #4 (Annex B.12-B.13) allows us to observe that in the Mintos platform, unsecured personal loans (including short-term loans) represents around 75% of total loans outstanding at the end of 2020 and European borrowers are the majority with about 75.5% of all loans outstanding in Mintos in the same date. Car loans were also a relevant loan type outstanding in Mintos. Almost every loan type had increased between 2015 and 2020, the exceptions being invoice financing in 2019 and 2020; and unsecured personal loans (including short-term loans) which decreased in 2020 (Figure 3.5). After increasing since inception, all regions suffered a decrease in outstanding loans at the end of 2020 (Figure 3.6).

**Figure 3.5** – Mintos: Outstanding investments by loan type, 2015 – 2020

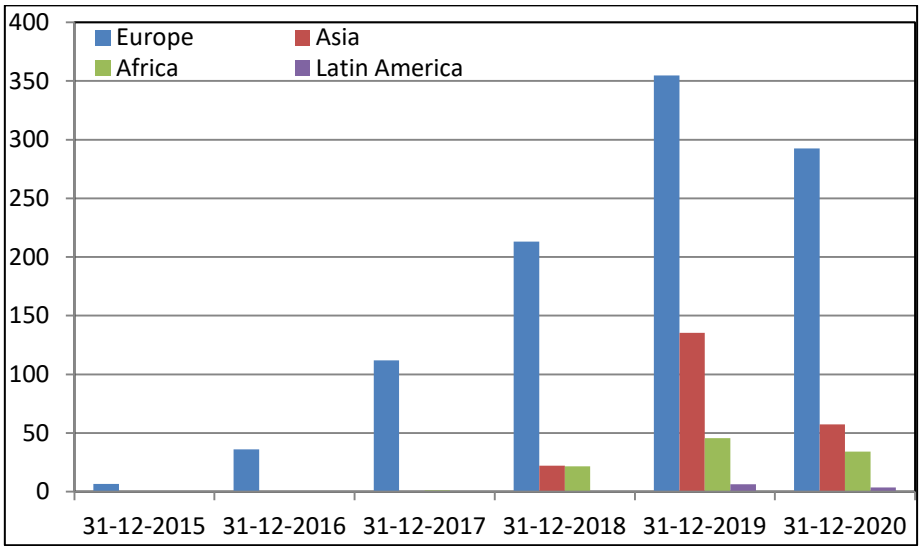
(Ratio: EUR millions)




Source: Mintos (2021).

**Figure 3.6** – Mintos: Outstanding investments by region, 2015 – 2020

(Ratio: EUR millions)

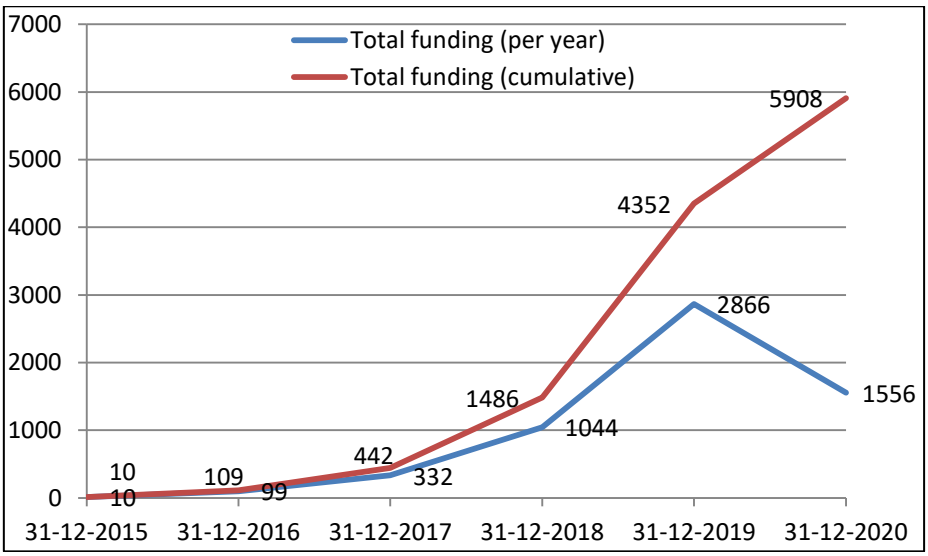



Source: Mintos (2021).

The year of 2020 was the only year when funded loans were less than the previous year, meaning there was a decrease of funding (Figure 3.7-3.8).

**Figure 3.7** – Mintos: Total funding, 2015 – 2020

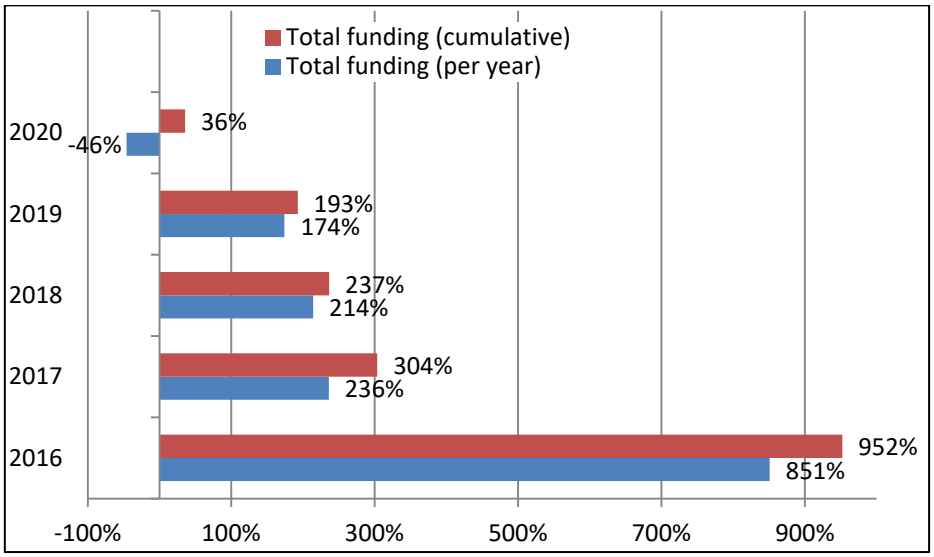
(Ratio: EUR millions)




Source: Mintos (2021).

**Figure 3.8** – Mintos: Funding growth rate, 2015 – 2020

(Ratio: %)




The results could suggest more credit needs in Europe, especially in unsecured personal loans, both short-term and long-term loans, that appeared to grow until the end of 2020, but in 2020 it grew less than in 2019, which could be explained by the COVID-19 pandemic that has put some pressure on loan originators due to their low liquidity caused by credit moratoriums implemented by several governments and by greater investors' risk aversion to finance the loan receivables[45].

Case exhibit #5 (Annex B.14-B.15) describes how Swedish financial regulators were the pioneers to authorize the listing of crypto ETPs on European stock exchanges in May 2015, but only eight ETPs were created and listed on the Swedish exchanges between May 2015 and April 2019, with four of them expiring in April 9th, 2021, about two years since their inception; also from a total of 40 crypto ETPs, eight of them were uncollateralized debt instruments, issued by Swedish issuers, the XBT Provider, reflecting a trend towards issuing physically backed crypto ETPs. In an universe of 40 multi-currency crypto ETPs[46] approved and listed on European exchanges, Switzerland is the jurisdiction with the most crypto ETPs approved, representing 80% of all crypto ETPs, followed by Germany with 65%, Netherlands and France with 22.5%, Sweden and Austria with 20% and 7.5% respectively (Annex B.16). Out of a total of 109 listings on European exchanges, Germany is the jurisdiction with the highest number of listings, with 42 listings on German exchanges or the equivalent of about 38.5% of all listings on European exchanges, Switzerland with 38 listings or about 35%, the Netherlands and France with nine listings each representing around 8% each, Sweden with eight listings and about 7% and finally Austria with only three listings representing 2.75% of the total listings on the European exchanges (Annex B.17). It is also worth

[45] Several loan originators on Mintos defaulted or had liquidity constrains that prevent them from repaying the principal and interest owed to investors on their pre-determined dates (Mintos, 2021).

[46] The physically backed crypto ETPs were issued in several currencies, including USD, EUR, CHF, and GBP, with the same ISIN for all currency denominations. The uncollateralized crypto ETPs had a distinct ISIN for each currency, the SEK and EUR.

mentioning the absence of crypto ETPs listed on the London Stock Exchange. Taking into account the origin of the crypto ETPs issuers, it can be observed that Switzerland is the preferred jurisdiction for issuers of these products, representing half of all crypto ETPs issued, created by three Swiss issuers. Sweden with one issuer represents 20% of all crypto ETPs issued, Germany with three issuers and the UK with two issuers represent 15% each, are the remaining jurisdictions with crypto ETPs issued by management companies based there (Annex B.18).

These results suggest that Switzerland is a crypto-friendly jurisdiction, both in attracting companies that issue financial instruments that are linked to the crypto-assets' performance and in their regulatory approval and listing on Swiss stock exchanges[47]. Germany despite having the same number of issuers as Switzerland, has started later and launched far fewer crypto ETPs, but it is offset by a significant number of listings on German exchanges[48]. The small number of listings on the French and Dutch exchanges reflects recent approvals from the respective financial regulators[49]. Sweden, despite being a pioneer in approving crypto ETPs, has not shown the same dynamism recently in approving and listing new crypto ETPs[50]. So we can distinguish an evolution from Swedish uncollateralized crypto ETPs to physically backed crypto ETPs first made in Switzerland that grew to other jurisdictions, such as Germany, which is becoming not only a financial center for crypto ETPs listings but also their issuance. Only very recently did the Netherlands and France admit crypto ETPs for trading, showing a willingness to follow the footsteps of Germany. This case exhibit also demonstrates a policy separation towards crypto ETPs between continental European financial regulators and the British financial regulator[51], which does not allow retail investors to trade crypto ETPs, while continental regulators show a greater openness to financial instruments linked to the crypto-assets' performance.

Case exhibit #6 addresses Bitcoin-denominated in multiple currencies (USD; EUR; JPY; GBP), 'stablecoin' (WBTC/USD) and crypto ETP (ABTC) both with reference to BTC/USD. The latter have obtained better returns, both cumulative and annualized, than the S&P 500 index in time periods exceeding five months (YTD), and with significant losses in shorter periods, especially in one month period, while the S&P 500 managed to have positive returns in all the analyzed time periods (Annex B.19-B.20). When compared to gold (XAU/USD) and its ETF (GLD), it turns out that Bitcoin cannot be considered as a safe haven asset, as gold and its ETF managed to obtain positive returns in all time periods, while Bitcoin

[47] Switzerland is considered one of the world's leading ecosystems for crypto-assets, blockchain, and distributed ledger technologies, being known as the Crypto Valley, due to its nationwide ecosystem; besides being a financial center, Switzerland benefits from a crypto-friendly regulatory environment and recently introduced blockchain legislation, which attracted 960 blockchain technology companies up to February 2021, including 11 unicorns or companies with market valuations of more than 1 billion USD each: Ethereum, Cardano, Polkadot, Aave, Cosmos, Solana, Tezos, Dfinity, Near, Nexo, and Diem (PwC, 2021; Crypto Valley Association, 2021).

[48] Deutsche Börse had its first listed crypto ETP on June 2020, growing to 15 crypto ETPs from six ETP issuers up to June 30th, 2021(Xetra, 2021).

[49] Euronext Paris and Euronext Amsterdam admitted for trading the first crypto ETPs on June 1st, 2021 (Eckett, 2021).

[50] The Swedish regulator, Finansinspektionen (Financial Supervisory Authority) issued warnings on the February 22nd, 2021, about the risks associated with crypto ETPs for retail investors.

[51] FCA, the British regulator showed concerns about these financial products, banning the sale of crypto ETNs to UK retail investors starting on January 6th, 2021 (Gordon, 2021).

obtained sizable negative returns at one and three months. The other 'stablecoins' had different results, while the 'stablecoin' PAXG/USD obtained approximate returns on its reference asset (gold), and on the ETF that intends to follow the performance of gold, except in shorter periods, less than six months where it seems to show a decreasing trend of bonding to gold and even having negative returns in YTD, opposite to those verified in gold and its ETF. On the other hand, the 'stablecoin' with reference to the USD and denominated in EUR, the USDT/EUR, had worse returns than the USD/EUR for periods of less than five years, showing that it is better to invest directly in the USD/EUR pair at least in the short/medium term. The other 'stablecoin' with a reference to the USD but denominated in USD, the USDT/USD, demonstrates that it does not have a null relationship (or zero returns) as one would expect, i.e., a 1:1 parity (Annex B.21), with negative annualized returns against the USD between -0.05% and -4.87%. This evolution thus demonstrates that this 'stablecoin' cannot be considered as a substitute for USD.

With regard to volatility (Annex B.22), it is observed that Bitcoin, and the instruments that follow its performance, are significantly volatile when compared to the S&P 500 index, gold and its ETF. Thus Bitcoin is not a possible replacement asset of gold as a safe haven, as well as when compared to the EUR/USD, Bitcoin cannot be considered as a substitute as a means of payment because the volatility prevents it from being considered a store of value (Annex B.23). The crypto ETP (ABTC) proves to be more volatile than its underlying asset, except for a period of one month (Annex B.24). The so-called 'stablecoins' proved to be more volatile when compared to their reference assets. The 'stablecoin' WBTC/USD with reference to BTC/USD has been shown to have similar volatility to its underlying asset (Annex B.25). The Gold ETF (GLD) proves to be a better alternative than the PAXG/USD for those who want to get exposure to gold (Annex B.26). The USDT/USD that intends to follow the USD has volatility between about 5% and 9%, while having the USD in a direct exposure will have no volatility. In the same way as having USD/EUR directly, you will have less volatility than if you have USDT/EUR (Annex B.27). Only the CBOE Volatility Index (VIX) has more volatility than the analyzed crypto-assets.

When studying risk-adjusted returns (Annex B.28), the S&P 500 manages to outperform Bitcoin and the instruments referenced to it, except in the one-year period when Bitcoin manages to be slightly better than the S&P 500 index. Bitcoin (BTC/USD) only manages to outperform gold (XAU/USD) in risk-adjusted returns in the periods between five months (YTD) and one year, however it manages to outperform the EUR/USD pair in almost all periods, the exceptions being between one and three months. The crypto ETP (ABTC) has worse risk-adjusted returns than its underlying asset (BTC/USD). Bitcoin-linked 'stablecoin' (WBTC/USD) continues to underperform the underlying asset. Gold-linked 'stablecoin' proves to have worse risk-adjusted returns than its underlying asset (XAU/USD) and its ETF (GLD). The USDT/EUR 'stablecoin' manages to have better risk-adjusted returns than the USD/EUR pair; finally the USDT/USD 'stablecoin' yields negative risk-adjusted returns but close to zero.

The tracking error[52] (Annex B.29) between the BTC/USD and the crypto ETP (ABTC) that follows it is considerable, between about 60% and 77%. In the segment 'stablecoin' the WBTC/USD, the 'stablecoin' that follows the BTC/USD has a tracking error between about 5% and 30%; gold ETF (GLD) has less tracking error than the 'stablecoin' PAXG/USD or 1.6% to 3.4% vs. 7.7% to 10.4%; and in the 'stablecoin' USDT/EUR, there is a tracking error of about 5% to 26% relative to USD/EUR. This reflects the fact that instruments that track the performance of an underlying asset have significant tracking errors when it comes to crypto-assets or ETPs that track them.

In the correlations (Annex B.30-B.38), Bitcoin (BTC/USD) and its 'stablecoin' WBTC/USD are positively correlated with the S&P 500 index, being more correlated than gold for periods longer than five months (YTD). The crypto ETP (ABTC) is generally more correlated with S&P 500 than gold. This thus fully confirms that Bitcoin and the instruments referenced to it cannot be considered as safe haven assets superior to gold. The WBTC/USD 'stablecoin' has an almost perfect positive correlation with the BTC/USD (Annex B.39), while the crypto ETP (ABTC) has a strong positive correlation with the BTC/USD (Annex B.40), but less than its 'stablecoin'. The PAXG/USD 'stablecoin' is less correlated with gold than the gold ETF (GLD), which has an almost perfect positive correlation (Annex B.41). The correlation between the USDT/EUR 'stablecoin' and USD/EUR is positive, but it does not come close to a perfect correlation as would be expected for a crypto-asset that intends to be considered as an alternative to the USD (Annex B.42). Bitcoin correlations denominated in various currencies are positive and close to one, meaning an almost perfect positive correlation, demonstrating that the denomination currency plays little role in Bitcoin valuation (Annex B.43).

[52] For more about tracking error, see Informa Investment Solutions (2016).

# Conclusion

The ambitious aim of this Dissertation seeks to discover whether financial digitalization presents itself as a risk or an opportunity, and what would be the main areas of disruption in financial services, its impacts on consumers of financial services, and whether financial digitalization will impact the financial sector and bring about challenges in financial regulation. The possibility exists that financial digitalization will bring new opportunities for financial sector actors, from consumers to regulators, including incumbents, but it also carries associated risks.

In order to be able to answer the questions of this Dissertation, we resort to the quantitative (i.e., statistical) analysis of several variables divided into several case exhibits according to a common theme. We perform a more macroeconomic analysis of the financial sector in each jurisdiction in the EEA+2 to a more granular analysis of financial assets, such as crypto-assets, paying attention to the specificities of each theme analyzed in individual case exhibits.

It can be observed that the jurisdictions with the greatest economic development are those that have a better ratio of banking services, but at the same time, they also have better access to FinTechs (e.g., Liechtenstein, Luxembourg, Malta, and Cyprus). Of note is the presence of the Baltic countries, especially Lithuania in the area of payments and Latvia in the area of credit financing. The UK is also a relevant player in financial innovation, with a significant number of FinTechs, both in payments and financing. With the exception of Latvia, where it was one of the jurisdictions with the highest number of bank closures and the existence of a greater number of credit platforms, which seems to suggest a greater need for credit in this economy, the other jurisdictions with a higher proportion of FinTechs are Liechtenstein, Luxembourg, Malta, and Cyprus. At the same time, better financial services and greater economic development may suggest the existence of external factors of attraction for the creation of FinTechs in these economies, such as a more favorable corporate taxation. In one of the economies with greater presence of FinTechs depending on its population, Lithuania, a more FinTech-friendly regulatory environment could be an important factor in attracting FinTechs to this jurisdiction. Also in the Baltic countries, in Latvia, regulation (in this case the lack of it) plays an important role for the existence of FinTechs. Finally, in Estonia, political actors created an ecosystem of technological innovation, as well as policies to attract technological companies.

The payments area in Europe and US is the financial domain with the highest number of users, followed by trading services (securities, derivatives, and crypto-assets) and credit financing with the lowest number of users. This suggests a greater need for payments than for other financial services. The results also suggest that US financial services consumers are more receptive to financial innovation than European consumers.

In the area of financing, results also suggest greater personal credit needs, mainly in continental Europe, with a significant presence of credit platforms in the Baltic countries, but these results are influenced by the global lack of data, mainly from the UK and US financing platforms. It can be concluded that there was a lower credit financing in 2020 in the largest credit platform in continental Europe, coinciding with the period

of the COVID-19 pandemic, the credit moratoriums granted by several governments, and a greater risk aversion of the non-bank lenders and the investors who financed the credits.

In the regulation related to crypto-assets, one can conclude that Switzerland has preponderance in the crypto-assets universe in Europe, the result of a favorable regulation that allows the creation and listing of financial products related to crypto-assets in Swiss stock exchanges, helped by the fact that Switzerland is a financial center and has passed legislation on the blockchain technology. Other European financial regulators, mainly from Germany, are looking to follow in the footsteps of Swiss regulators. In recent months, the approval of financial products related to crypto-assets has been increasing with a greater number of crypto ETPs being listed on the European exchanges. In the opposite direction, there is a distance between the British regulators in relation to products linked to crypto-assets.

From the point of view of financial instruments and their investment, the analysis herein conducted lead to the conclusion that crypto-assets and the ETP linked to them are extremely volatile despite being able to obtain high returns in the medium term; but when analyzing the risk-adjusted returns, Bitcoin and its crypto ETP prove to have worse results than investing in the S&P 500 index or in gold, directly or through the ETF that tracks the performance of gold, so Bitcoin cannot be considered as a safe haven asset, especially in short periods of time. Bitcoin's volatility also prevents it from being a store of value that can replace fiat currencies, due to its high volatility. 'Stablecoins' demonstrate that they are not really stable due to their volatility and typically fail to perfectly track their reference assets, as it is preferable to invest directly in the reference assets, thus missing the possibility of being a tokenized version that can replace the assets of reference. Bitcoin is shown to have a higher positive correlation with the S&P 500 than gold, confirming that Bitcoin is not a safe haven asset like gold, and 'stablecoins' are somewhat far from exhibiting a perfect positive correlation with their reference asset, with exception of the 'stablecoin' linked to Bitcoin. Similar performances among the various Bitcoin pairs denominated in various fiat currencies should be highlighted, proving that the denomination currencies play a minor role in Bitcoin's performance.

Overall, it can be concluded that the critical analysis carried out demonstrate the existence of several clusters linked to digital financial innovation, namely payments in Lithuania and the United Kingdom, credit financing in Latvia, and a crypto-asset ecosystem in Switzerland. Regulation plays an important role in the existence of FinTechs and financial innovation in certain jurisdictions, as does the existence of legislation and political will on technology companies. Other factors that may contribute to the presence of FinTechs include the fact that some jurisdictions are financial centers or have more business-friendly tax regimes.

As answers to the research sub-questions, the following were obtained: the main area of digital disruption is the area of payments, followed by trading services and credit financing, as demonstrated by consumer preferences. A direct link between higher number of bank closures and the emergence of more FinTechs has not been confirmed. Regulators have adopted different positions regarding the acceptance of financial products linked to crypto-assets, especially for retail investors, but at the same time these assets are found to be extremely volatile and unpredictable, jeopardizing the consumer protection of financial services. Crypto-assets have demonstrated that they cannot be considered as safe haven and store of value assets and have not

yet sufficiently demonstrated that they can be considered a means of payment, in addition to not being able to be considered as substitutes for fiat currencies or other financial assets. Existing 'stablecoins' are not really fully stable and fail to provide a faithful digital representation of traditional financial assets. This could serve as case exhibits for Central Bank adoption of CBDC, such as how to keep a digital currency perfectly tied to a reference asset or keep its volatility under control against its non-digital currency.

To conclude, answering the main research question, is financial digitalization a risk or an opportunity? Updated critical analyses suggest that the answer is rather ambiguous, but so far, it presents multiple challenges to the various players in the financial system. It brings new paths, such as the digitalization and tokenization of currency and financial assets, it has facilitated access to financial services, making them more efficient and with lower costs, but at the same time, they present potential risks, such as, market risk with the volatility of crypto-assets and financial instruments referenced to them, privacy and security issues, money laundering and terrorist financing problems, IT and operational risks, and banking disintermediation through shadow banking disrupting the traditional transmission channels of monetary policy. Political and regulatory actors are increasing their intervention in financial digital innovation. Learning is the common denominator for all actors in the financial system, from challengers to regulators, through consumers and incumbents. And as technology is dynamic and with a life of its own, it will never be a process with an announced end or that can be stopped. Therefore, regulators will continue to monitor and regulate financial innovations when they occur, knowing that it has been a dynamic and evolutionary process that has been going on for centuries.

During the course of this Dissertation, several limitations were found, starting with the existing literature on the subject, which, despite being relevant, is mostly theoretical. Since the nature of the companies involved are recent and private companies, data acquisition becomes much more challenging, from the existence of little history to the lack of public disclosure of data, since the companies involved rely on business secrecy, so the little existing public information is fragmented and unstructured. Existing data do not allow an analysis of the connection between FinTechs and BigTechs, and the incumbents, nor do they allow for the assessment of the contribution of financial technologies to the economic growth of the jurisdictions under analysis.

The constant technological evolution, including in finance, in addition to making all studies out of date quickly, allows new studies to be carried out. As suggestions for future investigations, a continuous monitoring of crypto-assets could be included as they are financial instruments with little history and as they are not yet fully regulated; analyze more deeply the factors that attract FinTechs in certain economies, namely through a qualitative legal and regulatory analysis; or deepen the study of potential IT risks from a technological point of view that may contribute to the destabilization of the financial system, such as interruptions in IT infrastructures or the spread of malware or cyber attacks. These are suggestions that require more specialized knowledge within the intersection of law and IT. The existence of social networks and social trading, together with a growing democratization of access to financial services, could bring new phenomena, such as the case of meme stocks, or the increase in pump and dump cases, which could harm not only retail investors as well as damaging confidence in the financial markets and their stability, so it may be relevant to analyze this mass behavior in the financial world, its causes and impacts.

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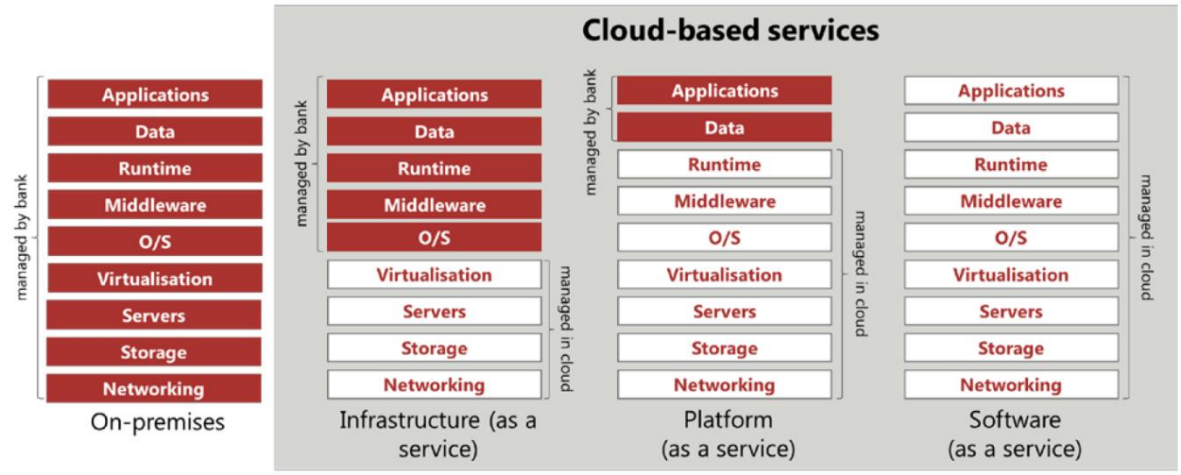
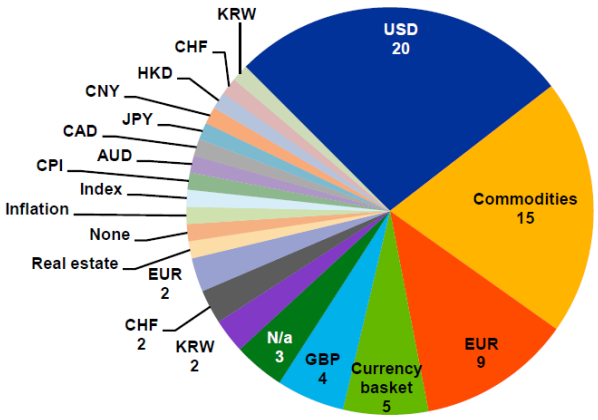
# Annexes

**Annex A.1** – Cloud-based services




Source: Technet.
Source: BCBS (2017).

**Annex A.2** – Reference units of 'stablecoins' and of tokenization of commodities




Source: ECB staff elaboration based on publicly available data.
Notes: This chart aims to reflect the reference targets of stablecoins. In the case of one stablecoin initiative issuing multiple stablecoins pegging to different reference units, all of these stablecoins have been counted separately. Labels not showing a value have a value of 1 that is not displayed in order to increase readability.

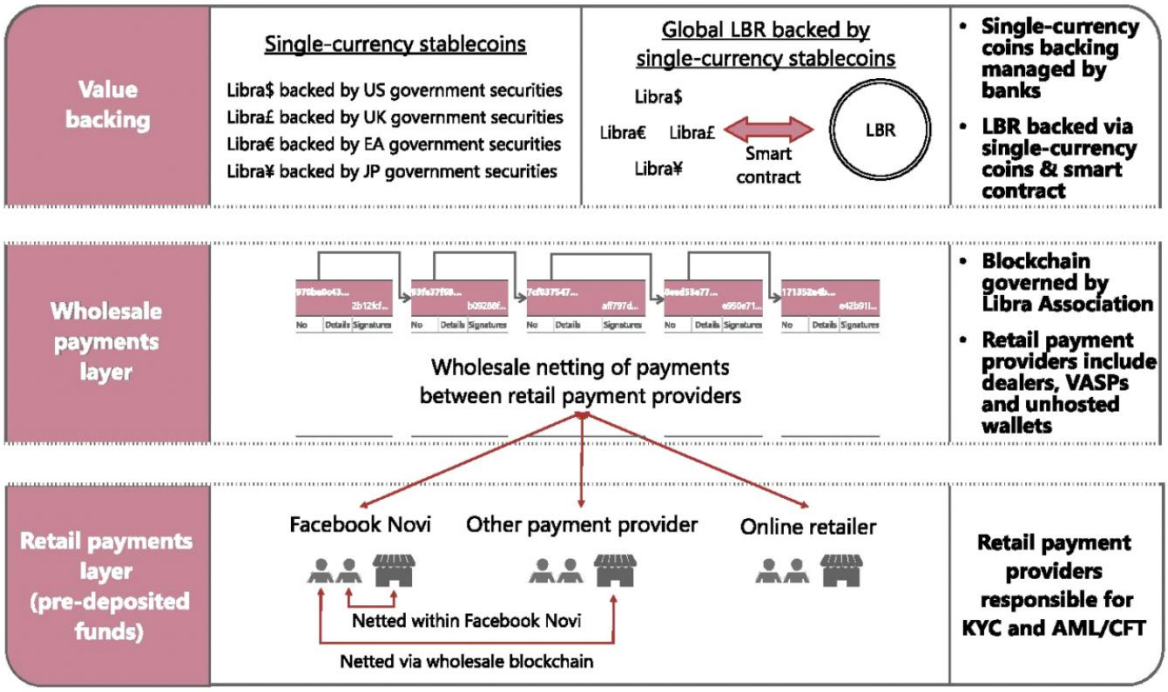
Source: Bullmann, Klemm and Pinna (2019).

**Annex A.3** – Top 6 'stablecoins': Collateral

| Coin | Symbol | Blockchain | System of Collateral |
|---|---|---|---|
| Tether | USDT | Omni and Ethereum | 100% USD Deposits held in centralized Tether Treasury |
| USD Coin | USDC | Ethereum | 100% USD Deposits in decentralized (private) accounts. |
| Paxos Standard | PAX | Ethereum | 100% USD Deposits held by FDIC-insured banks |
| Binance USD Coin | BUSD | Ethereum | 100% USD Deposits held by FDIC-insured banks |
| True USD | TUSD | Ethereum | 100% USD Deposits held in escrow accounts |
| Multi Collateral DAI | DAI | Ethereum | Ethereum held in CDO with value of >150% DAI borrowed |

The table lists properties of the top-six stablecoins by market capitalization as of April 2020. Blockchain refers to the platform on which the history of transactions is recorded. System refers to method of collateral; for dollar-collateral-based systems this means there is, as a stated principle, 100% backing of dollar deposits.
Source: Lyons and Viswanath-Natraj (2020).

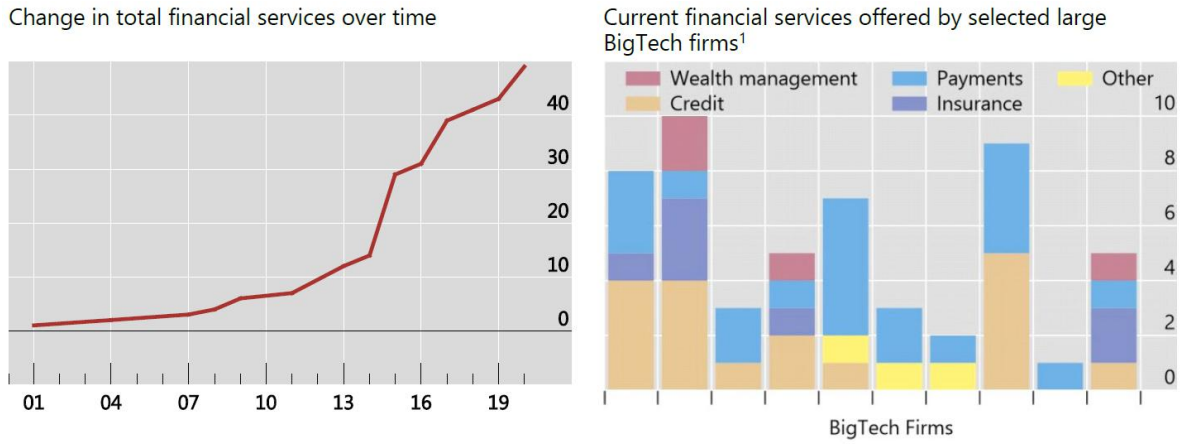
**Annex A.4** – The architecture of Libra 2.0: Global and single-currency 'stablecoins'




Libra 2.0 is to feature both single-currency stablecoins and a global stablecoin (LBR) that is a basket of the single-currency stablecoins. The architecture has three layers. The first layer is the value backing. In the second Libra Blockchain/wholesale layer, the various stablecoins are made available to retail payment providers through dealers/market makers. The third layer is that these payment service providers, in turn, make LBR and the single-currency stablecoins available to retail clients for use in payments.
Source: Arner, Auer and Frost (2020).

**Annex A.5** – BigTechs: Current financial services offered by ten large BigTechs

(Ratio: Number of services)



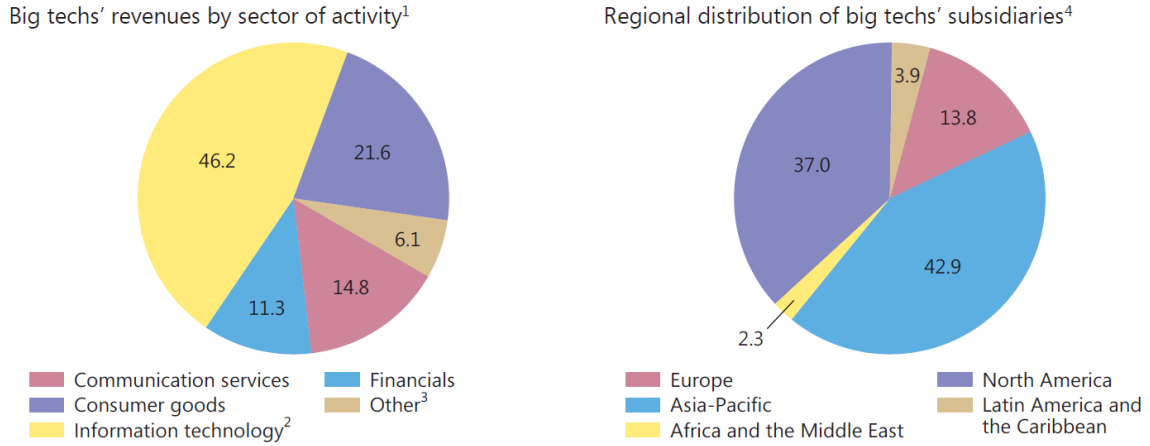

[1] The category "Other" includes services such as messaging services and venture capital providers.

Sources: Banque de France, based on public sources.

Source: FSB (2019c).

**Annex A.6** – BigTechs: Sector of activity and geographic distribution

(Ratio: %)




The sample includes Alibaba, Alphabet, Amazon, Apple, Baidu, Facebook, Grab, Kakao, Mercado Libre, Rakuten, Samsung and Tencent.

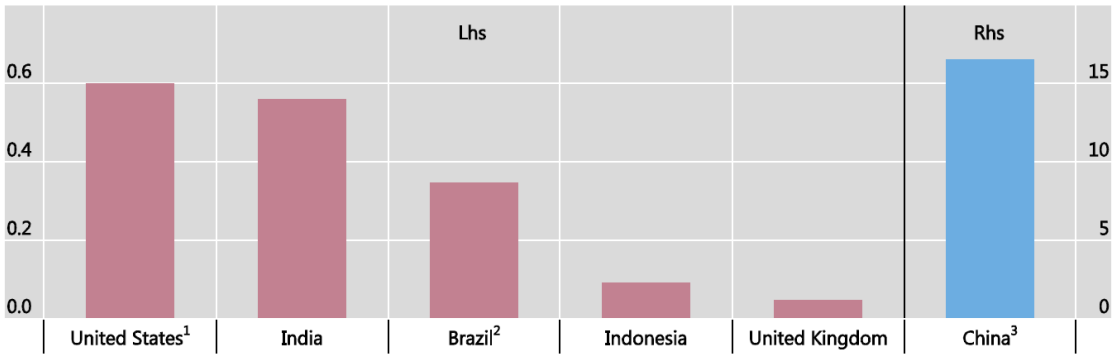
[1] Shares based on 2018 total revenues, where available, as provided by S&P Capital IQ; where not available, data for 2017. [2] Information technology can include some financial-related business. [3] Includes health care, real estate, utilities and industrials. [4] Shares are calculated on the number of subsidiaries as classified by S&P Capital IQ.

Sources: S&P Capital IQ; BIS calculations.

Source: BIS (2019).

**Annex A.7** – BigTech mobile payments, 2017

(Ratio: Yearly/GDP, %)




[1] 2016 data are used for US. [2] Estimate based on public data for Mercado Libre. [3] Only mobile payments for consumption.

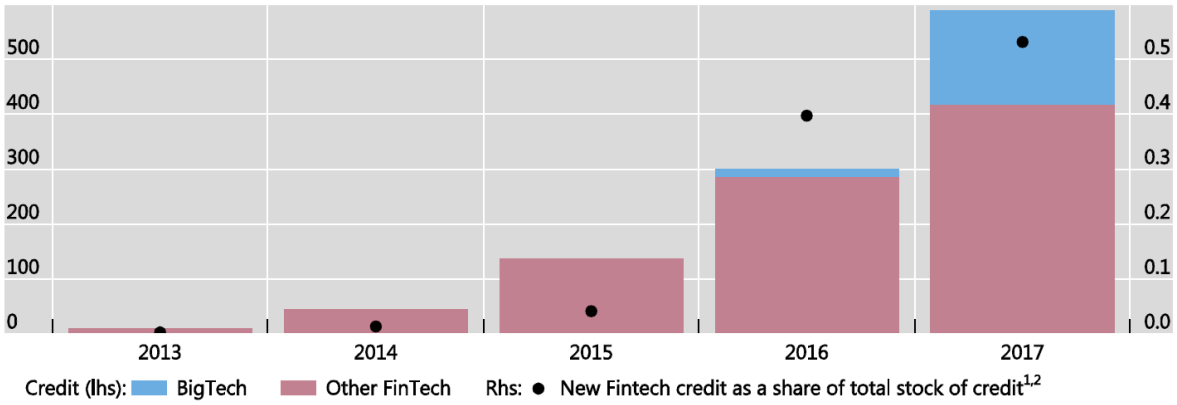
The figure shows the annual volume of BigTech payment services in selected jurisdictions divided by GDP. China is displayed on a separate axis due to the large difference in scale to the other jurisdictions.

Sources: Forrester Research; GlobalData; iResearch; Mercado Libre; Nikkei; Worldpay; BIS.

Source: Frost et al. (2019).

**Annex A.8** – Global volume of new FinTech and BigTech credit, 2013 – 2017

(Ratio: Lhs USD billions, Rhs %)




The bars indicate annual global lending flows by BigTech and other FinTech firms over 2013-2017. Figure includes estimates.

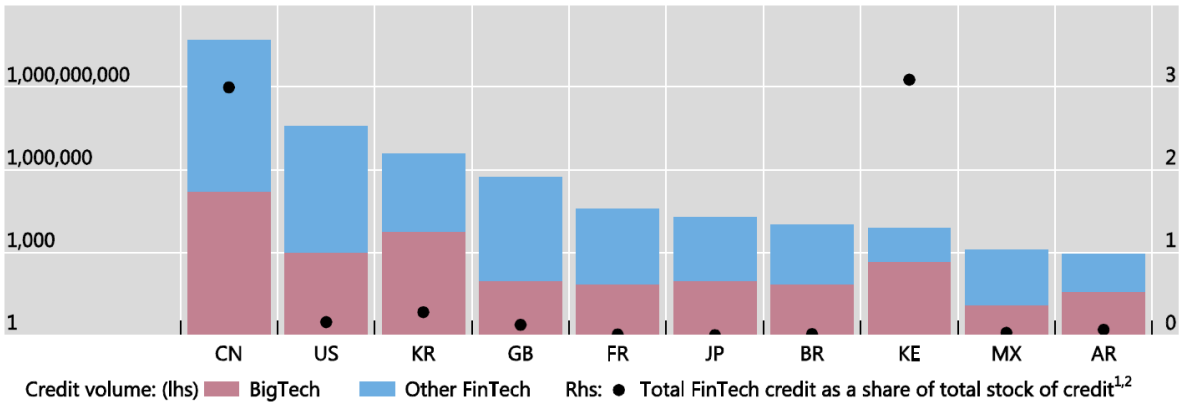
[1] Total FinTech credit is defined as the sum of the flow of BigTech and other FinTech credit. This is then divided by the stock of total credit to the private non-financial sector. [2] Calculated for countries for which data were available for 2013–2017.

Sources: Cambridge Centre for Alternative Finance and research partners; BigTech companies' financial statements; authors' calculations.

Source: Frost et al. (2019).

**Annex A.9** – Volume of FinTech and BigTech credit by jurisdiction, 2017

(Ratio: Lhs USD millions logarithmic scale, Rhs %)



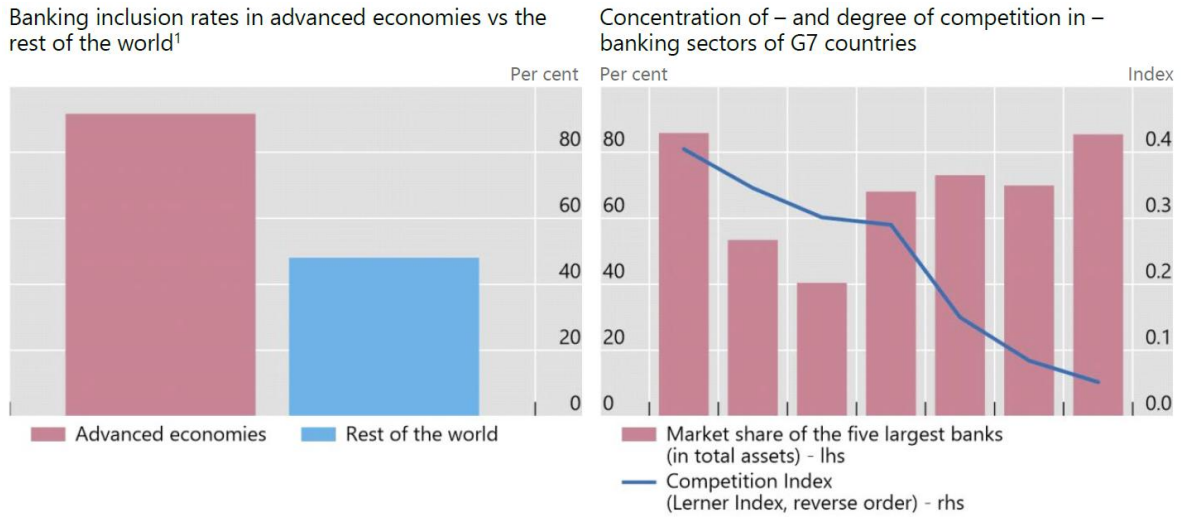

Figures includes estimates. Bars are sorted by the sum of the logarithm of the FinTech and the logarithm of the BigTech credit.

[1] FinTech credit (including BigTech credit) divided by the sum of credit to the private non-financial sector (including FinTech credit). [2] Calculated on a selected set of countries.

Sources: Cambridge Centre for Alternative Finance; IMF WEO; World bank; national data; Frost et al. (2019).

Source: Frost (2020).

**Annex A.10** – Banking inclusion rates; Competition in banking of G7 countries, 2017




The Lerner index measures market competition: the weaker it is, the higher the competition.

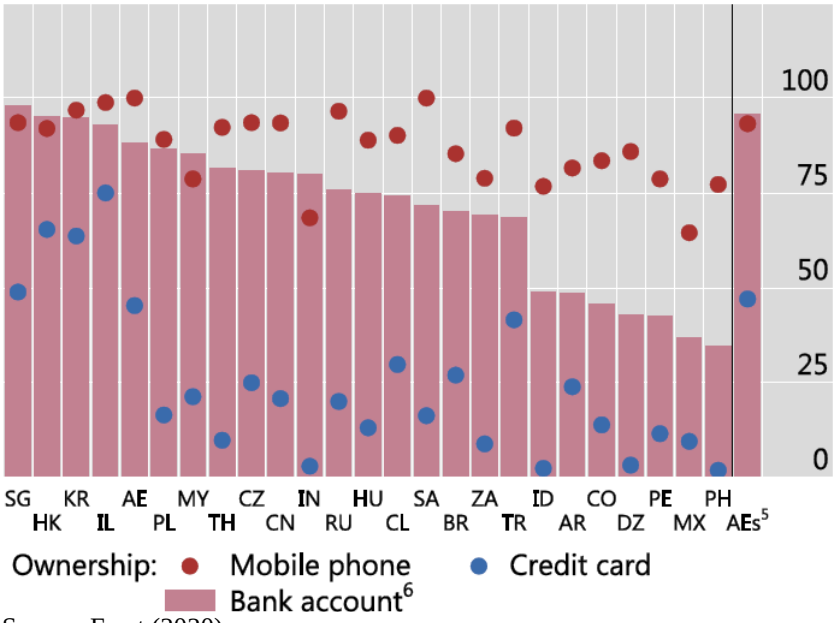
[1] Percentage of respondents who report having a bank account (by themselves or jointly with someone else).

Sources: 2017 Global Findex, World Bank

Source: FSB (2019c).

**Annex A.11** – Mobile phone, credit cards and bank accounts by jurisdiction, 2017

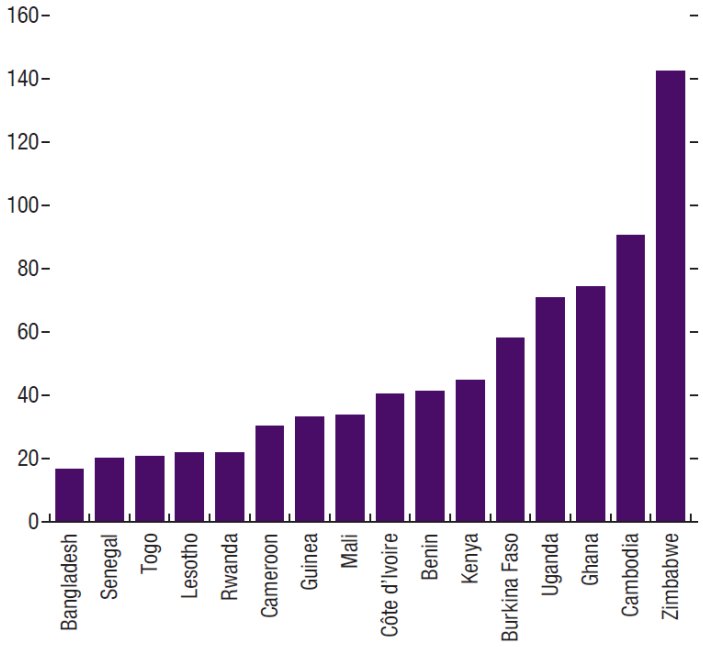
(Ratio: %)




Source: Frost (2020).

**Annex A.12** – Value of mobile money transactions, 2018

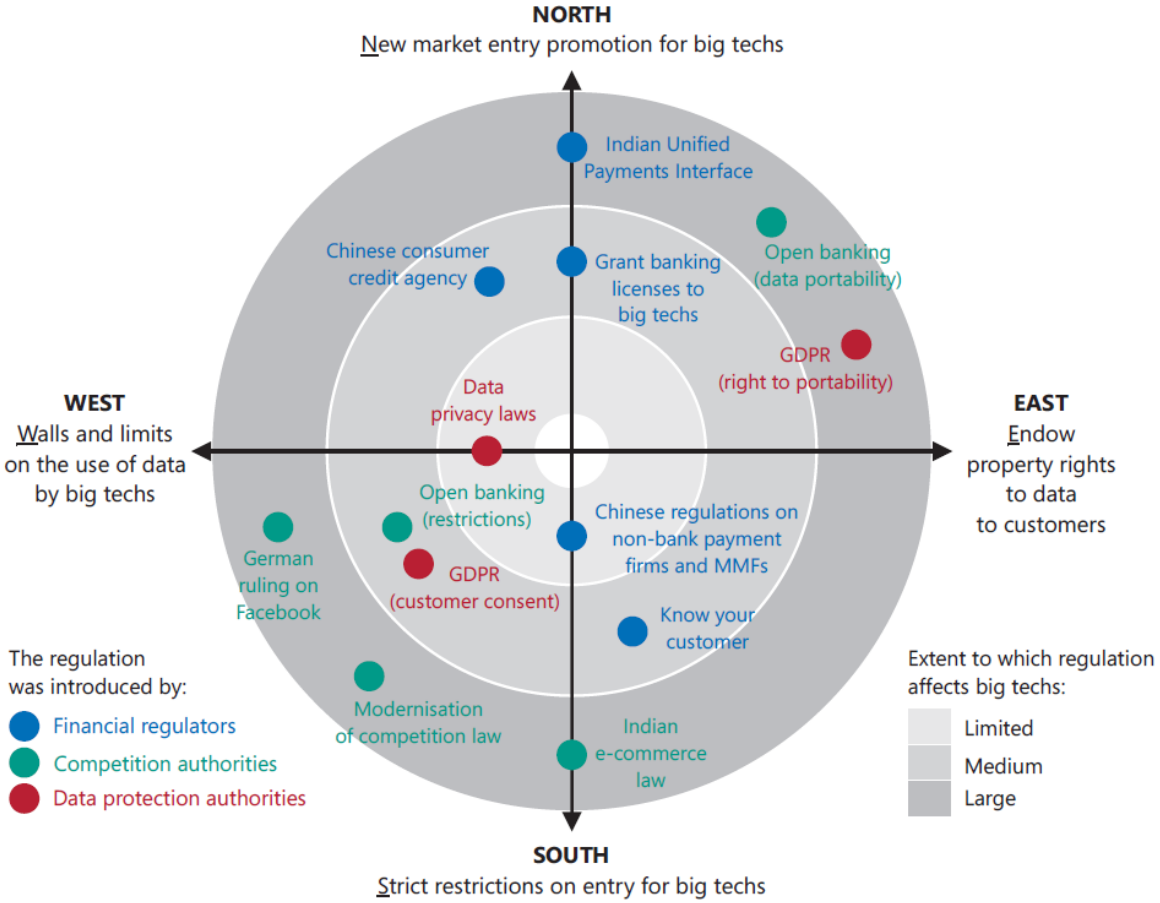
(Ratio: % of GDP)




Source: IMF Financial Access Survey.

Source: Sahay et al. (2020).

**Annex A.13** – Regulatory compass: BigTechs in finance



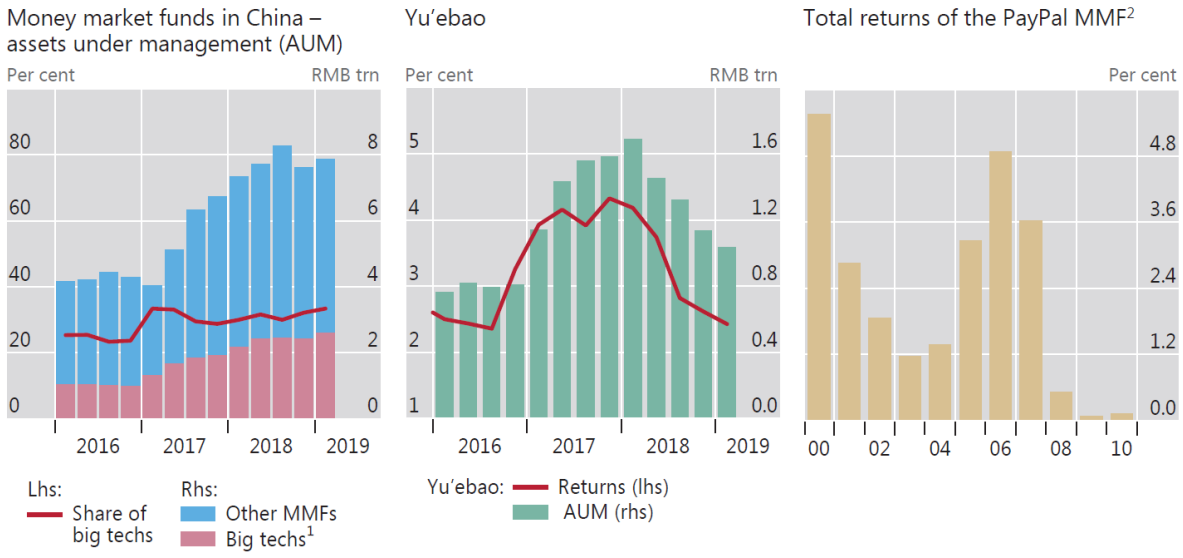

Each dot refers to a public policy affecting big techs to some degree. Each policy is described in Table III.3. The placement of a policy on the compass reflects the choice of a policymaker (financial regulator, competition authority or data protection authority) in terms of: (i) promoting/restricting big techs' entry into finance (north-south axis); or (ii) endowing customers with data property rights/restricting big techs' use of customer data (east-west axis).

For example, in some jurisdictions, competition authorities have been promoting new entry into finance – including by big techs – (north direction) by enabling individuals (eg borrowers) to share their financial transaction data among multiple financial institutions (east direction). This policy choice is reflected by the placement of the green dot "open banking (data portability)" in the northeast quadrant of the compass.

Source: BIS.

Source: BIS (2019).

**Annex A.14** – BigTechs: Money market funds



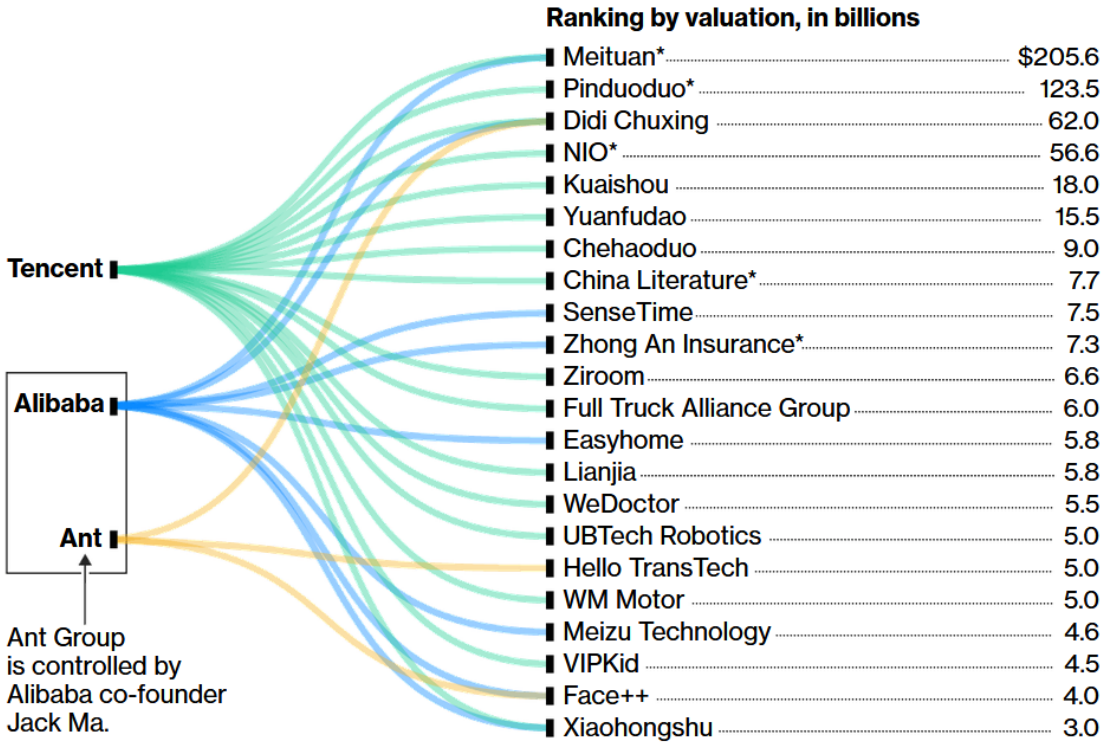

[1] Ant Financial, Tencent, Baidu and JD. [2] Quarterly average of annualised weekly returns.

Sources: Wind; company reports.

Note: Yu'ebao money market fund is offered by Alipay, owned by Ant Financial.

Source: BIS (2019).

**Annex A.15** – BigTechs: Chinese empire in technological startups

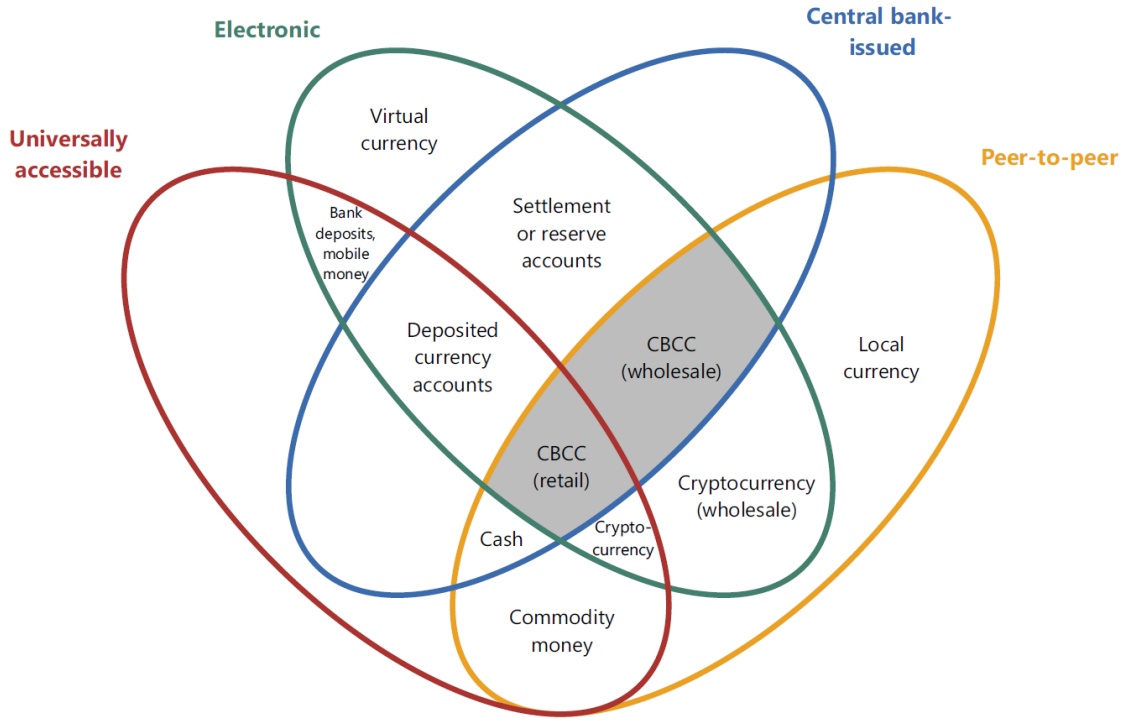



Sources: Bloomberg, CB Insights, Crunchbase

*Listed or applied to list in an IPO. Data as of Nov. 11.

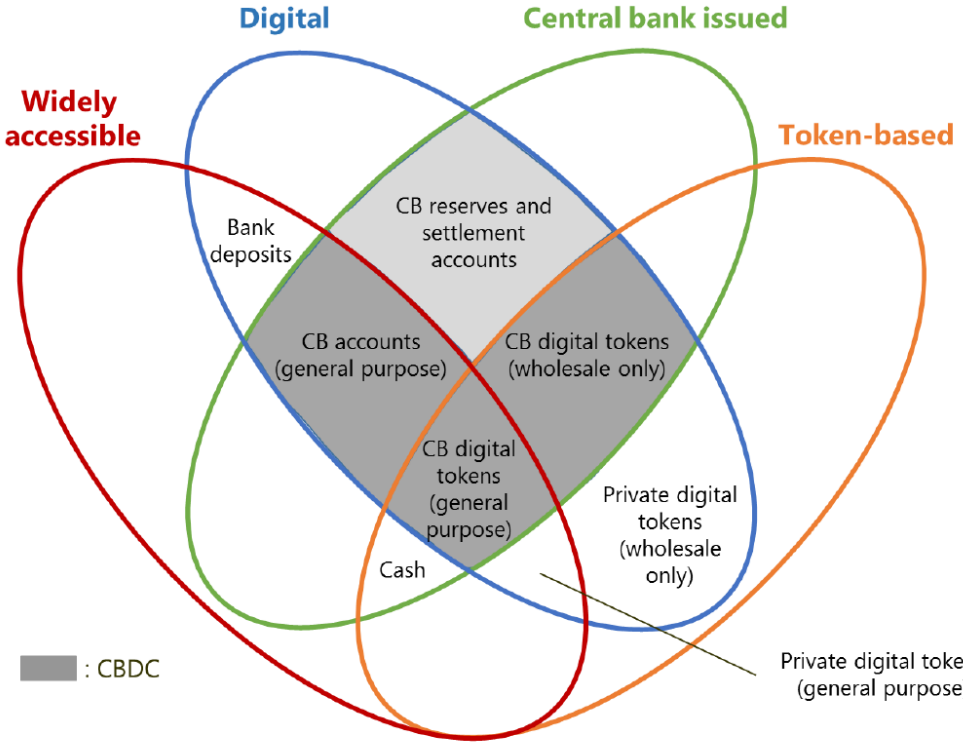
Source: Chen and Liu (2020).

**Annex A.16** – The taxonomy of money




Source: Bech and Garratt (2017).

**Annex A.17** – The taxonomy of money: Updated

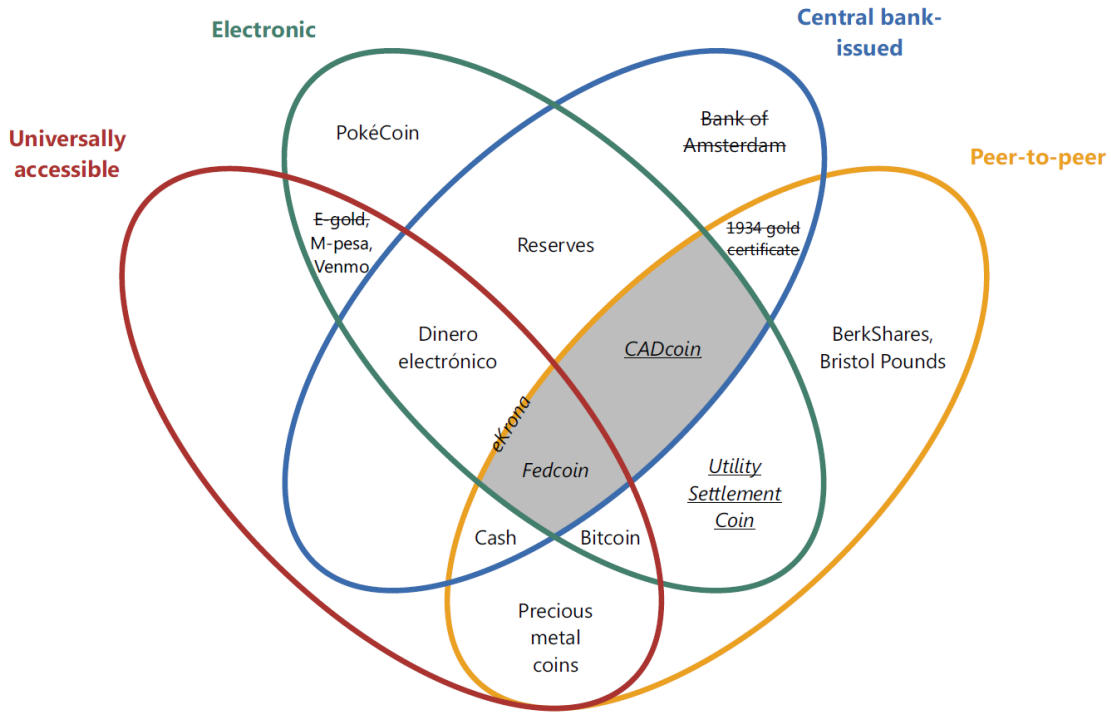



Notes: The Venn-diagram illustrates the four key properties of money: *issuer* (central bank or not); *form* (digital or physical); *accessibility* (widely or restricted) and *technology* (account-based or token-based). *CB* = central bank, *CBDC* = central bank digital currency (excluding digital central bank money already available to monetary counterparties and some non-monetary counterparties). *Private digital tokens (general purpose)* include crypto-assets and currencies, such as bitcoin and ethereum. *Bank deposits* are not widely accessible in all jurisdictions. For examples of how other forms of money may fit in the diagram, please refer to the source.

Source: Based on Bech and Garratt (2017).

Source: CPMI and MC (2018).

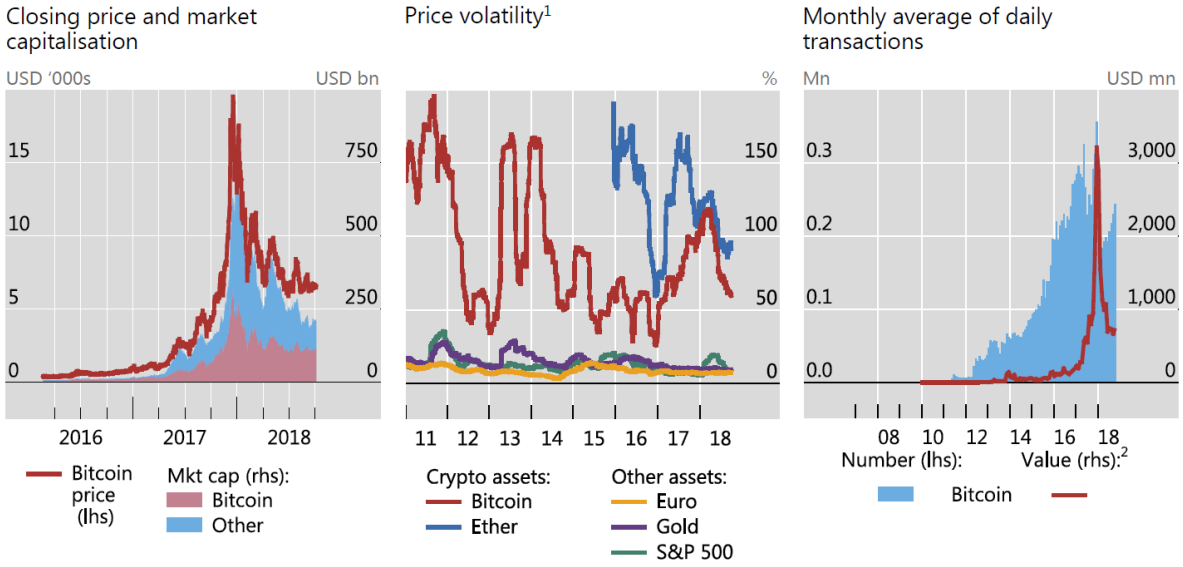
**Annex A.18** – The taxonomy of money: Examples




A standard font indicates that a system is in operation; an *italic* font indicates a proposal; an *italic and underlined* font indicates experimentation; a ~~strikethrough~~ font indicates a defunct company or an abandoned project.

Source: Bech and Garratt (2017).

**Annex A.19** – Market capitalization, price volatility and transactions in crypto-assets

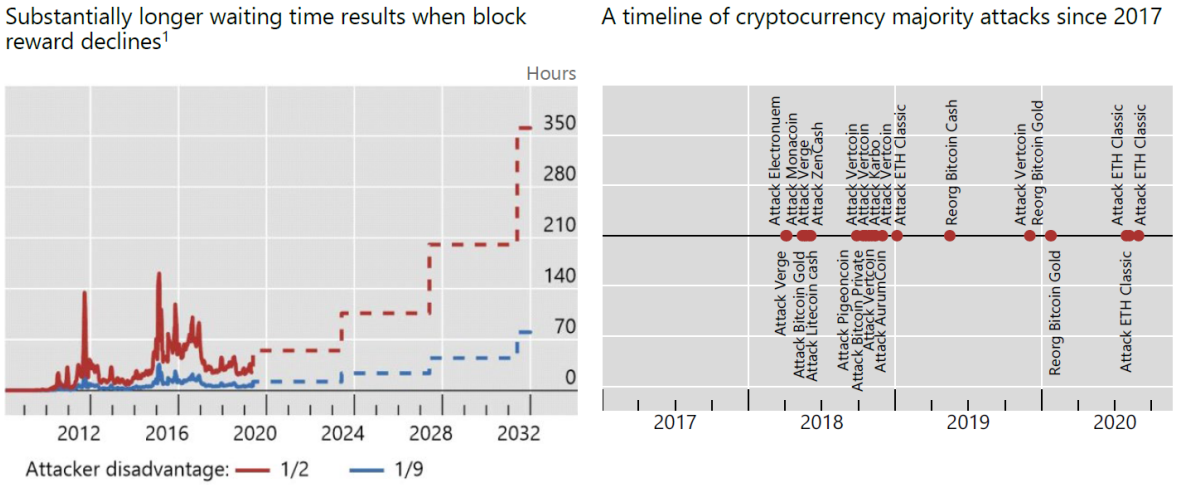



[1] Ninety-day moving standard deviation of daily returns. [2] Total estimated value of transactions on the Bitcoin Blockchain, in USD value.

Sources: Bloomberg; coinmarketcap.com; CoinDesk, https://www.coindesk.com/price/; www.blockchain.info; BIS calculations.

Source: FSB (2018).

**Annex A.20** – Bitcoin vulnerability to cyber attacks and crypto-assets' attacks timeline



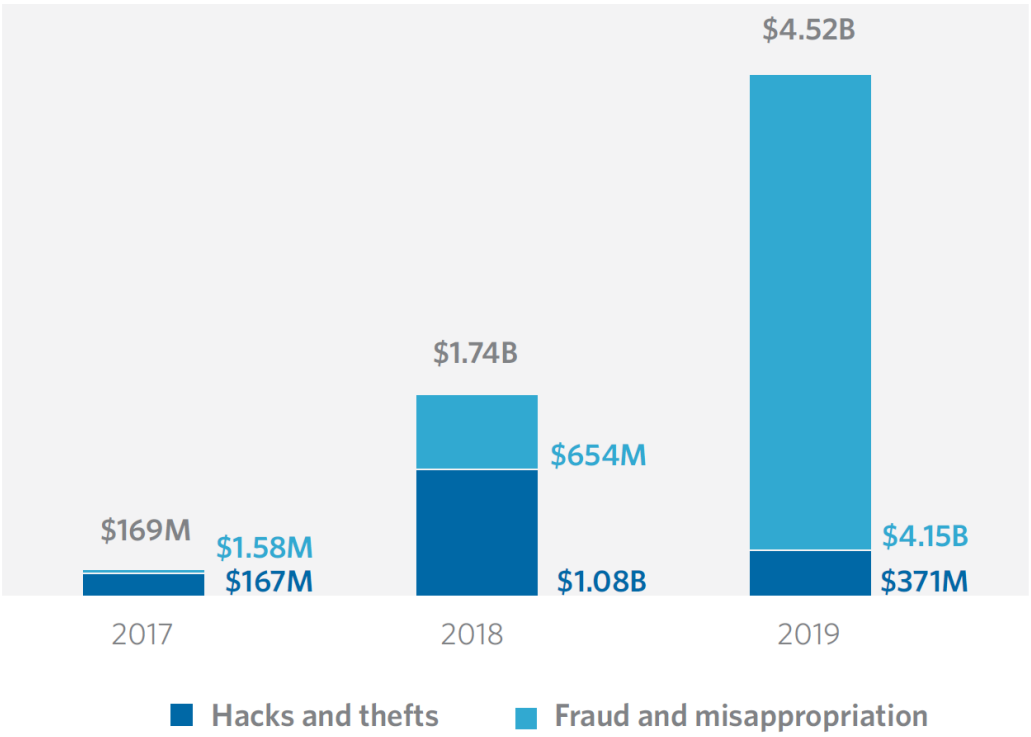

[1] The lines show the implied waiting time (number of block confirmations before merchants can safely assume that a payment is irreversible) required to make an economic attack unprofitable: the attacker rents mining equipment on a short-term basis and executes a change-of-history attack. The dashed pattern indicates predicted values (see Auer (2019) for calculations).

Sources: R Auer, "Beyond the doomsday economics of 'proof-of-work' in cryptocurrencies", *BIS Working Papers*, no 765, January 2019; S Shanaev, A Shuraeva, M Vasenin and M Kuznetsov, "Cryptocurrency value and 51% attacks: evidence from event studies", *The Journal of Alternative Investments*, Winter, 2020; blocksdecoded.com; bravenewcoin.com; btcmanager.com; coinbase.com; Coindesk.com; deribit.com; github.com; medium.com.

Source: Carstens (2021).

**Annex A.21** – Blockchain ecosystem losses by illicit activity, 2017 – 2019

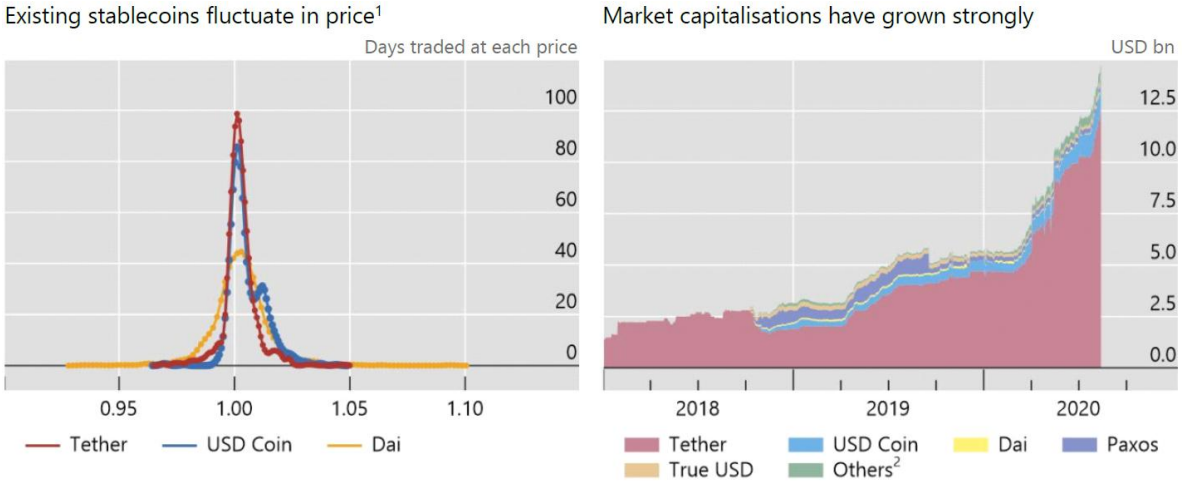
(Ratio: USD)




Source: CipherTrace Cryptocurrency Intelligence

Source: CipherTrace (2020).

**Annex A.22** – 'Stablecoins': USD peg and market capitalization

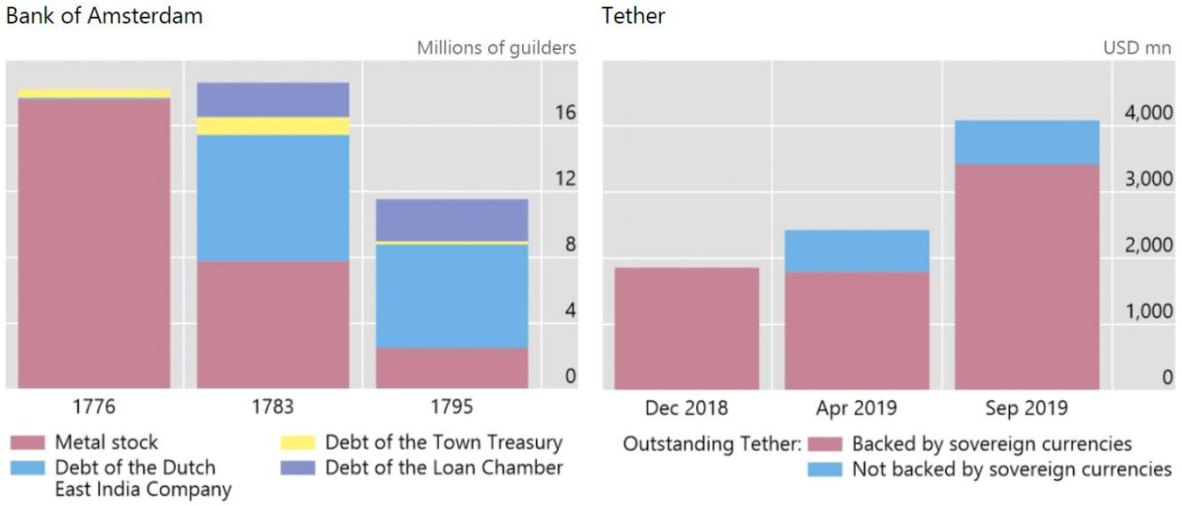



[1] Histogram of daily trading prices in USD. The sample includes Tether (2 Jan 2018–14 Aug 2020), USD Coin (9 Oct 2018–14 Aug 2020), Dai (2 Jan 2018–14 Aug 2020), Paxos (28 Sep 2018–14 Aug 2020) and TrueUSD (6 Mar 2018–14 Aug 2020).

Source: The stablecoin index, Messari.

Source: Arner, Auer and Frost (2020).

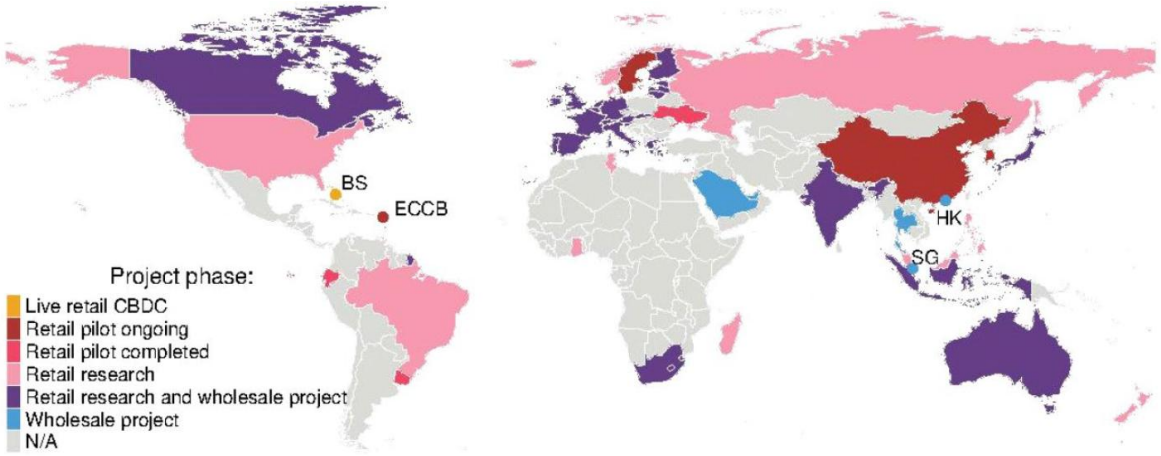
**Annex A.23** – 'Stablecoins': The Bank of Amsterdam and Tether




Sources: van Dillen (1934); Frost et al. (2020); CoinMarketCap.com; authors' calculations.

Source: Arner, Auer and Frost (2020).

**Annex A.24** – CBDC projects status around the globe, January 2021



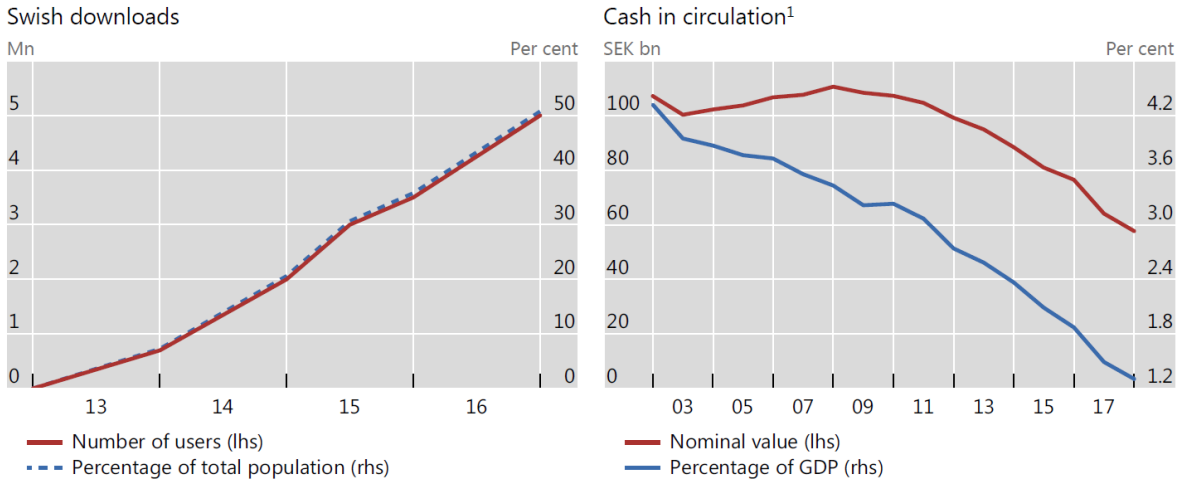

BS = The Bahamas; ECCB = Eastern Caribbean Central Bank; HK = Hong Kong SAR; SG = Singapore.

The use of this map does not constitute, and should not be construed as constituting, an expression of a position by the BIS regarding the legal status of, or sovereignty of, any territory or its authorities, to the delimitation of international frontiers and boundaries and/or to the name and designation of any territory, city or area.

Source: R Auer, G Cornelli and J Frost, "Rise of the central bank digital currencies: drivers, approaches and technologies", *BIS Working Paper*, no 880, August 2020.

Source: Carstens (2021).

**Annex A.25** – Sweden, a cashless society: Swish mobile phone app and demand for cash

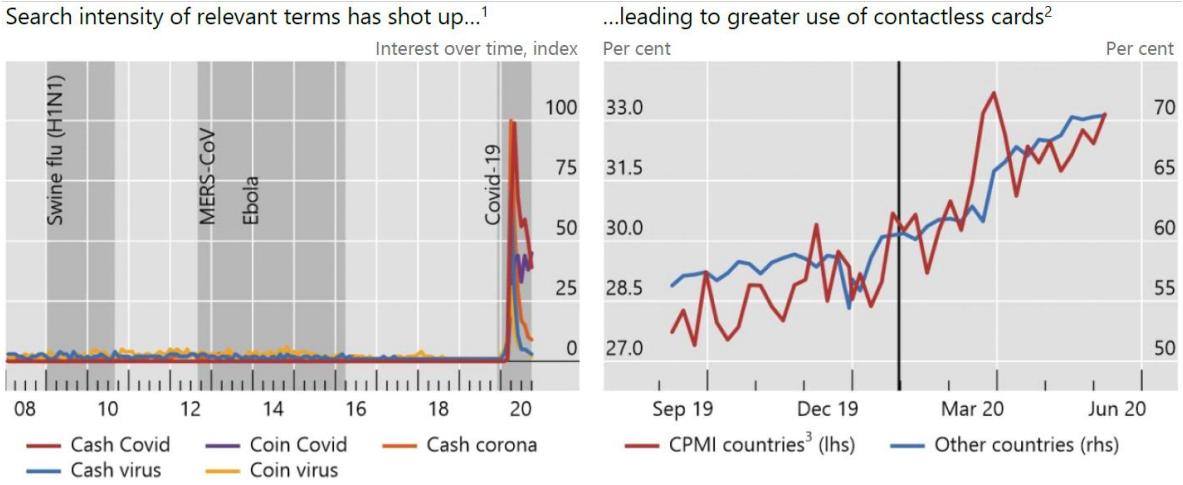



[1] Measured as an annual average.

Sources: IMF, *International Financial Statistics*; United Nations, *World Population Prospects*; www.getswish.se; national data; authors' calculations.

Source: Bech and Garratt (2017).

**Annex A.26** – Viral transmission and the growing trend of digital payments




The shaded areas in the left-hand panel indicate Jan 2009–Aug 2010 (Swine Flu (H1N1)), Sep 2012–Mar 2016 (Middle East Respiratory Syndrome Coronavirus (MERS-CoV)), Dec 2013–Mar 2016 (West African Ebola epidemic) and Dec 2019–current (Covid-19). The black vertical line in the right-hand panel indicates 30 January 2020, when the World Health Organisation (WHO) declared the Covid-19 outbreak a "public health emergency of international concern".

[1] Data accessed on 21 Mar 2020. Data resulting from worldwide Google search queries for selected terms in the period 2008-current, indexed to 100 by peak search interest. [2] Share of contactless in all card-present transactions by a global card network. In many countries, transaction limits for contactless payments were raised in Q2 2020. [3] Countries that are members of the Committee on Payments and Market Infrastructures (CPMI). Excludes MX and TR due to data availability.

Sources: Auer et al (2020a), BIS (2020) and GoogleTrends.

Source: Arner, Auer and Frost (2020).

**Annex A.27** – The EC's proposed taxonomy of crypto-assets in MiCA

| Crypto-asset | Asset-referenced tokens and e-money tokens (general and significant*) | Crypto-assets qualifying as financial instruments |
|---|---|---|
| - utility tokens | - asset-referenced tokens<br>- e-money tokens (includes e-money) | Financial instruments (MiFiD) |
| *'**crypto-asset**' means a digital representation of value or rights which may be transferred and stored electronically, using distributed ledger technology or similar technology* | *'**asset-referenced token**' means a type of crypto-asset that purports to maintain a stable value by referring to the value of several fiat currencies that are legal tender, one or several commodities or one or several crypto-assets, or a combination of such assets*<br>*'**electronic money token' or 'e-money token**' means a type of crypto-asset the main purpose of which is to be used as a means of exchange and that purports to maintain a stable value by referring to the value of a fiat currency that is legal tender* | *'crypto-assets that qualify as: (a) financial instruments as defined in Article 4(1), point (15), of Directive 2014/65/EU;* |
| • 'Catch-all' definition – in line with the FATF recommendations<br>• Not attempting exhaustive list or a full taxonomy<br>• Future-proof | **'Asset-referenced token'**<br>A token referring to gold<br>A token referring to several currencies<br>A token referring to other crypto-assets | • Promote consistent application across EU (Commission interpretative communication)<br>• DLT pilot |
| ➡ **covered by MiCA** | ➡ **covered by MiCA** | ➡ **not covered by MiCA** |

*Source*: European Commission staff presentation, October 2020.

Source: OECD (2021).

**Annex A.28** – Predicted prices of 1 Bitcoin according to crypto-asset valuation models (Ratio: USD)

| Model | Price |
|---|---|
| **Elliott wave theory**[1] | US$13,971 |
| **Cost of production**[2] | US$5,000 |
| **Equation of exchange**[3] | US$45,000 |
| **Linear replacement**[4] | US$4,400 |
| **Black-Scholes**[5] | US$0 - US$undefined |
| **Mixed**[6] | US$25,000 |
| **Stock-to-flow**[7] | US$55,000 |
| **Store of value**[8] | US$0 - US$800,000 |
| **Size of network**[9] | US$6,000 |

Source: FCA (2020b).

**Annex B.1** – Case exhibit #1: Macroeconomics and financial system in EEA+2

| Jurisdiction | Population | GDP (nominal) (Millions EUR) | GDP (PPP) (Millions EUR) | Banks | | Banks Unsuccess Rate | EMIs | | EMIs/Banks Ratio | Equity Crowdfunding Platforms | P2P Lending Platforms | Total Investing Crowdfunding Platforms | Innovation Indicator |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Operating | Closed | | Operating | Closed | | | | | |
| Austria | 8 879 920 | 397 575 | 357 339 | 110 | 57 | **34.13%** | 0 | 0 | **0.00%** | 2 | 5 | **7** | **7** |
| Belgium | 11 488 980 | 476 344 | 431 271 | 89 | 44 | **33.08%** | 7 | 0 | **7.87%** | 1 | 4 | **5** | **12** |
| Bulgaria | 6 975 761 | 61 240 | 117 643 | 26 | 8 | **23.53%** | 6 | 0 | **23.08%** | 0 | 2 | **2** | **8** |
| Croatia | 4 067 206 | 54 237 | 84 364 | 25 | 12 | **32.43%** | 4 | 0 | **16.00%** | 0 | 1 | **1** | **5** |
| Cyprus | 881 952 | 22 287 | 25 122 | 30 | 15 | **33.33%** | 10 | 1 | **33.33%** | 0 | 1 | **1** | **11** |
| Czech Republic | 10 671 870 | 223 950 | 314 900 | 58 | 12 | **17.14%** | 3 | 1 | **5.17%** | 0 | 5 | **5** | **8** |
| Denmark | 5 814 422 | 312 747 | 240 702 | 97 | 90 | **48.13%** | 2 | 0 | **2.06%** | 2 | 3 | **5** | **7** |
| Estonia | 1 326 898 | 28 112 | 35 342 | 15 | 5 | **25.00%** | 1 | 0 | **6.67%** | 2 | 10 | **12** | **13** |
| Finland | 5 521 606 | 240 261 | 195 323 | 49 | 20 | **28.99%** | 1 | 0 | **2.04%** | 2 | 4 | **6** | **7** |
| France | 67 248 926 | 2 425 708 | 2 278 323 | 238 | 114 | **32.39%** | 17 | 0 | **7.14%** | 8 | 8 | **16** | **33** |
| Germany | 83 092 962 | 3 449 050 | 3 186 484 | 362 | 83 | **18.65%** | 9 | 1 | **2.49%** | 6 | 15 | **21** | **30** |
| Greece | 10 721 582 | 183 414 | 227 085 | 37 | 27 | **42.19%** | 3 | 0 | **8.11%** | 0 | 0 | **0** | **3** |
| Hungary | 9 771 141 | 146 093 | 227 655 | 37 | 20 | **35.09%** | 2 | 0 | **5.41%** | 0 | 0 | **0** | **2** |
| Iceland | 360 563 | 22 182 | 14 864 | 9 | 6 | **40.00%** | 2 | 0 | **22.22%** | 0 | 0 | **0** | **2** |
| Ireland | 4 934 340 | 356 051 | 302 778 | 61 | 31 | **33.70%** | 17 | 0 | **27.87%** | 1 | 4 | **5** | **22** |
| Italy | 59 729 081 | 1 790 942 | 1 838 073 | 208 | 134 | **39.18%** | 10 | 0 | **4.81%** | 3 | 7 | **10** | **20** |
| Latvia | 1 913 822 | 30 421 | 42 024 | 18 | 15 | **45.45%** | 3 | 1 | **16.67%** | 0 | 11 | **11** | **14** |
| Liechtenstein | 38 563 | 5 972 | - | 13 | 4 | **23.53%** | 4 | 1 | **30.77%** | 0 | 0 | **0** | **4** |
| Lithuania | 2 794 137 | 48 809 | 74 318 | 18 | 10 | **35.71%** | 68 | 1 | **377.78%** | 1 | 6 | **7** | **75** |
| Luxembourg | 620 001 | 63 516 | 51 457 | 131 | 53 | **28.80%** | 9 | 1 | **6.87%** | 0 | 0 | **0** | **9** |
| Malta | 504 062 | 13 592 | 16 174 | 24 | 9 | **27.27%** | 19 | 1 | **79.17%** | 0 | 0 | **0** | **19** |
| Netherlands | 17 344 874 | 810 247 | 707 732 | 93 | 70 | **42.94%** | 8 | 1 | **8.60%** | 1 | 4 | **5** | **13** |
| Norway | 5 347 896 | 362 243 | 250 781 | 61 | 23 | **27.38%** | 5 | 0 | **8.20%** | 0 | 4 | **4** | **9** |
| Poland | 37 965 475 | 533 600 | 891 751 | 69 | 21 | **23.33%** | 1 | 0 | **1.45%** | 0 | 1 | **1** | **2** |
| Portugal | 10 286 263 | 213 949 | 260 231 | 69 | 18 | **20.69%** | 1 | 0 | **1.45%** | 0 | 2 | **2** | **3** |
| Romania | 19 371 648 | 222 998 | 429 314 | 38 | 11 | **22.45%** | 2 | 0 | **5.26%** | 0 | 0 | **0** | **2** |
| Slovakia | 5 454 147 | 93 901 | 121 837 | 28 | 5 | **15.15%** | 0 | 0 | **0.00%** | 0 | 1 | **1** | **1** |
| Slovenia | 2 088 385 | 48 393 | 59 027 | 17 | 8 | **32.00%** | 2 | 0 | **11.76%** | 0 | 0 | **0** | **2** |
| Spain | 47 134 837 | 1 244 772 | 1 364 268 | 136 | 60 | **30.61%** | 9 | 0 | **6.62%** | 3 | 12 | **15** | **24** |
| Sweden | 10 278 887 | 474 551 | 388 381 | 98 | 44 | **30.99%** | 4 | 1 | **4.08%** | 2 | 6 | **8** | **12** |
| Switzerland | 8 575 280 | 653 471 | 430 187 | 252 | 84 | **25.00%** | 0 | 0 | **0.00%** | 4 | 12 | **16** | **16** |
| United Kingdom | 66 836 327 | 2 526 615 | 2 224 751 | 315 | 110 | **25.88%** | 230 | 5 | **73.02%** | 5 | 16 | **21** | **251** |
| **Total** | | | | **2 831** | **1 223** | **30.17%** | **459** | **15** | **16.21%** | **43** | **144** | **187** | **646** |
| **Average** | **16 501 307** | **548 039** | **537 172** | **88** | **38** | **30.44%** | **14** | **0** | **25.19%** | **1** | **5** | **6** | **20** |
| **Minimum** | **38 563** | **5 972** | **14 864** | **9** | **4** | **15.15%** | **0** | **0** | **0.00%** | **0** | **0** | **0** | **1** |
| **Maximum** | **83 092 962** | **3 449 050** | **3 186 484** | **362** | **134** | **48.13%** | **230** | **5** | **377.78%** | **8** | **16** | **21** | **251** |

Sources: Eurostat (2021a; 2021b), TheBanks.eu (2021) and P2P Market Data (2021), Author.

**Annex B.2** – Case exhibit #1: Macroeconomics and financial system in EEA+2 (population adjusted)

| Jurisdiction | GDP (nominal) per capita (EUR) | GDP (PPP) per capita (EUR) | Population per Banks | Population per EMIs | Population per Invest. Crowdfunding Platforms | Population per Innovation Indicator | Account ownership (population ages 15+) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 2011 | 2014 | 2017 | Average |
| Austria | 44 772 | 40 241 | 80 727 | 0 | 1 268 560 | 1 268 560 | 97.08% | 96.73% | 98.16% | **97.33%** |
| Belgium | 41 461 | 37 538 | 129 090 | 1 641 283 | 2 297 796 | 957 415 | 96.31% | 98.13% | 98.64% | **97.69%** |
| Bulgaria | 8 779 | 16 865 | 268 299 | 1 162 627 | 3 487 881 | 871 970 | 52.82% | 62.99% | 72.20% | **62.67%** |
| Croatia | 13 335 | 20 742 | 162 688 | 1 016 802 | 4 067 206 | 813 441 | 88.39% | 86.03% | 86.14% | **86.85%** |
| Cyprus | 25 270 | 28 485 | 29 398 | 88 195 | 881 952 | 80 177 | 85.24% | 90.15% | 88.72% | **88.03%** |
| Czech Republic | 20 985 | 29 507 | 183 998 | 3 557 290 | 2 134 374 | 1 333 984 | 80.65% | 82.18% | 80.99% | **81.27%** |
| Denmark | 53 788 | 41 397 | 59 942 | 2 907 211 | 1 162 884 | 830 632 | 99.74% | 100.00% | 99.92% | **99.88%** |
| Estonia | 21 187 | 26 635 | 88 460 | 1 326 898 | 110 575 | 102 069 | 96.82% | 97.67% | 97.99% | **97.50%** |
| Finland | 43 513 | 35 374 | 112 686 | 5 521 606 | 920 268 | 788 801 | 99.65% | 100.00% | 99.79% | **99.81%** |
| France | 36 071 | 33 879 | 282 559 | 3 955 819 | 4 203 058 | 2 037 846 | 96.98% | 96.58% | 94.00% | **95.86%** |
| Germany | 41 508 | 38 348 | 229 539 | 9 232 551 | 3 956 808 | 2 769 765 | 98.13% | 98.76% | 99.14% | **98.68%** |
| Greece | 17 107 | 21 180 | 289 772 | 3 573 861 | 0 | 3 573 861 | 77.94% | 87.52% | 85.47% | **83.64%** |
| Hungary | 14 951 | 23 299 | 264 085 | 4 885 571 | 0 | 4 885 571 | 72.67% | 72.26% | 74.94% | **73.29%** |
| Iceland | 61 520 | 41 224 | 40 063 | 180 282 | 0 | 180 282 | - | - | - | **-** |
| Ireland | 72 158 | 61 361 | 80 891 | 290 255 | 986 868 | 224 288 | 93.89% | 94.71% | 95.34% | **94.65%** |
| Italy | 29 984 | 30 774 | 287 159 | 5 972 908 | 5 972 908 | 2 986 454 | 71.01% | 87.33% | 93.79% | **84.04%** |
| Latvia | 15 895 | 21 958 | 106 323 | 637 941 | 173 984 | 136 702 | 89.66% | 90.22% | 93.22% | **91.03%** |
| Liechtenstein | 154 858 | - | 2 966 | 9 641 | 0 | 9 641 | - | - | - | **-** |
| Lithuania | 17 468 | 26 598 | 155 230 | 41 090 | 399 162 | 37 255 | 73.76% | 77.91% | 82.88% | **78.18%** |
| Luxembourg | 102 445 | 82 996 | 4 733 | 68 889 | 0 | 68 889 | 94.59% | 96.17% | 98.77% | **96.51%** |
| Malta | 26 965 | 32 088 | 21 003 | 26 530 | 0 | 26 530 | 95.27% | 96.33% | 97.36% | **96.32%** |
| Netherlands | 46 714 | 40 804 | 186 504 | 2 168 109 | 3 468 975 | 1 334 221 | 98.66% | 99.30% | 99.64% | **99.20%** |
| Norway | 67 736 | 46 893 | 87 670 | 1 069 579 | 1 336 974 | 594 211 | - | 100.00% | 99.75% | **99.87%** |
| Poland | 14 055 | 23 488 | 550 224 | 37 965 475 | 37 965 475 | 18 982 738 | 70.19% | 77.86% | 86.73% | **78.26%** |
| Portugal | 20 800 | 25 299 | 149 076 | 10 286 263 | 5 143 132 | 3 428 754 | 81.23% | 87.39% | 92.34% | **86.99%** |
| Romania | 11 512 | 22 162 | 509 780 | 9 685 824 | 0 | 9 685 824 | 44.59% | 60.84% | 57.75% | **54.39%** |
| Slovakia | 17 216 | 22 338 | 194 791 | 0 | 5 454 147 | 5 454 147 | 79.58% | 77.24% | 84.18% | **80.34%** |
| Slovenia | 23 172 | 28 264 | 122 846 | 1 044 193 | 0 | 1 044 193 | 97.14% | 97.24% | 97.53% | **97.31%** |
| Spain | 26 409 | 28 944 | 346 580 | 5 237 204 | 3 142 322 | 1 963 952 | 93.28% | 97.58% | 93.76% | **94.87%** |
| Sweden | 46 167 | 37 784 | 104 887 | 2 569 722 | 1 284 861 | 856 574 | 98.99% | 99.72% | 99.74% | **99.48%** |
| Switzerland | 76 204 | 50 166 | 34 029 | 0 | 535 955 | 535 955 | - | 97.99% | 98.43% | **98.21%** |
| United Kingdom | 37 803 | 33 287 | 212 179 | 290 593 | 3 182 682 | 266 280 | 97.20% | 98.93% | 96.37% | **97.50%** |
| **Average** | **39 119** | **33 868** | **168 068** | **3 637 944** | **2 923 088** | **2 129 093** | **86.48%** | **90.19%** | **91.46%** | **89.38%** |
| **Minimum** | **8 779** | **16 865** | **2 966** | **0** | **0** | **9 641** | **44.59%** | **60.84%** | **57.75%** | **54.39%** |
| **Maximum** | **154 858** | **82 996** | **550 224** | **37 965 475** | **37 965 475** | **18 982 738** | **99.74%** | **100.00%** | **99.92%** | **99.88%** |

Source: Demirgüç-Kunt et al. (2018), Author.

**Annex B.3** – Case exhibit #1: Banks in EEA+2 (population adjusted)

| Jurisdiction | Population | GDP (nominal) per capita (EUR) | GDP (PPP) per capita (EUR) | Banks | | Pop. per Banks | Account ownership (population ages 15+) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Operating | Closed | | 2011 | 2014 | 2017 | Average |
| Liechtenstein | 38 563 | 154 858 | - | 13 | 4 | **2 966** | - | - | - | - |
| Luxembourg | 620 001 | 102 445 | 82 996 | 131 | 53 | **4 733** | 94.59% | 96.17% | 98.77% | **96.51%** |
| Malta | 504 062 | 26 965 | 32 088 | 24 | 9 | **21 003** | 95.27% | 96.33% | 97.36% | **96.32%** |
| Cyprus | 881 952 | 25 270 | 28 485 | 30 | 15 | **29 398** | 85.24% | 90.15% | 88.72% | **88.03%** |
| Switzerland | 8 575 280 | 76 204 | 50 166 | 252 | 84 | **34 029** | - | 97.99% | 98.43% | **98.21%** |
| **Average** | **16 501 307** | **39 119** | **32 810** | **88** | **38** | **168 068** | **86.48%** | **90.19%** | **91.46%** | **89.38%** |
| **Minimum** | **38 563** | **8 779** | **16 865** | **9** | **4** | **2 966** | **44.59%** | **60.84%** | **57.75%** | **54.39%** |
| **Maximum** | **83 092 962** | **154 858** | **82 996** | **362** | **134** | **550 224** | **99.74%** | **100.00%** | **99.92%** | **99.88%** |

**Annex B.4** – Case exhibit #1: EMIs in EEA+2 (population adjusted)

| Jurisdiction | Population | GDP (nominal) per capita (EUR) | GDP (PPP) per capita (EUR) | EMIs | | Pop. per EMIs | Account ownership (population ages 15+) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Operating | Closed | | 2011 | 2014 | 2017 | Average |
| Liechtenstein | 38 563 | 154 858 | - | 4 | 1 | **9 641** | - | - | - | - |
| Malta | 504 062 | 26 965 | 32 088 | 19 | 1 | **26 530** | 95.27% | 96.33% | 97.36% | **96.32%** |
| Lithuania | 2 794 137 | 17 468 | 26 598 | 68 | 1 | **41 090** | 73.76% | 77.91% | 82.88% | **78.18%** |
| Luxembourg | 620 001 | 102 445 | 82 996 | 9 | 1 | **68 889** | 94.59% | 96.17% | 98.77% | **96.51%** |
| Cyprus | 881 952 | 25 270 | 28 485 | 10 | 1 | **88 195** | 85.24% | 90.15% | 88.72% | **88.03%** |
| **Average** | **16 501 307** | **39 119** | **33 868** | **14** | **0** | **3 637 944** | **86.48%** | **90.19%** | **91.46%** | **89.38%** |
| **Minimum** | **38 563** | **8 779** | **16 865** | **0** | **0** | **0** | **44.59%** | **60.84%** | **57.75%** | **54.39%** |
| **Maximum** | **83 092 962** | **154 858** | **82 996** | **230** | **5** | **37 965 475** | **99.74%** | **100.00%** | **99.92%** | **99.88%** |

**Annex B.5** – Case exhibit #1: Investing crowdfunding platforms in EEA+2 (population adjusted)

| Jurisdiction | Population | GDP (nominal) per capita (EUR) | GDP (PPP) per capita (EUR) | Investing Crowdfunding | Pop. per Investing Crowdfunding | Account ownership (population ages 15+) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 2011 | 2014 | 2017 | Average |
| Estonia | 1 326 898 | 21 187 | 26 635 | 12 | **110 575** | 96.82% | 97.67% | 97.99% | **97.50%** |
| Latvia | 1 913 822 | 15 895 | 21 958 | 11 | **173 984** | 89.66% | 90.22% | 93.22% | **91.03%** |
| Lithuania | 2 794 137 | 17 468 | 26 598 | 7 | **399 162** | 73.76% | 77.91% | 82.88% | **78.18%** |
| Switzerland | 8 575 280 | 76 204 | 50 166 | 16 | **535 955** | - | 97.99% | 98.43% | **98.21%** |
| Cyprus | 881 952 | 25 270 | 28 485 | 1 | **881 952** | 85.24% | 90.15% | 88.72% | **88.03%** |
| **Average** | **16 501 307** | **39 119** | **33 868** | **6** | **2 923 088** | **86.48%** | **90.19%** | **91.46%** | **89.38%** |
| **Minimum** | **38 563** | **8 779** | **16 865** | **0** | **0** | **44.59%** | **60.84%** | **57.75%** | **54.39%** |
| **Maximum** | **83 092 962** | **154 858** | **82 996** | **21** | **37 965 475** | **99.74%** | **100.00%** | **99.92%** | **99.88%** |

**Annex B.6** – Case exhibit #1: 'Innovation indicator' in EEA+2 (population adjusted)

| Jurisdiction | Population | GDP (nominal) per capita (EUR) | GDP (PPP) per capita (EUR) | EMIs | Investing Crowd. | Innovation Indicator | Pop. per Innovation Indicator | Account ownership (population ages 15+) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Operating | | | | 2011 | 2014 | 2017 | Average |
| Liechtenstein | 38 563 | 154 858 | - | 4 | 0 | **4** | **9 641** | - | - | - | - |
| Malta | 504 062 | 26 965 | 32 088 | 19 | 0 | **19** | **26 530** | 95.27% | 96.33% | 97.36% | **96.32%** |
| Lithuania | 2 794 137 | 17 468 | 26 598 | 68 | 7 | **75** | **37 255** | 73.76% | 77.91% | 82.88% | **78.18%** |
| Luxembourg | 620 001 | 102 445 | 82 996 | 9 | 0 | **9** | **68 889** | 94.59% | 96.17% | 98.77% | **96.51%** |
| Cyprus | 881 952 | 25 270 | 28 485 | 10 | 1 | **11** | **80 177** | 85.24% | 90.15% | 88.72% | **88.03%** |
| **Average** | **16 501 307** | **39 119** | **33 868** | **14** | **6** | **20** | **2 129 093** | **86.48%** | **90.19%** | **91.46%** | **89.38%** |
| **Minimum** | **38 563** | **8 779** | **16 865** | **0** | **0** | **1** | **9 641** | **44.59%** | **60.84%** | **57.75%** | **54.39%** |
| **Maximum** | **83 092 962** | **154 858** | **82 996** | **230** | **21** | **251** | **18 982 738** | **99.74%** | **100.00%** | **99.92%** | **99.88%** |

**Annex B.7** – Case exhibit #1: EMIs per banks ratio in EEA+2

| Jurisdiction | Population | GDP (nominal) per capita (EUR) | GDP (PPP) per capita (EUR) | Banks | EMIs | EMIs/Banks Ratio | Account ownership (population ages 15+) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Operating | Operating | | 2011 | 2014 | 2017 | Average |
| Lithuania | 2 794 137 | 17 468 | 26 598 | 18 | 68 | **377.78%** | 73.76% | 77.91% | 82.88% | **78.18%** |
| Malta | 504 062 | 26 965 | 32 088 | 24 | 19 | **79.17%** | 95.27% | 96.33% | 97.36% | **96.32%** |
| United Kingdom | 66 836 327 | 37 803 | 33 287 | 315 | 230 | **73.02%** | 97.20% | 98.93% | 96.37% | **97.50%** |
| Cyprus | 881 952 | 25 270 | 28 485 | 30 | 10 | **33.33%** | 85.24% | 90.15% | 88.72% | **88.03%** |
| Liechtenstein | 38 563 | 154 858 | - | 13 | 4 | **30.77%** | - | - | - | - |
| **Average** | **16 501 307** | **39 119** | **33 868** | **88** | **14** | **25.19%** | **86.48%** | **90.19%** | **91.46%** | **89.38%** |
| **Minimum** | **38 563** | **8 779** | **16 865** | **9** | **0** | **0.00%** | **44.59%** | **60.84%** | **57.75%** | **54.39%** |
| **Maximum** | **83 092 962** | **154 858** | **82 996** | **362** | **230** | **377.78%** | **99.74%** | **100.00%** | **99.92%** | **99.88%** |

**Annex B.8** – Case exhibit #1: Banks 'unsuccess rate' in EEA+2

| Jurisdiction | Population | GDP (nominal) per capita (EUR) | GDP (PPP) per capita (EUR) | Banks | | Banks Unsuccess Rate | Account ownership (population ages 15+) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Operating | Closed | | 2011 | 2014 | 2017 | Average |
| Denmark | 5 814 422 | 53 788 | 41 397 | 97 | 90 | **48.13%** | 99.74% | 100.00% | 99.92% | **99.88%** |
| Latvia | 1 913 822 | 15 895 | 21 958 | 18 | 15 | **45.45%** | 89.66% | 90.22% | 93.22% | **91.03%** |
| Netherlands | 17 344 874 | 46 714 | 40 804 | 93 | 70 | **42.94%** | 98.66% | 99.30% | 99.64% | **99.20%** |
| Greece | 10 721 582 | 17 107 | 21 180 | 37 | 27 | **42.19%** | 77.94% | 87.52% | 85.47% | **83.64%** |
| Iceland | 360 563 | 61 520 | 41 224 | 9 | 6 | **40.00%** | 99.65% | 100.00% | 99.79% | **99.81%** |
| **Average** | **16 501 307** | **39 119** | **33 868** | **88** | **38** | **30.44%** | **86.48%** | **90.19%** | **91.46%** | **89.38%** |
| **Minimum** | **38 563** | **8 779** | **16 865** | **9** | **4** | **15.15%** | **44.59%** | **60.84%** | **57.75%** | **54.39%** |
| **Maximum** | **83 092 962** | **154 858** | **82 996** | **362** | **134** | **48.13%** | **99.74%** | **100.00%** | **99.92%** | **99.88%** |

**Annex B.9** – Case exhibit #2: FinTechs - Total registered users, 2016 – 2020

(Ratio: millions people)

| FinTech | Launch Date | HQ | 2016 | 2017 | 2018 | 2019 | 2020 | Industry | Markets |
|---|---|---|---|---|---|---|---|---|---|
| Mintos | 1 Jun. 2015 | LV | 0.017 | 0.043 | 0.099 | 0.235 | 0.363 | P2P Lending | Various |
| Revolut | 1 Jul. 2015 | GB | 0.1 | 0.6 | 2 | 6 | 12 | Payments & Trading * | Various |
| eToro | Jan. 2007 | IL | 5.6 | 8.1 | 10 | 12.3 | 17.5 | Social Trading * | Various |
| Robinhood | 18 Apr. 2013 | US | 1 | 2 | 6 | 10 | 13 | Trading * | US |
| Coinbase | Jun. 2012 | US | 5 | 13 | 22 | 30 | 35 | Crypto-assets Trading | Various |
| PayPal | Dec. 1998 | US | 197 | 227 | 267 | 305 | 377 | Payments | Various |
| Venmo (PayPal) | Aug. 2009 | US | 5 | 10 | 23 | 40 | 52 | Payments | US |
| Cash App (Square) | 15 Oct. 2013 | US | 3 | 7 | 15 | 24 | 36 | Payments & Trading * | US; UK |

* FinTechs offering trading services in securities, derivatives and crypto-assets.

Note: Venmo and Cash App are subsidiaries of Paypal and Square respectively. Codes: LV - Latvia; GB - United Kingdom; IL - Israel; US - United States.

Sources: Business of Apps (2021a, 2021b, 2021c); eToro (2021); Mintos (2021).

**Annex B.10** – Case exhibit #3: Investment crowdfunding - Funding, 30-04-2021

(Ratio: EUR millions)

| Country (Legal Address) | Business Lending | Crypto Lending | Litigation Equity | Marketplace Lending | Personal Lending | Real Estate Equity | Real Estate Lending | Social Lending | Startup Equity | Student Lending | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Argentina | 0.00 | 0.00 | 0.00 | 0.00 | 11.25 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **11.25** |
| Austria | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 56.07 | 0.00 | 1.54 | 0.00 | **57.61** |
| Belgium | 102.89 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **102.89** |
| Bulgaria | 0.00 | 0.00 | 0.00 | 1.67 | 8.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **10.27** |
| Croatia | 0.00 | 0.00 | 0.00 | 244.96 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **244.96** |
| Cyprus | 0.00 | 0.00 | 0.00 | 2.83 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **2.83** |
| Czech Republic | 0.00 | 0.00 | 0.00 | 63.88 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **63.88** |
| Denmark | 59.06 | 0.00 | 0.00 | 0.00 | 0.00 | 19.60 | 5.86 | 0.00 | 0.00 | 0.00 | **84.52** |
| Estonia | 20.36 | 0.00 | 0.00 | 398.11 | 429.01 | 0.00 | 486.59 | 0.00 | 0.00 | 0.00 | **1 334.07** |
| Finland | 0.00 | 0.00 | 0.00 | 0.00 | 751.08 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **751.08** |
| France | 714.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 118.21 | 0.00 | 0.00 | 0.00 | **832.22** |
| Germany | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 138.92 | 0.00 | 0.00 | 0.00 | **138.92** |
| Ireland | 0.00 | 0.00 | 0.00 | 72.08 | 0.00 | 0.00 | 13.22 | 0.00 | 0.00 | 0.00 | **85.30** |
| Italy | 1 864.86 | 0.00 | 0.00 | 0.00 | 32.08 | 0.00 | 13.84 | 0.00 | 0.00 | 0.00 | **1 910.78** |
| Latvia | 51.99 | 0.00 | 0.00 | 8 189.27 | 0.00 | 0.00 | 0.63 | 0.00 | 0.00 | 0.00 | **8 241.89** |
| Lithuania | 0.00 | 0.00 | 0.00 | 38.63 | 109.16 | 0.00 | 39.25 | 0.00 | 0.00 | 0.00 | **187.04** |
| Mexico | 0.00 | 0.00 | 0.00 | 0.00 | 69.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **69.05** |
| Netherlands | 0.00 | 0.00 | 0.00 | 0.00 | 36.80 | 0.00 | 0.00 | 73.60 | 0.00 | 0.00 | **110.40** |
| Norway | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 17.68 | 0.00 | 0.00 | 0.00 | **17.68** |
| Peru | 0.00 | 0.00 | 0.00 | 0.00 | 5.59 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **5.59** |
| Poland | 0.00 | 0.00 | 0.00 | 0.00 | 31.72 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **31.72** |
| Slovakia | 0.00 | 0.00 | 0.00 | 0.00 | 21.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **21.33** |
| Spain | 169.19 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 123.03 | 0.74 | 0.00 | 0.00 | **292.96** |
| Sweden | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 115.39 | 0.00 | 0.00 | 0.00 | **115.39** |
| Switzerland | 801.60 | 0.00 | 0.00 | 0.00 | 129.32 | 0.00 | 0.00 | 0.00 | 0.00 | 3.74 | **934.66** |
| United Kingdom | 168.89 | 0.00 | 1.35 | 0.00 | 5 004.25 | 0.00 | 482.92 | 0.00 | 0.00 | 14.37 | **5 671.78** |
| United States | 0.00 | 78.02 | 0.00 | 0.00 | 0.00 | 0.00 | 2 111.57 | 0.00 | 0.00 | 0.00 | **2 189.59** |
| **Total** | **3 952.85** | **78.02** | **1.35** | **9 011.43** | **6 639.24** | **19.60** | **3 723.18** | **74.34** | **1.54** | **18.11** | **23 519.66** |

Source: P2P Market Data (2021), Author.

**Annex B.11** – Case exhibit #3: Investment crowdfunding - Funding type, 30-04-2021

(Ratio: %)

| Country (Legal Address) | Business Lending | Crypto Lending | Litigation Equity | Marketplace Lending | Personal Lending | Real Estate Equity | Real Estate Lending | Social Lending | Startup Equity | Student Lending | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Argentina | 0.00% | 0.00% | 0.00% | 0.00% | 0.17% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | **0.05%** |
| Austria | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 1.51% | 0.00% | 100.00% | 0.00% | **0.24%** |
| Belgium | 2.60% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | **0.44%** |
| Bulgaria | 0.00% | 0.00% | 0.00% | 0.02% | 0.13% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | **0.04%** |
| Croatia | 0.00% | 0.00% | 0.00% | 2.72% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | **1.04%** |
| Cyprus | 0.00% | 0.00% | 0.00% | 0.03% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | **0.01%** |
| Czech Republic | 0.00% | 0.00% | 0.00% | 0.71% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | **0.27%** |
| Denmark | 1.49% | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.16% | 0.00% | 0.00% | 0.00% | **0.36%** |
| Estonia | 0.52% | 0.00% | 0.00% | 4.42% | 6.46% | 0.00% | 13.07% | 0.00% | 0.00% | 0.00% | **5.67%** |
| Finland | 0.00% | 0.00% | 0.00% | 0.00% | 11.31% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | **3.19%** |
| France | 18.06% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 3.17% | 0.00% | 0.00% | 0.00% | **3.54%** |
| Germany | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 3.73% | 0.00% | 0.00% | 0.00% | **0.59%** |
| Ireland | 0.00% | 0.00% | 0.00% | 0.80% | 0.00% | 0.00% | 0.36% | 0.00% | 0.00% | 0.00% | **0.36%** |
| Italy | 47.18% | 0.00% | 0.00% | 0.00% | 0.48% | 0.00% | 0.37% | 0.00% | 0.00% | 0.00% | **8.12%** |
| Latvia | 1.32% | 0.00% | 0.00% | 90.88% | 0.00% | 0.00% | 0.02% | 0.00% | 0.00% | 0.00% | **35.04%** |
| Lithuania | 0.00% | 0.00% | 0.00% | 0.43% | 1.64% | 0.00% | 1.05% | 0.00% | 0.00% | 0.00% | **0.80%** |
| Mexico | 0.00% | 0.00% | 0.00% | 0.00% | 1.04% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | **0.29%** |
| Netherlands | 0.00% | 0.00% | 0.00% | 0.00% | 0.55% | 0.00% | 0.00% | 99.00% | 0.00% | 0.00% | **0.47%** |
| Norway | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.47% | 0.00% | 0.00% | 0.00% | **0.08%** |
| Peru | 0.00% | 0.00% | 0.00% | 0.00% | 0.08% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | **0.02%** |
| Poland | 0.00% | 0.00% | 0.00% | 0.00% | 0.48% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | **0.13%** |
| Slovakia | 0.00% | 0.00% | 0.00% | 0.00% | 0.32% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | **0.09%** |
| Spain | 4.28% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 3.30% | 1.00% | 0.00% | 0.00% | **1.25%** |
| Sweden | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 3.10% | 0.00% | 0.00% | 0.00% | **0.49%** |
| Switzerland | 20.28% | 0.00% | 0.00% | 0.00% | 1.95% | 0.00% | 0.00% | 0.00% | 0.00% | 20.65% | **3.97%** |
| United Kingdom | 4.27% | 0.00% | 100.00% | 0.00% | 75.37% | 0.00% | 12.97% | 0.00% | 0.00% | 79.35% | **24.12%** |
| United States | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 56.71% | 0.00% | 0.00% | 0.00% | **9.31%** |
| **Total** | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** | **100.00%** |
| **Weight** | **16.81%** | **0.33%** | **0.01%** | **38.31%** | **28.23%** | **0.08%** | **15.83%** | **0.32%** | **0.01%** | **0.08%** | |

**Annex B.12** – Case exhibit #4: Mintos - Outstanding investments by loan type, 31-12-2015 – 31-12-2020

(Ratio: EUR)

| Loan Type | 31-12-2015 | 31-12-2016 | 31-12-2017 | 31-12-2018 | 31-12-2019 | 31-12-2020 |
|---|---|---|---|---|---|---|
| Agricultural Loans | - | - | 38 006 | - | 825 585 | 4 060 527 |
| Business Loans | 1 547 886 | 1 855 410 | 4 600 916 | 8 704 675 | 8 177 211 | 8 377 945 |
| Car Loans | 2 161 191 | 13 972 858 | 53 327 235 | 49 081 299 | 78 655 310 | 82 852 123 |
| Invoice Financing | - | 609 285 | 1 307 257 | 10 681 376 | 959 101 | 258 797 |
| Mortgage Loans | 2 412 218 | 3 550 474 | 4 027 097 | 3 264 798 | 4 835 221 | 5 209 894 |
| Pawnbroking Loans | - | - | 861 677 | 1 207 933 | 2 160 119 | 2 826 468 |
| Personal Loans | 520 562 | 16 082 018 | 35 925 417 | 115 654 771 | 287 703 790 | 206 599 168 |
| Short Term Loans | - | - | 13 473 917 | 68 561 009 | 158 782 610 | 77 432 849 |
| **Total** | **6 641 857** | **36 070 045** | **113 561 522** | **257 155 861** | **542 098 947** | **387 617 771** |

Source: Mintos (2021).

**Annex B.13** – Case exhibit #4: Mintos - Outstanding investments by region, 31-12-2015 – 31-12-2020

(Ratio: EUR)

| Region | 31-12-2015 | 31-12-2016 | 31-12-2017 | 31-12-2018 | 31-12-2019 | 31-12-2020 |
|---|---|---|---|---|---|---|
| Africa | - | - | 1 029 886 | 21 601 034 | 45 734 054 | 34 077 191 |
| Asia | - | - | 468 994 | 22 060 652 | 135 376 959 | 57 264 236 |
| Europe | 6 641 858 | 36 070 045 | 112 062 642 | 213 048 097 | 354 732 550 | 292 623 851 |
| Latin America | - | - | - | 446 078 | 6 255 384 | 3 652 493 |
| **Total** | **6 641 858** | **36 070 045** | **113 561 522** | **257 155 861** | **542 098 947** | **387 617 771** |

Source: Mintos (2021).

**Annex B.14** – Case exhibit #5: Digital Asset ETPs in Europe, 30-06-2021

| Inception Date | ETP Issuer | Country | Product Name | Underlying | Domicile | ISIN |
|---|---|---|---|---|---|---|
| 18-05-2015 | XBT Provider | SE | XBT Provider Bitcoin Tracker One ETN | Bitcoin (BTC/USD) | SE | SE0007126024 |
| 15-09-2015 | XBT Provider | SE | XBT Provider Bitcoin Tracker EUR ETN | Bitcoin (BTC/USD) | SE | SE0007525332 |
| 09-10-2017 | XBT Provider | SE | XBT Provider Ether Tracker Euro ETN | Ethereum (ETH/USD) | SE | SE0010296582 |
| 09-10-2017 | XBT Provider | SE | XBT Provider Ether Tracker One ETN | Ethereum (ETH/USD) | SE | SE0010296574 |
| 22-11-2018 | 21Shares | CH | 21Shares Crypto Basket Index ETP | 21Shares Crypto Basket Index | CH | CH0445689208 |
| 26-02-2019 | 21Shares | CH | 21Shares Bitcoin ETP | Bitcoin (BTC/USD) | CH | CH0454664001 |
| 05-03-2019 | 21Shares | CH | 21Shares Ethereum ETP | Ethereum (ETH/USD) | CH | CH0454664027 |
| 22-03-2019 | XBT Provider | SE | XBT Provider Litecoin Tracker One ETN | Litecoin (LTC/USD) | SE | SE0011414465 |
| 22-03-2019 | XBT Provider | SE | XBT Provider Litecoin Tracker Euro ETN | Litecoin (LTC/USD) | SE | SE0011414457 |
| 02-04-2019 | 21Shares | CH | 21Shares Ripple XRP ETP | Ripple XRP (XRP/USD) | CH | CH0454664043 |
| 05-04-2019 | XBT Provider | SE | XBT Provider XRP Tracker One ETN | Ripple XRP (XRP/USD) | SE | SE0011414481 |
| 05-04-2019 | XBT Provider | SE | XBT Provider XRP Tracker Euro ETN | Ripple XRP (XRP/USD) | SE | SE0011414473 |
| 03-07-2019 | 21Shares | CH | 21Shares Bitwise Select 10 Large Cap Crypto Index ETP | Bitwise Select 10 Large Cap Crypto Index | CH | CH0475986318 |
| 04-07-2019 | 21Shares | CH | 21Shares Bitcoin Cash ETP | Bitcoin Cash (BCH/USD) | CH | CH0475552201 |
| 04-10-2019 | 21Shares | CH | 21Shares Bitcoin Suisse ETP | 21Shares Bitcoin Suisse Crypto Index | CH | CH0496484640 |
| 15-10-2019 | 21Shares | CH | 21Shares Binance BNB ETP | Binance Coin (BNB/USD) | CH | CH0496454155 |
| 14-11-2019 | 21Shares | CH | 21Shares Tezos ETP | Tezos (XTZ/USD) | CH | CH0491507486 |
| 02-12-2019 | WisdomTree Issuer X | GB | WisdomTree Bitcoin ETC | Bitcoin (BTC/USD) | JE | GB00BJYDH287 |
| 04-12-2019 | 21Shares | CH | Sygnum Platform Winners Index ETP | Sygnum Platform Winners Index | CH | CH0508793459 |
| 22-01-2020 | 21Shares | CH | 21Shares Short Bitcoin ETP | Short Bitcoin (USD/BTC) | CH | CH0514065058 |
| 08-06-2020 | ETC Issuance | DE | BTCetc - ETC Group Physical Bitcoin | Bitcoin (BTC/USD) | DE | DE000A27Z304 |
| 28-07-2020 | Bitcoin Capital | CH | 15 FiCAS Active Crypto ETP | Actively-managed top 15 by market cap | CH | CH0548689600 |
| 02-11-2020 | SA1 Issuer | CH | SEBA Bitcoin ETP | Bitcoin (BTC/USD) | CH | CH0558875933 |
| 18-11-2020 | SA1 Issuer | CH | SEBA Crypto Asset Select ETP | SEBA Crypto Asset Select Index | CH | CH0568452707 |
| 19-11-2020 | VanEck (Europe) | DE | VanEck Vectors Bitcoin ETN | Bitcoin (BTC/USD) | LI | DE000A28M8D0 |
| 27-11-2020 | SA1 Issuer | CH | SEBA Bitcoin ETP CHF Hedged | Bitcoin (BTC/USD) | CH | CH0574683683 |
| 19-01-2021 | CoinShares | GB | CoinShares Physical Bitcoin | Bitcoin (BTC/USD) | JE | GB00BLD4ZL17 |
| 20-01-2021 | SA1 Issuer | CH | SEBA Ethereum ETP | Ethereum (ETH/USD) | CH | CH0587418630 |
| 04-02-2021 | 21Shares | CH | 21Shares Polkadot ETP | Polkadot (DOT/USD) | CH | CH0593331561 |
| 23-02-2021 | CoinShares | GB | CoinShares Physical Ethereum | Ethereum (ETH/USD) | JE | GB00BLD4ZM24 |
| 05-03-2021 | ETC Issuance | DE | ETHetc - ETC Group Physical Ethereum | Ethereum (ETH/USD) | DE | DE000A3GMKD7 |
| 26-03-2021 | VanEck (Europe) | DE | VanEck Vectors Ethereum ETN | Ethereum (ETH/USD) | LI | DE000A3GPSP7 |
| 06-04-2021 | CoinShares | GB | CoinShares Physical Litecoin | Litecoin (LTC/USD) | JE | GB00BLD4ZP54 |
| 12-04-2021 | ETC Issuance | DE | LTCetc - ETC Group Physical Litecoin | Litecoin (LTC/USD) | DE | DE000A3GN5J9 |
| 13-04-2021 | CoinShares | GB | CoinShares Physical XRP | Ripple XRP (XRP/USD) | JE | GB00BLD4ZN31 |
| 26-04-2021 | 21Shares | CH | 21Shares Cardano ETP | Cardano (ADA/USD) | CH | CH1102728750 |
| 26-04-2021 | 21Shares | CH | 21Shares Stellar ETP | Stellar (XLM/USD) | CH | CH1109575535 |
| 26-04-2021 | Iconic Funds | DE | Iconic Funds Physical Bitcoin ETP | Bitcoin (BTC/USD) | DE | DE000A3GK2N1 |
| 27-04-2021 | WisdomTree Issuer X | GB | WisdomTree Ethereum ETC | Ethereum (ETH/USD) | JE | GB00BJYDH394 |
| 30-06-2021 | 21Shares | CH | 21Shares Solana ETP | Solana (SOL/USD) | CH | CH1114873776 |

Note: All ETPs are Collateralized Debt Instruments with physically backed replication method, except the XBT Provider ETPs that are Uncollateralized Debt Instruments with synthetic replication method.

Sources: 21Shares, CoinShares, ETC Group, FiCAS, HANetf, Iconic Holding, Morningstar, SEBA Bank, VanEck and WisdomTree.

**Annex B.15** – Case exhibit #5: Digital Asset ETPs in Europe - Stock exchange listings, 30-06-2021

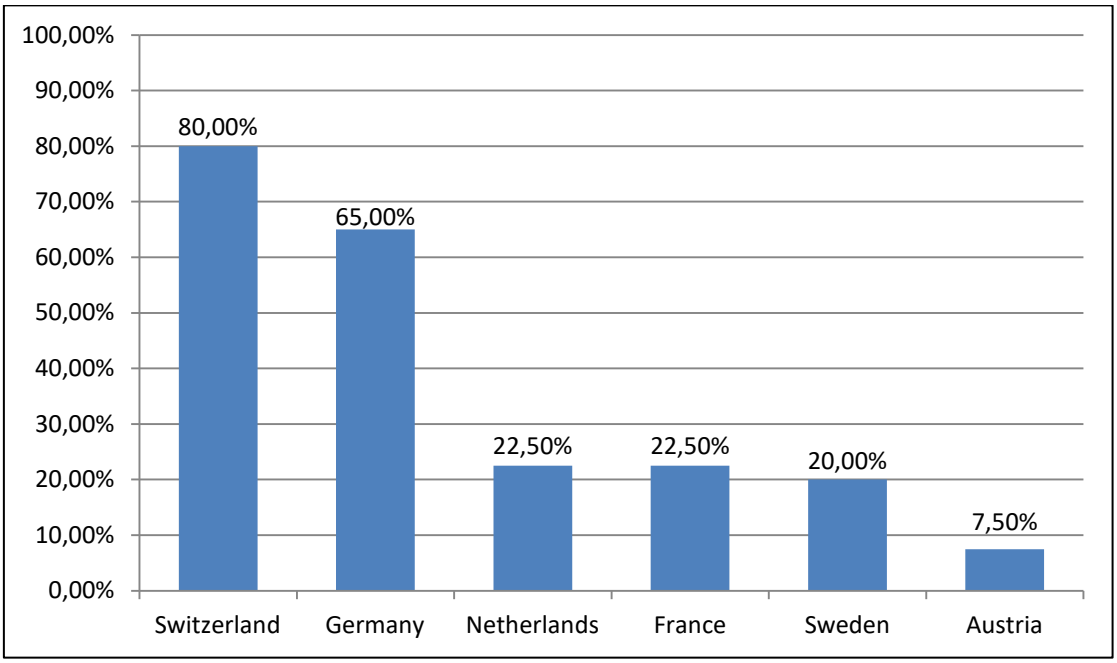
| Inception Date | Product Name | Domicile | XSWX | XETR | XDUS | XSTU | XAMS | XPAR | XBRN | XSTO | XWBO | XNGM | ISIN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18-05-2015 | XBT Provider Bitcoin Tracker One ETN | SE | | | | | | | | x | | | SE0007126024 |
| 15-09-2015 | XBT Provider Bitcoin Tracker EUR ETN | SE | | | | | | | | x | | | SE0007525332 |
| 09-10-2017 | XBT Provider Ether Tracker Euro ETN | SE | | | | | | | | x | | | SE0010296582 |
| 09-10-2017 | XBT Provider Ether Tracker One ETN | SE | | | | | | | | x | | | SE0010296574 |
| 22-11-2018 | 21Shares Crypto Basket Index ETP | CH | x | | x | x | | | | | | | CH0445689208 |
| 26-02-2019 | 21Shares Bitcoin ETP | CH | x | x | x | x | x | x | x | | x | | CH0454664001 |
| 05-03-2019 | 21Shares Ethereum ETP | CH | x | x | x | x | x | x | x | | x | | CH0454664027 |
| 22-03-2019 | XBT Provider Litecoin Tracker One ETN | SE | | | | | | | | | | (x) | SE0011414465 |
| 22-03-2019 | XBT Provider Litecoin Tracker Euro ETN | SE | | | | | | | | | | (x) | SE0011414457 |
| 02-04-2019 | 21Shares Ripple XRP ETP | CH | x | | x | x | | | x | | | | CH0454664043 |
| 05-04-2019 | XBT Provider XRP Tracker One ETN | SE | | | | | | | | | | (x) | SE0011414481 |
| 05-04-2019 | XBT Provider XRP Tracker Euro ETN | SE | | | | | | | | | | (x) | SE0011414473 |
| 03-07-2019 | 21Shares Bitwise Select 10 Large Cap Crypto Index ETP | CH | x | | x | x | | | | | | | CH0475986318 |
| 04-07-2019 | 21Shares Bitcoin Cash ETP | CH | x | x | x | x | | | x | | | | CH0475552201 |
| 04-10-2019 | 21Shares Bitcoin Suisse ETP | CH | x | | x | x | | | | | | | CH0496484640 |
| 15-10-2019 | 21Shares Binance BNB ETP | CH | x | | x | | | | x | | | | CH0496454155 |
| 14-11-2019 | 21Shares Tezos ETP | CH | x | | x | | | | x | | | | CH0491507486 |
| 02-12-2019 | WisdomTree Bitcoin ETC | JE | x | x | | | x | x | | | | | GB00BJYDH287 |
| 04-12-2019 | Sygnum Platform Winners Index ETP | CH | x | | | | | | | | | | CH0508793459 |
| 22-01-2020 | 21Shares Short Bitcoin ETP | CH | x | x | x | x | x | x | | | | | CH0514065058 |
| 08-06-2020 | BTCetc - ETC Group Physical Bitcoin | DE | x | x | | | x | x | | | | | DE000A27Z304 |
| 28-07-2020 | 15 FiCAS Active Crypto ETP | CH | x | | | x | | | | | x | | CH0548689600 |
| 02-11-2020 | SEBA Bitcoin ETP | CH | x | | | | | | | | | | CH0558875933 |
| 18-11-2020 | SEBA Crypto Asset Select ETP | CH | x | | | | | | | | | | CH0568452707 |
| 19-11-2020 | VanEck Vectors Bitcoin ETN | LI | x | x | | | x | x | | | | | DE000A28M8D0 |
| 27-11-2020 | SEBA Bitcoin ETP CHF Hedged | CH | x | | | | | | | | | | CH0574683683 |
| 19-01-2021 | CoinShares Physical Bitcoin | JE | x | x | | | | | | | | | GB00BLD4ZL17 |
| 20-01-2021 | SEBA Ethereum ETP | CH | x | | | | | | | | | | CH0587418630 |
| 04-02-2021 | 21Shares Polkadot ETP | CH | x | | x | x | | | | | | | CH0593331561 |
| 23-02-2021 | CoinShares Physical Ethereum | JE | x | x | | | | | | | | | GB00BLD4ZM24 |
| 05-03-2021 | ETHetc - ETC Group Physical Ethereum | DE | x | x | | | x | x | | | | | DE000A3GMKD7 |
| 26-03-2021 | VanEck Vectors Ethereum ETN | LI | x | x | | | x | x | | | | | DE000A3GPSP7 |
| 06-04-2021 | CoinShares Physical Litecoin | JE | x | x | | | | | | | | | GB00BLD4ZP54 |
| 12-04-2021 | LTCetc - ETC Group Physical Litecoin | DE | x | x | | | | | | | | | DE000A3GN5J9 |
| 13-04-2021 | CoinShares Physical XRP | JE | x | | | | | | | | | | GB00BLD4ZN31 |
| 26-04-2021 | 21Shares Cardano ETP | CH | x | | x | x | | | | | | | CH1102728750 |
| 26-04-2021 | 21Shares Stellar ETP | CH | x | | x | x | | | | | | | CH1109575535 |
| 26-04-2021 | Iconic Funds Physical Bitcoin ETP | DE | x | x | | | | | | | | | DE000A3GK2N1 |
| 27-04-2021 | WisdomTree Ethereum ETC | JE | x | x | | | x | x | | | | | GB00BJYDH394 |
| 30-06-2021 | 21Shares Solana ETP | CH | x | | x | x | | | | | | | CH1114873776 |
| | **Total** | | **32** | **15** | **14** | **13** | **9** | **9** | **6** | **4** | **3** | **(4)** | |

Note: The four XBT Provider ETPs listed on the XNGM are expired. Codes: See Glossary of Acronyms.

Sources: 21Shares, CoinShares, ETC Group, FiCAS, HANetf, Iconic Holding, Morningstar, SEBA Bank, VanEck and WisdomTree.

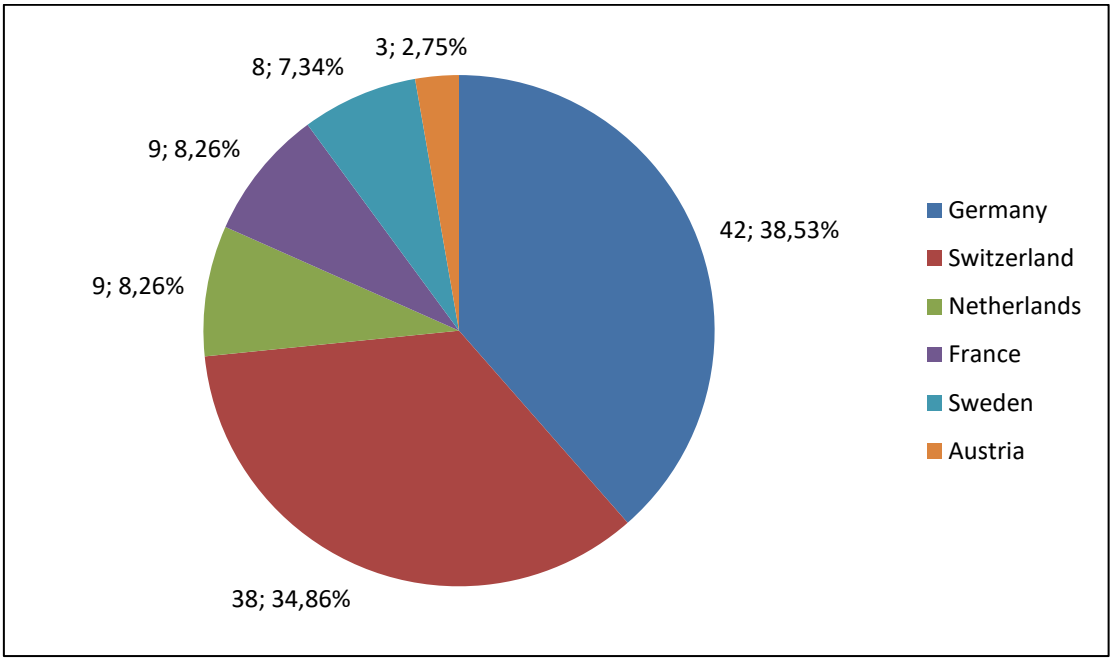
**Annex B.16** – Case exhibit #5: Crypto ETPs - European listings per jurisdiction, 30-06-2021

(Ratio: %)

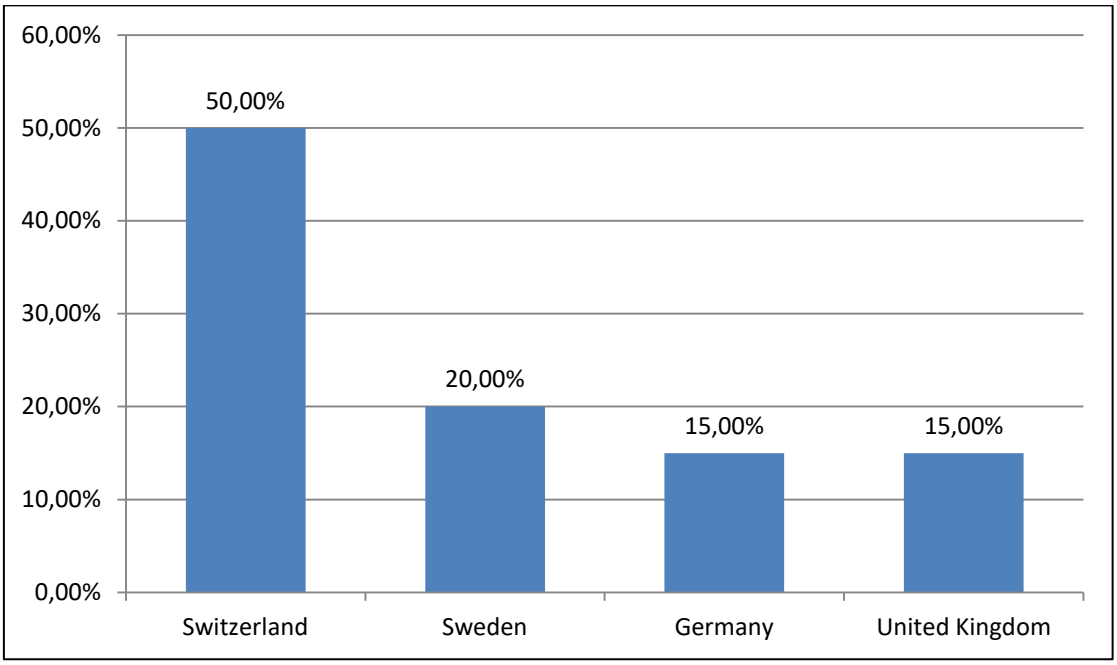



**Annex B.17** – Case exhibit #5: Crypto ETPs - European listings per stock exchanges, 30-06-2021

(Ratio: %)



**Annex B.18** – Case exhibit #5: Crypto ETPs - Origin of the crypto ETPs issuers, 30-06-2021 (Ratio: %)



**Annex B.19** – Case exhibit #6: Cumulative returns (Logarithmic returns), 31-05-2021

(Ratio: %)

| Name | YTD | 1 Month | 3 Months | 6 Months | 1 Year | 2 Years | 3 Years | 5 Years | 29-04-2013 |
|---|---|---|---|---|---|---|---|---|---|
| S&P 500 (SPX) | 11.27% | 0.55% | 9.81% | 14.91% | 32.28% | 42.37% | 44.09% | 69.56% | 97.01% |
| CBOE Volatility Index (VIX) | -30.56% | -10.47% | -51.14% | -20.48% | -49.56% | -11.01% | 8.27% | 16.65% | 20.09% |
| SPDR Gold Shares (GLD) | 0.01% | 7.40% | 9.75% | 6.79% | 9.07% | 36.91% | 37.09% | 42.98% | 22.60% |
| 21Shares Bitcoin ETP (ABTC) | 26.88% | -43.24% | -26.55% | 63.01% | 134.79% | 145.81% | - | - | - |
| USD/EUR - US Dollar Euro | -0.10% | -1.71% | -1.25% | -2.46% | -9.69% | -8.92% | -4.48% | -9.40% | 6.88% |
| EUR/USD - Euro US Dollar | 0.10% | 1.71% | 1.24% | 2.46% | 9.67% | 9.05% | 4.46% | 9.37% | -6.91% |
| XAU/USD - Gold Spot US Dollar | 0.52% | 7.50% | 9.51% | 7.03% | 9.92% | 37.88% | 38.41% | 45.03% | 25.54% |
| BTC/USD - Bitcoin US Dollar | 25.25% | -43.63% | -21.61% | 64.30% | 137.50% | 147.11% | 160.57% | 425.21% | 555.41% |
| BTC/EUR - Bitcoin Euro | 26.15% | -44.13% | -21.79% | 62.48% | 127.94% | 138.05% | 156.15% | 416.29% | 562.15% |
| BTC/JPY - Bitcoin Japanese Yen | 31.62% | -42.69% | -18.34% | 69.78% | 139.61% | 147.65% | 161.74% | 424.41% | 567.01% |
| BTC/GBP - Bitcoin British Pound | 21.32% | -45.22% | -22.81% | 58.14% | 123.44% | 135.41% | 154.07% | 428.45% | 564.25% |
| PAXG/USD - PAX Gold US Dollar | -0.60% | 7.23% | 9.26% | 7.04% | 9.41% | - | - | - | - |
| WBTC/USD - Wrapped Bitcoin US Dollar | 25.49% | -43.69% | -21.11% | 64.50% | 137.40% | 146.08% | - | - | - |
| USDT/USD - Tether US Dollar | -0.25% | -0.25% | -1.24% | -0.07% | -0.18% | -0.25% | -0.25% | -0.25% | - |
| USDT/EUR - Tether Euro | -0.37% | -2.11% | -2.33% | -2.53% | -9.81% | -9.25% | -4.78% | -9.17% | - |

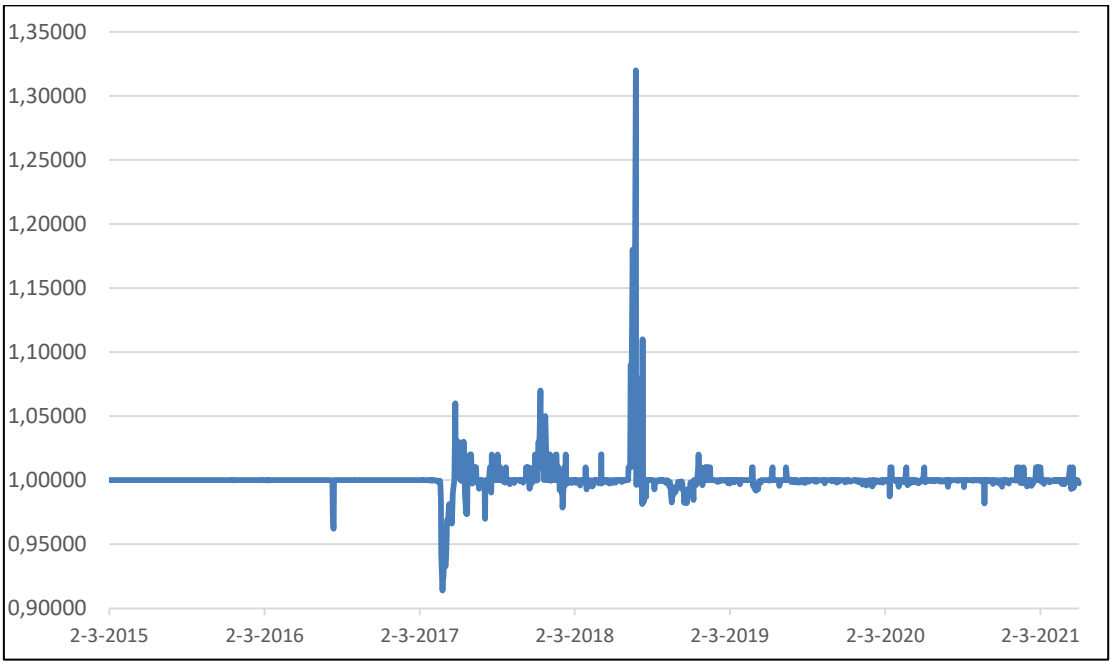
**Annex B.20** – Case exhibit #6: Annualized returns (Logarithmic returns), 31-05-2021

(Ratio: %)

| Name | YTD | 1 Month | 3 Months | 6 Months | 1 Year | 2 Years | 3 Years | 5 Years | 29-04-2013 |
|---|---|---|---|---|---|---|---|---|---|
| S&P 500 (SPX) | 29.21% | 6.77% | 45.42% | 32.05% | 32.28% | 19.32% | 12.95% | 11.14% | 8.74% |
| CBOE Volatility Index (VIX) | -58.32% | -73.48% | -94.30% | -36.77% | -49.56% | -5.66% | 2.68% | 3.13% | 2.29% |
| SPDR Gold Shares (GLD) | 0.03% | 135.48% | 45.08% | 14.04% | 9.07% | 17.01% | 11.09% | 7.41% | 2.55% |
| 21Shares Bitcoin ETP (ABTC) | 77.07% | -99.89% | -70.90% | 165.73% | 134.79% | 56.78% | - | - | - |
| USD/EUR - US Dollar Euro | -0.23% | -18.69% | -4.91% | -4.87% | -9.69% | -4.56% | -1.52% | -1.96% | 0.83% |
| EUR/USD - Euro US Dollar | 0.24% | 22.53% | 5.06% | 4.98% | 9.67% | 4.43% | 1.46% | 1.81% | -0.88% |
| XAU/USD - Gold Spot US Dollar | 1.25% | 138.21% | 43.80% | 14.55% | 9.92% | 17.42% | 11.44% | 7.72% | 2.85% |
| BTC/USD - Bitcoin US Dollar | 71.67% | -99.90% | -62.24% | 169.95% | 137.50% | 57.20% | 37.61% | 39.34% | 26.17% |
| BTC/EUR - Bitcoin Euro | 74.63% | -99.91% | -62.58% | 164.01% | 127.94% | 54.29% | 36.82% | 38.86% | 26.33% |
| BTC/JPY - Bitcoin Japanese Yen | 93.38% | -99.87% | -55.54% | 188.26% | 139.61% | 57.37% | 37.81% | 39.29% | 26.44% |
| BTC/GBP - Bitcoin British Pound | 59.01% | -99.93% | -64.51% | 150.07% | 123.44% | 53.43% | 36.45% | 39.51% | 26.38% |
| PAXG/USD - PAX Gold US Dollar | -1.42% | 131.22% | 42.52% | 14.58% | 9.41% | - | - | - | - |
| WBTC/USD - Wrapped Bitcoin US Dollar | 72.46% | -99.90% | -61.26% | 170.59% | 137.40% | 56.87% | - | - | - |
| USDT/USD - Tether US Dollar | -0.59% | -2.90% | -4.87% | -0.14% | -0.18% | -0.12% | -0.08% | -0.05% | - |
| USDT/EUR - Tether Euro | -0.88% | -22.53% | -9.01% | -5.00% | -9.81% | -4.74% | -1.62% | -1.90% | - |

**Annex B.21** – Case exhibit #6: Evolution of USDT/USD, 02-03-2015 – 31-05-2021

(Ratio: USD)




Source: CoinGecko (2021).

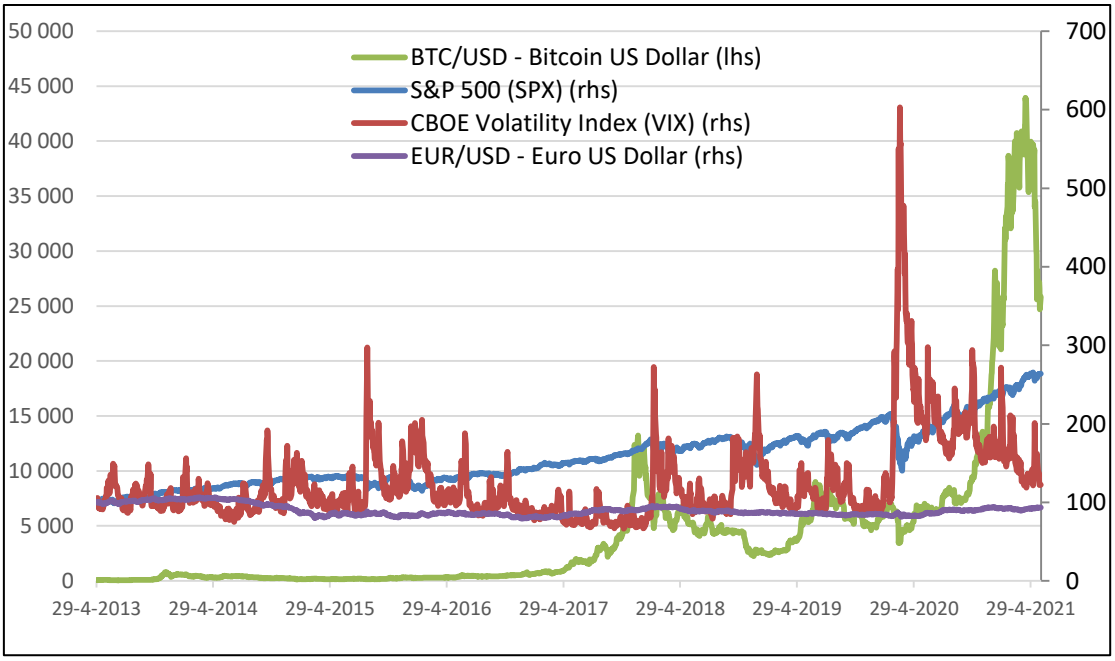
**Annex B.22** – Case exhibit #6: Volatility (Standard deviation), 31-05-2021

(Ratio: %)

| Name | YTD | 1 Month | 3 Months | 6 Months | 1 Year | 2 Years | 3 Years | 5 Years | 29-04-2013 |
|---|---|---|---|---|---|---|---|---|---|
| S&P 500 (SPX) | 14.47% | 13.74% | 13.82% | 13.60% | 17.24% | 26.24% | 23.17% | 19.25% | 17.23% |
| CBOE Volatility Index (VIX) | 151.31% | 163.99% | 124.45% | 141.42% | 126.70% | 136.84% | 133.42% | 134.47% | 128.41% |
| SPDR Gold Shares (GLD) | 14.90% | 10.03% | 11.98% | 14.71% | 16.54% | 16.92% | 14.85% | 13.63% | 14.90% |
| 21Shares Bitcoin ETP (ABTC) | 105.42% | 100.43% | 81.27% | 101.03% | 81.28% | 78.64% | - | - | - |
| USD/EUR - US Dollar Euro | 6.10% | 6.26% | 6.13% | 6.15% | 6.17% | 6.55% | 6.50% | 6.99% | 7.81% |
| EUR/USD - Euro US Dollar | 6.11% | 6.30% | 6.14% | 6.17% | 6.18% | 6.56% | 6.50% | 7.00% | 7.82% |
| XAU/USD - Gold Spot US Dollar | 14.99% | 10.46% | 12.28% | 14.80% | 16.80% | 16.71% | 14.68% | 13.54% | 14.77% |
| BTC/USD - Bitcoin US Dollar | 92.01% | 107.30% | 80.44% | 88.81% | 72.13% | 79.30% | 74.46% | 77.47% | 80.61% |
| BTC/EUR - Bitcoin Euro | 92.77% | 111.00% | 82.33% | 89.29% | 72.30% | 79.86% | 74.96% | 77.99% | 81.17% |
| BTC/JPY - Bitcoin Japanese Yen | 93.15% | 109.20% | 81.87% | 89.64% | 72.78% | 80.03% | 75.16% | 78.07% | 81.35% |
| BTC/GBP - Bitcoin British Pound | 92.35% | 111.10% | 81.72% | 88.72% | 72.44% | 80.73% | 75.70% | 78.85% | 81.41% |
| PAXG/USD - PAX Gold US Dollar | 17.53% | 16.41% | 14.39% | 17.17% | 18.68% | - | - | - | - |
| WBTC/USD - Wrapped Bitcoin US Dollar | 92.32% | 108.42% | 81.01% | 89.16% | 72.80% | 85.28% | - | - | - |
| USDT/USD - Tether US Dollar | 7.08% | 8.91% | 5.65% | 6.49% | 5.56% | 4.91% | 25.91% | 21.77% | - |
| USDT/EUR - Tether Euro | 8.41% | 9.77% | 7.67% | 8.29% | 8.32% | 8.67% | 26.87% | 23.13% | - |

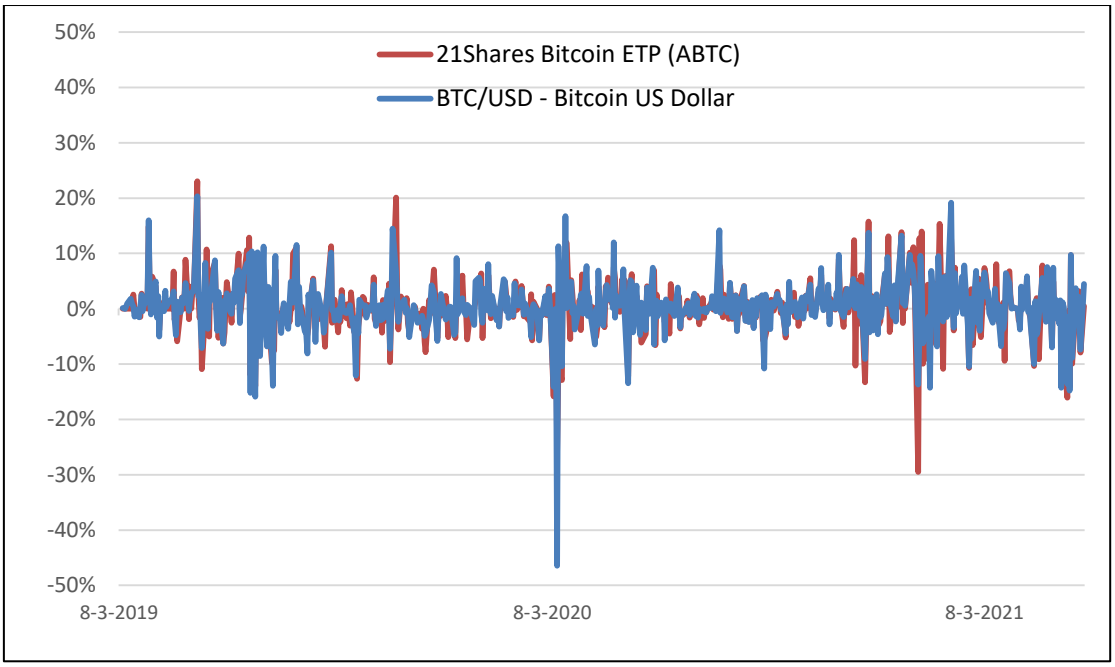
**Annex B.23** – Case exhibit #6: Evolution of BTC/USD vs. S&P 500 vs. VIX vs. EUR/USD, 29-04-2013 – 31-05-2021

(Ratio: Values rebased at 100)



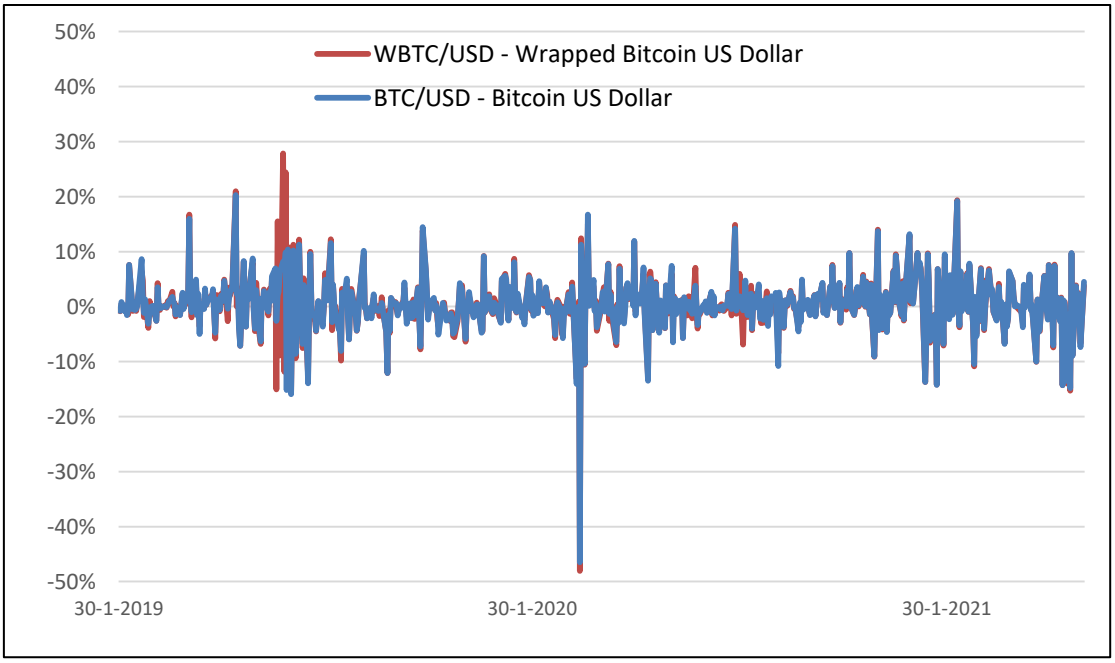

**Annex B.24** – Case exhibit #6: Evolution of daily returns of the ABTC vs. BTC/USD, 08-03-2019 – 31-05-2021

(Ratio: %)



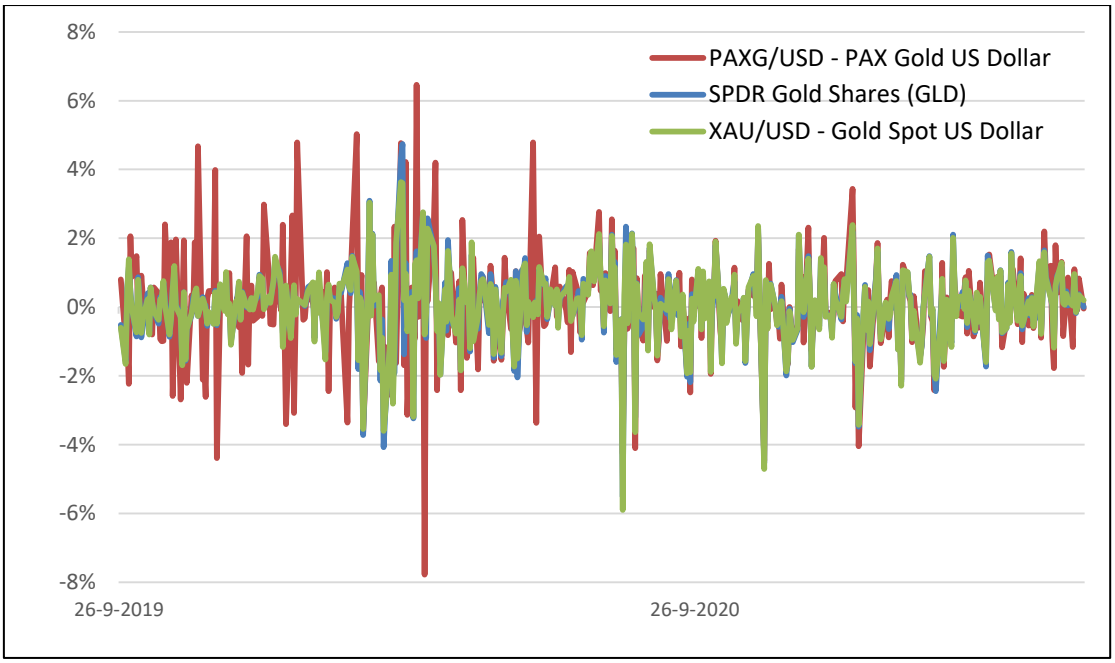
**Annex B.25** – Case exhibit #6: Evolution of daily returns of the WBTC/USD vs. BTC/USD, 30-01-2019 – 31-05-2021

(Ratio: %)



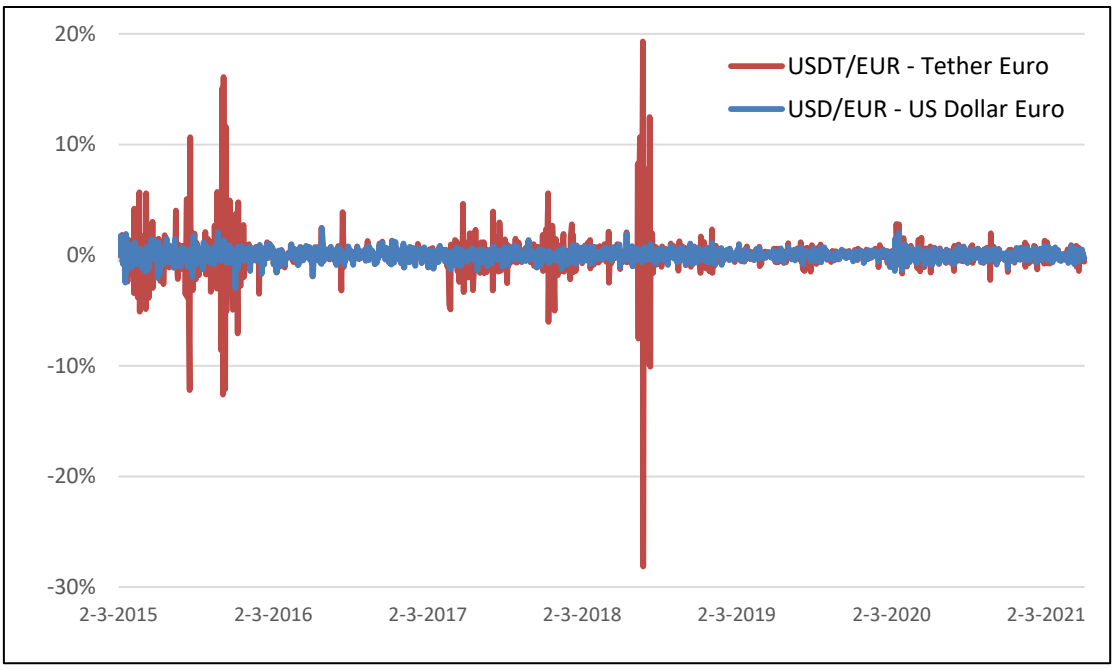

**Annex B.26** – Case exhibit #6: Evolution of daily returns of the PAXG/USD vs. GLD vs. XAU/USD, 26-09-2019 – 31-05-2021

(Ratio: %)



**Annex B.27** – Case exhibit #6: Evolution of daily returns of the USDT/EUR vs. USD/EUR, 02-03-2015 – 31-05-2021

(Ratio: %)



**Annex B.28** – Case exhibit #6: Risk-adjusted returns, 31-05-2021

| Name | YTD | 1 Month | 3 Months | 6 Months | 1 Year | 2 Years | 3 Years | 5 Years | 29-04-2013 |
|---|---|---|---|---|---|---|---|---|---|
| S&P 500 (SPX) | 2.02 | 0.49 | 3.29 | 2.36 | 1.87 | 0.74 | 0.56 | 0.58 | 0.51 |
| CBOE Volatility Index (VIX) | -0.39 | -0.45 | -0.76 | -0.26 | -0.39 | -0.04 | 0.02 | 0.02 | 0.02 |
| SPDR Gold Shares (GLD) | 0.00 | 13.50 | 3.76 | 0.95 | 0.55 | 1.00 | 0.75 | 0.54 | 0.17 |
| 21Shares Bitcoin ETP (ABTC) | 0.73 | -0.99 | -0.87 | 1.64 | 1.66 | 0.72 | - | - | - |
| USD/EUR - US Dollar Euro | -0.04 | -2.98 | -0.80 | -0.79 | -1.57 | -0.70 | -0.23 | -0.28 | 0.11 |
| EUR/USD - Euro US Dollar | 0.04 | 3.57 | 0.83 | 0.81 | 1.56 | 0.67 | 0.23 | 0.26 | -0.11 |
| XAU/USD - Gold Spot US Dollar | 0.08 | 13.21 | 3.57 | 0.98 | 0.59 | 1.04 | 0.78 | 0.57 | 0.19 |
| BTC/USD - Bitcoin US Dollar | 0.78 | -0.93 | -0.77 | 1.91 | 1.91 | 0.72 | 0.51 | 0.51 | 0.32 |
| BTC/EUR - Bitcoin Euro | 0.80 | -0.90 | -0.76 | 1.84 | 1.77 | 0.68 | 0.49 | 0.50 | 0.32 |
| BTC/JPY - Bitcoin Japanese Yen | 1.00 | -0.91 | -0.68 | 2.10 | 1.92 | 0.72 | 0.50 | 0.50 | 0.33 |
| BTC/GBP - Bitcoin British Pound | 0.64 | -0.90 | -0.79 | 1.69 | 1.70 | 0.66 | 0.48 | 0.50 | 0.32 |
| PAXG/USD - PAX Gold US Dollar | -0.08 | 8.00 | 2.95 | 0.85 | 0.50 | - | - | - | - |
| WBTC/USD - Wrapped Bitcoin US Dollar | 0.78 | -0.92 | -0.76 | 1.91 | 1.89 | 0.67 | - | - | - |
| USDT/USD - Tether US Dollar | -0.08 | -0.33 | -0.86 | -0.02 | -0.03 | -0.03 | 0.00 | 0.00 | - |
| USDT/EUR - Tether Euro | -0.10 | -2.31 | -1.18 | -0.60 | -1.18 | -0.55 | -0.06 | -0.08 | - |

**Annex B.29** – Case exhibit #6: Tracking error, 31-05-2021

(Ratio: %)

| Name | YTD | 1 Month | 3 Months | 6 Months | 1 Year | 2 Years | 3 Years | 5 Years | 29-04-2013 |
|---|---|---|---|---|---|---|---|---|---|
| BTC/USD - Bitcoin US Dollar **(Benchmark)** | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| 21Shares Bitcoin ETP (ABTC) | 76.52% | 71.14% | 57.83% | 72.18% | 59.60% | 61.35% | - | - | - |
| | | | | | | | | | |
| BTC/USD - Bitcoin US Dollar **(Benchmark)** | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| WBTC/USD - Wrapped Bitcoin US Dollar | 4.96% | 5.75% | 5.14% | 4.72% | 12.29% | 30.15% | - | - | - |
| | | | | | | | | | |
| XAU/USD - Gold Spot US Dollar **(Benchmark)** | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| SPDR Gold Shares (GLD) | 2.24% | 1.62% | 2.17% | 2.15% | 2.99% | 3.36% | 2.86% | 2.54% | 2.52% |
| PAXG/USD - PAX Gold US Dollar | 7.76% | 9.97% | 7.69% | 8.12% | 10.37% | - | - | - | - |
| | | | | | | | | | |
| USD/EUR - US Dollar Euro **(Benchmark)** | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| USDT/EUR - Tether Euro | 6.04% | 8.26% | 5.81% | 5.66% | 5.39% | 5.43% | 26.04% | 22.74% | - |

**Annex B.30** – Case exhibit #6: Correlations YTD, 31-05-2021

| | Name | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | S&P 500 (SPX) | 1.0000 | -0.8465 | 0.2586 | 0.0148 | -0.2393 | 0.2382 | 0.2123 | 0.3021 | 0.3133 | 0.3080 | 0.3208 | 0.1950 | 0.2972 | 0.1170 | -0.0719 |
| 2 | CBOE Volatility Index (VIX) | -0.8465 | 1.0000 | -0.1823 | -0.0339 | 0.1965 | -0.2001 | -0.1499 | -0.2964 | -0.3113 | -0.3028 | -0.3227 | -0.1989 | -0.2948 | -0.0812 | 0.0895 |
| 3 | SPDR Gold Shares (GLD) | 0.2586 | -0.1823 | 1.0000 | -0.0121 | -0.5240 | 0.5232 | 0.9888 | 0.0278 | 0.0302 | 0.0216 | 0.0246 | 0.8749 | 0.0347 | 0.0059 | -0.3791 |
| 4 | 21Shares Bitcoin ETP (ABTC) | 0.0148 | -0.0339 | -0.0121 | 1.0000 | -0.1679 | 0.1727 | -0.0165 | 0.7074 | 0.7063 | 0.7065 | 0.7066 | 0.0237 | 0.7125 | -0.2748 | -0.3019 |
| 5 | USD/EUR - US Dollar Euro | -0.2393 | 0.1965 | -0.5240 | -0.1679 | 1.0000 | -0.9993 | -0.5040 | -0.1215 | -0.1260 | -0.1101 | -0.1206 | -0.4509 | -0.1275 | 0.0562 | 0.6968 |
| 6 | EUR/USD - Euro US Dollar | 0.2382 | -0.2001 | 0.5232 | 0.1727 | -0.9993 | 1.0000 | 0.5032 | 0.1274 | 0.1319 | 0.1159 | 0.1265 | 0.4494 | 0.1333 | -0.0590 | -0.6976 |
| 7 | XAU/USD - Gold Spot US Dollar | 0.2123 | -0.1499 | 0.9888 | -0.0165 | -0.5040 | 0.5032 | 1.0000 | 0.0131 | 0.0154 | 0.0078 | 0.0099 | 0.8976 | 0.0184 | 0.0236 | -0.3669 |
| 8 | BTC/USD - Bitcoin US Dollar | 0.3021 | -0.2964 | 0.0278 | 0.7074 | -0.1215 | 0.1274 | 0.0131 | 1.0000 | 0.9979 | 0.9985 | 0.9972 | 0.0738 | 0.9986 | -0.0985 | -0.1516 |
| 9 | BTC/EUR - Bitcoin Euro | 0.3133 | -0.3113 | 0.0302 | 0.7063 | -0.1260 | 0.1319 | 0.0154 | 0.9979 | 1.0000 | 0.9985 | 0.9982 | 0.0756 | 0.9964 | -0.0992 | -0.1540 |
| 10 | BTC/JPY - Bitcoin Japanese Yen | 0.3080 | -0.3028 | 0.0216 | 0.7065 | -0.1101 | 0.1159 | 0.0078 | 0.9985 | 0.9985 | 1.0000 | 0.9972 | 0.0708 | 0.9967 | -0.1015 | -0.1452 |
| 11 | BTC/GBP - Bitcoin British Pound | 0.3208 | -0.3227 | 0.0246 | 0.7066 | -0.1206 | 0.1265 | 0.0099 | 0.9972 | 0.9982 | 0.9972 | 1.0000 | 0.0737 | 0.9958 | -0.0986 | -0.1506 |
| 12 | PAXG/USD - PAX Gold US Dollar | 0.1950 | -0.1989 | 0.8749 | 0.0237 | -0.4509 | 0.4494 | 0.8976 | 0.0738 | 0.0756 | 0.0708 | 0.0737 | 1.0000 | 0.0772 | 0.0667 | -0.3343 |
| 13 | WBTC/USD - Wrapped Bitcoin US Dollar | 0.2972 | -0.2948 | 0.0347 | 0.7125 | -0.1275 | 0.1333 | 0.0184 | 0.9986 | 0.9964 | 0.9967 | 0.9958 | 0.0772 | 1.0000 | -0.1084 | -0.1612 |
| 14 | USDT/USD - Tether US Dollar | 0.1170 | -0.0812 | 0.0059 | -0.2748 | 0.0562 | -0.0590 | 0.0236 | -0.0985 | -0.0992 | -0.1015 | -0.0986 | 0.0667 | -0.1084 | 1.0000 | 0.6556 |
| 15 | USDT/EUR - Tether Euro | -0.0719 | 0.0895 | -0.3791 | -0.3019 | 0.6968 | -0.6976 | -0.3669 | -0.1516 | -0.1540 | -0.1452 | -0.1506 | -0.3343 | -0.1612 | 0.6556 | 1.0000 |

**Annex B.31** – Case exhibit #6: Correlations 1 month, 31-05-2021

| | Name | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | S&P 500 (SPX) | 1.0000 | -0.9582 | 0.5784 | 0.1454 | -0.5676 | 0.5750 | 0.5786 | 0.5428 | 0.5487 | 0.5510 | 0.5630 | 0.5165 | 0.5385 | 0.1597 | -0.2304 |
| 2 | CBOE Volatility Index (VIX) | -0.9582 | 1.0000 | -0.4393 | -0.1044 | 0.4623 | -0.4711 | -0.4541 | -0.5005 | -0.5063 | -0.5086 | -0.5222 | -0.4244 | -0.4966 | -0.0358 | 0.2983 |
| 3 | SPDR Gold Shares (GLD) | 0.5784 | -0.4393 | 1.0000 | -0.0309 | -0.7016 | 0.6916 | 0.9884 | 0.2197 | 0.2201 | 0.2220 | 0.2309 | 0.7750 | 0.2246 | 0.3015 | -0.2748 |
| 4 | 21Shares Bitcoin ETP (ABTC) | 0.1454 | -0.1044 | -0.0309 | 1.0000 | -0.2433 | 0.2476 | -0.0676 | 0.7674 | 0.7755 | 0.7706 | 0.7757 | 0.0016 | 0.7674 | -0.1542 | -0.1630 |
| 5 | USD/EUR - US Dollar Euro | -0.5676 | 0.4623 | -0.7016 | -0.2433 | 1.0000 | -0.9996 | -0.6658 | -0.5319 | -0.5335 | -0.5292 | -0.5398 | -0.3167 | -0.5351 | 0.0664 | 0.5431 |
| 6 | EUR/USD - Euro US Dollar | 0.5750 | -0.4711 | 0.6916 | 0.2476 | -0.9996 | 1.0000 | 0.6559 | 0.5399 | 0.5414 | 0.5371 | 0.5481 | 0.3085 | 0.5427 | -0.0674 | -0.5432 |
| 7 | XAU/USD - Gold Spot US Dollar | 0.5786 | -0.4541 | 0.9884 | -0.0676 | -0.6658 | 0.6559 | 1.0000 | 0.2176 | 0.2176 | 0.2216 | 0.2285 | 0.8133 | 0.2181 | 0.2687 | -0.3200 |
| 8 | BTC/USD - Bitcoin US Dollar | 0.5428 | -0.5005 | 0.2197 | 0.7674 | -0.5319 | 0.5399 | 0.2176 | 1.0000 | 0.9985 | 0.9989 | 0.9982 | 0.1558 | 0.9986 | -0.1404 | -0.3732 |
| 9 | BTC/EUR - Bitcoin Euro | 0.5487 | -0.5063 | 0.2201 | 0.7755 | -0.5335 | 0.5414 | 0.2176 | 0.9985 | 1.0000 | 0.9993 | 0.9988 | 0.1479 | 0.9972 | -0.1564 | -0.3811 |
| 10 | BTC/JPY - Bitcoin Japanese Yen | 0.5510 | -0.5086 | 0.2220 | 0.7706 | -0.5292 | 0.5371 | 0.2216 | 0.9989 | 0.9993 | 1.0000 | 0.9983 | 0.1647 | 0.9974 | -0.1488 | -0.3793 |
| 11 | BTC/GBP - Bitcoin British Pound | 0.5630 | -0.5222 | 0.2309 | 0.7757 | -0.5398 | 0.5481 | 0.2285 | 0.9982 | 0.9988 | 0.9983 | 1.0000 | 0.1590 | 0.9960 | -0.1395 | -0.3751 |
| 12 | PAXG/USD - PAX Gold US Dollar | 0.5165 | -0.4244 | 0.7750 | 0.0016 | -0.3167 | 0.3085 | 0.8133 | 0.1558 | 0.1479 | 0.1647 | 0.1590 | 1.0000 | 0.1503 | 0.3713 | -0.1396 |
| 13 | WBTC/USD - Wrapped Bitcoin US Dollar | 0.5385 | -0.4966 | 0.2246 | 0.7674 | -0.5351 | 0.5427 | 0.2181 | 0.9986 | 0.9972 | 0.9974 | 0.9960 | 0.1503 | 1.0000 | -0.1391 | -0.3701 |
| 14 | USDT/USD - Tether US Dollar | 0.1597 | -0.0358 | 0.3015 | -0.1542 | 0.0664 | -0.0674 | 0.2687 | -0.1404 | -0.1564 | -0.1488 | -0.1395 | 0.3713 | -0.1391 | 1.0000 | 0.7687 |
| 15 | USDT/EUR - Tether Euro | -0.2304 | 0.2983 | -0.2748 | -0.1630 | 0.5431 | -0.5432 | -0.3200 | -0.3732 | -0.3811 | -0.3793 | -0.3751 | -0.1396 | -0.3701 | 0.7687 | 1.0000 |

**Annex B.32** – Case exhibit #6: Correlations 3 months, 31-05-2021

| | Name | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | S&P 500 (SPX) | 1.0000 | -0.8476 | 0.4390 | 0.0279 | -0.4358 | 0.4352 | 0.3979 | 0.3507 | 0.3669 | 0.3589 | 0.3679 | 0.3648 | 0.3442 | 0.1141 | -0.2764 |
| 2 | CBOE Volatility Index (VIX) | -0.8476 | 1.0000 | -0.3466 | 0.0429 | 0.3465 | -0.3485 | -0.3351 | -0.3076 | -0.3299 | -0.3184 | -0.3387 | -0.3418 | -0.3075 | -0.0519 | 0.2674 |
| 3 | SPDR Gold Shares (GLD) | 0.4390 | -0.3466 | 1.0000 | -0.0551 | -0.5688 | 0.5711 | 0.9842 | 0.0433 | 0.0535 | 0.0473 | 0.0479 | 0.8097 | 0.0440 | 0.1702 | -0.3316 |
| 4 | 21Shares Bitcoin ETP (ABTC) | 0.0279 | 0.0429 | -0.0551 | 1.0000 | 0.0352 | -0.0345 | -0.0778 | 0.7443 | 0.7389 | 0.7424 | 0.7421 | -0.0819 | 0.7469 | -0.1551 | -0.0074 |
| 5 | USD/EUR - US Dollar Euro | -0.4358 | 0.3465 | -0.5688 | 0.0352 | 1.0000 | -0.9993 | -0.5369 | -0.1523 | -0.1546 | -0.1426 | -0.1552 | -0.4541 | -0.1591 | -0.0124 | 0.6656 |
| 6 | EUR/USD - Euro US Dollar | 0.4352 | -0.3485 | 0.5711 | -0.0345 | -0.9993 | 1.0000 | 0.5396 | 0.1578 | 0.1602 | 0.1482 | 0.1609 | 0.4564 | 0.1642 | 0.0124 | -0.6652 |
| 7 | XAU/USD - Gold Spot US Dollar | 0.3979 | -0.3351 | 0.9842 | -0.0778 | -0.5369 | 0.5396 | 1.0000 | 0.0281 | 0.0377 | 0.0334 | 0.0314 | 0.8453 | 0.0258 | 0.1800 | -0.3192 |
| 8 | BTC/USD - Bitcoin US Dollar | 0.3507 | -0.3076 | 0.0433 | 0.7443 | -0.1523 | 0.1578 | 0.0281 | 1.0000 | 0.9973 | 0.9981 | 0.9966 | 0.0370 | 0.9980 | -0.1286 | -0.1617 |
| 9 | BTC/EUR - Bitcoin Euro | 0.3669 | -0.3299 | 0.0535 | 0.7389 | -0.1546 | 0.1602 | 0.0377 | 0.9973 | 1.0000 | 0.9982 | 0.9980 | 0.0427 | 0.9950 | -0.1360 | -0.1624 |
| 10 | BTC/JPY - Bitcoin Japanese Yen | 0.3589 | -0.3184 | 0.0473 | 0.7424 | -0.1426 | 0.1482 | 0.0334 | 0.9981 | 0.9982 | 1.0000 | 0.9964 | 0.0444 | 0.9952 | -0.1310 | -0.1545 |
| 11 | BTC/GBP - Bitcoin British Pound | 0.3679 | -0.3387 | 0.0479 | 0.7421 | -0.1552 | 0.1609 | 0.0314 | 0.9966 | 0.9980 | 0.9964 | 1.0000 | 0.0405 | 0.9944 | -0.1276 | -0.1597 |
| 12 | PAXG/USD - PAX Gold US Dollar | 0.3648 | -0.3418 | 0.8097 | -0.0819 | -0.4541 | 0.4564 | 0.8453 | 0.0370 | 0.0427 | 0.0444 | 0.0405 | 1.0000 | 0.0326 | 0.2673 | -0.2880 |
| 13 | WBTC/USD - Wrapped Bitcoin US Dollar | 0.3442 | -0.3075 | 0.0440 | 0.7469 | -0.1591 | 0.1642 | 0.0258 | 0.9980 | 0.9950 | 0.9952 | 0.9944 | 0.0326 | 1.0000 | -0.1348 | -0.1688 |
| 14 | USDT/USD - Tether US Dollar | 0.1141 | -0.0519 | 0.1702 | -0.1551 | -0.0124 | 0.0124 | 0.1800 | -0.1286 | -0.1360 | -0.1310 | -0.1276 | 0.2673 | -0.1348 | 1.0000 | 0.6317 |
| 15 | USDT/EUR - Tether Euro | -0.2764 | 0.2674 | -0.3316 | -0.0074 | 0.6656 | -0.6652 | -0.3192 | -0.1617 | -0.1624 | -0.1545 | -0.1597 | -0.2880 | -0.1688 | 0.6317 | 1.0000 |

**Annex B.33** – Case exhibit #6: Correlations 6 months, 31-05-2021

| | Name | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | S&P 500 (SPX) | 1.0000 | -0.8271 | 0.2879 | 0.0338 | -0.2424 | 0.2407 | 0.2497 | 0.2751 | 0.2854 | 0.2801 | 0.2891 | 0.2197 | 0.2703 | 0.0959 | -0.0996 |
| 2 | CBOE Volatility Index (VIX) | -0.8271 | 1.0000 | -0.1901 | -0.0306 | 0.1684 | -0.1705 | -0.1598 | -0.2711 | -0.2847 | -0.2765 | -0.2908 | -0.1954 | -0.2707 | -0.0688 | 0.0870 |
| 3 | SPDR Gold Shares (GLD) | 0.2879 | -0.1901 | 1.0000 | 0.0111 | -0.5297 | 0.5289 | 0.9894 | 0.0198 | 0.0206 | 0.0153 | 0.0167 | 0.8650 | 0.0265 | -0.0142 | -0.4202 |
| 4 | 21Shares Bitcoin ETP (ABTC) | 0.0338 | -0.0306 | 0.0111 | 1.0000 | -0.1855 | 0.1883 | 0.0094 | 0.7180 | 0.7184 | 0.7171 | 0.7186 | 0.0898 | 0.7220 | -0.2677 | -0.3028 |
| 5 | USD/EUR - US Dollar Euro | -0.2424 | 0.1684 | -0.5297 | -0.1855 | 1.0000 | -0.9993 | -0.5185 | -0.1247 | -0.1293 | -0.1166 | -0.1246 | -0.4501 | -0.1293 | 0.0701 | 0.7305 |
| 6 | EUR/USD - Euro US Dollar | 0.2407 | -0.1705 | 0.5289 | 0.1883 | -0.9993 | 1.0000 | 0.5180 | 0.1281 | 0.1329 | 0.1201 | 0.1281 | 0.4485 | 0.1327 | -0.0728 | -0.7313 |
| 7 | XAU/USD - Gold Spot US Dollar | 0.2497 | -0.1598 | 0.9894 | 0.0094 | -0.5185 | 0.5180 | 1.0000 | 0.0062 | 0.0070 | 0.0023 | 0.0032 | 0.8811 | 0.0112 | 0.0018 | -0.4120 |
| 8 | BTC/USD - Bitcoin US Dollar | 0.2751 | -0.2711 | 0.0198 | 0.7180 | -0.1247 | 0.1281 | 0.0062 | 1.0000 | 0.9977 | 0.9984 | 0.9966 | 0.1178 | 0.9986 | -0.0865 | -0.1518 |
| 9 | BTC/EUR - Bitcoin Euro | 0.2854 | -0.2847 | 0.0206 | 0.7184 | -0.1293 | 0.1329 | 0.0070 | 0.9977 | 1.0000 | 0.9984 | 0.9977 | 0.1182 | 0.9963 | -0.0896 | -0.1562 |
| 10 | BTC/JPY - Bitcoin Japanese Yen | 0.2801 | -0.2765 | 0.0153 | 0.7171 | -0.1166 | 0.1201 | 0.0023 | 0.9984 | 0.9984 | 1.0000 | 0.9970 | 0.1152 | 0.9967 | -0.0896 | -0.1480 |
| 11 | BTC/GBP - Bitcoin British Pound | 0.2891 | -0.2908 | 0.0167 | 0.7186 | -0.1246 | 0.1281 | 0.0032 | 0.9966 | 0.9977 | 0.9970 | 1.0000 | 0.1152 | 0.9951 | -0.0873 | -0.1516 |
| 12 | PAXG/USD - PAX Gold US Dollar | 0.2197 | -0.1954 | 0.8650 | 0.0898 | -0.4501 | 0.4485 | 0.8811 | 0.1178 | 0.1182 | 0.1152 | 0.1152 | 1.0000 | 0.1217 | 0.0438 | -0.3735 |
| 13 | WBTC/USD - Wrapped Bitcoin US Dollar | 0.2703 | -0.2707 | 0.0265 | 0.7220 | -0.1293 | 0.1327 | 0.0112 | 0.9986 | 0.9963 | 0.9967 | 0.9951 | 0.1217 | 1.0000 | -0.0964 | -0.1607 |
| 14 | USDT/USD - Tether US Dollar | 0.0959 | -0.0688 | -0.0142 | -0.2677 | 0.0701 | -0.0728 | 0.0018 | -0.0865 | -0.0896 | -0.0896 | -0.0873 | 0.0438 | -0.0964 | 1.0000 | 0.6310 |
| 15 | USDT/EUR - Tether Euro | -0.0996 | 0.0870 | -0.4202 | -0.3028 | 0.7305 | -0.7313 | -0.4120 | -0.1518 | -0.1562 | -0.1480 | -0.1516 | -0.3735 | -0.1607 | 0.6310 | 1.0000 |

**Annex B.34** – Case exhibit #6: Correlations 1 year, 31-05-2021

| | Name | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | S&P 500 (SPX) | 1.0000 | -0.7558 | 0.2010 | 0.0764 | -0.2611 | 0.2595 | 0.1805 | 0.2649 | 0.2684 | 0.2755 | 0.2672 | 0.1712 | 0.2667 | 0.0603 | -0.1530 |
| 2 | CBOE Volatility Index (VIX) | -0.7558 | 1.0000 | -0.1981 | -0.0590 | 0.2200 | -0.2206 | -0.1735 | -0.2855 | -0.2955 | -0.2957 | -0.3025 | -0.1961 | -0.2794 | -0.0480 | 0.1397 |
| 3 | SPDR Gold Shares (GLD) | 0.2010 | -0.1981 | 1.0000 | 0.1262 | -0.5090 | 0.5052 | 0.9840 | 0.1687 | 0.1671 | 0.1651 | 0.1737 | 0.8265 | 0.1687 | -0.0238 | -0.4132 |
| 4 | 21Shares Bitcoin ETP (ABTC) | 0.0764 | -0.0590 | 0.1262 | 1.0000 | -0.1576 | 0.1573 | 0.1285 | 0.7041 | 0.7002 | 0.7000 | 0.6953 | 0.1289 | 0.7023 | -0.2423 | -0.2768 |
| 5 | USD/EUR - US Dollar Euro | -0.2611 | 0.2200 | -0.5090 | -0.1576 | 1.0000 | -0.9993 | -0.5001 | -0.1915 | -0.1928 | -0.1910 | -0.1915 | -0.4690 | -0.1932 | 0.0800 | 0.7624 |
| 6 | EUR/USD - Euro US Dollar | 0.2595 | -0.2206 | 0.5052 | 0.1573 | -0.9993 | 1.0000 | 0.4960 | 0.1926 | 0.1939 | 0.1919 | 0.1925 | 0.4650 | 0.1935 | -0.0837 | -0.7634 |
| 7 | XAU/USD - Gold Spot US Dollar | 0.1805 | -0.1735 | 0.9840 | 0.1285 | -0.5001 | 0.4960 | 1.0000 | 0.1628 | 0.1618 | 0.1603 | 0.1679 | 0.8344 | 0.1623 | -0.0225 | -0.4149 |
| 8 | BTC/USD - Bitcoin US Dollar | 0.2649 | -0.2855 | 0.1687 | 0.7041 | -0.1915 | 0.1926 | 0.1628 | 1.0000 | 0.9961 | 0.9966 | 0.9932 | 0.1981 | 0.9857 | -0.0614 | -0.1933 |
| 9 | BTC/EUR - Bitcoin Euro | 0.2684 | -0.2955 | 0.1671 | 0.7002 | -0.1928 | 0.1939 | 0.1618 | 0.9961 | 1.0000 | 0.9962 | 0.9955 | 0.1987 | 0.9808 | -0.0639 | -0.1948 |
| 10 | BTC/JPY - Bitcoin Japanese Yen | 0.2755 | -0.2957 | 0.1651 | 0.7000 | -0.1910 | 0.1919 | 0.1603 | 0.9966 | 0.9962 | 1.0000 | 0.9932 | 0.1969 | 0.9803 | -0.0664 | -0.1949 |
| 11 | BTC/GBP - Bitcoin British Pound | 0.2672 | -0.3025 | 0.1737 | 0.6953 | -0.1915 | 0.1925 | 0.1679 | 0.9932 | 0.9955 | 0.9932 | 1.0000 | 0.2043 | 0.9779 | -0.0625 | -0.1926 |
| 12 | PAXG/USD - PAX Gold US Dollar | 0.1712 | -0.1961 | 0.8265 | 0.1289 | -0.4690 | 0.4650 | 0.8344 | 0.1981 | 0.1987 | 0.1969 | 0.2043 | 1.0000 | 0.1934 | -0.0130 | -0.4023 |
| 13 | WBTC/USD - Wrapped Bitcoin US Dollar | 0.2667 | -0.2794 | 0.1687 | 0.7023 | -0.1932 | 0.1935 | 0.1623 | 0.9857 | 0.9808 | 0.9803 | 0.9779 | 0.1934 | 1.0000 | -0.0875 | -0.2141 |
| 14 | USDT/USD - Tether US Dollar | 0.0603 | -0.0480 | -0.0238 | -0.2423 | 0.0800 | -0.0837 | -0.0225 | -0.0614 | -0.0639 | -0.0664 | -0.0625 | -0.0130 | -0.0875 | 1.0000 | 0.6246 |
| 15 | USDT/EUR - Tether Euro | -0.1530 | 0.1397 | -0.4132 | -0.2768 | 0.7624 | -0.7634 | -0.4149 | -0.1933 | -0.1948 | -0.1949 | -0.1926 | -0.4023 | -0.2141 | 0.6246 | 1.0000 |

**Annex B.35** – Case exhibit #6: Correlations 2 years, 31-05-2021

| | Name | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | S&P 500 (SPX) | 1.0000 | -0.7024 | 0.1180 | 0.1694 | 0.0094 | -0.0090 | 0.0875 | 0.3135 | 0.3078 | 0.3051 | 0.3102 | - | 0.2896 | 0.1386 | 0.0956 |
| 2 | CBOE Volatility Index (VIX) | -0.7024 | 1.0000 | -0.0427 | -0.0946 | -0.0435 | 0.0442 | -0.0142 | -0.2389 | -0.2439 | -0.2394 | -0.2393 | - | -0.2339 | -0.1201 | -0.0996 |
| 3 | SPDR Gold Shares (GLD) | 0.1180 | -0.0427 | 1.0000 | 0.1620 | -0.3673 | 0.3657 | 0.9802 | 0.2188 | 0.2154 | 0.2157 | 0.2118 | - | 0.1968 | -0.0363 | -0.2976 |
| 4 | 21Shares Bitcoin ETP (ABTC) | 0.1694 | -0.0946 | 0.1620 | 1.0000 | -0.0872 | 0.0876 | 0.1596 | 0.6982 | 0.6985 | 0.6954 | 0.6902 | - | 0.6682 | -0.1564 | -0.1951 |
| 5 | USD/EUR - US Dollar Euro | 0.0094 | -0.0435 | -0.3673 | -0.0872 | 1.0000 | -0.9993 | -0.3723 | -0.0785 | -0.0671 | -0.0728 | -0.0594 | - | -0.0809 | 0.0300 | 0.7797 |
| 6 | EUR/USD - Euro US Dollar | -0.0090 | 0.0442 | 0.3657 | 0.0876 | -0.9993 | 1.0000 | 0.3709 | 0.0778 | 0.0665 | 0.0721 | 0.0586 | - | 0.0796 | -0.0322 | -0.7817 |
| 7 | XAU/USD - Gold Spot US Dollar | 0.0875 | -0.0142 | 0.9802 | 0.1596 | -0.3723 | 0.3709 | 1.0000 | 0.2074 | 0.2050 | 0.2062 | 0.2008 | - | 0.1860 | -0.0369 | -0.3048 |
| 8 | BTC/USD - Bitcoin US Dollar | 0.3135 | -0.2389 | 0.2188 | 0.6982 | -0.0785 | 0.0778 | 0.2074 | 1.0000 | 0.9966 | 0.9958 | 0.9929 | - | 0.9354 | 0.0519 | -0.0496 |
| 9 | BTC/EUR - Bitcoin Euro | 0.3078 | -0.2439 | 0.2154 | 0.6985 | -0.0671 | 0.0665 | 0.2050 | 0.9966 | 1.0000 | 0.9962 | 0.9951 | - | 0.9325 | 0.0513 | -0.0429 |
| 10 | BTC/JPY - Bitcoin Japanese Yen | 0.3051 | -0.2394 | 0.2157 | 0.6954 | -0.0728 | 0.0721 | 0.2062 | 0.9958 | 0.9962 | 1.0000 | 0.9922 | - | 0.9318 | 0.0521 | -0.0482 |
| 11 | BTC/GBP - Bitcoin British Pound | 0.3102 | -0.2393 | 0.2118 | 0.6902 | -0.0594 | 0.0586 | 0.2008 | 0.9929 | 0.9951 | 0.9922 | 1.0000 | - | 0.9279 | 0.0509 | -0.0320 |
| 12 | PAXG/USD - PAX Gold US Dollar | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 13 | WBTC/USD - Wrapped Bitcoin US Dollar | 0.2896 | -0.2339 | 0.1968 | 0.6682 | -0.0809 | 0.0796 | 0.1860 | 0.9354 | 0.9325 | 0.9318 | 0.9279 | - | 1.0000 | 0.0366 | -0.0682 |
| 14 | USDT/USD - Tether US Dollar | 0.1386 | -0.1201 | -0.0363 | -0.1564 | 0.0300 | -0.0322 | -0.0369 | 0.0519 | 0.0513 | 0.0521 | 0.0509 | - | 0.0366 | 1.0000 | 0.4920 |
| 15 | USDT/EUR - Tether Euro | 0.0956 | -0.0996 | -0.2976 | -0.1951 | 0.7797 | -0.7817 | -0.3048 | -0.0496 | -0.0429 | -0.0482 | -0.0320 | - | -0.0682 | 0.4920 | 1.0000 |

**Annex B.36** – Case exhibit #6: Correlations 3 years, 31-05-2021

| | Name | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | S&P 500 (SPX) | 1.0000 | -0.7118 | 0.0814 | - | -0.0111 | 0.0116 | 0.0572 | 0.2455 | 0.2393 | 0.2409 | 0.2425 | - | - | 0.0066 | 0.0085 |
| 2 | CBOE Volatility Index (VIX) | -0.7118 | 1.0000 | -0.0154 | - | -0.0183 | 0.0194 | 0.0070 | -0.1591 | -0.1600 | -0.1605 | -0.1592 | - | - | -0.0036 | -0.0120 |
| 3 | SPDR Gold Shares (GLD) | 0.0814 | -0.0154 | 1.0000 | - | -0.3793 | 0.3782 | 0.9813 | 0.1930 | 0.1909 | 0.1891 | 0.1891 | - | - | -0.0256 | -0.1163 |
| 4 | 21Shares Bitcoin ETP (ABTC) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 5 | USD/EUR - US Dollar Euro | -0.0111 | -0.0183 | -0.3793 | - | 1.0000 | -0.9989 | -0.3846 | -0.0738 | -0.0677 | -0.0709 | -0.0617 | - | - | 0.0000 | 0.2456 |
| 6 | EUR/USD - Euro US Dollar | 0.0116 | 0.0194 | 0.3782 | - | -0.9989 | 1.0000 | 0.3837 | 0.0741 | 0.0682 | 0.0714 | 0.0620 | - | - | -0.0010 | -0.2467 |
| 7 | XAU/USD - Gold Spot US Dollar | 0.0572 | 0.0070 | 0.9813 | - | -0.3846 | 0.3837 | 1.0000 | 0.1857 | 0.1845 | 0.1833 | 0.1820 | - | - | -0.0288 | -0.1211 |
| 8 | BTC/USD - Bitcoin US Dollar | 0.2455 | -0.1591 | 0.1930 | - | -0.0738 | 0.0741 | 0.1857 | 1.0000 | 0.9962 | 0.9958 | 0.9924 | - | - | -0.0156 | -0.0382 |
| 9 | BTC/EUR - Bitcoin Euro | 0.2393 | -0.1600 | 0.1909 | - | -0.0677 | 0.0682 | 0.1845 | 0.9962 | 1.0000 | 0.9954 | 0.9949 | - | - | -0.0219 | -0.0435 |
| 10 | BTC/JPY - Bitcoin Japanese Yen | 0.2409 | -0.1605 | 0.1891 | - | -0.0709 | 0.0714 | 0.1833 | 0.9958 | 0.9954 | 1.0000 | 0.9912 | - | - | -0.0221 | -0.0446 |
| 11 | BTC/GBP - Bitcoin British Pound | 0.2425 | -0.1592 | 0.1891 | - | -0.0617 | 0.0620 | 0.1820 | 0.9924 | 0.9949 | 0.9912 | 1.0000 | - | - | -0.0243 | -0.0431 |
| 12 | PAXG/USD - PAX Gold US Dollar | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 13 | WBTC/USD - Wrapped Bitcoin US Dollar | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 14 | USDT/USD - Tether US Dollar | 0.0066 | -0.0036 | -0.0256 | - | 0.0000 | -0.0010 | -0.0288 | -0.0156 | -0.0219 | -0.0221 | -0.0243 | - | - | 1.0000 | 0.9604 |
| 15 | USDT/EUR - Tether Euro | 0.0085 | -0.0120 | -0.1163 | - | 0.2456 | -0.2467 | -0.1211 | -0.0382 | -0.0435 | -0.0446 | -0.0431 | - | - | 0.9604 | 1.0000 |

**Annex B.37** – Case exhibit #6: Correlations 5 years, 31-05-2021

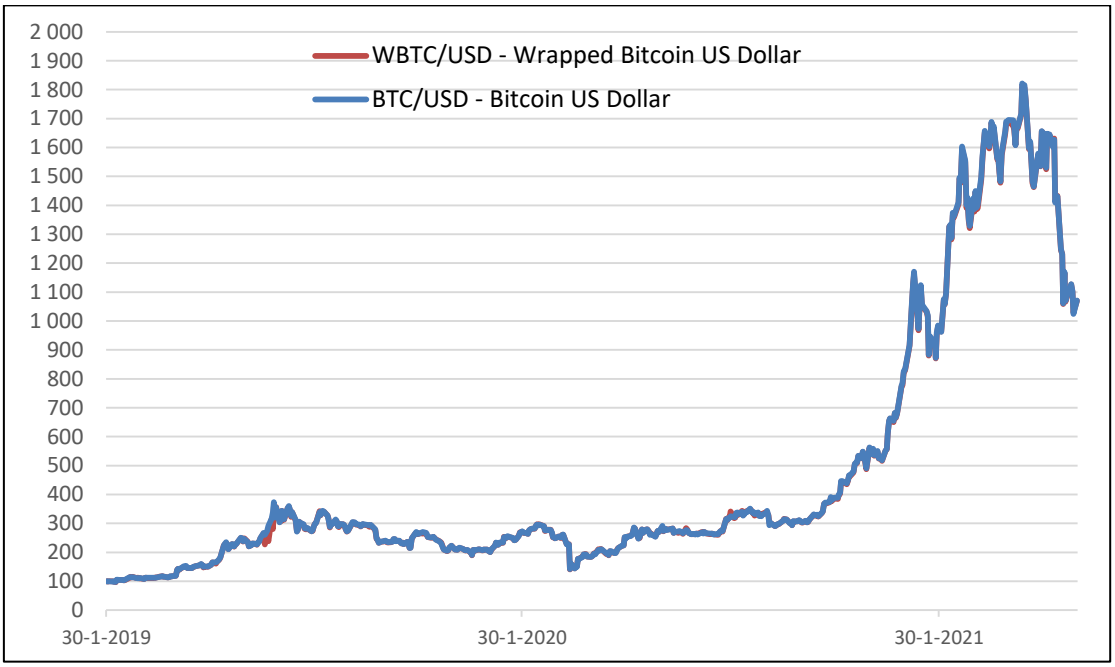
| | Name | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | S&P 500 (SPX) | 1.0000 | -0.6932 | 0.0365 | - | -0.0285 | 0.0291 | 0.0150 | 0.1867 | 0.1811 | 0.1833 | 0.1798 | - | - | -0.0072 | -0.0082 |
| 2 | CBOE Volatility Index (VIX) | -0.6932 | 1.0000 | 0.0349 | - | 0.0264 | -0.0263 | 0.0503 | -0.1477 | -0.1482 | -0.1468 | -0.1443 | - | - | 0.0104 | 0.0080 |
| 3 | SPDR Gold Shares (GLD) | 0.0365 | 0.0349 | 1.0000 | - | -0.3818 | 0.3813 | 0.9825 | 0.1274 | 0.1256 | 0.1226 | 0.1279 | - | - | -0.0212 | -0.0978 |
| 4 | 21Shares Bitcoin ETP (ABTC) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 5 | USD/EUR - US Dollar Euro | -0.0285 | 0.0264 | -0.3818 | - | 1.0000 | -0.9993 | -0.3876 | -0.0382 | -0.0334 | -0.0384 | -0.0310 | - | - | 0.0119 | 0.2053 |
| 6 | EUR/USD - Euro US Dollar | 0.0291 | -0.0263 | 0.3813 | - | -0.9993 | 1.0000 | 0.3871 | 0.0384 | 0.0337 | 0.0386 | 0.0312 | - | - | -0.0125 | -0.2060 |
| 7 | XAU/USD - Gold Spot US Dollar | 0.0150 | 0.0503 | 0.9825 | - | -0.3876 | 0.3871 | 1.0000 | 0.1210 | 0.1204 | 0.1177 | 0.1225 | - | - | -0.0238 | -0.1007 |
| 8 | BTC/USD - Bitcoin US Dollar | 0.1867 | -0.1477 | 0.1274 | - | -0.0382 | 0.0384 | 0.1210 | 1.0000 | 0.9958 | 0.9946 | 0.9919 | - | - | -0.0059 | -0.0159 |
| 9 | BTC/EUR - Bitcoin Euro | 0.1811 | -0.1482 | 0.1256 | - | -0.0334 | 0.0337 | 0.1204 | 0.9958 | 1.0000 | 0.9943 | 0.9943 | - | - | -0.0097 | -0.0177 |
| 10 | BTC/JPY - Bitcoin Japanese Yen | 0.1833 | -0.1468 | 0.1226 | - | -0.0384 | 0.0386 | 0.1177 | 0.9946 | 0.9943 | 1.0000 | 0.9884 | - | - | -0.0103 | -0.0188 |
| 11 | BTC/GBP - Bitcoin British Pound | 0.1798 | -0.1443 | 0.1279 | - | -0.0310 | 0.0312 | 0.1225 | 0.9919 | 0.9943 | 0.9884 | 1.0000 | - | - | -0.0105 | -0.0167 |
| 12 | PAXG/USD - PAX Gold US Dollar | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 13 | WBTC/USD - Wrapped Bitcoin US Dollar | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 14 | USDT/USD - Tether US Dollar | -0.0072 | 0.0104 | -0.0212 | - | 0.0119 | -0.0125 | -0.0238 | -0.0059 | -0.0097 | -0.0103 | -0.0105 | - | - | 1.0000 | 0.9422 |
| 15 | USDT/EUR - Tether Euro | -0.0082 | 0.0080 | -0.0978 | - | 0.2053 | -0.2060 | -0.1007 | -0.0159 | -0.0177 | -0.0188 | -0.0167 | - | - | 0.9422 | 1.0000 |

**Annex B.38** – Case exhibit #6: Correlations since 29-04-2013, 31-05-2021

| | Name | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | S&P 500 (SPX) | 1.0000 | -0.7332 | -0.0109 | - | 0.0302 | -0.0303 | -0.0238 | 0.1189 | 0.1161 | 0.1163 | 0.1141 | - | - | - | - |
| 2 | CBOE Volatility Index (VIX) | -0.7332 | 1.0000 | 0.0540 | - | -0.0519 | 0.0522 | 0.0607 | -0.0782 | -0.0784 | -0.0771 | -0.0752 | - | - | - | - |
| 3 | SPDR Gold Shares (GLD) | -0.0109 | 0.0540 | 1.0000 | - | -0.3632 | 0.3631 | 0.9856 | 0.0527 | 0.0513 | 0.0490 | 0.0535 | - | - | - | - |
| 4 | 21Shares Bitcoin ETP (ABTC) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 5 | USD/EUR - US Dollar Euro | 0.0302 | -0.0519 | -0.3632 | - | 1.0000 | -0.9996 | -0.3641 | -0.0142 | -0.0106 | -0.0128 | -0.0108 | - | - | - | - |
| 6 | EUR/USD - Euro US Dollar | -0.0303 | 0.0522 | 0.3631 | - | -0.9996 | 1.0000 | 0.3640 | 0.0143 | 0.0109 | 0.0130 | 0.0110 | - | - | - | - |
| 7 | XAU/USD - Gold Spot US Dollar | -0.0238 | 0.0607 | 0.9856 | - | -0.3641 | 0.3640 | 1.0000 | 0.0499 | 0.0491 | 0.0466 | 0.0510 | - | - | - | - |
| 8 | BTC/USD - Bitcoin US Dollar | 0.1189 | -0.0782 | 0.0527 | - | -0.0142 | 0.0143 | 0.0499 | 1.0000 | 0.9952 | 0.9944 | 0.9936 | - | - | - | - |
| 9 | BTC/EUR - Bitcoin Euro | 0.1161 | -0.0784 | 0.0513 | - | -0.0106 | 0.0109 | 0.0491 | 0.9952 | 1.0000 | 0.9941 | 0.9949 | - | - | - | - |
| 10 | BTC/JPY - Bitcoin Japanese Yen | 0.1163 | -0.0771 | 0.0490 | - | -0.0128 | 0.0130 | 0.0466 | 0.9944 | 0.9941 | 1.0000 | 0.9903 | - | - | - | - |
| 11 | BTC/GBP - Bitcoin British Pound | 0.1141 | -0.0752 | 0.0535 | - | -0.0108 | 0.0110 | 0.0510 | 0.9936 | 0.9949 | 0.9903 | 1.0000 | - | - | - | - |
| 12 | PAXG/USD - PAX Gold US Dollar | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 13 | WBTC/USD - Wrapped Bitcoin US Dollar | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 14 | USDT/USD - Tether US Dollar | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 15 | USDT/EUR - Tether Euro | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

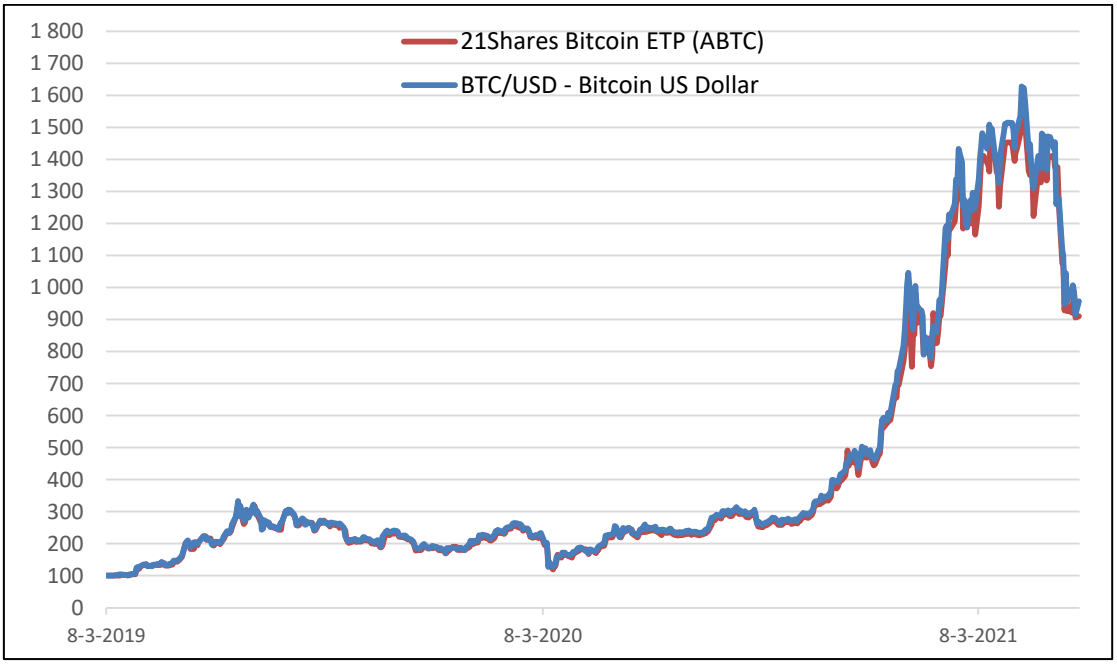
**Annex B.39** – Case exhibit #6: Evolution of WBTC/USD vs. BTC/USD, 30-01-2019 – 31-05-2021

(Ratio: Values rebased at 100)



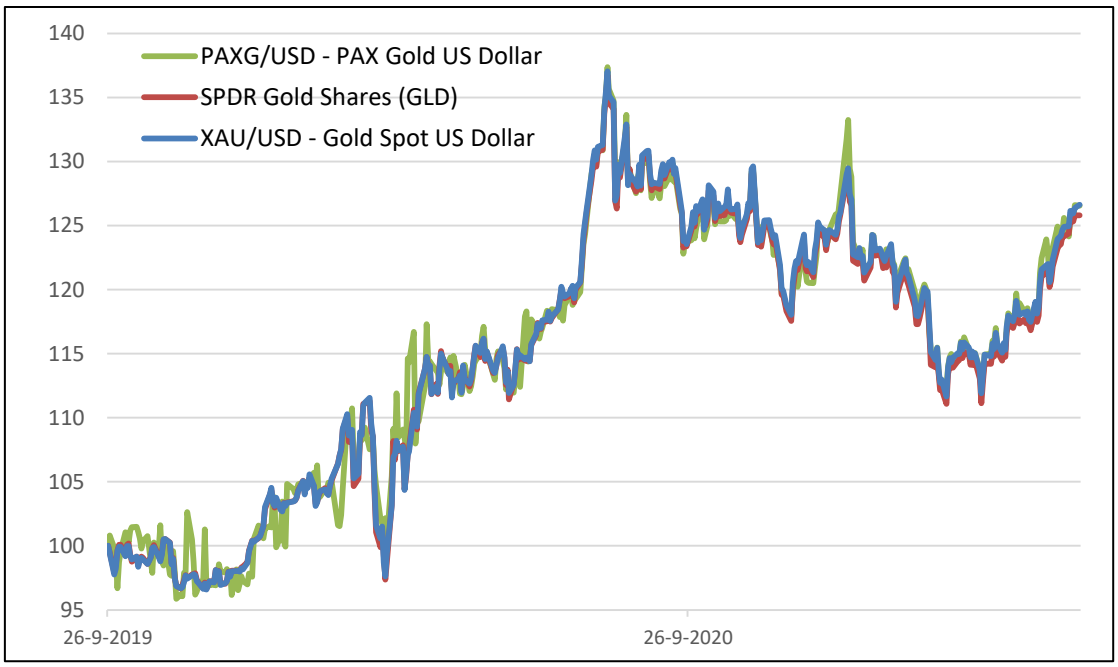

**Annex B.40** – Case exhibit #6: Evolution of ABTC vs. BTC/USD, 08-03-2019 – 31-05-2021

(Ratio: Values rebased at 100)



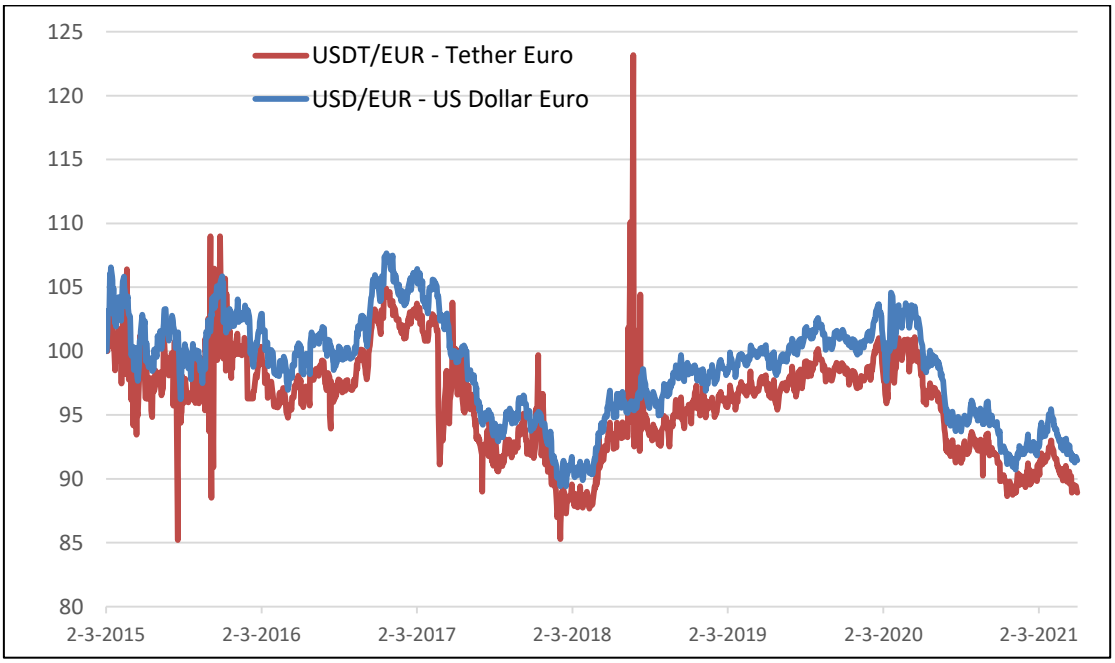
**Annex B.41** – Case exhibit #6: Evolution of PAXG/USD vs. GLD vs. XAU/USD, 26-09-2019 – 31-05-2021

(Ratio: Values rebased at 100)




**Annex B.42** – Case exhibit #6: Evolution of USDT/EUR vs. USD/EUR, 02-03-2015 – 31-05-2021

(Ratio: Values rebased at 100)



**Annex B.43** – Case exhibit #6: Evolution of BTC/USD vs. BTC/EUR vs. BTC/JPY vs. BTC/GBP, 29-04-2013 – 31-05-2021

(Ratio: Values rebased at 100)