Financial Innovation and Technology

Abeba N. Turi *Editor*

Financial Technologies and DeFi

A Revisit to the Digital Finance Revolution

Springer

Financial Innovation and Technology

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Abeba N. Turi
Editor

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To the true love in our family.

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Executive Summary

The hunt for new forms of value generation is shaping the future of economic and financial interactions leading to the emergence of innovative business models and technological enablers. Technologies like new edge computing, 5G, distributed ledger technologies, cloud edge computing, internet of things (IoT), next-generation commerce, biometrics, big data, immersive and visualization technologies like augmented reality (AR), virtual reality (VR), extended reality (XR), and 3D, are the game changers in the digital finance and its underlying business models. Other than challenging our time and space limits, such technological advancements have allowed the generation of value at a nearly zero marginal cost (Rifkin, 2014). With the irreversible consumer behavior of the digital natives and digital immigrants, strategies to seize on the market opportunities through emerging technologies and innovative business models are vital.

The industry is massive, proliferating online and mobile payments, big data, alternative finance, and financial management services. Payments, lending, asset management, and retail banking are the prominent disruptions to the legacy financial system by fintech companies. Over the past few years, we have observed stiff competition from fintech start-ups and tech giants (like Google, Amazon, Facebook, Apple, and Alibaba) to the legacy financial institutions.

Apart from the potential risks these emerging trends bring, Innovator's Dilemma with the risk of business cannibalization (Christensen, 2013) on the side of the institutional investors (in the most rigid sectors like the financial institutions) is detrimental. Studies show that however sluggish the digital transformation and innovation diffusion of Fintech will co-exist with the conventional financial system until the latter eventually fades out and the transformation to the new digital financial system is realized. According to Intuit's Future of Accountancy Report (2013), with the demographic shifts from the digital immigrants to the digital natives, irreversible consumer behavior emerges, and the transformation of the traditional service sector to the modern digitized service naturally smooths by itself as the millennials hold the market through time, and the baby boomers retire. In line with this, Jaksic and Marinc (2015), in favor of human-centric decisions in banking, argued that automated decision-making in transaction lending techniques cannot make human decision-making based on the soft information in banking relationships obsolete. The argument is based on the ground that a game of incomplete information, such as a poker game, is much more difficult for computers to master compared to chess, and

hence that human decision-making surpasses that of automated actors when it comes to strategic decision-making.

Goals

As we pick this topic, we are targeting a multi-trillion-dollar industry that has observed dramatic changes over the last decade. Stiff competition and the switch in consumer preferences have led to novel financial services value chains and market structures. The industry has broad coverage, including Digital Payments (with a market value of about 8488 billion USD in 2022, an estimated 15,170 billion USD market value, and a user base of 5480.33 million by 2027), Alternative Financing (with average transaction value per user of US$27.10 k in 2022) Alternative Lending (407.80 billion USD transaction value by 2027), Neobanking (expected revenue growth of 42.2% in 2023 and 8975 billion USD transaction value by 2027), digital assets (34. 10 billion USD transaction value in 2021 - the blockchain economy is not fully incorporated in the data), digital investment (3836 billion USD transaction value by 2027). As part of decentralized finance, the cryptocurrency market capitalization is not steady, while it has observed a significant expansion since 2017 with a global market value of trillions of dollars. For example, the European Securities and Markets Authority in February 2022 reported a total of 1.5 trillion euros market capitalization of crypto assets in the European Union alone, with an eight-fold increase over the last two years. Incumbents in the industry which spotted the dynamics have partnered with or acquired fintech companies and, in some cases, established their innovation hubs where they explore new financial products (Statista Digital Market Outlook, 2021).

The main goal of this work is to provide a holistic view of the industry through the business, tech, and regulatory layers. Further, we intend to identify and address the core issues of the evolving digital finance system. In this regard, we aim to approach financial technologies and decentralized financial systems and identify the emerging trends, opportunities, and challenges for stakeholders, including the government, businesses, investors, and consumers. By considering specific use cases of the digital finance markets and identifying the case-specific problems, we provide an in-depth analysis of the industry, its underlying business models, key players, and enabling technologies.

In addition, by focussing on the key pillars of the modern financial system and technological enablers, we provide a detailed analysis of the advances in financial technologies. Besides, by having a closer look into the distributed economic system, we offer an in-depth analysis of Decentralized Finance and varied forms of business models underlying this economic system. The book is supported by up-to-date data and use cases from across industries to support the analysis presented under each topic.

Book Organization

As it evolves, the digital finance system has a broad coverage dimension with multilayer applications and complex technological solutions. For ease of presentation, level of abstraction, and further to help us have a look into the multifaceted aspects of the industry, we break the book into three main parts as follows:

Part One focuses on the theories and practices of financial technologies. The discussion in the book's first three chapters will help dive into the common practices and theories by concentrating on the merging fintech trends, money creation principles, and practices of the fintech world and further exploring the newly evolving metaverse economy. More specifically:

Chapter 1 presents the Immersive 3D virtual world's innovation diffusion in the financial sector, highlighting state of the art in the metaverse, virtual goods, and digital assets. In this chapter, – the virtual economy will be in the spotlight, focusing on its monetary base, the velocity of money, and metaverse banking. The chapter further identifies the opportunities and challenges in metaverse adoption in the financial sector.

Chapter 2 presents the emerging technological trends in the financial sector. By focusing on Fintech and its developments like payment technology and currency, open banking, investment management, robo-advising, and P2P decentralized lending, the chapter fleshes out the core advancements in the sector using up-to-date data and empirical evidence. In addition, it presents a detailed discussion on Fintech tech components and market structure, including the collaboration, merger, and acquisition deals between fintech companies and financial institutions. The chapter further identifies developments and innovation diffusion of financial technologies and the main challenges and sheds light on the sector's future.

In the world of instant millionaires with wild market volatilities, it will be relevant to ask the question of predictable returns in the digital economy of the twenty-first century. Building on this, Chapter 3 presents value generation strategies based on the basics of money creation with enterprise risk control, Matching and focusing, and tech positioning in Payments, InsurTech, RegTech, WealthTech, Distributed Ledger Technologies, analytics and, Cybersecurity). Besides, with a touch on the post-COVID-19 pandemic, the chapter highlights major fintech deals and investments during this period. Besides, trends from payments, and embedded finance, to Public-Private Artificial Intelligence are exhaustively discussed in this chapter. The chapter concludes with the forward-thinking reputation-based business model migrating from collateral to credibility.

Part Two provides a high-level analysis of distributed network economy with a focus on cryptocurrencies, market volatilities and stablecoins, payment technology, and digital wallets, and the broader application of blockchain technology in supply chain traceability beyond the monetary consensus system. The principal coverage of each of these chapters is highlighted as follows. Here:

Chapter 4: as part of the discussions on the currency and payment technologies, this chapter presents the developments in cryptocurrencies, starting with the blockchain technology that powers the transfer of such digital assets, different

forms of cryptocurrencies, the role this currency plays in e-commerce and the risk involved with the digital currency system. Besides, cryptocurrency exchange and market stability issues are briefly covered here.

Chapter 5: by extending on the cryptocurrency topic presented under Chap. 5, this chapter analyzes market stability issues in the cryptocurrency market. Here, we discuss the moves toward shock-resistant programmable money and stablecoins with the industry's empirical and theoretical evidence and common practices.

Chapter 6: provides a systemic review of digital wallets and presents the state of art in this technology. With a highlight on the conventional payment technologies and the functional requirements of digital wallets, the chapter covers privacy and security issues in their usage.

Chapter 7: in addition to powering money creation and transfer, blockchain and distributed ledger technologies, in general, have created opportunities for efficient transfer and traceability of any asset class (Turi, 2020). Based on this, this chapter covers the prospects brought by blockchain tech in enabling supply-chain traceability. By conducting a meta-synthesis on the literature in the field, the chapter presents an extensive analysis of its application. Further, the chapter identifies the key challenges in adopting the tech to the sector.

Part Three presents digital finance Issues, policy, and regulatory insights with a principal focus on the digital finance risks and financial inclusion and further look into the artificial excludability based on a blockchain-based patent system. This part is intended to cover digital financial risks and crimes like cybersecurity, money laundering and fraud, and Fintech and crypto-asset regulations. In this regard, the challenge to regulators is noticeable as governments struggle to catch up with the dynamic business and tech environment, which results in loopholes for potential market exploitation leaving the investors vulnerable and disrupting government revenues. Under this part:

Chapter 8: in search of mechanisms for allocative efficiency for non-excludable digital assets, the question of intellectual property rights and efficient patent systems is at the forefront of the evolving digital finance environment. Based on this, the chapter presents the surge in blockchain-based patent applications with the quest for the booster or bump role this trend plays in the financial sector and the digital economic system. By identifying the emerging trends in the patent system, the chapter draws insight into blockchain-based patent systems, thereby achieving market efficiency. The chapter further identifies the possibilities for institutional blockchain-based patents as market signals for cryptocurrency markets and thus serve as a tool for market prediction and stability of the wild cryptocurrency market. Moreover, to suppress sub-optimal centralized patent solutions, it proposes co-utile mechanisms (self-enforcing mutually beneficial protocols) in a distributed system and foster efficiency.

Chapter 9: While the technological trends have led to broader financial inclusion across the globe, such inclusion has not been smooth and free of attack. By focusing on the digital finance risks of financial crimes, money laundering, and fraud, the chapter provides a holistic view of the current and future digital finance landscape and potential risks that arise with it. Applying the Fraud Triangle approach to

financial tampering identifies the three cornerstones of financial fraud: opportunities due to the existing loopholes in Fintech, motives, and rationale. The chapter concludes with an insight into the future direction of the robust digital financial system free of cyberattacks of any form.

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About the Editor

Abeba N. Turi is a scholar with expertise in Digital Economy. She has worked as an assistant researcher with the UNESCO Chair in Data Privacy, Spain. Currently, Dr. Turi is an associate professor at the University Canada West in Vancouver and a Master of Data Science Student at the University of British Columbia, Canada. She has also served in various international research and teaching positions in Africa, Europe, and Canada. Her research interests include Algorithm Economy, Applied Economics, Collaborative Economy, Fintech applications, and e-commerce, Decentralized Finance, Mechanism Design, Business Model Design and Engineering, Distributed Ledger Technologies and Cryptonomics, Digital Transformation, Tech Policy, and Emerging Tech Analysis, Decentralization, and Data Science. She is a member of various professional groups, including the IEEE Technology and Engineering Management Society (TEMS) 's Technical Committee (TC) on Blockchain and Distributed Ledger Technologies (DLT). Her works have been published in various peer-reviewed journals and indexed conference proceedings. She is the author of the book 'Technologies for Modern Digital Entrepreneurship: Understanding Emerging Tech at the Cutting-Edge of the Web 3.0 Economy'. Dr. Turi's works have been presented at several international conferences in China, Canada, Germany, Italy, Spain, and the United Kingdom. Dr. Turi identifies herself as a disruptive tech and decentralization enthusiast.

Part I

Financial Technologies-Theory and Practice

Metaverse—The Immersive 3D Virtual World's Innovation Diffusion in the Financial Sector

1

Abeba N. Turi

Abstract

The chapter portrays possible traditional finance landings in the metaverse and emerging financial technology constructs of the 3D virtual space. It further provides insights on how financial institutions can benefit from the emerging wave of the 3D Internet beyond the hype. The financial component of the metaverse is one of the vital developments we will observe in the years to come as the applications and business cases that run on it emerge. In connection with this, the chapter presents a detailed analysis of the opportunities and challenges of metaverse banking by closely examining the 3D virtual economic system and its focal constructs. The potential for Defi protocols and fintech companies is immense to facilitate financial interactions in metaverse platforms. Yet, not to be left behind in our evolving digital world, there is a potential for legacy financial institutions to leverage metaverse in creating value through a thoughtful virtual presence. Yet, this will take time, and a detailed examination of the financial application areas is vital before any at-scale enterprise adoption where most metaverse platforms are sparsely populated.

Keywords

Virtual goods · Digital asset · Metaverse banking · Fintech · Programmable world

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1 Introduction

The chapter provides a holistic view of the emerging trends in the experience economy and metaverse platforms by synthesizing the information from industry reports, analytics, ongoing research, and the scanty body of scientific knowledge encompassing the empirics and theory around this notion. The metaverse economic system is designed to operate under the core economic assumptions of cost and scarcity constraints (for example, digital scarcity in digital assets like NFTs) under which the physical world operates. This allows to ingrain value creation and exchange in this economic system while pertaining to the principles of sense of presence, hence called the experience economy with its underlying virtual immersions. The exchange between avatars mimics the real-world economic units building a metaverse ecosystem with virtual spaces and other virtual goods the system encompasses. These economic interactions call for financial infrastructures that meet the needs of the markets by design.

Financial innovations offer new experiences, products, or services responsively. Yet, legacy financial institutions are complex, sluggish, and therefore challenging to manage and modernize when it comes to financial technologies. With the limited application of the emergent 3D experience economy, literature in the field is at a nascent stage and thus a scanty body of knowledge.

The latest uses of a metaverse in financial institutions are limited to virtual meetings and events, virtual online games, training, and financial literacy mainly targeted at younger customers and employee avatar interactions with clients in the metaverse (Simple transactions, such as remittances, risk-return analysis or investment portfolios designing services[1]) and visual analytics offering real-time stock charts and consultations with employee avatars on a metaverse platform.[2,3] Adapting the metaverse in the marketing strategies of the banks is underway with new business models, products (currently underway: real-time payments (RTP) and cryptocurrency investing), and digital financial products that meet the virtual experiences within the metaverse community in a bid to win tech game afield.

The remainder of the chapter is organized as follows. In the subsequent sections, we discuss the state of the art of metaverse and lucid light on *virtual goods and digital assets, followed by a look into* the 3D virtual economy. In connection with the financial component of the metaverse, the chapter will further present a detailed analysis of Defi and traditional finance elements in the metaverse and its key drivers and identify opportunities and challenges of metaverse banking. The chapter wraps up by pointing out concluding remarks for metaverse adoption by the legacy financial institutions.

[1] https://forkast.news/headlines/south-korea-kb-kookmin-bank-presents-metaverse-vr-bank-testbed/

[2] https://www.thebanker.com/Transactions-Technology/South-Korea-s-banks-move-from-the-pandemic-to-the-metaverse?ct=true

[3] https://www.koreatimes.co.kr/www/biz/2022/02/602_323865.html

2 Metaverse: State of the Art

The notion emerged from the futuristic fiction novel *Snow Crash* in 1992 by Neal Stephenson. The concept is adopted to the next-gen Internet that simulates real-world social connections. It virtually enhances physical and digital reality using connectivity and network technologies, mainly, 5G, blockchain, cloud edge computing, and immersive and visualization technologies like augmented reality (AR), virtual reality (VR), extended reality (XR), and 3D that create a one-stop virtual space. Besides technologies in the areas of programmable money, non-fungible tokens and decentralized digital IDs create an extra-economic layer to the 3D virtual world.

Generally speaking, there is no unique definition of the metaverse as it emerges into its early stages of long and winding evolution. However, the Web 3.0 distributed network technologies, Decentralized Autonomous Organizations (DAO), digital assets like NFTs, and the virtual experience like gaming laid a foundation for its open emergence mainly in 2021.

The programmable world is set to blur the boundaries between the physical and virtual world and further shrink the friction between multiple digital platforms by aggregating each digital experience into one place. As it evolves, it is expected to condense the fragmented web and mobile tech experience into a single universal 3D world. This will also ease the data and value transfers across diverse digital platforms. However, regional segregation of the metaverse space (for example, US/international—metaverse and China/firewall—Metaverse) is expected to reflect the geopolitics and distribution of the communication technology (Citi Bank Report, 2022).

The immersive user experience through supportive tech and spatial organization of events and information is the unique value add that metaverse has on top of the real-time synchronous social connections over the Web 2.0 social networks. In simple terms, a user in Web 2.0 browses the Internet while one seamlessly immerses in the metaverse using a headset and other enabling devices that create a seamless sense of presence and real-world experience. The economic agents in this virtual space are designed as programmable avatars representing individual users with their behaviors.

Unlike the prior communication and network technologies, the metaverse is not a new notion but convergence and maturity of the underlying technologies leading into a common space. The genesis fragmented 3D virtual world, metaverse 1.0, was a closed-loop system limited to gaming with a limited non-existent financial component. Metaverse 2.0 augmented the genesis metaverse with financial elements and business cases like virtual shopping experiences and digital assets. Thus, this makes it ideal that the potential growth and innovation diffusion in the area will be rapid and far reaching, Accenture (2022).

3 Virtual Goods and Digital Assets

The metaverse and web 3.0 economic systems mimic the classical economic system through the underlying assumptions of scarcity and cost. These notions are associated with the virtual goods and money that circulate and change hands in these nano-economies.

Virtual goods exhibit the following features: (1) have economic value with the limit in supply, title of ownership, and cost of production associated with them; (2) exhibit scarcity that creates the economic drive within the network and thus allows the nano-economy operate as a fully functional market (for example, virtual land in the Decentraland are capped at 90,000 corresponds to the fixed total amount of MANA for stability); (3) can purely be intangible (for example, cryptocurrencies, virtual real estate and virtual space for events, housing, or branded contents); (4) can be a virtual representation of physical goods or collateralized with a physical asset (for example, non-fungible tokens and NFTs).

However, one should note that with the interoperability issues of the virtual platforms and native tokens across virtual spaces, there appear to be inconsistent standards for the valuation of the goods, unlike the traditional goods and services which we are used to in the physical-economic system. Moy, 2022 pointed out this in the path to building a viable metaverse by defining standards for digital assets such as wearables, objects, brands, and virtual/cryptocurrencies. This, according to Moy, will enable cross-platform value transfers and unique identification of virtual products with potentially different manifestations in each world, e.g., the same NFT manifests as a special edition t-shirt in a 3D virtual world; however, it is a uniquely designed vehicle in a race car video game' (Moy, 2022).

4 The 3D Virtual Economy

Metaverse (the next generation of the Internet), the web with virtual spaces and avatars where the physical reality is developed through real-time 3D software, has become one of the business trends building on the accelerated shift to digital channels, growth of the augmented reality/virtual reality (AR/VR) market, and advances in blockchain technology and cryptocurrencies.[4] Some major metaverse platforms are Roblox, a Nasdaq-listed Metaverse, Zepeto, Sandbox, Decentraland—an Ethereum-based metaverse platform, Cryptovoxels and Somnium Spac. The virtual space is intended to elevate physical world experiences. In economic terms, the combined tech in metaverse platforms projects an economical image in the minds of the homo economicus users; however, the setting lacks common sense, which in some ways might deviate from the behavior people manifest in common social settings (see Pettit (1995) for the analysis of the virtual reality of homo economicus).

[4] https://fintechnews.sg/57530/fintech/what-is-behind-the-metaverse-boom/

The metaverse market is expected to generate about $800 billion by 2024.[5] The PwC estimates the global metaverse market to reach a staggering $1.5 trillion by 2030 (PWC Report, 2019). Citi bank predicts a target addressable market of 8–13 trillion US dollars and a billion users of AR/VR devices (Citi Bank Report, 2022). Similarly, JPMorgan (one of the banks with a virtual lounge in the Decentraland metaverse) sees the market and business opportunities of more than one trillion US dollars for companies in the metaverse (Moy, 2022).

Like all other web and mobile technology revolutions, the metaverse, along with its constructing technologies like VR, AR, distributed ledger technologies, and XR is here to shape the way financial institutions operate, manage financial data, interact with clients, and generate value. The opportunities brought by the metaverse, which merges the fragmented virtual environment activities like digital asset investment, real estate, shopping, virtual immersive social experience, and games, a one-stop virtual space is too big to lose, with about 25% of global users expected to spend more than an hour per day and about 30% global enterprises creating values in this virtual world by 2026.[6] However, any individual and enterprise investments in this programmable world should consider reasonable decisions with the hype around this emerging trend. Figure 1.1 highlights institutional metaverse investments as of 2022, with a significant investment in cryptocurrencies and NFTs, which are equally expected to power the metaverse economy. According to the Metaverse For Business Survey, we also see an emerging institutional investment in a metaverse (Sortlist, 2022).

5 Monetary Base in the Metaverse

Building blocks for financial services as part of metaverse engagement between the virtual and fiscal world include Internet money, Defi, and tokens (mainly NFTs). As we know, in the blockchain-based nano-economic setting, a single application is facilitated by a native token, and the value generation is to be circulated within the same community. When it comes to the metaverse economy, diverse services are at play, requiring an efficient and integrative monetary system within and across other metaverse platforms. Currently, metaverse economies use local digital currency (AXIE INFINITY (AXS), The Sandbox (SAND), Decentraland (MANA), Gala Games (GALA), Enjin Coin (ENJ)) or rely on first-generation Web 3.0 cryptocurrencies like Bitcoin, Ether, or Solana. Besides, the conventional forms of money are also (to be) embedded in the metaverse. See Table 1.1 for metaverse

[5] Bloomber Intelligence at https://www.bloomberg.com/professional/blog/metaverse-may-be-800-billion-market-next-tech-platform/ Accessed on June 8, 2022.

[6] Gartner research on the metaverse notion at https://www.gartner.com/en/newsroom/press-releases/2022-02-07-gartner-predicts-25-percent-of-people-will-spend-at-least-one-hour-per-day-in-the-metaverse-by-2026 Accessed on June 1, 2022.

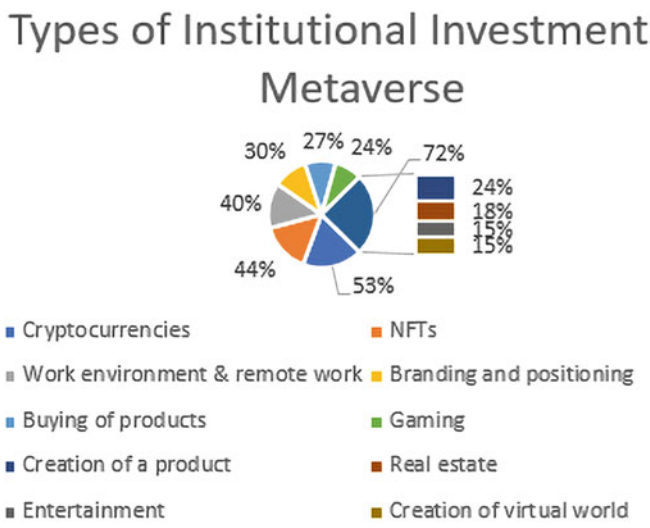

Fig. 1.1 Global Corporate Project Investments in the Metaverse in 2022. According to Metaverse For Business (2022 State of the Metaverse Study) survey of companies that have already invested in the metaverse from selected countries. Source: Author's composition based on Metaverse For a Business survey of companies, Sortlist. (April 1, 2022). In what type of projects does your company invest in the metaverse? In Statista

Table 1.1 Preferred metaverse payment methods according to US gamers 2021

Metaverse payment method	Preference in percent
In-game tokens	47%
Globally recognized cryptocurrencies	46%
Government-controlled currency, such as USD/GBP	45%
Metaverse-specific currency	45%
Non-Fungible Tokens (NFTs)	22%

Source: Author's composition based on the survey by Improbable (January 20, 2022). Statista

payment preferences by the gaming community, the first-generation metaverse services.

Varied forms of currency could fit into the metaverse (Citi Bank Report, 2022). Yet the life cycle and evolution of the metaverse will define which form of currency the system will land on as it hits maturity. Below are the major currency systems which currently (potentially) run in the metaverse.

Native in-game tokens: mainly used in gaming guilds (for example, Robux, Minecraft, and Linden Dollars). These tokens are local to the platform and are in a centralized form.

5.1 Conventional Cryptocurrencies and Native Tokens

These digital currency systems have values within and off the platform (for example, Bitcoin, Ether, MANA, and NFTs). They are used in virtual real estate, NFTs, decentralized finance, etc. Major concerns around such a monetary system are migrated as they circulate within a metaverse. These issues are related to the distributed network economy concerning instability, classification as currency or an asset class, energy-inefficient consensus protocols (like proof of work), anonymity, and dark web money laundering concerns.

5.2 Stablecoins

We can see Stablecoins such as USDT, USDC, Dal, and BUSD for Defi, international payments, settlements, commerce, and service delivery (like entertainment, music, and tourism). Like the cryptocurrencies, the underlying constraints in stabilizing such a currency will manifest in the metaverse in addition to collateralization requirements, anonymity, and AML concerns. Note existing concerns around the stablecoins: privacy and security with the institutionalization of such currencies through licensed token issuers (Libra), potential volatility in the value of an underlying pegging asset or currency leading to financial instability, and the prominent concerns around the robustness of the underlying technology (DLTs in general). Besides, For the fiat-pegged stablecoins, a regulated fiat currency valuation defines the value of the stablecoin, and there is a potential insolvency risk for asset-pegged stablecoins (Turi, 2020a, 2020b).

5.3 Central Bank Digital Currencies

Central Bank Digital Currencies like Digital Yuan will enable tracking of the metaverse due to the centralized feature of these currencies. Added to this are the relative financial stability and monetary policy implications of the CBDCs for the metaverse. However, this will be limited to a closed metaverse that operates on permission tech infrastructure and network.

5.4 Fiat Currency

Here is another venue where we expect traditional financial services will play a role. This will go through the legacy payment channels and are non-tokenized.

6 Seamless Payment and Velocity of Money in Metaverse

The velocity of money is one of the vital macroeconomic measures depicting estimates of the movement of money, average currency changing hands, in an economy at a given year. A high velocity is associated with a bustling economy with intense value creation and economic activity. Bordo et al. (1997) show a unique long-run relationship in velocity with institutional changes (monetization process, the spread of commercial banking, financial development, and economic stability growth) in Canada, the USA, the UK, Sweden, and Norway. This will lead us into the quest of how the institutional structure and migration of the conventional institutions in Web 3.0 and metaverse could shape the efficiency of this economic system. Correspondingly, the following factors should be taken into account as we emerge into the new era of the Internet, the metaverse.

(i) *Industry Layer:*
At the market level, efficient monetization of virtual experiences and values created in the metaverse is needed. Besides, the spread of commercial banking with the conventional financial institutions embracing the Web.0 and further developments in the Defi will further build the financial infrastructure of the metaverse. This will also come with financial developments, including new asset classes, customer experience, and investment opportunities.

(ii) *Macroeconomic and Policy Layer:*
The economic stability of the metaverse is to be defined by the underlying business models and currency systems that facilitate value creation and exchange. This is also to be linked with the shock resistance and predictability of the Web 3.0 world. Further, macroeconomic instabilities in the legacy economic system (for example, financial instability) will reflect on the metaverse operation. The Nobel Prize—winner Milton Friedman (1956) augmented the quantity theory of money by identifying changes in expected inflation, interest rate, and the ratio of current to permanent income as factors affecting the velocity of money.

(iii) *Technological Layer:*
The speed of transactions for a given cryptocurrency is defined by block time, block size, transaction fees, and network traffic. Hence, When it comes to the Web 3.0 economy, we see extra layers of factors that define the velocity, including the infrastructural development and market efficiency this kind of currency system observes. This, combined with the estimated time for deposit confirmation, defines the speed of transactions in this economic system and what is considered the underlying factor for the velocity of money in the conventional economic system. Some currencies/tokens observe instant deposit (transfer of data) while some (for example, Cardano, Cosmos (ATOM), Solana, Ripple (XRP), Terra (LUNA), TerraUSD (UST), Stellar Lumens (XLM), Internet Computer (ICP), EOS (EOS), Kava (KAVA), ICON (ICX)) take up to several hours/days. According to Statista, as of March 2022, Bitcoin, and Dogecoin (DOGE), for example, take about 40 minutes for confirmation

depending on the fee structure, and Ethereum Classic takes about 6.5 days.[7]). The transaction speed will reflect on the economic efficiencies these tokens/currencies power as a native or foreign currency system, which in turn, depends on the underlying tech on which the coin runs. Transaction speed can be influenced by several factors, including block time, block size, transaction fees, and network traffic.

7 Defi and Traditional Finance Elements in the Metaverse

The key components of the metaverse are digital currencies, marketplace/digital Commerce and online shopping, Non-Fungible Tokens (NFTs), gaming, natural language processing, digital assets, social networks and events, creators, workplace, and digital humans—avatars (Gupta, 2022). A survey of the game developers in the USA indicates that technology, cyber security and privacy, feasible business model, well-structured and authentic content creators, cross-metaverse platform and service interoperability and openness, and convenient monetary system (mainly, NFTs and cryptocurrencies, setting the far end legacy currency system aside) the principal components expedient metaverse, Improbable (2022). Technology, security, and privacy together with feasible business models, accounted for a significant share of the metaverse enablers.

Metaverse aims to boost customer experience through virtual immersion (sense of presence) and efficient business communication and payment methods. This will allow financial institutions to incorporate fintech solutions into the virtual universe, metaverse. With the legacy notions of VR and AR, especially in the video gaming industry, this development provides a significant opportunity for financial institutions to ape on.

Companies from diverse corners bet on this newly evolving future of the Internet which is reaching the mainstream audience. Such corporate-level considerations aim at excelling in the pre-existing video gaming industry, which is built on games as service, competition, franchise, platform, and community. According to the Block Research Report (2022), in October and November 2022 alone, NFT and gaming deals reached a historic high of 42% out of the 15 largest deals.

7.1 Metaverse Banking: Skepticism

Opponents of metaverse banking by legacy financial institutions argue that the existing online banking could perform the same service as the metaverse bank would. Opponents also argue that even if there might arise a need for financial

[7] Available at an average transaction speed of 66 cryptocurrencies with the highest market cap as of March 2022 https://www-statista-com.ezproxy.myucwest.ca/statistics/944355/cryptocurrency-transaction-speed/ Accessed on June 14, 2022.

institutions at the later stages of the metaverse development, there is no need for banking in the metaverse at its current nascent stages of the user-avatar migration to the common 3D virtual world and that the underlying business models lack maturity, Johnson (2022). The principal reason is that the metaverse in its current form is sparsely populated to pull sufficient demand for the financial institutions[8] and that financial service providers have to wait until the community is well built and different forms of virtual transactions peak. Scott-Briggs (2022) stressed the need for the financial infrastructure of the metaverse. Yet argues, on the extreme end, that traditional financial institutions, which are "still hovering on the periphery of decentralized finance" not to be the prominent players; rather, digital banks and Defi protocols are a better fit for metaverse transactions.

On the other hand, metaverse banking proponents argue that the 3D virtual world holds immense potential in creating value and redefining customer experience in the financial world. The decay of classical consumer behavior has laid a fertile ground for digital banking, which finds itself at the periphery of decentralized finance. Unlike the Defi protocols, which the rigid institutions are skeptical about adapting, proponents of metaverse see some potential for traditional finance (Bhagvan (2019), PWC Report (2019), Abbott and Muray (2022), Citi Bank Report (2022), Long k. (2022), and Moy, 2022, to mention some).

7.2 Metaverse Banking Use Cases: Early-Stage Adoption

The metaverse comes with a diverse set of immersive activities ranging from gaming and shopping to socializing. It will enhance the virtual and real-world experience and operates by transporting, extending, or transforming real-world activities. Thus, any financial service that runs in this environment will replicate the same principle according to the business need in the metaverse.

This comes with a significant potential for autonomous and enterprise financial players to facilitate the exchange element and monetary value creation in the 3D virtual space. Possible venues of application include exchanging currencies between different worlds, virtual or real-world asset conversion, or provision of virtual banking through employee avatars (Abbott & Muray, 2022). Other areas of application range from Virtual 3D real estate transactions (metaverse "mortgage") to lending, digital asset management, and other financial services. For example, TerraZero Technologies offers a "mortgage" for investors to acquire virtual lands in the metaverse platforms like Decentraland.[9] Figure 1.2 depicts the IT and connectivity rail rides of the financial institutions from pre-digital banking of ATMs and

[8] See, for example, a visit to the Decentraland, "Decentraland: The Metaverse's Early Mover" by Mario Gabriele at the Generalist, https://www.readthegeneralist.com/briefing/decentraland. Accessed on June 21, 2022.

[9] TerraZero https://terrazero.com/tech-firm-closes-first-metaverse-mortgage-for-acquisition-in-decentraland/ Accessed on May 25, 2022.

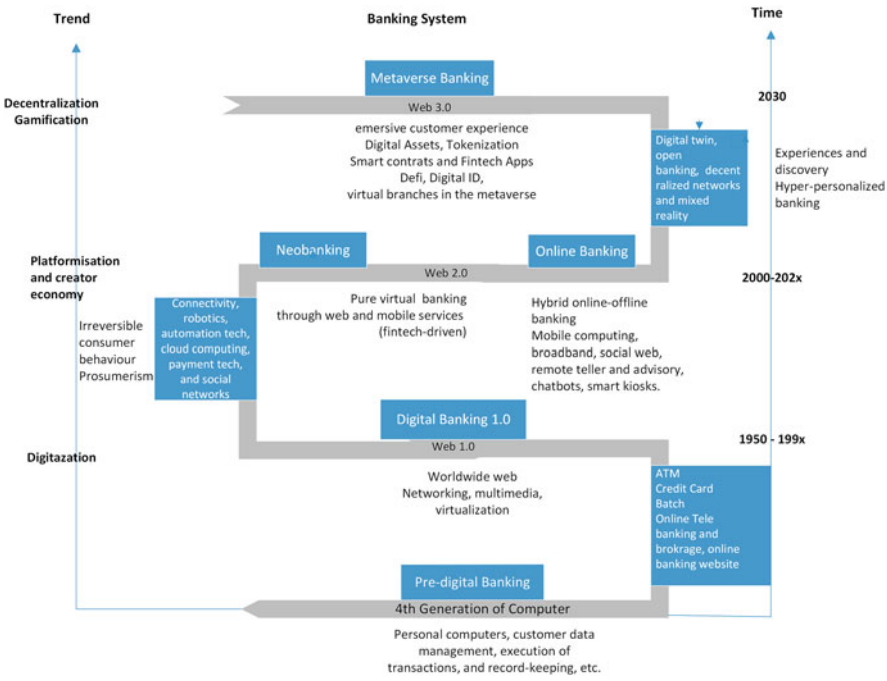

Fig. 1.2 Illustrative diagram—The IT and Connectivity Rail in the Banking—evolution from the Web 1.0–3.0. Source: Author's development

computers, Web 2.0 online banking to the metaverse banking, which is around the corner.

The current state of the art in the Financial Sector includes (1) Data Visualization: Immersive Experience through 3D environments has helped to analyze financial data and allow investors to make informed decisions with the help of virtual financial advisors; *(2) Virtual Trading events:* visualizing and presenting trading through VR allowing traders to see and interact with the markets and identify the holistic patterns in the trading environment; (3) VR immersive shopping experience (for example, Mastercard and Swarovski's virtual reality (VR) shopping app for the home' using Mastercard's digital payment service, Masterpass),[10] (4) Extra security layer for financial services—on top of the existing authentication mechanisms, including fingerprints, facial recognition ATMs, AR solutions have enabled AR, iris identification, and voice recognition (while privacy concerns around such tech applications

[10] https://newsroom.mastercard.com/press-releases/mastercard-and-swarovski-launch-virtual-reality-shopping-experience/

remain open)[11]; (5) Virtual Banking—with an increased host of financial institutions on the metaverse bandwagon, we see some nascent developments where some financial institutions have partnered with potential metaverse players like the Sandbox. Yet, with the gray field in the regulation and stability issues in the Web 3.0, the metaverse experience to be offered by the financial institutions is currently limited, with almost all the metaverse banking platforms serving as a testbed for the emerging trends of the experience economy and the underlying technologies, Long (2022). (6) Other areas of application are decentralized finance. Table 1.2 summarizes some of the ongoing metaverse projects and initiatives by financial institutions and fintech companies across the globe.

Atelier Swarovski where consumers buy from virtual immersive "decorated"

8 Metaverse Is Around the Corner; What Are the Key Drivers?

The establishment of businesses across different sectors in the virtual world will call for the strategic presence of financial institutions, including banks and fintech companies, to facilitate financial transactions across metaverse services. Recent trends in corporate metaverse initiatives have spiked a new wave of interest in the virtual space. Moreover, technology companies like Facebook claiming to migrate or operate as metaverse have driven the Metaverse Hype. In January 2022, Microsoft's move to acquire Activision Blizzard, a video game holding company, for $68.7 billion was one of the prominent trends in the emerging metaverse world. In 2021, Facebook invested at least 10 billion dollars in hardware and software to develop its metaverse environment.[12] For example, this was followed by a significant increase in digital asset investments like virtual lands (See Fig. 1.2 on ....). Latest developments indicate the foray into the metaverse world by financial institutions. Here, we will discuss the driving forces behind the emerging institutional metaverse in the financial sector.

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(i) *Technology*

On the technical side, potential advances in new edge computing (like quantum computing and bio-inspired computing) allow businesses to compute and solve problems like never before in terms of cost, capacity, and abstraction of intractable business problems. A survey by Accenture Technology Vision 2022 shows that 94% of executives agree that next-generation computing is a competitive advantage

[11] For example, Axis Bank, India—uses Iris scan authentication tech (see: https://www.axisbank.com/docs/default-source/press-releases/press-release%2D%2D-axis-bank-introduces-iris-authentication-over-micro-atms.pdf?sfvrsn=7277b455_0)

[12] The Verge reported, "Facebook is spending at least $10 billion this year on its metaverse division And expects to spend more 'for the next several years'" https://www.theverge.com/2021/10/25/22745381/facebook-reality-labs-10-billion-metaverse Accessed on March 15, 2022.

Table 1.2 Sample metaverse projects by financial institutions and fintech companies as of June 2022

Institution	Metaverse platform / partnership	Current state
KB (South Korea)	Gather	Opened a beta service to offer virtual banking, real-time stock charts, and face-to-face consultations with its banking staff on a metaverse platform Testbed to new business models and emerging tech
BNP Paribas (France)	VR-based app in partnership with French startup Vectuel and RF Studio	Wealth management, real estate Launched a virtual reality app for retail banking, real estate, and insurance The bank traded its first intraday repo on JP Morgan's permissioned blockchain, Onyx
EQIFI (DeFi platform backed by a digital regulated bank)	Netvrk	Partnered with PolkaCity, a contract-based NFT platform, to create an NFT card for metaverse users
Fidelity Investments (US)	Decentraland	Immersive educational metaverse
Mercobank (Digitalbank—Sweden)	Undisclosed	Pilot project on digital asset custody service to secure, lend and insure NFTs
JPMorgan Chase (US)	Decentraland	Onyx Lounge in Decentraland (a permissioned blockchain for wholesale payments and transactions), offers virtual plots of land with NFTs or cryptocurrency in a bid to transform money and asset movement around the globe and value creation Facilitate cross-border payments, foreign exchange, financial assets creation, and trading and serve as a custodial (safekeeping)
Metabank	Metabank	Provides Defi services of P2P lending, over-the-counter securities, staking, virtual credit, and debit cards. It also offers yield farming, NFTs purchases, cryptocurrency and IBAN payments, and remittances
CryptoKitties	SANBOX	Metaverse "lounge" in Decentraland
Woori Bank (South Korea)	Zepeto, Naver, and member of the Korean Metaverse Alliance	–Event—Woori-MZ on Metaverse –Set up a trial metaverse outlet to enable its customers to experience AR services in advance
Standard Chartered (Hong Kong, UK)	SANBOX	Obtain virtual land at The Sandbox metaverse's Mega-City neighborhood

(continued)

Table 1.2 (continued)

Institution	Metaverse platform / partnership	Current state
HSBC	SANBOX	HSBC Stadium targets sports, esports, and gaming enthusiasts Minted NFTs
CaixaBank (Spain)	Decentraland—imaginLAND	Joined the metaverse with a plan to explore innovative digital platforms through its experiential space ImaginLAND in the Decentraland A host of music events by the Spanish pop group Marlon on its imaginCafé, a physical coworking space in its imaginLAND metaverse
Hana Bank	Zepeto, Naver, and member of the Korean Metaverse Alliance	Intracompany meetings and new employee training
Industrial Bank of Korea (IBK)	Cyworld's Metaverse	Training employees and financial literacy educational service provision for the young adults

Source: Composed by Author

(Accenture, 2022). Metaverse embedding such a technological layer will lay a foundation for businesses' direct and indirect involvement. The technological advancements in the communication technologies like the 5G and computing, 3D, analytics, VR, and AR technologies are appealing to businesses, including improved user experiences and business process engineering. Accenture identified six main technological building blocks and enablers of the metaverse: converging device technologies, digital identity technology, multiparty systems and distributed computing technologies, abundant computing power, emerging protocols and standards, and rapidly expanding bandwidth (Abbott & Muray, 2022).

With new revenue streams being open for the hardware and software providers, the market forces will allow the efficiency and affordability of the tech. This in turn will speed up the innovation diffusion and broaden the user base. However, it is also important to mention that from the businesses' perspective, the costs of high-end VR and AR hardware remain high for investment compared to a significant decline in the price of end-user devices like headsets. Such changes in the complementary market forces will keep the adoption of metaverse by businesses lower.

(ii) *New Asset Classes and Virtual Goods*

The market forces for virtual goods will shape the future of the experience economy. For example, as the supply and demand forces interact in the virtual real estate market, the business models like "mortgage," rental, and credits mimicking the physical housing market will take root calling for more customizable financial service models for the metaverse digital assets. See figure, for example, depicting the

trends of virtual land sales in four major metaverse platforms during the last two years following the COVID-19 pandemic. The virtual real estate market observed about a 700% price increase in 2021 with the hype around digital assets.[13] This comes with a potential boom in the banks' metaverse credit and mortgage business lines (Shelvin, 2022; Moy, 2022).

(iii) *Supply Push and "Ease of Adoption"*

Technological advancements: developments in software and hardware that enhance the experience economy will increase the innovation diffusion, reachability, and efficiency of the experience economy. For example, there has been a significant decrease in the price of VR and AR hardware supplies (such as the supply of HTC and Oculus by Microsoft and Meta, respectively, which has observed a significant price decline than the early stages of its adoption for the gaming industry). Moreover, the ready-to-integrate metaverse platforms make it easy for financial institutions to join the virtual world without further requirements to build the network from scratch. Business clients are not always required to create their metaverse infrastructure because the open virtual shared space of the metaverse is designed to integrate multiple layers of real-world experience immersed in the virtual world and provide the framework.

Competition and fear of missing out from the competitive banking landscape with the hasty tech environment will make financial institutions migrate and adopt the metaverse. Besides, the increase in the number of the gaming community and the emergence of NFTs' play-to-earn gaming guilds business model in the metaverse creates a favorable ground for the scale of the market by populating more users in the virtual space.

South Korea is one of the underpinning countries with a significant number of the gaming community, and picking on to this advantage, we see an increasing trend of retail banking adoption of the metaverse, even though such developments are still in the early stages of development. The country also has a national metaverse initiative, Metaverse Alliance, launched by the government with hundreds of members from different sectors ranging from financial institutions to tech companies.[14]

For example, Acorns is a mobile investment app designed to round up transactions made with a linked credit or debit card and invest the difference into ETFs (exchange-traded funds). The company has over 8.2 million users who have invested $2 billion through its platform since launching in 2012. Another fintech gamification startup, Flourish Savings, even gives rewards to users that can be

[13] Ron Shevlin at the Forbes from the observations on Fintech Snak Tank on February 4, 2022, Digital Land Grab: Metaverse Real Estate Prices Rose 700% In 2021 https://www.forbes.com/sites/ronshevlin/2022/02/04/digital-land-grab-metaverse-real-estate-prices-rose-700-in-2021/?sh=4daa4b7c7cdc Accessed on June 2, 2022.

[14] On November 2, 2021, The Korea times ran a story on "Korea launches 'metaverse' alliance" highlighting the governmental and institutional attention toward the emerging 3D virtual world and its enabling technologies. Retrieved in June 2022.

cashed out later. A study by Apis Partners noted, "Gamification is about customer centricity: it helps customers achieve their goals in a way that emotionally engages them."[15] Besides, the NFT and play-to-earn (P2E) business model has paved the way to incentivize users to use new business models, gaming guilds, in the gaming industry. Recent success stories in traditional banking come from the Spanish bank, CaixaBank, through its virtual destination and immersive event series project in the Decentraland metaverse, imaginLAND.[16] The Spanish virtual fintech company, the first in its form, provides a platform for immersive content and experiences targeted at its more than 3.7 million users of Imagin, a "digital services and lifestyle platform" backed by the CaixaBank. The year 2022 remarked significant large-scale mergers and acquisitions in the video game industry with online buzz and hype around the tech. In 2022, Block's research indicates that mergers and acquisitions in the crypto industry increased by about 730%, getting to more than $6 billion.

According to Statista, in 2020, more than 33.6 billion dollars in deals of about 665 transactions were recorded. Here, it is also important to note the COVID-19 pandemic is one of the main catalysts of the digital wave.[17] According to Newzoo's, 2022 report, the audience in live-streamed games is expected to climb to 1.41 billion by 2025 (Newzoo report, 2022). North America and Europe generated 349.7 million and 345.3 million US dollars each in esports during this year, respectively. See Fig. 1.1 for the regional proportion of online population and esports information diffusion.

(iv) *Demand-pull*

With the increase in the experience economy in gaming, media, and entertainment and the number of cryptocurrency users, financial institutions are considering virtual assets like cryptocurrency for investment, custody, exchange with fiat currency, and lending Shevlin (2022). The growing inhabitation of the consumer in the virtual space as the trends of adoption for mixed reality has a significant role to play in the emerging enterprise metaverse. Gen MZ's (Generation Z and the millennials) tests and preferences for digital goods leading to digital assets and virtual possession trends with the scarcity embedded in these resources of the metaverse ecosystem drives diverse business models that fit into the digital community. For example, Fig. 1.3 depicts the virtual plots of land possessions in millions of dollars across four major metaverse platforms, The Sandbox, Decentraland, Cryptovoxels, and Somnium Space.

[15] https://fintechmagazine.com/sustainability/17-fintech-trends-you-should-know-about-ultimate-guide

[16] https://www.caixabank.com/comunicacion/noticia/imagin-takes-the-leap-into-the-metaverse-becoming-the-first-european-fintech-company-in-the-virtual-world_en.html?id=43410

[17] https://www.statista.com/statistics/259455/value-of-games-industry-mergers-and-acquisitions-worldwide/

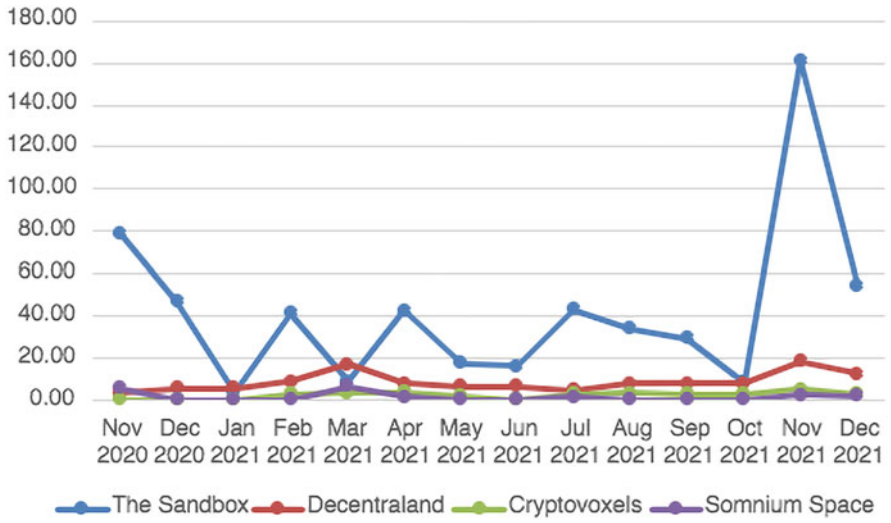

Fig. 1.3 Sales value of virtual plots of land in four major metaverses 2020 to 2021 (in million US dollars). Source: Author's computation based on data from Statista on the metaverse virtual land sales

(v) *Remote work*

Early-stage institutional adoptions of the metaverse in banking include virtual event and financial literacy organizations to digital twins with employee avatars of basic roles. The pandemic drives the growing remote work preferences, and enabling tech infrastructures will hasten the adoption of one-stop 3D experiential spaces.

9 Metaverse Finance: Opportunities

Breaking the financial barrier in the metaverse will facilitate value capture in the newly evolving 3D virtual economy. Accordingly, with clearly defined regulations and technological layers to secure the system and lower transaction costs, the metaverse comes with a new edge in banking service. Here, we discuss the potential benefits metaverse holds for the financial sector as one of the technological developments that shape the virtual economy.

1. *Business Process Engineering*

Simulated financial environments using VR and AR technologies can help financial institutions speed up financial product design and development, business process improvement, and reduction of risks (PWC Report (2019)). Testing new business models and financial products by simulating complex agent/investor behaviors in real multi-agent financial markets will be a milestone development in

the existing models that reproduce and predict markets. The potential for this range from the monetary exchange to reproducing, learning, and training the market with the underlying market dynamics. Note that agent-based modeling and simulation approaches in the financial markets are not a new notion (Samanidou et al. (2007)).

Metaverse will lend a seamless real-world experience and serve as a test bed for the new products, business models, and emerging tech as applied by the KB Kookmin Bank of Korea and similar other banks in the financial sector.[18] For example, militaries use VR to train soldiers for parachute jumps and bomb disposal. A similar approach to product design and development has already been in different sectors where VR has significantly reduced the time from product design and physical development with meager/null physical prototyping requirements (for example, automotive industry, education, housing, space exploration, health care, and military). Besides, such virtual environments can help deliver training (see, for example, Fidelity Investments and Industrial Bank of Korea, which use the metaverse for immersive education and financial literacy and training purposes).

Advancing banking solutions in an engaging and immersive 3D virtual environment—The marketing tool offers customer-centric apps that display real-time costs and other asset information and offers a "mortgage" calculator. Studies show that metaverse will enhance the financial sector by enabling technologies that transform financial data into a visual, engaging experience, and boost customers' experience in the comfort of their homes. Hybrid branches where physical branches use AR technology to offer self-service like chatbots or robots to provide information and videoconferencing is another application sphere.

2. *Value Creation and new revenue streams with possibilities for a new client interface*

The principal added value to the banks is the monetary value of the metaverse economy. Primarily, banks can pick on their facilitation role to provide payment rails for virtual transactions and other financial services like securitization, lending, or transferring funds in the metaverse. This will also create a broader customer base by attracting the younger generation, which populates the metaverse. This will also allow for developing digital-only brands as new business models that fit metaverse culture emerge.

Below are some of the potential new product lines for banking in the metaverse:

- Virtual or physical asset collateralized loans and insurance.
- Digital wealth management secures and facilitates financial interactions within the 3D virtual world.

[18] Yahoo Finance reported on November 30, 2021, reported "KB Kookmin Bank—one of the biggest financial institutions in South Korea—has entered the virtual realm with the development of the KB Metaverse VR Branch Testbed." https://ca.finance.yahoo.com/news/south-korea-kb-bank-enters-121438920.html Accessed on April 21, 2022.

- Asset management in acquiring, maintaining (as a custodian), and trading NFTs and digital assets is one of the asset classes in metaverse banking.
- To extend the financial services for the growing metaverse community through conversion of fiat currency into digital currencies or tokens in the metaverse or extending loans.
- Hosting client services on the metaverse. Providing a service for client investments in metaverse assets (NFTs, virtual lands, and tokens).
- NFTs with ownership rights of virtual land used for virtual real estate development like virtual housing and digital retail stores.

Payment rails and secure wallet—Metaverse, which embeds the economic element in its setting, calls for efficient monetary infrastructure and payment channels in fiat and/or digital currency. A seamless payment structure is needed to bring an enhanced customer experience for virtual purchases, NFTs payments, and exchanges with an efficient speed of transaction and transaction validations (Ball, 2021; Abbott & Muray, 2022). Real-time payments (RTP) and cryptocurrency investing are the prominent new products under development by banks and credit unions (Gupta, 2022). See, for example, the current developments in the payments for the gaming community: Sightline Payments which built infrastructure for the traditionally cash-based industry by providing cashless digital gaming for live sports and casinos.

Virtual real estate lending and asset valuation: The same conventional models could be augmented for the virtual element of such digital assets. Hence, it will be ideal for innovative banks to look into opportunities to build a brand in metaverse lending and seize the customer base as early adopters.

Moreover, the crowd-based business models of Defi will take root with the self-sovereign data management technologies like blockchain underlying such networks. As it appears, existing business models are a mere reflection of a neo-classical model with an extra virtuality layer of the metaverse. As the virtual space hits its maturity and gets populated with more users, novel business models that fit the environment are expected. In line with this, it will be interesting to observe how this redefines the collaborative economy's business models, which are built on the zero-marginal cost society of the last two decades.

3. *Competitive edge—digital twin*

There exists an opportunity in banking and seizing on the potential of social networking, gamification, and immersive experience (mainly for younger clients) through the digital twin of metaverse banking. The digital twin component will give the legacy banking system, which the fintech neobank and decentralized finance have challenged, a footstep into seizing the opportunities opened by the metaverse. This will allow the incumbents to climb the decentralized network and embrace the embedded technologies to transform value creation and exchange, asset transfer, and data flow. Besides, the digital twin element can extend into providing a virtual twin of a physical asset that will be used for underwriting the corresponding loans.

The VR and AR tech, together with the computing and analytics tech embedded in the metaverse platforms, will allow analyzing financial data for investors to make informed decisions. It will also feed financial advisors information such as the financial market using an AR interface and help them identify risks and propose strategies to deal with the potential risk, minimize loss, and optimize return. Moreover, this also creates opportunities for banks to access younger clients with decentralized and gamified offerings and enhanced customer experience through VR, AR, and XR.[19] Note that prominent ones in immersive customer engagement are the gaming and entertainment industries, while the potential to excel in this is open for financial institutions. In addition, engaging with global financial services providers and sports communities in different metaverse platforms is another opportunity the digital twin in the metaverse holds. On the financial literacy component of metaverse banking, a simulated financial learning environment for clients and employees (new) with different stakeholder avatars is one of the areas of applications we saw in the early stages of the metaverse adoption by the banks. A typical example is KB's metaverse plan with a virtual branch to educate young people about finance.

4. *Cost Reduction*

Develop and market new products more quickly and efficiently, reducing time to market while taking cost and complexity out of the process. Collaboration efficiency in one space reduces the need for physical presence and prototyping, and augmentation of the financial product design will lower the time required to develop and test these products in a real market and further reduce monetary costs associated with it. Additionally, this will also allow reducing risk. Besides, the efficiency in training employees and potential customers is a place to save costs in the financial literacy and the internal human capital investments of the financial institutions. Moreover, the one-stop platform with access to the younger adults (Mainly Gen ZM) will create new revenue streams using the existing financial products and potentially new products (yet) to be developed fitting the metaverse world.

5. *Rejuvenating the human touch and bridging the emotional digital divide in banking*

On the same scale, the digital banking system redefined financial services and led to efficiency; it has also cost banks in terms of the emotional customer relationship. The emotional divide following the massive digital transformations (which was aggravated following the COVID-19 pandemic) has been immense, with a significant drop in-branch teller transactions. Gallup's research shows that banks could make about 23% additional revenue from emotional connections with fully engaged

[19] Redefining Customer Experience in Financial Sector with VR and AR https://ibsintelligence.com/blogs/redefining-customer-experience-in-financial-sector-with-vr-and-ar/ Accessed on June 11, 2022.

customers (Ratanjee and Tschida (2019)). The immersive 3D virtual banking environment has promising features to reclaim the "shoe leather." This, on top of the product differentiation, will help banks in customer experience differentiation, mainly for younger clients.

"In today's digital world, digital banking is functionally correct but emotionally devoid. Think of when you were a child, and your parents took you to your bank branch to get your first card or savings book. That was an exciting experience that may well have started a lifetime relationship with your personal bank. What will future generations' first memories of banking be?" (Abbott and Muray (2022)). The realistic bank representative or financial service advisor's avatar will create a sense of connection and seamlessly real customer experience far better than videoconferencing, mobile applications, or chatbots could do.

10 Metaverse Finance: Challenges

Regardless of the opportunities mentioned above, the metaverse holds for traditional financial institutions, and its early adoption in the financial sector is under par. There still is a limit to the efficiency of adoption of metaverse by these institutions, unlike the other sectors like entertainment, shopping, and gaming. Talent acquisition, cybersecurity, monetary policies and regulations, the efficiency of operation and costs, the post-pandemic economic downturn and its effect on the credit market and loans, non-interest income, new customer base, and the cost of funds are the major concerns of metaverse banking (Shevlin (2022)). Below, we explicitly discuss some of the challenges of instituting traditional financial institutions in the metaverse.

(i) *The Scanty Metaverse User Base*
Even if the gaming community has significantly increased over the past few years, the 3D virtual worlds across services are still sparsely populated. This is something that time will answer as the innovation diffusion hastens and increased business applications that populate more digital humans. Indeed, demand creates supply, which significantly constrains enterprises' incentive to join the metaverse early. The same logic applies to the financial institutions that will have to identify meaningful financial interactions to facilitate in well-established communities.

(ii) *Platform Sharding and interoperability*
Metaverse platform sharding and transaction costs in relation to cross-virtual platform service usage will mimic the cross-border roaming fees in the communication services. In line with this, preferences are toward a universal open-source metaverse like the current worldwide web. 2021 survey on the US video gamers indicates about 47% preference for the public metaverse, Improbable. (2022). This will dissolve the platform sharding and cross-platform interoperability issues in the metaverse if attainable. The survey also indicated about 41% preference for institutional metaverses (for example, tech companies) with a significantly lesser preference of only 12% for

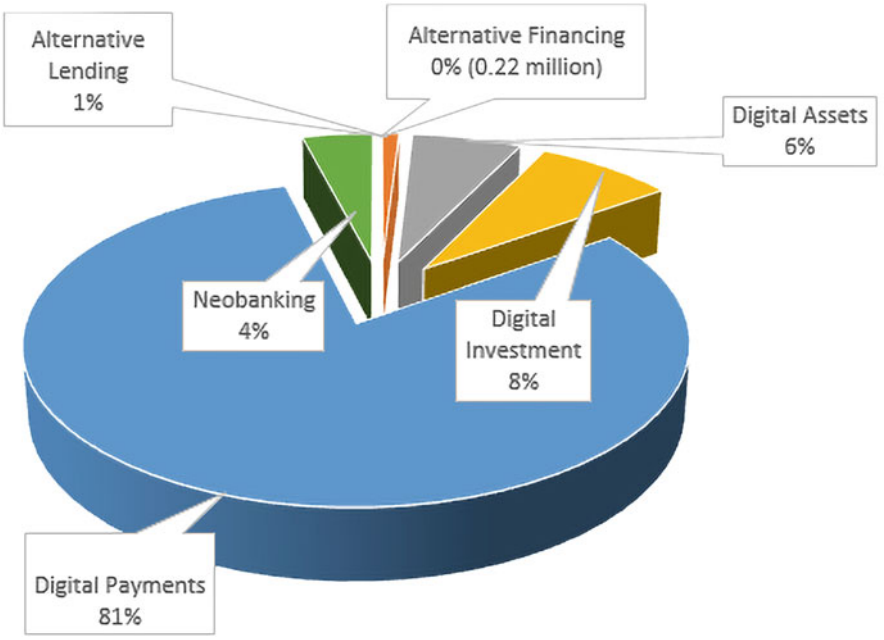

Fig. 1.4 Global Fintech users in 2022 by segment (in millions). The number of users increased to a total of 5.14 billion global users, a significant increase from the number of users before COVID-19 pandemic (from about 3 billion users in 2018). Source: Author's computation based on data from the Statista on Fintech (FinTech–Worldwide. (n.d.). Retrieved on June 13, 2022, from https://www.statista.com/outlook/dmo/fintech/worldwide?currency=USD)

metaverse owned and populated by users. Platform sharding also comes with the interoperability issues of platforms and infrastructure across and between different metaverse platforms.

(iii) *The Competitive Financial Service Landscape*

Banking business environment faces fierce competition from big tech firms (like Apple, Facebook, Amazon, and Google), fintech (like Stripe, Klarna, FTX, Ripple, Square, and PayPal), neobanks (challenger banks like Nubank, Revolut, Chime, and Webank), and fellow banks that will operate in similar virtual worlds. Note also that, for the decentralized networks, far beyond the legacy financial services, decentralized autonomous organizations (DAO) and community banking will have a significant footprint in these credit markets (JPMorgan Report, 2022 and Johnson (2022)). For example, the fintech giant, Stripe, offers crypto-payments—for exchanges, on-ramps, wallets, and NFT marketplaces which will add up to the payment tech in the metaverse.[20] The principal business lines in banking that are prone to market competition are payments and of digital assets and investment. Figure 1.4 shows the user base

[20] Available at Stripe: https://stripe.com/en-ca/use-cases/crypto Accessed June 2022.

in major market Fintech market segments with a significant concentration in digital payments.

(iv) *Reputation and Identity Management System*
Trust and social capital are generally considered currencies of the digital economic system (Turi, 2021). The underlying technologies in the metaverse, like blockchain, are set to guarantee transparency and immutability of records. However, the issues of trust and reputation (ranging from whitewashing, identity changes, fraud, and strategic manipulation of reputations, to retaliation effects) remain open when it comes to the virtual society. Thus, efficient reputation and identity management mechanisms are the principal coins of the virtual open society. This should be accompanied by the self-governance of data and security and personal safety of the user by design.

(v) *Technology*
Here is the tech checklist as financial institutions put their foot in the metaverse. (1) Being one of the metaverse components, the implementation issues concerning the AI, VR, AR, and distributed ledger technologies remain the same, and financial institutions have to be considerate of this issue in their business; (2) efficient avatar movement and interoperability across metaverse platforms (which will contribute to the virtual product type and help increase the user base with free cross-platform movements of value and exchange) are the additional tech layers financial institutions should take into account; (3) cross-platform and inter-platform governance, and reduced sharding with one-stop global metaverse across experiences and services; (4) the design and incorporations of complex human and business interactions; (5) hardware and software efficiency in terms of application and usage; (6) unique digital asset identification with a defined value across 3D virtual worlds; (7) extended data and visual analytics (Moy, 2022). The current metaverse manifests itself with diverse native tokens that power different virtual platforms in addition to the legacy payment trails and distributed digital currencies. For example, Fortnite, Roblox, Call of Duty, and Minecraft use V-Bucks, Robux, COD Points, and Minecoin as native tokens.

(vi) *Metanomics*
Incorporating the legacy payment channels of conventional financing and the coexistence of these payment systems with the distributed monetary system of cryptocurrencies and NFTs is a gray field that calls for further work in the commercial aspects of the meta economy (Citi Bank Report, 2022). Thus, the coexistence of distributed and fiat currency is another challenger in the metaverse economy, with more work ahead on synchronizing the currency system of the experience economy for the common good. On the other hand, volatility in digital assets and currencies poses a severe problem for the stability of the experience economy. Crypto scams, project failures due to unsuccessful launching or rug pulling with the poorly defined regulatory framework, and immature technologies to secure the system will aggravate the problem making the economy vulnerable to internal and external shocks.

(vii) *Regulatory uncertainties*

Defining a regulatory framework that applies to the dynamics in the metaverse world is vital. However, the hype around the immersive virtual world poses a significant enterprise and individual investor potential loss and further disruptions in the government's revenue before new rules are enacted, and the virtual market's sky clears. Besides, the complex and evolving legal sphere of the distributed networks and cryptocurrencies that run the metaverse leaves a gray field on how such a system's regulation is fully met. As is common with emerging tech, it takes time for the law and legal codes that govern the virtual community interactions to arrive. Hence, that governs the metaverse. To date, no actual law or legal code governs the metaverse. While new regulatory and legal codes for the metaverse are sure to come, banks must consider the existing and evolving laws that govern the dispersed virtual activities that now run in a single space, the metaverse.

(viii) *Flexibility*

Metaverse if joined by the rigid legacy financial institutions, will, in most cases, require them to operate with the flexibility of alternative programmable money and tokens which are used in the metaverse platform. Following the hype around metaverse, there have been growing institutional investments, including banks, in cryptocurrencies and NFTs. For example, in its metaverse report, JPMorgan agrees that a *flexible and robust financial system that facilitates virtual and off-metaverse transactions should be considered to operate at scale* (JPMorgan Report, 2022). The bank facilitates real estate transactions in virtual lands with NFTs and cryptos at its Onyx Lounge in the Decentraland metaverse.

11 Concluding Remarks

The migration of incumbent financial institutions in the metaverse calls for redefining, developing, and implementing solutions that meet the crypto transaction and crypto investment needs. The current metaverse banking hype intends to create the impression that the financial institution is ahead of time in its innovations in the eyes of the stakeholders and potential investors. However, this must be supported by feasible business cases in metaverse banking. Accordingly, in the early stage of development, enterprise adoption of the metaverse and individual investments must be done with great caution.

Based on the current state-of-the-art metaverse and its potential adoptions in the financial sector, we highlight the following key points for metaverse banking:

Talent acquisition, strategic partnership, and tech investment: A survey by CornerStone Advisors shows that, in 2022, about 67% of executives are concerned about attracting qualified talent.

Research and development: Financial institutions must assess the core business problems underlying the existing delivery of financial services and explore the potential for business cases and solutions where such technology will play a role than a mere industry herding a mere adoption of the tech with no added value. As of

the writing of this text, there has not been significant financial application in the banking metaverse with those opening metaverse "lounge" merely displaying the financial institution's tech progress, and avatars, video games, and employee avatars of no actual role.[21]

Early-stage banking research, pilot tests, and experiments should focus on observing the tech landscape, designing metaverse banking business models and strategies that meet the metaverse tech and diverse financial interactions in the virtual world.

Identify Financial risks in the metaverse: These risks include (1) currency risk with the interoperability of fiat currency with the programmable money and tokens in the metaverse; (2) Credit risk for potential defaults and asset value changes in the virtual real estate lending and mortgage; (3) Commodity risk with the virtual goods and NFTs with wild prices in the distributed network economy; (4) Market risks concerning default; and (5) Liquidity risk concerning digital assets, virtual goods, NFTs, and cryptocurrencies.

Quit the same as the existing digital economic system; metaverse will be exposed to the dark web and AML risks. In connection with this, banks have to strategically identify (with the supportive tech in place) the possibilities for unwittingly facilitating financial transactions that fall under money laundering practices.

Identify technological risks in relation to (1) privacy and security of metaverse platforms and their derivatives for the financial service delivery. State of the art in autonomous finance are biometric security, blockchain, multi-cloud data storage, secure access service edge (SASE), and decentralization, allowing self-governance of data. Other technological aspects include (2) internal security breaches with unauthorized access, fraud, and tampering with the banking computer system; (3) operational risks—functionality and scalability of technological tools and applications: Suitable tech selection that meets the financial business need of the metaverse banking; (4) readiness and flexibility to adapt to the emerging trends in the dynamic and hasty tech environment where rapid changes in the technological system make existing tech obsolete.

Metaverse banking should be considerate of the concerns around tech bias, fairness, and the human impact of the virtual space in general—inclusion and diversity, to sustainability. Accenture (2022) states authenticity in business delivery through genuine use of AI, which is considerate of provenance, policy, people, and purpose, is one of the principal components of the metaverse.

Cost of adoption and digital transformation: regardless of the readily available metaverse platforms, there still is a need to invest in enabling software and hardware and spend on business operations. Thus, such investments have to be optimally met. This can be followed by strategic market testing and deployment before a full-scale

[21] see Shevlin's observations of the JPMorgan's Decentraland lounge from the Fintech Shark Tank at the Forbes at https://www.forbes.com/sites/ronshevlin/2022/02/16/jpmorgan-opens-a-bank-branch-in-the-metaverse-but-its-not-for-what-you-think-its-for/?sh=638a5700158d Accessed on June 5, 2022.

implementation, followed by pilot programs and market experiments. (check out PwC's Report, 2019, on the VR's and AR's potential for businesses, Seeing is believing).

Fintech: Emerging Trends and the Future of Finance

2

Hamed Taherdoost

Abstract

The rapid growth of technology has influenced different industry sectors including the financial sector. The world of finance and banking is transformed significantly replacing conventional customer-facing services with application-based digital processes. New financial service providers recognized as Fintech companies have been raised as a result of technological advancements in the financial sector aiming to launch technology-based financial services and improve customer experience. Despite the promising role of fintech to provide safer, faster, and cheaper financial services for customers, there are still some challenges in the application of fintech. Besides, there are a great number of innovation opportunities to be employed in offering financial services by fintech companies considering constantly changing customers' preferences and habits regarding the employment of new technologies in the financial sector. This chapter objectively clarifies the building blocks of fintech and how it has shifted the financial services (FS) sector, the challenges of employing fintech, and the future of fintech, catalyzing to provide a common understanding regarding fintech and futuristic perspectives through its development.

Keywords

Fintech · Financial technology · Blockchain technology · Fin-Tech future

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1 Introduction

Traditional financial institutions have been faced with considerable opportunities in the last couple of years as a result of developments in technological innovations. Fintech that is emerged as the result of advancements in technology in the financial sector and is revolutionizing the financial services industry significantly. Fintech refers to the adoption of new technologies to improve financial transactions and activities (Al Hammadi & Nobanee, 2019). A large scope of technologies and techniques are covered in fintech by combining innovation, finance, and technology. Fintech companies that are commonly start-ups established based on innovation compete with traditional financial institutions in offering financial services to customers (Lee, Yen, & Hurlburt, 2018).

The growth of fintech companies to promote customer experience through offering digital financial services is constantly changing customers' expectations. Reliance on smartphones or tablets to handle payments, and investments simple with a few clicks have provided an enjoyable experience for customers (Lu, Wu, & Ye, 2020). Change in customers' preferences has also led to a deep shift in traditional banking processes aiming to minimize the gap between traditional banking, insurance, and investment with services offered by fintech companies. Some traditional financial institutions have seized the opportunity by collaborating with fintech companies to deliver fast and accessible financial services to their customers and generate revenue; accordingly, otherwise, they may simply lose their market share in the competitive environment.

The ecosystem in which fintech operates consists of several components including fintech companies, regulators, and financial institutions. Integration of processes and policies in these three elements can help to run a productive fintech service. In this chapter, the components of fintech are clarified first. Then, the role of fintech in the market structure, technologies used in fintech, challenges of employing fintech by financial institutions, and future fintech trends are investigated.

2 Fintech

Integrating technology including mobile applications, software, or any other forms of technology and finance to provide better financial services for clients and businesses is referred to as fintech (Pant, 2020). Any company that provides financial services using technology including software and mobile applications is referred to as a fintech company (Lee et al., 2018).

Fintech companies focus on facilitating, automating, and modifying financial services. Mobile banking services, trading platforms, and cryptocurrency wallets are examples of fintech services. The way individuals and businesses pay each other daily, buy stocks, deposit a check, and other financial processes are entirely revolutionized through the development of unique services offered by many different fintech companies (Lu et al., 2020).

The basic fintech concept was initially introduced in the early 1950s when credit cards were offered to eliminate the necessity of carrying physical money for daily transactions. PayPal was then established as one of the first Internet-based fintech companies in 1998. PayPal was then broadly revolutionized as long as significant advancements happened in the development of mobile applications and social media (Allayarov & Ravshanova, 2021). Despite fintech being initially recognized for its employment in financial institutions, it was soon also used in investment management, retail banking, education, and many other industries and sectors (Lee et al., 2018).

Most financial service users rely on financial tools that are developed by fintech companies since they comply with relevant banking regulations. Besides, the benefits provided by fintech companies are so valuable for consumers that they may neglect possible risks (Cai, Marrone, & Linnenluecke, 2022).

3 Fintech Developments

The economy is influenced by technological developments same as many other sectors. Technological developments are employed in the financial sector to meet cost reduction and fast and secure transaction expectations. Financial technologies are widely required in the banking sector to facilitate secure banking processes including investments, capital management, lending, saving, and payments (Chaikovskyi & Kovalchuk, 2020). Financial Technologies that refer to the employment of modern digital technologies for financial purposes are recognized as fintech. Fintech is today widely used and accepted in all markets in the world. Consumers are also motivated to use fintech alongside software, hardware, and network developments (Al Hammadi & Nobanee, 2019).

As a result of employing fintech in financial services, considerable changes are witnessed in the performance of traditional financial institutions. Fintech companies have made significant cooperation with traditional financial institutions leading to innovative products and procedures and increasing customer confidence. Thus, banking institutions as the main elements in the digital payment chain are highly influenced by fintech developments (Allayarov & Ravshanova, 2021).

The main employment of fintech is considered to be in payment, lending, and management segments. However, with rapid improvements in technology, fintech companies are also growing fast specifically in underdeveloped countries with developing banking infrastructure. Digital wallets and cryptocurrencies, the insurance industry, open banking, and investment management are commonly active areas with fintech innovation (Sjamsudin, 2019).

Here, there is a closer look into some of the main developments in the industry with a highlight of the tech component and the underlying business models under each. This is presented in the discussion as the following.

3.1 Payment Tech and Currency

Financial services systems are based on operations including performance analysis, systems design, inventory, cash management, waiting line analysis, revenue management, and pricing. Fintech approaches are making a significant contribution to providing services through facilitating investment and payment lines across different business partners. Money is positively correlated to financial services and payment systems. To transfer money, a secure platform should be provided. Previously, physical coins and banknotes were simply exchanged; however, modern payment systems are technology-based and money is exchanged or paid in digital records (Ali, Barrdear, Clews, & Southgate, 2014).

Today, payments are made by making an equivalent balance in the customer's and recipient's accounts same as traditional payment systems; however, digital records are replaced instead of intrinsically valuable items. Recent changes in payment systems have provided more accessible, faster, and more secure transactions. Payment systems that rely on cryptography instead of central authority have become more popular in recent innovations because of their decentralized structure. Digital currencies, commonly known as cryptocurrencies, are the most popular innovations that have been developed in payment technologies. There are many cryptocurrencies such as Peercoin, and Litecoin; however, Bitcoin is the first and the largest digital currency. Thus, digital currencies have made a fundamental change in the payment systems bringing along benefits. The decentralized approach ensures records of transactions are securely stored on centralized databases (Ali et al., 2014).

3.2 Open Banking

Traditionally, physical branches of banks were the main points of money transactions. Transactions; however, are switching from in-person banking to digital banking services as a result of technological developments that offer wider access to digital services and products. While banks are operating on digital platforms, easier access to data is provided which serves as a catalyst in the development of businesses (Brodsky & Oakes, 2017). As a result of easy access to shared data, open banking is developed to offer benefits for end-users and aims to foster innovation while there is serious competition between banks and nonbanks in the financial market. Open banking offers a range of services to benefit both consumers and providers in the financial area and it is expected to deliver more profitable services in the future (Brodsky & Oakes, 2017).

3.3 Peer-to-Peer Lending

Fintech is driven by a different range of technological advancements. FinTech Peer-to-Peer (P2P) lending as a growing technology in finance provides borrowing and

lending money through connection platforms among borrowers and investors without directly referring to a physical bank. Money transaction is facilitated by reliance on terms and rates that are provided by the platform (Agarwal & Zhang, 2020). Although this is a significant breakthrough to flourish in the money transaction market, it could be also risky because of the threat of sharing inappropriate data from the borrower side that requires the monitoring of the administrative partner. Peer-to-Peer (P2P) lending is also succeeding in the competition over traditional banking in terms of operational costs by eliminating the intermediary roles and eventually cutting relevant costs (Suryono et al., 2019).

3.4 Fintech Companies and Financial Institutions: Collaboration, Merger, and Acquisition

As the world is changing dramatically as a result of developments in digital technologies, the financial sector is no exception. Technological advancements are making a massive impact on the global economy through the emergence of fintech companies (Suprun, Petrishina, & Vasylchuk, 2020). Technology has provided the opportunity to improve financial products and services and offer more accessible services with lower costs to end-users. However, traditional banks and fintech companies have a lot in common. This, on one hand, may lead to competition between traditional banks and fintech companies and, on the other hand, it may pave the way for possible constructive cooperation. However, studies demonstrate that cooperation is more likely to happen in the near future since the market share of fintech companies is minor compared to traditional banks (Ruhland & Wiese, 2022).

Thus, traditional banks are expected to go digital and benefit from the innovative features of fintech companies soon since customer behaviors and preferences are rapidly changing in the digital world. For this purpose, banks can cooperate with fintech companies in several ways including collaborating with fintech companies for mutual goals, buying shares of a fintech company, outsourcing developmental tasks in technology to fintech companies, merging with a fintech company, founding fintech companies by banks, top-down collaboration with fintech companies or making investments in fintech companies (Payandeh, Shahbazi, Manteghi, & Karimi, 2021).

3.5 Investment Management and Robo-Advising

Robo-advising is a data-driven wealth management service that makes customized portfolios for investors based on analyzing the data extracted from their transactional history. Making diversified portfolios in the stock market may be challenging for individual investors. Robo-advisors can mitigate the risk of undiversified portfolios by making investment portfolios that not only are diversified but also free from objective biases and cognitive limitations. Thus, portfolios can be optimized for

financial decision-making by balancing investors' current portfolios or adding extra stocks to their portfolios (D'Acunto, Prabhala, & Rossi, 2019).

The Robo-advising services offered by fintech companies reduce the risk of managing wealth by analyzing investors' trade history and market trends and will eventually lead to more sophisticated investment and better fee-adjusted performance (D'Acunto et al., 2019).

3.6 Fintech Developments and Innovation Diffusion

The diffusion of technology has significantly influenced financial markets in recent years. Automated Teller Machines, mobile phone technology, and digital payment technologies are transforming banking services. Advancements in information and communication technology (ICT) have offered a range of new financial services and products affecting financial inclusion (Alt, Beck, & Smits, 2018). The diffusion in technology and innovation is a long-term process that happened over time as the result of being influenced by different variable data. The development of fintech companies that offer a wide range of financial innovations makes a positive impact on financial inclusion. This positive relationship between innovation diffusion, fintech development, and financial inclusion highlights the importance of setting wider policies by policymakers to ensure the performance of the financial sector (Kanga, Oughton, Harris, & Murinde, 2022).

4 Fintech Components

Fintech as an unavoidable area in the finance industry is rapidly growing and fintech companies employ new technologies to support financial services. A great number of new start-ups have been launched motivated by the existence of possible room for improvement and innovation in this industry. Financial technology is considerably influencing digital lending, e-commerce, digital marketing, data solution, insurance industry, payments, human resources, information security, business processes, investment, and capital management segments (Lu et al., 2020).

A fintech ecosystem works based on three major players including financial institutions, government, or regulators, and fintech companies. Financial institutions provide the main platform for the operation of fintech companies through sharing data and collaborating with fintech companies. The government is responsible for establishing relevant policies and regulations to secure the environment in which fintech companies are operating. Thus, it facilitates the acceptable collaboration of financial institutions and fintech companies and provides a competitive environment among fintech companies accordingly (Pant, 2020).

Fintech companies that are commonly innovative offer innovative solutions to the financial services industry and generate revenue in the industry through new financial services and products that they launch in the market. To flourish a successful

fintech, innovation, capital for initial investment, demand from the market side, and adaptable policies are required (Sjamsudin, 2019).

5 Technologies in Finance

Employment of trending technologies including Blockchain, Internet of Things (IoT), Artificial Intelligence (AI), Cloud, and big data has been the focal point in the development of fintech. These technologies have completely changed the way financial institutions store, transfer, and protect individuals' digital currency. Artificial Intelligence (AI) helps fintech companies to analyze consumer behavior in their financial transactions and provide valuable insights for decision-making. Thus, Artificial Intelligence (AI) will be also beneficial in making smart investments. Changes in the market can be predicted using big data analytics to develop new strategies. Also, decentralized transactions with encrypted data provided by blockchain technology offer more secure transactions (Lu et al., 2020). The smart contract, as one of the most prominent applications of Blockchain, has been also used in financial services. One of the use cases of the Internet of Things (IoT) is in assessing, and verifying accidents and eventually making payments accordingly (Suryono et al., 2020).

Learning applications developed by fintech companies rely on trending technologies to learn users' spending habits and engage them to realize their unconscious decisions in spending and saving. Smart chatbots are also another technological tool used by fintech companies to help their customers to perform secure and supported transactions (Kavuri & Milne, 2019).

6 Fintech and Market Structure

Fintech plays a crucial role in the stability of market and market structure. Despite various benefits of financial innovations for both consumers and businesses, there are also potential risks in the prevalence of fintech to consider since consumer preferences and choices are constantly changing. Market structure is defined by three main elements including contestability, concentration, and composition (FSB, 2020). Contestability refers to the situation in which there is high competition in the market as the result of new entrants; however, the opportunity to price differently is limited considerably. Concentration represents the power of a limited number of big firms to influence the market (Vučinić, 2020). As concentration gets limited, the competition gets tougher and in turn, leads to more innovation opportunities and lower prices. Composition refers to the ability of service providers to cooperate and offer a portfolio of services that is more valuable for the customer. Based on the composition feature, fintech companies can offer financial services that are different from traditional bank activities (Vučinić, 2020).

7 Fintech Challenges

Although fintech has led to a revolution in financial services and has provided a unique customer journey for users, it has some challenges too. Customers can simply make personal investments, trade, and use insurance and credit services relying on algorithms, processes, software, application, and new business models instead of using traditional banking services. Some customers still rely on traditional banking because of a lack of trust in fintech companies (Suryono et al., 2020). Customers claim that they prefer to perform their financial transactions using traditional banking services because of low transparency and the possibility of security breaches.

Security and privacy concerns are the most significant issues in fintech development since fintech companies are among interesting targets for hackers. Fintech companies deal with valuable individuals' and businesses' financial data. Loss of this data brings along considerable difficulties for both companies and individuals who are highly reliant on digital money and online transactions. Thus, the importance of protecting data is a constant challenge for even the most reputable fintech companies since ways of cyberattacks are continuously improved by hackers. Thus, the establishment of high-level security infrastructure is expected to ensure data security including multifactor authentication, biometric authentication, and data encryption (Suryono et al., 2020).

Another obstacle that fintech companies may face is the necessity to keep up with technological advancements. Fintech is driven by innovation and it may be soon threatened by competitors as new financial technology emerges. Outdated applications and software infrastructure prevent alignment with modern digital financial services. Thus, the survival of financial businesses is increasingly dependent on the adoption of trending technologies including artificial intelligence, cloud computing, machine learning, big data, and other applicable technologies that are beneficial in delivering financial services (Suryono et al., 2020).

Employment of up-to-date and appropriate technological tools not only provides the opportunity to offer quality and more secure services to customers but also increases customers' satisfaction significantly. The application of cutting-edge technologies indeed needs initial investments for companies; however, satisfied customers are more likely to increase their financial transactions using fintech and rely on digital money assets that will in turn lead to more revenue for the institution. On the other hand, being excessively dependent on technological devices makes fintech companies vulnerable to the overall performance of software, functional system bugs, speed of operations, and quality of applications. A single factor regarding the performance of the online systems can help the business stand ahead of its competitors or lose customers' trust because of the dependence of fintech on user experience (Kavuri & Milne, 2019).

Industry and government regulations are other factors that may bring along certain difficulties for fintech companies. Fintech companies are required to respect compliance regulations that banks and credit institutions need to comply with. The necessity to comply with regulations can strain the activity of fintech companies and disrupt the agility of their processes (Vučinić, 2020).

8 Future of Fintech

Fintech will be reshaped through the employment of trending technologies in the near future. Fintech companies need to customize their services based on each customer's demands by analyzing customer behavior. Investment in the global fintech market is significantly increasing over years. Investment in the global fintech market increased from $120 billion in 2018 to $37.9 billion in the first half of 2019 (Suprun et al., 2020). Total investment activity in fintech from 2013 to 2018 is shown in Fig. 2.1.

Employment of Artificial Intelligence (AI) and big data helps to collect and analyze customer financial behavior data and make decisions accordingly. This data helps fintech applications determine the level of risk and customers' rates when it comes to credit (Kavuri & Milne, 2019). It can be also remarkably beneficial in offering customized financial services to customers reaching the customer at the right time with the right services to offer. Adequate resource allocation to apply to acquire expertise in Artificial Intelligence (AI) and big data is essential for fintech companies to survive in the competitive market. Thus, fintech companies need to combine Artificial Intelligence (AI) and big data to analyze a large number of data sets and create value by meeting customers' expectations accordingly (Suryono et al., 2020). In 2020, many financial service providers have adopted artificial intelligence (AI) technologies to decrease their operational costs (Fig. 2.2).

Besides, the integration of fintech and blockchain technology provides secure platforms for better data exchange in which customers can rely on more trustworthy systems. Through the employment of Distributed Ledger Technology (DLT), each transaction can be traced and unauthorized changes will be prevented. Smart contracts, distributed data storage, and exchange are critical innovation factors for the performance of digital assets, digital assets, and non-fungible tokens (NFT), which are all fintech tools (Aysan & Ünal, 2021). Blockchain technology has not

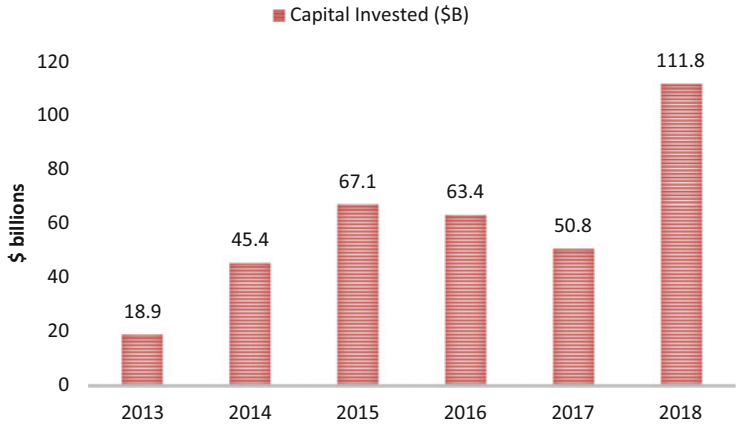

Fig. 2.1 Total investment activity in fintech 2013–2018 (Suprun et al., 2020)

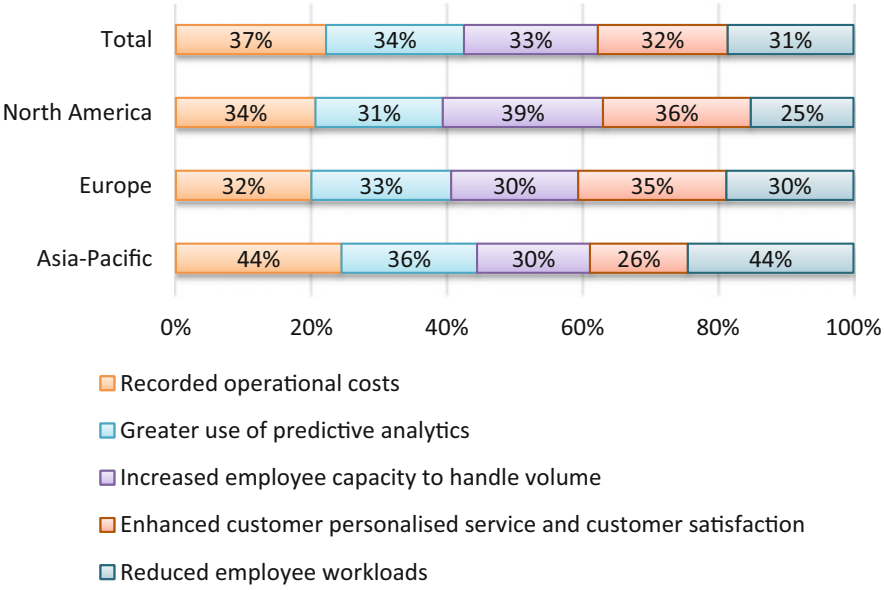

Fig. 2.2 Benefits from adoption of AI in the financial services sector worldwide in 2020, by region ("Financial services: benefits from AI adoption 2020," 2020)

been adopted by many fintech companies yet because of the difficulty of implementation in practice; however, it is one promising element for the future of fintech companies because of the secure platforms that it can provide (Chaikovskyi & Kovalchuk, 2020).

Considering maintenance and data storage costs, cloud computing is expected to make significant shifts in financial markets. The employment of cloud services can reduce infrastructure costs and application downtime significantly (Chaikovskyi & Kovalchuk, 2020). Thus, through recognizing the potential of the cloud in fintech, the next generation of core banking and financial technologies is expected to be reliant on cloud services. The Internet of Things (IoT) is also playing a crucial role in the financial sector since it can be employed for digital payments, property financing, and risk management through monitoring financial transactions. Besides, IoT can be applied for insurance purposes to appropriately determine risk and simplify processes. Considering new trends in fintech, relevant policies and regulations are also required to be established and respected (Cai et al., 2022).

9 Conclusion

Traditional financial institutions are influenced by the rapid developments of fintech. Traditional financial institutions need to change their business models and follow trends in the fintech market to satisfy their customers' demands that need fast,

accessible, approachable, and easy financial services. The emergence of trending technologies in the world of finance with their potential to grow fast has influenced fintech companies as well. Fintech services integrated with trending technologies are expected to offer greater cyber security, wider diversification of products, faster services, and more transparent transactions. However, being excessively dependent on innovations, fintech can also endanger the stability of financial markets.

Follow the Money: Back to the Basics

3

Manbo He

Abstract

According to KPMG, there was over US$210 billion invested in global FinTech with over 5684 deals in 2021 (KPMG Pulse, 2022), which doubled 2020's numbers of US$105 billion invested in 2861 deals (KPMG Pulse, 2021). This tells us two things. First, despite COVID-19 and its many variants troubling the globe, FinTech has made its way back, strong, and square. Second, with record deals and a record amount of money invested in FinTech, it is clearer than ever that FinTech is the future for both Financial and Technology businesses in the financial services industry. For financial and technology companies to survive and thrive, they have to respond swiftly and robustly to the inevitable trend of transformation to FinTech. By studying FinTech investment deals in the past two years, we have discovered that the development trend has gone through three main phases—from payments, to embedded finance, and to Public–Private Artificial Intelligence. Along with this trend, both business practices and related investments have shown a stronger tendency of matching and focusing with clearly defined positioning that is better aligned with resources. The areas of major focus include payments, insurtech, regtech, wealthtech, blockchain and cryptocurrency, and cybersecurity. As more and more FinTech businesses have realized the value in the aforementioned areas and are promoting opening and cooperating practices, risk control has also become more important a task, not just for FinTech businesses, but for regulators as well. This is another trend in which we are witnessing growing levels of cooperation and collaboration between the public and private sectors. In summary, all recent efforts we have seen in the FinTech sector are pointing in one direction: credibility, which happens to be the basis of finance. In this chapter, we will attempt to reveal the "secret equation"

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which governs this money invested, as well as the targets which have attracted such large sums. Analyzing this will help us better understand how the FinTech sector has evolved and what to expect for the future.

Keywords

FinTech · Trend · Investment · Risk management · Credibility

1 Overview: FinTech Investment Under the Global Pandemic

In some way, all of us are affected by the financial services industry. Hence, it is important to pay close attention to the changes in this field, just as an increasing number of businesses do. At the end of the day, money is at the core of this industry, and that money, as you may have already guessed, is your money! "Follow the money!", a catchphrase normally used to suggest the best way in fighting corruption, is also a perfect description of investment deals in the FinTech industry.

Let us take a short trip back in time to 2020. Despite the largest FinTech unicorn Ant Financials' dual-IPO being canceled prior to listing, there was still strong interest in FinTech investment, resulting in a total investment of US$105 billion over 2861 deals (KPMG Pulse, 2021). It is a sheer drop from the US$168 billion invested in 2019, largely thanks to the global pandemic. Nevertheless, a strong comeback in the second half of 2020, more than doubling investment in the first half of the year, tells us that the investment fever in FinTech has not subsided, not even a little. When looking at venture capital (VC) investment, FinTech attracted US $42.3 billion in 2020, the second-highest level in history. It is a major contributing factor to KPMG labeling the year 2020 as a "Game Changer" in FinTech (KPMG Pulse, 2021).

Here are the top 10 global FinTech deals in 2020, as compiled by KPMG:

1. TD Ameritrade—$22B, Omaha, US—Wealth/investment management—*M&A.*
2. Credit Karma—$7.1B, San Francisco, US—Lending—*M&A.*
3. Vertafore—$5.35B, Denver, US—Institutional/B2B—*M&A.*
4. Honey Science—$4B, Los Angeles, US—Payments/transactions—*M&A.*
5. Gojek—$3B, Jakarta, Indonesia—Payments/transactions—*Series F.*
6. IberiaBank—$2.54B, Lafayette, US—Banking—*M&A.*
7. Avaloq—$2.3B, Zurich, Switzerland—Institutional/B2B—*M&A.*
8. Paya—$1.3B, Dunwoody, US—Payments/transactions—*Reverse merger.*
9. Open Lending—$1.3B, Austin, US—Lending—*Reverse merger.*
10. Galileo—$1.2B, Salt Lake City, US—Payments/transactions—*M&A.*

Through this list, we can see that the majority are M&A deals (7/10) and payments are the hot attractions. For the 3 non-M&A deals (2 Reverse Mergers and 1 Series F financing), the focus on payments holds true. Some key trends in 2020 are:

– Digitalization is the top priority, for all.
– Customer behaviors have changed dramatically to e-commerce platforms, e-wallets, and so on.
– Increasing ambition from both tech and financial institutions (FI's) to join forces and add value for their consumers.

Let us zip our time machine ahead from 2020 to 2021. Investment in the payment space continues to boom, but the prom king and queen are crypto and blockchain, with investments of over US$30 billion eclipsing US$5.4 billion in 2020.

Through the record high of US$210 billion invested in global FinTech with 5684 deals in 2021 (KPMG Pulse, 2022), we observe a new high of US$115 billion from VC investment, more than doubling the historical high point of US$53.2 billion in 2018. Alongside the VC firms are global private equity (PE) firms aggressively investing in the FinTech sector—with a record 144 deals totaling over US$12 billion.

As the investment in FinTech heats up in 2021, we see a growing interest in data connectivity and analytics, embedded finance (BNPL "Buy-Now-Pay-Later," Embedded insurance), BaaS (Banking-as-a-Service), as well as AI (Artificial Intelligence) and ML (Machine Learning). Continuing the 2020 trend, the segmental structure of FinTech investment remains focused on the same areas namely payments, insurtech, regtech, wealthtech, blockchain and cryptocurrency, and cybersecurity. However, the interest and development in three key areas are specific to 2021:

– A growing number of banks and tech firms are cooperating and promoting open banking services.
– Increasing regulatory scrutiny of embedded finance with more sandbox practices worldwide.
– Growing focus on ESG (Environmental, Social, and Governance) (Brock, 2022) capabilities offered by FinTech in the wake of COP26 (Conference of the Parties—the global climate summit in Glasgow, UK) (UN, 2021).

Here is the list of the top 10 FinTech deals for 2021 (KPMG Pulse, 2022):

1. Refinitiv—$14.8B, London, UK—Institutional/B2B—*M&A.*
2. Nets—$9.2B, Ballerup, Denmark—Payments—*M&A.*
3. Adenza—$3.75B, San Francisco, US—Institutional/B2B—*Buyout.*
4. Robinhood—$3.4B, Menlo Park, US—Wealth/investment management—*Series G.*
5. Verafin—$2.75B, St. John's, Canada—Institutional/B2B—*M&A.*
6. Paidy—$2.7B, Tokyo, Japan—Lending—*M&A.*
7. Itiviti Group—$2.6B, Stockholm, Sweden—Institutional/B2B—*M&A.*
8. SoFi—$2.4B, San Francisco, US—Lending—*Reverse merger.*
9. Divvy—$2.3B, Draper, US—Payments/transactions—*M&A.*
10. Tink—$2.2B, Stockholm, Sweden—Banking—*M&A.*

Like 2020, the majority of the top 2021 deals were concentrated in M&A (7/10). The focus shifted from payments toward platforms with data analytics capability. Interestingly, exchanges and trade platforms were very active in FinTech deals in 2021. The #1 deal on the list was the acquisition of data and analytics giant Refinitiv by the London Stock Exchange Group (LSEG), while #4 was a Robinhood Series G financing deal, known by many as a zero-commission trading platform. The #5 deal involves Verafin, a St. John's online security and anti-fraud company, being acquired by Nasdaq. The #10 deal is Tink being acquired by VISA, a strategic move to enhance VISA's open banking platform.

Given the impact of the global pandemic throughout 2020 and 2021, established FinTech companies and start-ups alike are facing unprecedented challenges while also being amidst unprecedented opportunities. As shown by the record number of deals and investment amounts over the past two years—from payments to embedded finance to AI/ML, with focused subsectors more clearly defined and positioned in insurtech, regtech, wealthtech, blockchain and cryptocurrency, and cybersecurity, Fintech is a fast-evolving sector that is currently the single biggest factor in reshaping the real meaning and practice of the broader financial services industry.

2 Related Works

Since the inception of FinTech in the twenty-first century, when it was initially applied to the technology employed at the back-end systems of established financial institutions, it has emerged into a more consumer-oriented service spanning a wide breadth of sectors, even industries. Many works have been done in the past to study and address different aspects, and their impacts on businesses. For instance, Aldridge and Krawciw (2017) have studied that when technology collided with investing, the boom created stratospheric amounts of data that allows us to plumb untapped depths and discover solutions that were unimaginable 20 years ago, and their work has helped readers to learn why flash crashes happen, and how to mitigate damage in advance, as well as examine the FinTech disruption to established business models and practices.

Al Nawayseh's research (2020) empirically examines the factors affecting Jordanian citizens' intention to use FinTech applications. In Bao & Huang's (2021) study, they find that FinTech companies are more likely to expand credit access to new and financially constrained borrowers after the start of the pandemic. However, this increased credit provision may not be sustainable; the delinquency rate of FinTech loans triples after the outbreak, but there is no significant change in the delinquency of bank loans. Borrowers holding both loan types prioritize the payment of bank loans.

These results shed light on the benefits provided by shadow banking in a crisis and hint at the potential fragility of such institutions when delinquency rates spike. Boot et al. (2021) pointed out that the rise of new communication channels in FinTech can lead to the vertical and horizontal disintegration of the traditional bank business model. Cummings and Andrus (2022) studied Fintech's direct

indexing investment and found out that investors are buying with direct indexing to reduce unwanted exposures, harvest tax loss, and have the potential for ESG portfolios that are more finely tuned to their personal values. Lee et al. (2022) studied initial coin offerings (ICOs) and concluded that a market-based certification process that relies on a diverse group of individuals is at play in financing blockchain start-ups.

Goo and Heo (2020) found that the adoption of regulatory sandboxes had very positive influences on the growth of the fintech venture investment. The results implied that regulatory sandboxes may play a vital role in increasing the influx of venture capital into the fintech venture ecosystem by removing regulatory uncertainty.

3 Trending: From Payments, Embedded Finance, to Public–Private Artificial Intelligence

As we can see from the two top 10 lists for 2020 and 2021, the payments subsector has always been at the center of FinTech investment deals. Over the past four years, total global investment activity in payments was US$50 billion, US$111 billion, US $29 billion, and US$52 billion for 2018, 2019, 2020, and 2021, respectively (KPMG/PitchBook, 2021). This heavy investment in payments has been largely driven by:

- The continued acceleration of digitalization (smartphone and 5G network).
- The expansion of digital/contactless payments (COVID-19).
- FinTech itself pushing for more alternative payments models like "BNPL" (Buy-Now-Pay-Later), "POSL" (Point-of-service Lending), "IIS" (Integrated Insurance Services), "I&T"(Investment and Trading), and "FaaS" (Fintech-as-a-Service). These five alternative payment models are the most common uses of embedded finance nowadays.

Outside of the investment deals in FinTech reported publicly, the traditional banking industry has also played a critical role in driving FinTech development through internal investment. According to a joint study by Ant Group and ICBC (2021), JP Morgan Chase invested US$12 billion in FinTech in 2020 (half on IT infrastructure and half on digitalization). In comparison, Citi Group also invested heavily in FinTech in 2020, spreading US$7 billion into 6 innovative areas: data analytics, data currencitization, mobile payment, security authentication, New IT tech, and Next-generation FinTech. It has planned another US$11 billion for 2022. HSBC is set to invest US$3.5 billion more, on top of the US$6 billion already invested in FinTech back in 2019, to grow its FinTech service team, enhance its digital service capacity, and develop new products. Other financial institutions that have been following suit in FinTech investment include Bank of America US$10 billion, Wells Fargo US$9 billion, BNP US$7 billion, Deutsche Bank US$4.5 billion, Barclay US$3.5 billion, and Credit Suisse US$2.9 billion. It was estimated

that, in 2020, Chinese banks invested over RMB200 billion (or US$40 billion) in FinTech.

In general, investments in FinTech, be it through M&A deals or internal, are spent on the development of technologies in these categories:

1) Blockchain Technologies—enable low credit cost cooperation/collaboration models that are functional in a non-trust environment.
2) Distributed Ledger Technologies (DLT)—including Smart Contract, ZKP (Zero-Knowledge-Proof), and Distributed Data Storage/Exchange technologies that have made the applications like Digital Wallets, Digital Assets, DeFi (Decentralized Finance), and NFT (Non-Fungible Token) possible. It is estimated that in 2021 total digital assets in DeFi have reached a record level of over US $2.1 trillion, and the revenue of digital assets exchanges has also reached US$15 billion globally.
3) Cloud Finance Technologies—fastest-growing segment in cloud computing.
4) Big-data Analytics Technologies—for applications in both operations and risk control.
5) Open banking Technologies—In the UK, the 9 largest banks have formed OBIE (Open Banking Implementation Entity) with API (Application Programming Interface) standards since 2016 and it has grown to cover 74 financial institutions and 134 Third-party Service Providers in 2020. Similarly in the USA, Jack Henry and Finicity have joined forces to provide open banking services to community financial institutions since 2021, and also in the UK, BNPL platform, Zilch has teamed up with credit scoring start-up Credit Kudos (recently bought by Apple) to optimize Credit Kudos' open banking platform to promote Zilch's responsible lending to its customers.
6) AI/ML Technologies—Artificial Intelligence and Machine Learning Technologies to integrate all FinTech technologies, to foster optimization of efficient automation in the financial decision-making process, and drastically improve security, credit risk assessment, customer satisfaction, and fraud detection.

Alongside investments pouring into the evolving FinTech technologies also comes increased concerns over risks and compliance issues associated with FinTech, especially in the area of AI/ML. Finance regulators around the globe have since taken measurements toward the solutions that address those very concerns.

In November 2019, MAS (Monetary Authority of Singapore) has launched the Veritas platform, which "aims to enable financial institutions to evaluate their AIDA-driven solutions against the principles of fairness, ethics, accountability and transparency (FEAT) that MAS co-created with the financial industry in late 2018 to strengthen internal governance around the application of AI and the management and use of data" (MAS website). MAS goes on to state that "The Veritas is part of Singapore National AI Strategy. It was highlighted by Mr Heng Swee Keat, Deputy Prime Minister of Singapore, in his speech at the Singapore FinTech Festival and Singapore Week of Innovation and Technology (SFF x SWITCH) 2019 and 2020."

In February 2020, Australian Competition and Consumer Commission (ACCC) passed Consumer Data Right Rules (CDRR) to regulate data sharing and AI practice in the banking industry, and launched both RAAP (Consumer Data Right Register and Accreditation Application Platform) and CDRPP (Consumer Data Right Participant Portal) for the banks and FinTech to use in compliance with CDRR.

In October 2020, The Bank of England and the Financial Conduct Authority launched the Artificial Intelligence Public–Private Forum (AIPPF) and published its Final Report in February 2022. Here is the "Conclusion and Next Steps" of the report:

"Conclusion and next steps

160. The AIPPF discussions on the nature and uses of AI have been broad and deep, mirroring wider debates taking place across the financial services sector and beyond. The AIPPF meetings, workshops, and ad hoc discussions have highlighted the benefits as well as the many complex challenges in adopting and using AI. The Forum also brought together diverse views on potential ways of addressing those challenges.

161. While this report has focused largely on the role of Data, Model risk, and Governance in the adoption and use of AI in financial services, these sit within domestic and international regulatory and legislative frameworks. Clarity of regulatory expectations on the adoption and use of AI is a key component of fostering innovation. Regulators should provide greater clarity on existing regulation and policy. Such clarification and any new guidance should not be overly prescriptive and should provide illustrative case studies. Alongside that, regulators should identify the most important and/or high-risk AI use cases in financial services with the aim of developing mitigation strategies and/or policy initiatives.

162. In terms of next steps, it is clear that AI will continue to develop rapidly. Regulators and industry practitioners should continue to monitor and support the safe adoption of AI in financial services. Public-private engagement is invaluable and should continue with a wide range of stakeholders, including representation from civil society through regular or ad hoc forums. It would also be useful to have more structured and regular engagement on best practice or industry guidelines with a formal consultation process allowing for feedback.

163. An industry consortium could serve as a next step toward developing industry solutions to specific challenges and to creating industry-wide standards. Establishing an organisation to certify AI practitioners may also be useful and complementary to algorithm certification/auditing."

(Final Report 2022, AIPPF, Bank of England/Financial Conduct Authority).

4 Matching and Focusing: Positioning with Resources (Payments, InsurTech, RegTech, WealthTech, Blockchain and Cryptocurrency, CyberSecurity)

A closer look into the segmental FinTech investment deals in 2020/2021 confirms that the second and the third principles for business "matching principle" and "focusing principle" (He, 2017) are followed closely. Both established FI's and fintech companies are positioning themselves in alignment with their respective strength of resources (operational-wise and technology-wise) and staying focused on the areas that can further enhance their competitive advantages.

In payments, other than those mega deals on the top 10 list, like the US$9.2 billion acquisition of Denmark-based Nets by Nexi, and the US$2.7 billion acquisition of Japan-based Paidy by Paypal, we have also witnessed large VC funding poured into challenging banks: US$1.1 billion for Chime, US$800 million for Revolut, and US$510 million for Varo (KPMG Pulse, 2022). In 2021, Goldman Sachs announced its acquisition of GreenSky for US$2.2 billion, Square announced its acquisition of Australia-based AfterPay for US$29 billion, JP Morgan took a majority stake in Volkswagen's payments platform, and Walgreens and InComm Payments launched "ScarletTM"—all these and other activities of increased investment in payments are indicating a growing emphasis on embedded finance.

In the Insurtech subsector, we have seen very active VC funding: US$308 million raised for China-based MediTrust Health, US$255 million for India-based Acko, US $247 million for Hong Kong Singapore-based Bolttech, US$205 million for US-based At-Bay, and US$118 million for France-based Leocare.

In RegTech subsector, as Fabiano Gobbo at KPMG pointed out, "The regtech market saw quite a dichotomy in terms of funding during 2021—with M&A driving a significant amount of investment in the first half of the year—led by the $2.7 billion acquisition of Verafin—and late stage VC investments driving investment in the second half—led by the $500 million raise by Carta. While the US continued to attract the vast majority of investments in regtech, Europe is well-positioned to see growth heading into 2022." In this area, regulators are also playing a critical role to support the evolution of regtech solutions. For instance, the Monetary Authority of Singapore (MAS) has launched a series of initiatives aimed at strengthening the AI abilities of Singapore's financial services sector, including NovA! a technical platform to help financial institutions assess the environmental risks of companies and Veritas, an AI governance program meant to help financial institutions utilize AI and data analytics. Another example is the Hong Kong Monetary Authority, which also launched an AML-focused Regtech Lab to encourage the development and adoption of regtech.

In WealthTech, both the number of deals and the amount of investment have reached record highs in 2021: totaling US$1.6 billion over 66 deals (KPMG Pulse, 2022). VC investment has played a significant role: Canada-based Wealthsimple has raised US$600 million, US-based CleanCapital US$325 million, and Germany-based Moonfare and Liquid have raised US$125 million and US$104 million, respectively. Also worth noting are JP Morgan's acquisition of UK-based Nutmeg

for US$989 million, and Aberdeen announced its acquisition of Interactive Investor for US$2 billion.

In crypto and blockchain, global investment has increased fivefold to US$30 billion in 2021, almost doubling the amounts in 2018, 2019, and 2020—three years combined! In 2021, China banned cryptocurrency transactions, bitcoin mining, and the facilitation of cryptocurrency trading. India followed suit by introducing a bill that bans the use of cryptocurrencies as a method of payment, in addition to related activities.

Despite this, we have seen a significant expansion of interest in crypto and blockchain from countries like the USA, Canada, and Europe. To cope with the ever-growing interest in crypto and blockchain and increased pressure for oversight, regulators are working closely with the industry to support healthy development in this field: On March 09, 2020, US Congress passed the Crypto-Currency Act of 2020 (03/09/2020) Rep. Gosar. Paul A. [R-AZ-4] H. R. 6154–116th Congress (2020–2021). The legislation states that "The bill generally defines these assets as using a decentralized digital distributed ledger (e.g., blockchain) for transactions. The bill establishes the Commodity Futures Trading Commission as the primary regulator of cryptocommodities. The bill also establishes the Financial Crimes Enforcement Network and the Office of the Comptroller of the Currency as the primary regulators of cryptocurrencies. Finally, the bill establishes the Securities and Exchange Commission as the primary regulator of cryptosecurities and synthetic stablecoins." Later on August 17, 2021, US Congress passed the Blockchain Regulatory Certainty Act (08/17/2021) Rep. Emmer, Tom [R-MN-6] H.R.5045—117th Congress (2021–2022). According to Forbes, US Congress has introduced 50 Digital Asset Bills impacting Regulation, Blockchain, and CBDC Policy (Jason Brett Forbes 05/19/2022) since. Based on research completed at the Value Technology Foundation (VTF), the 50 bills identified are broken into six different categories. The categories include crypto taxation, central bank digital currency (CBDC), crypto clarity on the regulatory treatment of digital assets and digital asset securities, supporting blockchain technology, and issues of sanctions, ransomware, and implications involving either China or Russia's use of blockchain or cryptocurrency, and access and limitations on use of crypto by US elected officials. Also in 2020, the EU passed its own version of "Digital Finance Strategy/Framework/Package" and "Digital Finance Agenda," and launched "Digital Finance Platform" in April 2022.

Lastly, regarding cybersecurity—over the last two years, interest in managed detection and response (MDR) and endpoint detection and response (EDR) using AI, automation, and robotics solutions has grown significantly. Between 2020 and 2021, investment in cybersecurity more than doubled, with the $2.7 billion acquisition of Verafin accounting for over half of this total. We have seen a combination of M&A and VC investment in this subsector, including $310 million raised by US-based Fireblocks, the $250 million merger between Switzerland-based zero knowledge rollup blockchain company Hermez and India-based crypto company Polygon, and the acquisition of Israel-based cybersecurity firm GK8 by Celsius Network. As companies have accelerated their activities in the cloud and the speed of their digital transformation efforts, they have increasingly recognized the importance of secure

DevOps. They have also increased their investments in related areas, including cyber resilience, breach remediation, vulnerability testing, and ensuring basic security hygiene to ensure rapid change does not leave risk exposure.

5 Opening and Cooperating: Message from ACPR/NYDFS, Marquee, and Aladdin

Another interesting area in FinTech is the trend of opening and cooperation, which coincidentally echoes the fourth business principle (He, 2017), as evidenced in both public and private sectors.

In June 2020, the Autorité de Contrôle Prudentiel et de Résolution (ACPR) in France and the New York State Department of Financial Services (NYSDFS) in the USA announced they have signed a Memorandum of Understanding (MOU) to ease the operation of Fintech companies across the two jurisdictions. The new partnership aims at facilitating the increase of cross-border business and investment opportunities in the two markets. On April 8, 2020, the Monetary Authority of Singapore ("MAS") launched the "Fintech Service Providers ("FSP") Compliance Readiness Framework" to further promote openness and cooperation.

In the private sector, Goldman Sachs (2020) has opened up its SecDB database through Marquee. Marquee is the digital storefront for institutional client services, delivering Goldman Sachs' market insights, analytical tools, execution services, and developer and data services directly to clients via an integrated digital platform. Another financial giant, BlackRock (2020), also opened up its risk management platform, using Aladdin Studio and Aladdin Developer to help financial services providers better serve their customers.

(From BlackRock's website: Aladdin Studio is a data and developer platform delivered as part of BlackRock's end-to-end Aladdin® investment platform. Aladdin Studio enables investment professionals to build on top of core data and workflows in Aladdin® to create innovative solutions to meet bespoke needs across the investment process. Powered by Snowflake, Aladdin Data Cloud enables you to bring all your investment-related data together on a single, cloud-enabled platform, making it easy to generate differentiated analytics and insights.)

The examples above are just a few needles in a giant haystack, but enough to demonstrate the vital importance of staying open and cooperative in business, even in the most fiercely competitive FinTech sector.

6 Risk Controlling: Regulatory Sandbox (GFIN/DEPA) and Standards (ITU, ISO)

When it comes to finance, risk is the word that nobody can avoid. While innovations in technologies and creativities in business models have skyrocketed in FinTech in the past few years, so have the associated risks. In this aspect, regulators around the globe are taking initiatives to help both sides (the FinTech/FI businesses and the

Table 3.1 Inside the Digital Economic Partnership Agreement (DEPA)

Digital security	Digital trade	Digital inclusion	Data issues	Emerging tech
Cybersecurity cooperation	Paperless trading	Digital SME	Data	Fintech
Online consumer protection	Elimination of customs for digital products		Open government data	AI
	Non-discrimination of digital products		Prohibition of data localization	Data + regulatory sandboxed
	E-invoicing			

Note: On February 16, 2021, Canada started exploratory discussions with the DEPA parties for possible accession to the agreement. ~ Source: APF Canada
https://www.asiapacific.ca/publication/depa-worlds-first-digital-only-trade-agreement

regulators) explore the possibilities and viable options, so as to reach the ultimate goal of the optimized balance between "risk control" and "innovation." As a result, we are seeing more and more cross-board international cooperation taking place in regulatory sandbox.

In June 2020, Chile, New Zealand, and Singapore struck up the Digital Economic Partnership Agreement (DEPA), a ground-breaking, digitally focused trade agreement. Since then, many economies have expressed interest in joining this novel pact. On October 5, 2021, South Korea signed documents to formally request to join the Agreement. South Korea's request presents an opportunity to explore the world's first digital-only trade agreement and its potential impact on Canada. In December 2020, Canada notified the DEPA parties of its interest in joining the Agreement. In February of this year, Canada officially began exploratory discussions with those parties. One month later, Canada began public consultations with individuals and stakeholders on the current DEPA text and how DEPA could potentially be updated. The consultations closed in May, but Canada's exploratory discussions with DEPA members are ongoing. Table 3.1 provides some highlights about DEPA.

Another example of international regulatory sandbox cooperation over FinTech is GFIN. As of May 11, 2020, there were more than 20 regulators from countries including the UK, Canada, the USA, and Australia have opened applications for a global fintech "sandbox" following a trial last year. The regulators have come together, alongside related organizations, such as the Global Financial Innovation Network (GFIN). The group, which now has more than 60 member organizations, launched in January 2019 with the aim of boosting international cooperation around innovation.

Sandboxes allow fintechs and other innovators to test new products and services in a controlled environment under regulatory supervision, and are becoming more and more popular among countries that are aiming to strike a good balance between "risk control" and "innovation" in FinTech.

On top of the variant international and domestic regulatory sandboxes, international organizations are also working diligently in the development of standards that provide guidance and support for FinTech. In May 2020, ITU (International Telecommunication Union) published ITU-T X.1149 "security framework of an open platform for FinTech services," and in its Summary section, ITU states that "Recommendation ITU-T X.1149 describes an open platform architecture for financial technology (FinTech) services. It also specifies threats and vulnerabilities of open platform, open application programming interface (API) usage procedure for FinTech services, and detailed security requirements to open platform of FinTech services from both financial company and FinTech company sides. The appendix to this Recommendation includes some use cases of the proposed open platform."

On a broader basis, ISO (International Standards Organization) introduced ISO 20022 standard back in 2004, predominantly used for data exchange between financial institutions (ISO, n.d.). The genesis of the ISO 20022 messaging standard is to provide a common messaging protocol that will have a defined central dictionary and rules. All financial institutions across the globe need to migrate from current message standards (e.g., SWIFT MT Financial Messages) to the ISO 20022 standard by November 2022. According to experts in this field, some of the key benefits of the transition to ISO 20022 include:

Enhancing consistency and interoperability
Globally, financial institutions in different parts of the world currently use various messaging protocols, from proprietary standards to SWIFT MT messages. ISO 20022 has been designed to address issues related to consistency and interoperability (ISO, 2022).

Enabling richer data and enhanced efficiency
ISO 20022 messages are much richer in data, and the ability to accommodate more details helps in the creation of differentiated digital solutions and in the efficiency improvement of the existing payment processing systems.

Facilitating new-age solutions through real-time payments—Adoption of the ISO 20022 standards in certain parts of the world has accelerated through straight-through processing (STP) and with the implementation of real-time payments networks.

Allowing better data quality and analytics
The ISO 20022 standard ensures better data quality. It improves data analytics capabilities which require less manual intervention, and it also helps in the accurate compliance process.

Optimizing costs
ISO 20022-backed payment mechanisms have the potential to bring costs down drastically. Due to compatible message structures, payments between two countries could be almost instant and significantly inexpensive.

7 Forward-Thinking: Back to the Basics: From Collateral to Credibility (ESG)

Not all of us can keep up with the speed at which FinTech is evolving. While we are just getting familiarized with new concepts such as Blockchain, DLT, Bitcoin, and Timestamp, newer concepts are rapidly coming our way—Open banking, Smart Contract, API, DeFi, ZKP, NFT, Dapps, DAOs, to name just a few.

Although it feels like FinTech is capturing the attention of the whole world (at least the business world or the world of finance more precisely) overnight, it is surprising to note that FinTech is nothing new at all.

According to Fintech & Martech Blogger Vivek Agrawal (2020), Fintech history dates back to the nineteenth century, even preceding that. In 1860, a device called a pentelegraph was developed to verify signatures by banks. Historians accept 1866 as the year of the first valid fintech footprint because it was then that transatlantic cables were set up, leading to an era of creating network infrastructure and linkages around the world. Only after 150+ years of ongoing development has FinTech evolved into what we know it as today.

Despite all the fancy words and complicated technological definitions within FinTech, one thing remains unchanged, even over hundreds of years: FinTech is still, like money at its core, directly associated with (and heavily influenced by) credit, or credibility more precisely.

For hundreds of years, finance has been tied to credibility—governments issue money that is dependent on the governments' credibility, and banks issue bank notes which are tied to the banks' credibility. Without credibility, neither money nor banknotes will be issued, let alone traded or transferred. In a narrower definition, financing is simply lending money. We tend to be collectively bogged down with the idea that financing = collateral and forget that originally, financing did not necessarily have collateral as a metric for credibility. This collateral-based financing makes one wonder: what happened to our credibility?

Credibility, by any standard, is not just the cornerstone of finance, but also the backbone of the modern economy. Understanding credibility can help us look through all the layers of fancy covers and see the real picture: finance is all about the balance between risk/return and credibility. The development in FinTech, today or in the future, is to reveal that credibility in all of us, to all of us.

A growing number of people and organizations around the globe today have come to the realization that it is vital to have an ESG mindset—to be aware of the Environmental, Social, and Governance (ESG) consequences, for companies, organizations, governments, and individuals. In 2020, McKinsey has estimated that global sustainable investment reached US$30 trillion and has summarized 5 value creation ways ESG proposition can bring to business: top-line growth, cost reduction, regulatory and legal interventions, productivity uplift, and investment and asset optimization. In short, ESG proposition = Restoration of Credibility = Value, and that is the new equation for FinTech.

I wrap up the chapter by quoting from Anton Ruddenklau, Global Fintech Leader at KPMG:

> Since COP26, there has been seeing a lot of attention going to fintechs with ESG capabilities—including jurisdictions setting up incubators specifically focused on ESG solutions. While it's not a space that has been properly invested in to date, it has been gaining a lot of attention from governments and quite possibly has the biggest growth trajectory out of all fintech sub-sectors looking out over the next five years.

At the end of the day, what matters most is credibility, and that is the basis of FinTech.

Part II

Towards a Distributed Network Economy-Decentralized Finance

Currency and Payment Tech: Cryptocurrencies Transforming the Face of Finance

4

Pooja Lekhi

Abstract

Tax-free and high-speed transactions and anonymity in cryptocurrency ownership spur investors' interest in these forms of digital assets and currency systems. This chapter elucidates the in-depth review of the concept, features, adoption, and other significant topics associated with their development as a financial asset in 2009. Looking into its exponential growth, there are escalating speculations, "Whether it will be the mainstream payment medium in the future?" But on the other hand, despite tremendous price appreciation in recent years, cryptocurrencies are still called a bubble that can burst anytime due to three main reasons; regulatory oversight, the potential for illicit use due to anonymous transactions, and infrastructural breaches influenced by the growth of cyber criminality. Each affects the recognition of cryptocurrencies. Is it considered a credible investment alternative, mainstream payment too, and do these determinants influence its legitimate value? The chapter covers each of these aspects and explores what the future holds for cryptocurrencies? Crests or Troughs!

Keywords

Cryptocurrencies · Blockchain technology · Bitcoin · Legality · Risk

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1 Introduction

All that started with bitcoin back in 2009, a digital currency—now digital gold—designed with blockchain technology to be used as a medium of exchange without involving a third party like a central bank or government.

A cryptocurrency (or crypto) is a digital currency used as a medium to buy goods and services, but it uses an online ledger with strong cryptography to secure online transactions, control the creation of additional coins, and verify the transfer of coin ownership (Lekhi, 2021). Cryptocurrencies work using blockchain technology with no involvement of intermediaries like banks and the government. Much of the interest in these unregulated currencies is to trade for profit, with speculators at times driving prices upwards. They are not represented in a physical form and are infinitely divisible. Its value is not based on any tangible asset, a country's economy, or a firm, but instead on the security of an algorithm that can trace all the transactions (Corbet et al., 2019).

2 Use of Blockchain Technology

Blockchain is a decentralized technology spread across many computers that manage and record transactions. The appealing factor of this technology is its security. It records the information in a way that makes it challenging or almost impossible to alter, change, modify, hack, or cheat the system (Lekhi, 2021).

Blockchain is a distributed ledger technology in which transactions are recorded with an immutable cryptographic signature called a hash. Each block shows a cryptographic signature or hash of the previous block, a timestamp, and transaction data (like a Merkle tree). This is how transactions are recorded into every participant's ledger.

Blockchain is designed in such a way that its data cannot be easily altered or modified. This is because the data, once recorded in any given block, cannot be altered retroactively without modifying all subsequent blocks.

The unique feature of this technology is that collected data build as blocks connected to each other's while every block has the history data of the previous one. All operations and transactions bond together in dependable chronological order. So, the second block cannot exist without carrying the history data of the genius's block, the first one. At the same time, the last block can recall all the stored data starting from the first one effectively. This data coherence creates high security and eliminates fraud (Lin et al., 2019) "Imagine a book where you write down everything you spend money on each day," says Buchi Okoro, CEO, and co-founder of the African cryptocurrency exchange Quidax. "Each page is similar to a block, and the entire book, a group of pages, is a blockchain" (Ashford & Schmidt, 2022).

With a blockchain, everyone who uses a cryptocurrency has their own copy of this book to create a unified transaction record. The software logs each new transaction as it happens, and every copy of the blockchain is updated

simultaneously with the new information, keeping all records identical and accurate (Ashford & Schmidt, 2022; Turi, 2020a, 2020b).

3 Cryptocurrencies: Current Scenario

Cryptocurrency space has evolved over the last few years. One of the biggest reasons is the adoption and recognition by financial institutions and large corporations, like Square, Micro Strategy, and trading platforms like Paypal and Venmo. Moreover, nothing has garnered more attention in the crypto community than the emergence of DeFi (Decentralized Finance) applications. Defi focuses on providing a decentralized version of mainstream financial opportunities mainly customers' access to opportunities such as cash storage and loans. However, these offerings are governed by centralized entities.

One of the most interesting developments in the crypto space is the rise of non-fungible tokens (NFTs). "An NFT is a digital asset that represents real-world objects like art, music, in-game items, and videos. They are bought and sold online, frequently with cryptocurrency, and they are generally encoded with the same underlying software as many cryptos" (Broverman & Conto, 2022). Based on distributed ledger technology, NFT crypto assets serve as a method of authentication for buyers of unique items, proving aspects such as ownership. It became much more popular in the years 2020 and 2021. It made headlines when American artist Beeple's work, Everydays: The First 5000 Days, was sold for USD 69 million in March 2021.

Another recent trend in the crypto space is stable coins and CBDC, altering the crypto ecosystem. Stablecoins are cryptocurrencies where the price is designed to be pegged to a cryptocurrency, fiat money, or to exchange-traded commodities (such as precious metals or industrial metals). Tether (USDT) and TrueUSD (TUSD) are popular stablecoins backed by US dollar reserves and denominated at parity to the dollar as of May 2022, Tether (USDT) was the third-largest cryptocurrency by market capitalization, worth more than $83 billion (Hays, 2022).

Terra Luna's Crash Ripple Effect on Entire Crypto Space.

A stablecoin pegged to USD, Terra (LUNA) crypto token crashed by 99% from $120 to $0.02, within 48 hours of a black swan event in the month of May this year. The shocking fall of the Terra stablecoin made the overall crypto market unstable, wiping out more than $200 billion in space.

As Terra Luna crashed over 99%, crypto investors got frightened and started selling other coins as well, leading to a crash in the entire crypto space.

According to Coinmarketcap, the entire crypto market recently has a market capitalization of $1.2 trillion, less than half of the $2.9 trillion it was worth in November 2021. Even the world's leading crypto Bitcoin plummeted to $26, 300 on May 12. The stock price of the largest US crypto exchange, Coinbase Global, has fallen more than 75% this year.

The collapse of these stablecoins has wiped out more than $830 billion of the crypto sector's total market value.

It has a cascading effect across the hundreds of other projects built within the Terra ecosystem which includes non-fungible tokens (NFTs), and decentralized finance (Defi) platforms, driving them to a bearish trend as well.

4 The Cryptocurrency Revolution

Cryptocurrency adoption has been growing tremendously around the world. By the end of 2021, over 18,000 businesses were already accepting payments in cryptocurrencies and there were over 300 million crypto users across the globe. Cryptocurrencies have recorded a meteoric rise in their market capitalization in recent years. Its recognition and adoption by institutional investors have grown significantly. These aspects are building the steam for its phenomenal growth and widespread global success. As of March 30th, 2022, the total value of all cryptocurrencies was around $2.15 trillion, and the total value of bitcoin, the most popular digital currency, was pegged at about $ 896 billion. Furthermore, there are more than 9200 different cryptocurrencies traded publicly. And cryptocurrencies continue to proliferate, raising money through initial coin offerings (ICOs). According to fortunebusinessinsights.com, The global cryptocurrency market size is projected to grow from USD 910.3 million in 2021 to $1902.5 million in 2028 at a CAGR of 11.1%.

Figure 4.1 shows the region-wise data of crypto users with Asia registering the maximum number of users of around 160 million. Not only the number of users, but the number of cryptocurrencies has increased over the past few years. There are over 12,000 different types of cryptocurrencies in 2022, which is a huge increase compared to 2013 when there were just a handful of cryptocurrencies doing the rounds according to cryptocurrency statistics.

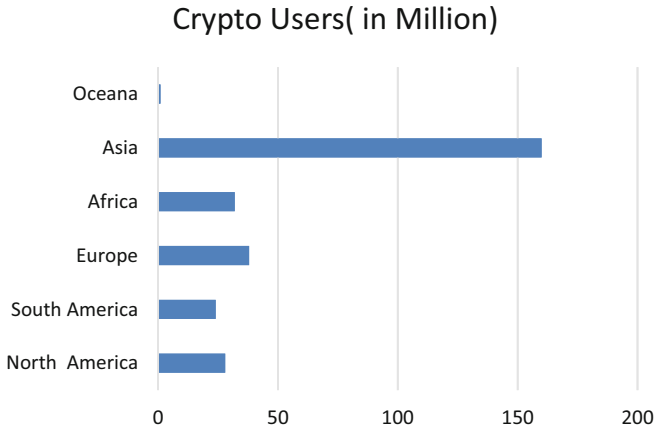

Fig. 4.1 Continent-wise Crypto users' data. Source: Composed by Author, Data collected from cryptocurrency-statistics, Buybitcoinworldwide.com

Powered by blockchain technology, crypto transactions are faster. Taking the example of NANO, it takes 0.14 seconds to confirm its transaction fully. It is feeless. Secondly, these cryptographic transactions are more secure, reducing the risk of fraud. Cross-border transfers are instant. Currencies like RIPPLE "position themselves as an alternative to SWIFT" (Daly, 2022). Furthermore, when it comes to foreign remittances, transferring cryptocurrencies is more cost-effective than transferring fiat currency through older platforms like MoneyGram and western union. Apart from this, Cryptocurrencies give more control to the user over their funds and provide scalability.

Looking at the different sectors, trading, e-commerce, and retail segments are expected to be revolutionized in the future. The penetration of digital currencies in digital payments is expected to affect cross-border transfers, and digital currencies have the potential to become the primary vehicle for e-payment, if not the only one. Many developed countries like the USA, Canada, Germany, and Japan have taken a positive stance toward cryptocurrencies.

Bitcoin, the first undistinguished leader and one of the most volatile assets, has such a wavy history since it was outlined in a paper in 2009, moving from the price of a buck to an all-time high of over $68,000 a coin in November 2021. Bitcoin's market value even crossed the $1 trillion mark in the previous year. It has been on a bull run in recent years and is responsible for roughly 69% of the total market value of cryptocurrencies. In today's time, Bitcoin is majorly adopted as digital cash worldwide. Bitcoin's growing use as a payment tool, the increasing availability of digital wallets, and developing institutional interests to invest in it ensure it becomes the mainstream for international trade in the future. Major companies, including Tesla and MicroStrategy, have invested billions in bitcoin in recent months.

Last year, PayPal also adopted cryptocurrencies to its platform. PayPal supports four different cryptocurrencies—bitcoin, Ethereum, Litecoin, and bitcoin cash (Hart, 2020). And lastly, Square, an American payments company, bought $150 million worth of Bitcoins in February 2021 (Bersztinsky, 2021). Well-known businesses are accepting bitcoin. Dish Network (DISH), Microsoft, Starbucks, Subway, Home Depot, Overstock (OSTK), and many more now accept payment in Bitcoin. Digital currency has also made its way into the US derivatives markets. The popularity of digital currencies garnered the attention of central banks also. Several central banks are launching digital currencies, and many more are thinking about it. Several companies, such as Facebook launched the digital money "Libra" in 2019.

What are the possibilities for digital currencies to take over the fiat currency system?

Several central banks are launching digital currencies and many more are thinking about it. A central bank digital currency (CBDC) is the virtual form of fiat money. There were 83 countries around the world pursuing CBDC development as of October 2021. The USA wants to introduce CBDCs in its monetary system to improve the domestic payments system. (Lekhi, 2022).

5 What Is Central Bank Digital Currency (CBDC)?

Central Bank Digital Currency (CBDC) is an electronic form of currency issued by a central government that citizens can use to make digital payments and store value. If a country issues a CBDC, its government will consider it to be legal tender, just like fiat currencies; both CBDC and physical cash would be legally acknowledged as a form of payment and act as a claim on the central bank or government.

One of the biggest advantages of central bank digital currency can be an increase in the safety and efficiency of both wholesale and retail payment systems. A central bank's digital currency shall facilitate the quick settlement of retail payments. It could improve the efficiency of POS (point of sale) and P2P (peer-to-peer) payments.

In addition to domestic transactions, the current cross-border payments model depends heavily on central banks operating the real-time gross settlement (RTGS) infrastructure within which all local banks' obligations must settle. Due to the existence of time lags in cross-border payments, participating parties are exposed to settlement and credit risk. A CBDC can eliminate counterparty credit risk and the use of digital currencies in cross-border transactions can be cost-effective.

The People's Bank of China is one of the first central banks to develop a CBDC. They deployed a special task force in 2014 to research and implement a digital Yuan. China's digital yuan can now be used for wealth management products and bank loans. This move by China's central bank extends the use of digital currency beyond the purchase of consumer goods. (Hallem (2022) "In the future, digital yuan can be applied in more scenarios such as medical treatment, education, and finance," wrote Zhang Ming, a senior economist at the Chinese Academy of Social Sciences on an online publication in China.

The Bank of England (BoE) and Bank of Canada (BoC) are still investigating integrating CBDC into their financial system. (Seth, 2022).

Introducing CBDCs worldwide will raise crypto adoption as people will have access to the platforms to convert cryptocurrencies into legal tenders (see the prospects on CBDCs presented by Turi, 2020a, 2020b). Moreover, it will also help in the financial inclusion of the bankless population.

Although fewer folks accept digital currencies due to their complexity compared to conventional currencies, some reasons can garner the public's interest to prefer them more than fiat currency.

To begin with, digital currencies allow users more freedom over their own money than fiat currencies do. Users can control how they spend their money without intermediaries like banks or the government. Secondly, unless a user deliberately or voluntarily discloses his Bitcoin transactions, his purchases never reflect or are associated with his personal identity, much like cash-only purchases, and cannot easily be traced back to him. Thirdly, there are no banking fees, and even transaction costs are pretty less as it has no third parties involvement. And last but not least, crypto users need Internet access to transact from any sphere of the world, making it convenient (Lekhi, 2021).

6 Role of Digital Currency in Strengthening e-Commerce

Service, trading, e-commerce, and retail sectors are expected to comprise a significant market share for cryptocurrencies in the coming period. The penetration of digital currencies in digital payments is expected to affect cross-border transfers. It is going to entirely transform the money transfer process. Whether national or international transfers, cryptocurrency transfers are instantaneous and can be tracked and securely stored in the blockchain, reducing the risk of fraud. It is expected that this will make digital payment services the next great upheaval in global e-commerce growth.

7 Cryptocurrency Regulatory Insights

This section of the chapter includes insights on cryptocurrency legality status across the countries, risks and concerns associated with digital currencies and cryptocurrency laws and regulatory requirements.

The legality of cryptocurrencies depends on the region and activity of the user. While Bitcoin is accepted in many parts of the world, a few countries oppose it because of its volatility, decentralized nature, and links to illicit activities like drug trafficking and money laundering.

Most developed countries such as the USA, Canada, and the UK have taken a positive stance on digital currencies (Bajpai, 2021).

However, other countries like China, Nepal, Egypt, Bangladesh, Russia, and Algeria have banned digital currencies. And many countries are still figuring out how to regulate and tax them. Overall, cryptocurrencies remain in a legal gray area in much of the world (Bajpai, 2021).

What must cryptocurrency laws include, and why?

FinCEN regulators should also require companies to report the exchanges they use. That information could help Treasury to identify which businesses or affiliated entities to target with sanctions. As Hackers and ransomware groups operate overseas (Uberty, Rundle n.d.).

Virtually every exchange around the world deals in some form with US currency. The USA could pressure all of them through sanctions and require them to adopt the same policies.

Improved oversight of cryptocurrency exchanges in foreign countries, which face lower regulatory standards, could require international cooperation or pressure.

8 Risks Involved in Digital Currencies

The primary risk when it comes to cryptocurrencies is their high volatility. Unexpected changes in market forces can lead to sudden fluctuations in price. It is common for cryptocurrencies to drop by hundreds, if not thousands, of dollars suddenly. For instance, Bitcoin dropped by more than 50% in May from $64,000

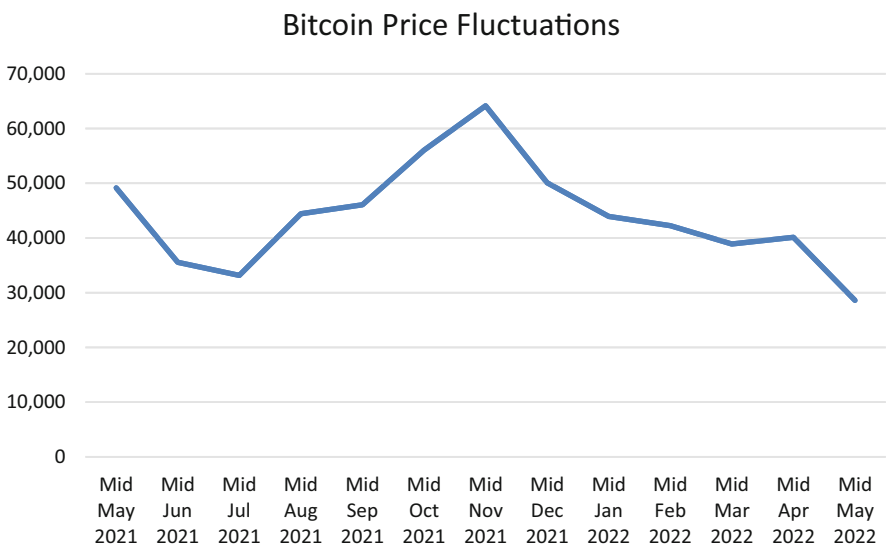

Fig. 4.2 Bitcoin price fluctuations. Source: Composed by Author, data collected from Yahoo Finance

to $30,000 due to negative headlines following Tesla CEO Elon Musk's comments and crackdowns by the Chinese government. Many other crypto assets have fallen even further. The daily price volatility for Bitcoin over the past three years is 75%.

Figure 4.2 elucidates the price changes of Bitcoin in the last year. Twelve months of data were collected starting from May 12, 2021, to May 12, 2022, and it has recorded a highly volatile wild ride in a year. It reached its all-time high in the month of November. Currently, in May 2022 its price is below $30,000.

Secondly, as a decentralized currency, cryptocurrencies are currently unregulated by both governments and central banks. It hampers its insurability and investor security. Also, the lack of appropriate internal controls makes it more susceptible to fraud and theft than regulated financial institutions.

Thirdly, they are highly vulnerable to hacking and errors in algorithms. As cryptos are getting more popular, it is becoming an increasingly large target for hackers. Many leading exchanges, including Binance's international operation and Ku Coin, have been hacked recently for millions of dollars. Last year, Crypto hackers stole more than $600 million from Poly Network, a decentralized finance or DeFi, a platform that allows users to swap tokens across different blockchains. Hackers made away $267 m of Ether currency, $252 m of Binance coins and roughly $85 million in USDC tokens.

And lastly, it involves technological risks too due to computational complexity and massive energy consumption for Bitcoin mining.

9 Chapter Insights

Cryptocurrencies are highly speculative investments. They can have a much higher return than any other investment, but they are prone to sudden price drops. Investing in cryptocurrencies should only be done if you are willing to accept a decent risk of losing all your money. It has no intrinsic value, making it susceptible to substantial price swings. For example, last year, Bitcoin and Dogecoin prices underwent huge price swings driven by Elon Musk's public statements and tweets.

Furthermore, some folks may never accept it, who prefer a physical or conventional form of wealth like currency notes and precious metals.

Any government intervention and regulations may lead to bursting it like a bubble. Its future success (or fall thereof) will depend on the ability to deal with such challenges.

Despite the phenomenal growth of digital currency, its future is still questionable. Although the number of businesses and retailers adopting cryptocurrencies is growing, they are still less.

For cryptocurrencies to expand globally, they must first gain widespread acceptance among consumers. However, their relative complexity compared to conventional currencies deters most people (Saha, 2022).

10 Conclusive Remarks

It has been observed that value fluctuation and volatility are cryptocurrencies' main challenges. Moreover, some countries still do not consider it a legitimate form of currency due to the lack of transparency, which raises the chance of tax evasion on money laundering.

So conclusively, you can treat your "investment" in cryptos like you would treat any other highly speculative venture. It is difficult to say if digital currencies will see dramatic price gains in the future. You can reap huge profits in the short term; however, you may lose heavily if the value drops due to its volatility in the long run. It can be classified under the high-risk, high-reward portfolio.

11 Direction for Future Work in Crypto Finance

There are many new forms of digital coins getting launched in the crypto space. Undoubtedly, there are going to be more digital assets in the future which will overcome the limitation of cryptocurrencies or that can offer price stability backed by reserve assets.

There are even more innovations like gold-backed cryptos, which have a gold value as an intrinsic value. In the future, we are expecting more scope for new forms of digital assets that will overcome the constraints like the volatility that are linked with cryptocurrencies.

In the upcoming years, government regulations for cryptocurrencies have yet to be put in place. In addition, regulations "should create a framework where there are disclosures," says Katherine Dowling, general counsel, and chief compliance officer for Bitwise Asset Management. These disclosures, Dowling goes on to say, will help create transparency for the overall investment class.

The lack of transparency for the algorithmic stablecoin TerraUSD (UST) not only caused massive price drops for UST in May, but the collapse also affected its sister coin LUNA and BTC prices as well. It is certainly expected to see more cryptocurrency regulations being implemented worldwide in the coming years.

Furthermore, some investors are looking forward to sustainable cryptocurrencies and efforts and research are being made to minimize the carbon foot print of cryptocurrencies. One example is SolarCoin. It has a novel approach to cryptocurrency, creating 1 Solarcoin for every Megawatt hour generated from solar technology. Currently, this network mostly relies on users uploading documentation to prove energy generation, but the Internet of Things may work on streamlining this process with automatic updates from solar arrays (Matthews, 2021).

To be considered a viable investment asset or form of payment, Bitcoin's blockchain should be able to handle millions of transactions in a short span of time. Still many types of research are being carried out to facilitate the scale of operations.

Currently, there is a tremendous increase in the number of Defi coins. There exist hundreds of them. Some of the top ones include Aave, Uniswap, Solana, and more. More developments in this area can be expected in the future. More developers shall work on their Defi projects, and the market will continue to grow exponentially. New and more efficient algorithms are expected to emerge out, as well as new ways of storing data. Furthermore, can be more DApps that are used for gaming, social networking, and more. Overall, there can be improvements in already existing frameworks and this will revolutionize the entire crypto ecosystem.

Shock-Resistant Programmable Money: Stablecoins

5

Abeba N. Turi and Chiranthi Thilakarathnei

Abstract

The evolution in currency and payments brought by financial technologies and the digital economic system are immense. In this chapter, we will have an in-depth look into stablecoins as one of the principal developments of decentralized networks and programmable money. The race toward securing the evolving cryptocurrency system, which suffers from wild price swings via a more stable monetary system, has led to the proliferation of stablecoins. Our industry assessment shows that there are no robust stablecoins that address the core issue of stability and secure digital asset valuations. Using a case study on the Terra(LUNA) mega crash, we showed that the industry is unstable, and a shock in one of the coins has a spillover effect on the whole market ranging from a coin substitution effect to crypto bank runs. Considerations in this area are efficiency in the collateralization ratio framework and a price stabilization policy that can cope with the crypto volatility.

Keywords

Crypto Bank Run · Stablecoins · Programmable money · Digital currency · Defi · Pegging · Algorithmic stablecoins

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1 Introduction

The significant volatility of cryptocurrencies makes it difficult for investors to achieve consistent profits or sustain value. Researches indicate that Bitcoin has a bigger negative skewness than high-yield corporate bonds, gold, and silver returns (Grobys et al., 2021). Thus, the risk of volatility overweighs the benefits due to its uncertainty. A stablecoin is a cryptocurrency that tries to maintain a stable value relative to an underlying asset class, pool, or basket of assets (FSB, 2020). These coins are intended to reduce price volatility by pegging against a fiat currency or commodity, collateralization against other cryptocurrencies, or as algorithmic coin supply management (Grobys et al., 2021).

According to Statista, as of June 17,[1] 2017, the stablecoins market cap was about $154.9 billion accounting for a 15.7% crypto market share. There are three major types of stablecoins: (i) Off-chain fiat-collateralized stablecoins backed by a fiat currency (e.g., the US dollar) as collateral for token issuance, (ii) cryptocurrency collateralized (on-chain) stablecoins backed by cryptocurrency tokens, and (iii) non-collateral (seigniorage). Stablecoins employ the Seigniorage Shares System, in which algorithms attempt to ensure price stability through a combination of collateral and/or a reserve token (Grobys et al., 2021).

As far as digital cash is concerned, there still are significant concerns about whether it will be ideal for programmable money to fulfill the essential functions of money as a store of value, unit of account, and medium of exchange. This mainly has to do with the wild volatility of such currency systems. Though debatable in their current form, stability is the most valued attribute of stablecoins. Liquidity and the stabilizing mechanism are the main determinants of stability (Block Research, 2021). Practically, stablecoins are more desirable if the deviation from the peg on liquid secondary markets is negligible.

2 Related Works

The speculative nature of cryptocurrencies makes these digital assets prone to instability. Unlike their genesis purpose of being shock-resistant and steady, stablecoins suffer from significant volatility (Turi (2020a), Chohan (2019), Grobys et al. (2021), Eichengreen (2019), and FabricVentures and TokenData report (2018)).[2]

[1] Distribution of stablecoin against Bitcoin (BTC), Ethereum (ETH), and other crypto, based on market capitalization on June 27, 2022; Available at https://www-statista-com.ezproxy.myucwest.ca/statistics/1316465/top-five-stablecoin-market-distribution/ Accessed June 2022.

[2] The most recent major incident comes from Terra's UST Stablecoin Collapse: "TerraUSD Crash Led to Vanished Savings, Shattered Dreams," *The Wall Street Journal* on the meltdown of digital tokens worth more than $40 billion. https://www.wsj.com/articles/terrausd-crash-led-to-vanished-savings-shattered-dreams-11653649201?mod=article_inline Accessed June 2022.

Grobys et al. (2021) found relative stability in stablecoins with the US dollar as an underlying asset than bitcoin, which is prone to wild volatility. They argue that the volatility of bitcoin is a significant factor influencing stablecoin, and there is a negative relationship between the lagged volatility of bitcoins and the volatility of stablecoins, while Lyons and Viswanath-Natraj (2020) found a positive relationship. In addition to the pegging asset or currency, the stabilization mechanism depends on whether a stablecoin can retain an enduring value. They also agree that a centralized peg system can function well even when the principal issuer stays passive and relies on demand-driven arbitrage to keep prices stable around the peg, yet mainstream adoption and further developments in the field will bring robust stabilization mechanisms. Various stabilization techniques may either necessitate the involvement of responsible organizations, acting as issuers and custodians, or delegation of responsibilities for users of stablecoins (Bullmann et al., 2019).

In addition to the issues of stability, limitations in regulations to catch up with the dynamic crypto world, including stablecoins, remain open (Turi, 2020a, Lyons and Viswanath-Natraj (2020)). Lyons and Viswanath-Natraj (2020) suggested that stablecoins could be regulated in a variety of ways, including as "(1) MMFs, (2) MMFs with more stringent capital and liquidity requirements, (3) special bank charters, (4) insured depository institutions, (5) FSOC-designated systemically important entities, and (6) under a new, separate framework with a single designated regulator for the digital asset markets."

3 Stablecoins: An Overview

Volatility in cryptocurrency valuations has challenged the pricing of assets through such mediums of exchange. Thus, this has been one of the main bottlenecks for the potential migration of physical assets to the blockchain space and broader adoption of this technology. To avoid currency risks arising from cryptocurrency price volatilities, some traders use new breeds of cryptocurrencies, stablecoins, when transacting using cryptocurrencies as a unit of account.

Stablecoins refer to the notion of price-stable cryptocurrencies pegged by other stable assets like gold or regular fiat currencies like USD or other cryptocurrency denominations. The (semi) collateralized stablecoin business model follows a hedge funding business model that creates a token for the stablecoin and pools capital from crypto investors that will collateralize the stablecoin in the form of an asset, fiat currency, or another cryptocurrency through a centralized institution that serves as a custodian of reserve assets and issuer of a token (see Fig. 5.2, for example, which depicts Tether's total assets used for the off-chain collateralization of USDT stablecoin). For example, Gemini Dollar,[3] Tether,[4] and TrueUSD[5] (one-to-one

[3] Gemini Dollar https://gemini.com/dollar/ Accessed July 2022.

[4] Tether https://tether.to/ Accessed July 2022.

[5] TrueUSD https://www.trusttoken.com/ Accessed July 2022.

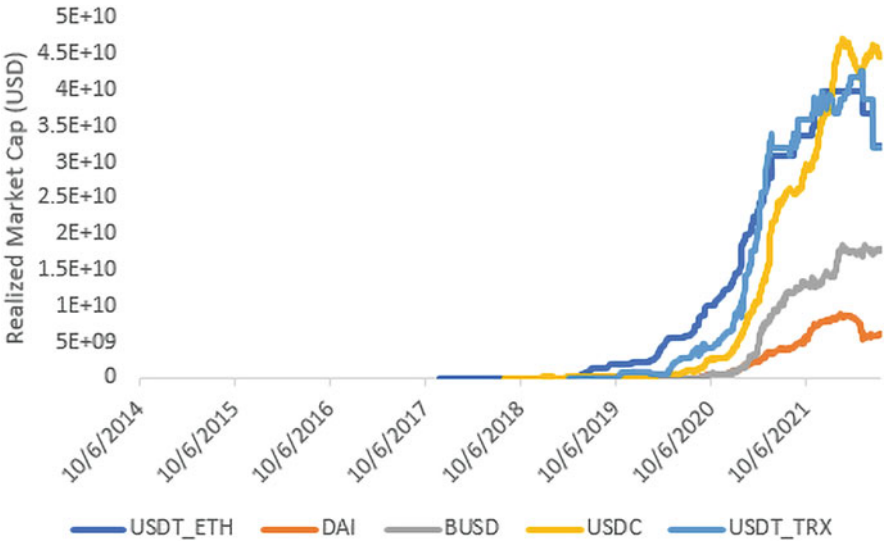


Fig. 5.1 Realized market capitalization (in USD) of 5 selected stablecoins from June 2014 to July 2022. Source: Authors' composition based on stablecoin market cap data of Coinmetrix https://charts.coinmetrics.io/network-data/ Accessed July 2022

fiat-backed centralized stablecoins) and MakerDAO,[6] METAX,[7] and Dai[8] (crypto-backed decentralized stablecoins), and Basis[9] the stablecoin shut down due to regulatory constraints (a non-collateralized stablecoin).

Since its inception, the market for stablecoins has observed an increasing trend while also absorbing the shocks in related markets. Figure 5.1 presents the market capitalization of selected stablecoins over the past eight years.

In its raw sense, the fiat-pegged stablecoins are no more than a digital representation of the fiat currencies; the currencies stablecoins are backed on a one-to-one ratio. For the crypto-collateralized stablecoins, the entire system is over the blockchain. The non-collateralized stablecoins replicate the idea of central banks controlling the money supply without collateralization. In the same fashion, the business logic that defines the value of programmable money is set in the smart contract and guarantees a steady supply of cryptocurrency through the forces of supply and demand. Note that cryptocurrency prices are unstable because the cryptocurrency supply does not respond to its demand (see Iwamura et al., 2019; Turi, 2020a).

[6] MakerDAO https://makerdao.com/en/ Accessed July 2022.

[7] An ERC20 utility Metabank token with 17 different cryptocurrencies as collateral for decentralized banking in the metaverse; see Metabank white paper (2022). Join the Metaverse Revolution! The first decentralized bank in the metaverse at https://drive.google.com/file/d/1r23k5e-31T9gpeUiNjIHvQHrlvhs06fO/preview Accessed June 5, 2022.

[8] Dai https://makerdao.com/en/dai/ Accessed July 2022.

[9] Basis https://www.basis.io/ Accessed July 2022.

Table 5.1 Top 10 Stablecoins by market capitalization as of July 26, 2022

Stablecoin	Price	Market cap	Volume(24 h)	Circulating supply
Tether USDT	$1.00	$65,850,102,299	$57,813,051,029	65,846,277,709 USDT
USD coin USDC	$1.00	$55,157,950,587	$6,594,968,962	55,148,593,242 USDC
Binance USD BUSD	$1.00	$17,945,716,415	$5,413,122,436	17,958,321,396 BUSD
DAI	$1.00	$7,309,993,302	$907,344,622	7,313,995,872 DAI
TrueUSD TUSD	$1.00	$1,194,284,902	$320,090,321	1,194,058,131 TUSD
Pax Dollar USDP	$1.00	$946,352,349	$9,291,687	945,642,940 USDP
Neutrino USD USDN	$0.99	$733,598,601	$2,747,257	741,764,311 USDN
USDD	$1.00	$724,918,971	$27,070,562	725,332,044 USDD
Fei USD FEI	$0.98	$418,522,409	$1,855,881	424,996,178 FEI
TerraClassicUSD USTC	$0.03	$328,869,404	$14,104,874	9,815,487,689 USTC

Source: CoinMarketCap as of July 2022 https://coinmarketcap.com/view/stablecoin/

Table 5.1 summarizes the major stablecoins in the industry. Tether (USDT) and USDC equate to more than 80% of the total market capitalization for all US dollar-pegged stablecoins. Some of the major incidents in this list of stablecoins include (i) Tether USDT: Suffered a bank run of about $16 billion following Terra's collapse in 2022 and suffered a civil monetary penalty of $41 million and to cease and desist from violations of the Commodity Exchange Act (CEA) and CFTC regulations in 2021. (ii) USD Coin USDC: its backer Circle is under investigation by the SEC; besides, its former subsidiary, Poloniex operated as an unregistered exchange and had a $10 M settlement with SEC in 2021. On the other hand, it enjoyed a significant market substitution effect following the Terra(LUNA) mega crash, with USDT balances redirected to USDC in 2022. (iii) Terra-one of the most significant market shocks with a spillover effect on other stablecoins: the Terra(LUNA) collapse and bank run in May 2022 (a detailed case-specific analysis of this market crash is presented in Section 6 of this chapter).

4 Major Concerns in Stablecoins

Unlike their genesis purpose of being shock-resistant and steady, stablecoins suffer from significant volatility (Turi (2020a), Chohan (2019), Grobys et al. (2021), Eichengreen (2019), and FabricVentures and TokenData report (2018)).[10] Below, we discuss stablecoin's internal and external shock resistance limitations.

[10]The most recent major incident comes from Terra's UST Stablecoin Collapse: "TerraUSD Crash Led to Vanished Savings, Shattered Dreams," *The Wall Street Journal* on the meltdown of digital

(i) *Crypto Bank Run*

One of the issues concerning the stability of stablecoins is the spillover effect that comes from instabilities in the peg to its reference value. Peg instability for public reserve-backed stablecoins can be due to investor redemption risk from the issuer and secondary market price dislocations. If stablecoin investors lose faith in the stability of a stablecoin's backing, a run dynamic may occur.[11] A stablecoin run increases the possibility of spillovers to other asset classes, as stablecoin reserves are sold or unloaded to meet redemption demand. Gorton & Zhang (2021) argue that a stablecoin run could disrupt the markets and services that rely on the stablecoin via compatible smart contracts while creating a more distressing situation.

(ii) *Secondary market dynamics*

Stablecoins are traded on both centralized and decentralized exchanges. These coins are susceptible to demand shocks that may briefly destabilize their peg until the stablecoin issuer adjusts supply. This is because public stablecoins serve as a store of value on the public blockchain-based exchange. Stablecoins are in high demand during crypto market downturns as investors rush to sell speculative positions into stablecoins (Liao & Caramichael, 2022). The market dynamics can reflect on the arbitrage flow. With the differences in the exchange rate in the primary and secondary markets, there will be increased arbitrage opportunities where the stablecoin price deviates from its peg resulting in endogenous investor flows (Lyons & Viswanath-Natraj, 2020).

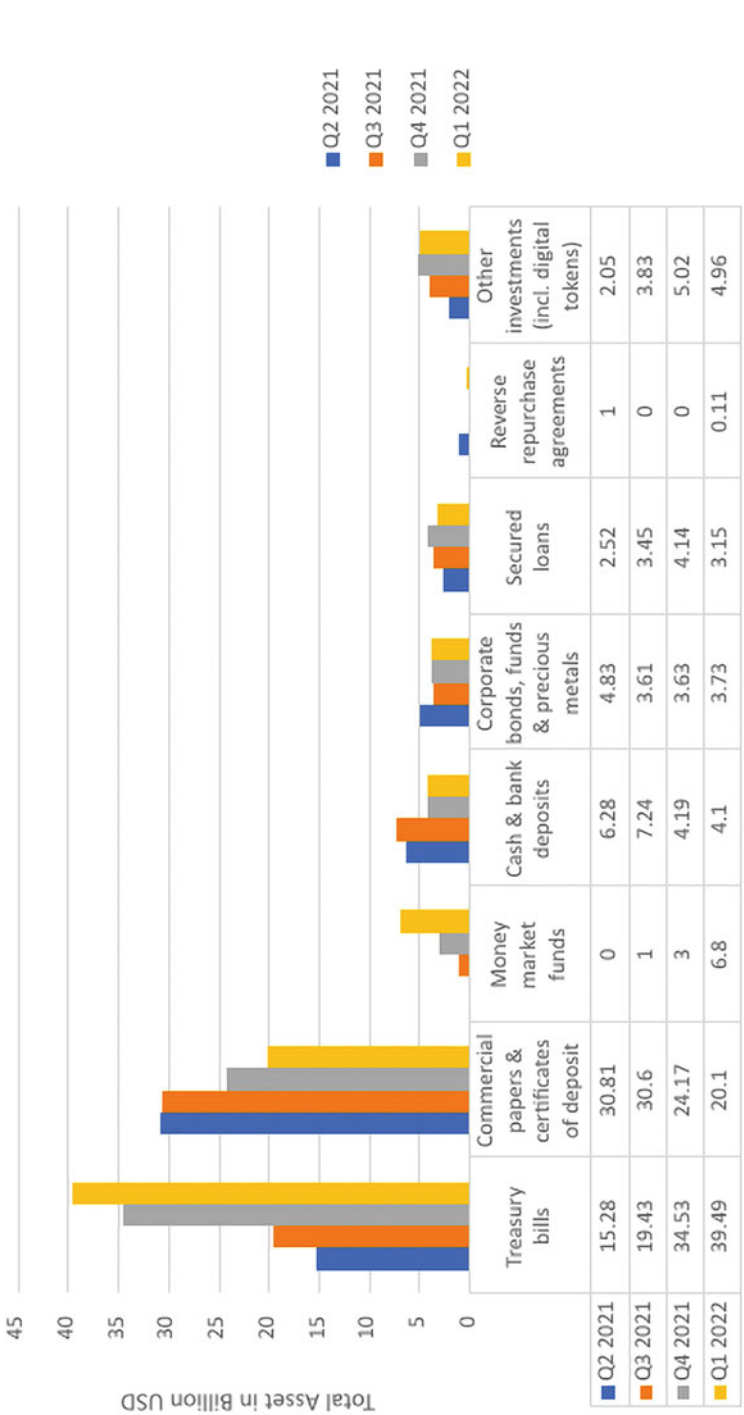
(iii) *Spillover effects from the pegging asset or currency instability*

Stablecoins typically seek to be convertible to dollars at par, but because they are backed by assets that could depreciate or become less liquid under pressure, they are subject to the same redemption concerns as prime and tax-exempt MMFs (see Tether's off-chain collateralization in Fig. 5.2, for example). Thus, transparency regarding the risk and liquidity of the assets underlying stablecoins may worsen these vulnerabilities. Stablecoin demand may fluctuate more frequently and present higher redemption risks due to stablecoins being used more often to satisfy margin requirements for leveraged trading in other cryptocurrencies (NBER, 2022).

Let us look at two different instabilities that can arise depending on the type of pegging of the stablecoin. Let us look into this by identifying the issues around fiat-, asset-, and cryptocurrency-pegged stablecoins.

tokens worth more than $40 billion. https://www.wsj.com/articles/terrausd-crash-led-to-vanished-savings-shattered-dreams-11653649201?mod=article_inline Accessed June 2022.

[11] On June 4, 2022, *The Wall Street Journal* covered a story, "Search Continues for Source of TerraUSD Crypto Bank Run." https://www.wsj.com/articles/search-continues-for-source-of-terrausd-crypto-bank-run-11654348117Retrieved Accessed June 2022.



	Treasury bills	Commercial papers & certificates of deposit	Money market funds	Cash & bank deposits	Corporate bonds, funds & precious metals	Secured loans	Reverse repurchase agreements	Other investments (incl. digital tokens)
Q2 2021	15.28	30.81	0	6.28	4.83	2.52	1	2.05
Q3 2021	19.43	30.6	1	7.24	3.61	3.45	0	3.83
Q4 2021	34.53	24.17	3	4.19	3.63	4.14	0	5.02
Q1 2022	39.49	20.1	6.8	4.1	3.73	3.15	0.11	4.96

Fig. 5.2 Tether's total assets used for the off-chain collateralization of USDT stablecoin from 2021 to 2022 (in billion US dollars). Source: Authors' composition based on Statista (March 31, 2022). Retrieved July 21, 2022, from https://www-statista-com.ezproxy.myucwest.ca/statistics/1316893/tether-reserves-breakdown/

Fiat-pegged stablecoins
A regulated fiat currency's valuation defines the value of the stablecoin it is backing. Stablecoin token issuers operate with accounts in the traditional banking system (like Tether's account in Cathay United Bank and Hwatai Bank in Taiwan). Thus, the trust in the central financial institution is crucial for the stability of the collateralized stablecoin (Chohan, 2019, highlights the constraints in pegging cryptocurrencies with traditional currencies).

Besides, in terms of the speed of transaction, unlike blockchain-based cryptocurrency, which has a fast transaction validation and transfer of values, the fiat-pegged coins rely on the legacy payment channels like a time-consuming wire transfer.

Asset-pegged stablecoins and potential risk of insolvency
For the asset-pegged stablecoins, market risks can arise from the collateralized assets. If the price of a collateral asset drops as opposed to the price of the stablecoin, then a similar risk management strategy to the legacy banking and financial systems come into play. That is, the curator should liquidate the collateral to close the position. A liquidity crunch situation of dried cash can limit the liquidation of the collateral asset as required. With a small number of the blockchain community, this risk is inevitable.

For asset-backed (like precious metals or derivatives) cryptocurrencies, the supply of stablecoin depends on the rate of asset production. When the asset stock increases more rapidly than the blockchain nano-economy over which the stablecoin operates, there is inflation and vice versa.

Cryptocurrency-pegged stablecoins
Cryptocurrency-pegged stablecoins are volatile with the underlying currency they are backed with. In the case of depreciation of the values of the collateral money, blockchain-enabled instant liquidation (a bank run) can make stablecoin less stable or even worthless. The collateralization ratio used to tackle this problem is inefficient, where a fractional reserve (not the total) is recovered when exiting the system. Hoang and Baur (2021) and Grobys et al. (2021) identify Bitcoin as a source of excess volatility in stablecoins and present evidence that stablecoins contribute to Bitcoin's excess volatility. Stablecoins, unlike their innate nature of steady price, suffered from significant volatility. For example, in 2021, Terra's Price Luna observed a significant price swing with a historical record of about 500% volatility in May 2021 (see Fig. 5.3). Here, the Defi application of Terra following the network's release on Wormhole (August 2021) and the access to Terra's market information with its integration in Crypto.com (July 2021) played a significant role in the performance of its native token, Luna.

Thanh et al. (2022) examined the relationship between the stabilities of the top five stablecoins named Tether (USDT), USD Coin (USDC), Paxos Standard (PAX), TrueUSD (TUSD), and Multi Collateral DAI (DAI) during the period of November 23, 2019, to April 1, 2021. It highlights that any instability of stablecoins can be a

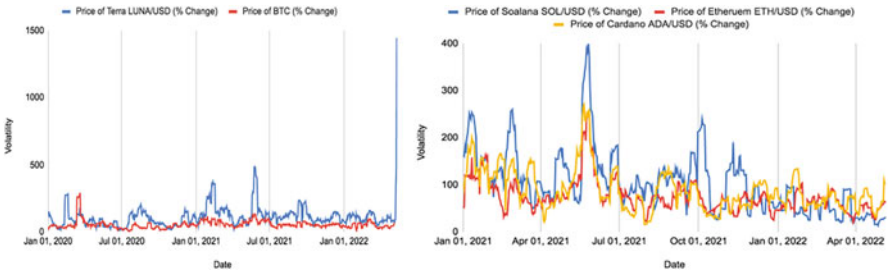


Fig. 5.3 Volatility—Panel (**a**) the price fluctuation—of Terra Luna USD (percentage change) from January 2020 to May 2022. And Panel (**b**) the price fluctuation—of Cardano (ADA), Ethereum (ETH), and Solana (SOL) (percentage change) from January 2021 to May 2022. Note: The volatility is measured by taking the differences in price over a given period—rolling 10-day realized volatility, benchmarked against the S&P 500. Source: Authors' composition based on PortfoliosLab Survey https://portfolioslab.com/

substantial barrier for users who seek to conclude transactions using a digital cryptocurrency version of the US dollar, aside from the counterparty risk of privately produced stablecoins, as pointed out by Griffin and Shams (2020). The results also demonstrate that algorithmic stablecoins outperform privately issued stablecoins, market price swings differ amongst stablecoins, and gains in USDT market prices significantly impact the market prices of the other stablecoins.

(iv) *Financial instability*

Cryptocurrency market speculations fuel the volatility in their prices. This volatility in monetary values of cryptocurrencies results in fluctuating the purchasing power of such currencies, thus making them unstable as a medium of exchange, a unit of account, and a store of value. A typical example of this can be the temporary price spike for bitcoin in late 2017 and early 2018. Cryptocurrency price fluctuations can result in winners and losers within the blockchain community. Given economic transactions involving long-term contracts extending over time, inflating cryptocurrency can, for example, create a bias in returns and produce winners and losers.

For example, a cryptocurrency-denominated loan is normally specified in terms of the current cryptocurrency valuations. A borrower pays a fixed interest rate on loan and the principal over a loan period. An inflated cryptocurrency can affect this return, given its prior valuation during the loan initiation. Consider a bitcoin-denominated 5-year term loan initiated at the current bitcoin inflation rate of 4%. Assuming that the bitcoin inflation rate remains constant under this loan period, then the inflation rate will be zero, which is less than the current inflation rate of 4%. The real interest rate in bitcoin is the nominal interest rate less the inflation effect; the real interest rate in bitcoin will be greater than the expected nominal interest rate. Thus, the cryptocurrency lender will gain, in which case the borrower will repay a return of higher real value at maturity.

Therefore, volatility in the value of an underlying pegging asset/currency can lead to financial instability within the cryptocurrency community, where uncertainty on the value of debts arises for lenders and borrowers.

(v) *Regulation of programable money and decentralized networks in general*

Despite the hasty evolution of the programmable money and distributed networks world, the regulatory framework that governs such developments has lagged. Over the past few years, the legislative loop wholes combined with the crypto poor investor maturity have caused significant losses in the industry (Turi, 2020a).

Bullmann et al. (2019) highlighted that on some occasions, stablecoins initiatives might fall outside the existing regulatory frameworks and carry the same risks as their off-blockchain counterparts that are important to central banks. These risks include (i) the monitoring of monetary aggregates, which is not currently impacted by the size of tokenized funds businesses but requires scrutiny in case of future developments; (ii) micro-prudential supervision, the evasion of which may significantly affect customers and their trust in the currency of denomination; and (iii) use for illegal purposes, in which case the anti-money laundering regime levied on the use of general "virtual currencies" in the European Union will apply (Bullmann et al., 2019). In general, money laundering concerns around cryptocurrencies have been rising over the past few years. Of the latest top news is Ukraine's seizure of about $three million in cash, real estate, and a trove of silver from a crypto OTC desk funneling Russian funds by converting assets owned by Russians into cryptocurrency, which the Ukrainian authorities claim is money laundering.[12]

Even though the legislations have not been directed to these forms of value creation, some developments in the regulatory sphere have succeeded in encompassing transactions in decentralized networks. For example, in the USA, stablecoins presently trade on digital asset trading platforms that are frequently state-registered businesses known as money transmitters. The Financial Crimes Enforcement Network (FinCEN) has registration and reporting requirements for money transmitters. Money transmitters must, for instance, request and confirm the client's identity, record beneficiary identification, and submit "Suspicious Activity Reports" for specific transactions. Tax reporting is also required for some transactions. Additionally, for some stablecoin-enabled electronic payments, the Consumer Financial Protection Bureau may have a customer protection role.

Besides seizing on the stablecoin custodian element, state and federal trust or custody bank charters are authorized to offer digital asset custody services. Further, under the SEC's custody rule, SEC-registered investment advisers must work with "qualified custodians," which may include banks. For instance, Paxos Trust Company issues the Binance Dollar, Paxos Dollar, and Gemini Trust Company issue the

[12] Kollen Post (July 13, 2022), The Block available at https://www.theblock.co/post/157400/ukraine-seizes-3-million-in-cash-other-assets-from-crypto-traders-accused-of-funneling-russian-funds Accessed July 2022.

Gemini Dollar. Thus, custody regulations have been established by banking and securities regulators alike to establish guidelines intended to safeguard customer assets from the danger of theft or loss (Congressional Research Service, 2021). Alternate legislative measures such as the Stablecoin Classification and Regulation Act of 2020 (STABLE Act; HR 8827 in the 116th) and Securities Act of 2019 (HR 5197 in 116th) have been developed as an answer to the weaknesses in the current stablecoin regulatory frameworks. Thus, certain stablecoins should adhere to banking regulations, and the managed stablecoins are proposed to stricter securities law regulations (Lyons & Viswanath-Natraj, 2020).

Another crucial development we have seen in the regulatory component is the move to forming coalitions by the major players in the crypto industry (Coinbase, Circle, Solidus Labs, and Anchorage Digital), which targets self-regulation. The Crypto Market Integrity Coalition aimed at "enabling a safe and sensibly-regulated crypto ecosystem" by bringing together the digital asset space stakeholders in the industry.[13] Such common pool regulatory spheres will allow the players to be watchdogs for market efficiency and minimize potential market manipulation and abuse. Yet this is to be under the consideration that the collision is built on a self-enforcing protocol and considerate of investor protections to curb selfish interests while overseeing the industry.

Regulatory spheres in this area should consider each stakeholder and multilayers of the value creation process. With investor protection and market integrity concerns, stablecoin agreements and digital asset trading operations may fall under the court's jurisdiction. In its form, a stablecoin may constitute a security, commodity, and derivatives such as forward and futures markets on stablecoins, and existing laws in the physical asset management and value transfer agreements with moderate adjustments could fit into the crypto world. Yet this is constrained by the transparency of the value creation process, efficient identification mechanism, robust foresight of the market efficient traceability of transactions.

(vi) *Market integrity and investor protection issues*

In the preeminent crypto world of instant millionaires and billionaires, market deceptions and investor enthusiasm without maturity is a series concerns for the competitive money market. One of the recent critical incidents of losing market integrity and investor protection is the inability to confirm the portfolio holdings of Tether, which is the largest stablecoin that is pegged for one-to-one backing with the US dollar. Together with privacy and security, investor protection issues are also one of the ongoing concerns around Terra's UST Stablecoin Collapse.[14] In such events,

[13] See at https://www.cryptomarketintegrity.com/?utm_content=196548197&utm_medium=social&utm_source=twitter&hss_channel=tw-987190230204600320 Accessed May 2022.

[14] For example, on June 9, 2022, Bloomberg's report covered "SEC Is Investigating Terra's UST Stablecoin Collapse," depicting one of the major shocks in the crypto market and investor protection issues in relation to this stablecoin's collapse. https://decrypt.co/102460/sec-terra-ust-stablecoin-collapse-report Accessed July 2022.

the price of big public reserve-backed stablecoins tends to rise temporarily until the issuer adjusts supply (Congressional Research Service, 2021). Moreover, like all other forms of cryptocurrencies, potential theft attacks on private keys are one of the issues stablecoin holders face.

(vii) *Central point of failure and potential manipulation risk*

For centralized stablecoins, like Gemini Dollar,[15] Tether,[16] and TrueUSD[17] Trust are built through licensed token issuers subject to regulatory supervision. A centralized form of operation, as opposed to the inherent democratic virtue of the blockchain system, will expose the cryptocurrency ecosystem to a single point of failure, privacy, and security risks with non-transparent off-the-chain verifications.

On the other hand, with the limited transparency of how much reserves exists in the system at a given time, off-chain auditing is risky (for example, the Enron scandal of fraudulent accounting practice). Such custodians might also benefit from the exploitation of institutional features like exploitation of legislative loopholes where the industry's practice is not yet solidified. For example, money laundering and illegal practices with the anonymous features of the stablecoin (by fully or partially utilizing the innate virtue of blockchain anonymous and censorship-resistant ledger) or pricing manipulation in the case of cryptocurrency-backed fractional reserve stablecoins can be some of the underlying problems.

5 Monetary Stability in Cryptocurrencies

Like the early developments in financial history, classical economic theories and empirics lay the foundation for the modern competitive programmable money world. Let us a flashback to the gold standard to allow us to glimpse the legacy monetary systems in the twenty-first century and identify those that could apply to our core purpose of stability in cryptocurrencies. In 1944, the United Nations Monetary and Financial Conference (Bretton Woods Conference) of 44 allied nations came up with a stable currency system to regulate international monetary and financial order following WWII. With the relative economic stability, the USA observed during that time, the new financial system considered the US dollar as the world's reserve currency backed by gold. Because the USA held most of the global gold reserves following the war, countries tied their local currencies with the US dollar.

Gold certificates issued by governments served as representative currency, the certificate being a claim check for a gold reserve in the treasury. The gold standard allowed the convertibility of gold for paper currencies. The 1971 Nixon Shock, following the suspension (cancellation) of the unilateral convertibility of US dollars

[15] Gemini Dollar https://gemini.com/dollar/ Accessed May 2022.
[16] Tether https://tether.to/ Accessed May 2022.
[17] TrueUSD https://www.trusttoken.com/ Accessed May 2022.

into gold or other reserve assets due to the increasing inflation, aborted the gold standard.[18] This led to the current monetary system of a freely floating fiat currency system with legal tender and no pegging of an asset with intrinsic value.

However, centralized monetary policy is limited in securing stability. A recent example we can raise concerning policy failures with inflation chasing is the hyperinflation in Zimbabwe[19] and Venezuela.[20] And more generally, the 2008 financial crisis led to questioning the classical economic theories. This resulted in challenging the role of government through the self-enforcing monetary protocols of the Nakamoto currency bombshell (Nakamoto, 2008). Like all other innovations, the programmable money revolution is sensitive to geopolitical issues with monetary sovereignty, adding an extra layer of complexity (see, for example, Huang & Mayer, 2022 for the USA-China geopolitics over the international monetary system. The two countries are at two extreme ends as far as industry regulation is concerned. While the US flexibility regulated cryptocurrencies and appeared reluctant on the CBDCs, China delegalized these forms of decentralized currencies while issuing its CBDC, the digital yuan). The COVID-19 expansionary policy failures and consequent inflation has renewed the attention to crypto assets as hedges against inflation.[21] There is an emerging claim for bitcoin to play the safe haven role of physical gold during this financial instability. Distributed nature of the programmable money is resistant to policy uncertainty shocks, but the decline in bitcoin prices during financial uncertainty puts a limit on its potential inflation hedging feature (Choi & Shin, 2022). Despite its promising features, this currency system and its derivatives suffer from market stabilization issues.

Early proposals for private money trace back to Hayek's proposal for monetary reform, allowing institutional private money issuance in 1976 (Hayek, 2009). Hayek stressed the stability in value for private money's acceptance with a basket of commodities as an ideal monetary base in this currency system. The notion of

[18] On August 15, 1971, President Richard Nixon closed the gold window and imposed a 10% surcharge on all dutiable imports to force other countries to revalue their currencies against the dollar.

[19] On February 14, 2011, CNBC covered a story, "The Worst Hyperinflation Situations of All Time." The Zimbabwean Hyperinflation is one of the pioneer examples in the history of monetary collapse. https://www.cnbc.com/2011/02/14/The-Worst-Hyperinflation-Situations-of-All-Time.html Accessed June 2022. Sources indicate that the country still suffers from an inflation rate of three digits after the currency plunge, Rene Vollgraaff at Bloomberg, May 25, 2022. https://www.bloomberg.com/news/articles/2022-05-25/zimbabwe-s-inflation-is-back-above-100-after-currency-plunge#xj4y7vzkg Accessed June 2022.

[20] See also "Venezuela's inflation hit 686.4% in 2021—central bank" Armas (2021) at Reuters https://www.reuters.com/world/americas/venezuelas-inflation-hit-6864-2021-central-bank-2022-01-08/#:~:text=CARACAS%2C%20Jan%208%20(Reuters),central%20bank%20said%20on%20Saturday. Accessed July, 2022.

[21] JPMorgan's note to its clients in October 2021 revives the life of the "digital gold" for mainstream institutional adoption—"institutional investors appear to be returning to Bitcoin, perhaps seeing it as a better inflation hedge than gold." https://www.yahoo.com/lifestyle/bitcoin-not-gold-inflation-hedge-181625965.html November 2021; See also The Block Research Report (2022).

pegging in the stablecoins of the cryptocurrency market resembles the monetary base pegged to the basket of commodities in Hayek's private money. The idea of competitive money assumes that market forces will define the favorable currency that does not distort the lender–borrower relationship as winner–loser and vice versa.[22]

Studies in the cryptocurrency volatility propose flexibility in the supply schedule (for example, instead of the predetermined algorithm in which the proof of work is the primary driving force in the case of Bitcoin), similar to Hayek's elastic currency supply that responds to demand (Ametrano, 2016; Iwamura et al., 2019; Sams, 2015). Ametrano (2016) proposed an elastic supply rule for a crypto market stabilization policy in response to the demand-pull crypto volatility. Yet, the stabilization policy overlooks the purchasing power of the crypto holders as the number of coins in each wallet changes.

Issues of crypto volatility have remained one of the open areas in crypto economics (Iwamura et al., 2019; Pernice et al., 2019; Ametrano, 2016; Sams, 2015). Mita et al. (2019) argue that the algorithmic non-collateralized stablecoin, despite its promising features, observes purchasing power instability and do not use a robust technique to maintain the purchasing power (for example, Hayek money of Ametrano (2016)). Pernice et al. (2019) identified six stabilization techniques used by stablecoins targeted at the demand and supply dynamics: collateralization, interest rates, currency interventions, open market operations, dynamic block reward, and dynamically burned transaction fees. According to the survey, these coins with exchange rate targeting inherently fail by design, and their long-term sustainability to maintain stability is questionable. The basic supply and demand targeted crypto-design suffers from speculative market forces that inherently make the monetary system unstable. Given the target cryptocurrency's unstable exchange rate and purchasing power, short-term smoothing of exchange rates is viable to sustain the monetary system (Pernice et al., 2019).

Overall, despite the efforts to stabilize the programmable money through competitive forces, the protocols to date are limited concerning the purchasing power alignment with that of the coin dynamics in the wallets, pegging instabilities, or secondary market dynamics, in addition to the inherent protocol design stablecoins. Hence, further developments should consider this beyond the basic demand pull and supply push analysis. In the following section, we will present a specific case of stablecoin market inefficiencies by taking a crypto bank run and stablecoin collapse by analyzing the recent major stablecoin incidents of the Terra stablecoin.

[22] Critics argue that Hayek's monetary stabilization through competitive forces is not functional. See White's critics, for example, at White, Lawrence. "Larry White on Hayek and Money." Library of Economics and Liberty at https://www.econtalk.org/larry-white-on-hayek-and-money/ Accessed June 2022.

6 Stablecoin Use Case: The TerraUSD Collapse

The information sensitivity of cryptocurrencies is reflected in the wild price swings these currencies observe (Eichengreen, 2019). Stablecoins designed to neutralize this monetary system's sensitivity have evidently stumbled in providing a steady price. Consequently, the central issue of whether stability is maintained through the issuance of stablecoins is doubtful. Below, we will look closely into this by considering empirical evidence from the most recent stablecoin mega crashes.

Terra was created by Terraform Labs, a South Korean software startup seeded by the Terra Alliance, a collection of 15 Asian e-commerce companies headquartered in Singapore. Terra's development is overseen by the Luna Foundation Guard (LFG). It is a fiat-pegged algorithmic stablecoin that combines multiple international fiat currencies (US dollar, South Korean won, Mongolian tugrik, and the IMF's Special Drawing Rights basket of currencies) and cryptocurrencies, mainly Bitcoin, for steady price global payments. UST maintains its peg through an algorithm with 1-to-1 collateralization of the US dollar. In February 2022, the Luna Foundation Guard (LFG) of Terraform Labs started backing the currency with cryptocurrencies as a reserve. Back then, according to Terra, the LUNA private token sale raised $1 Billion for Bitcoin Reserve.[23] Terra's LUNA is used to maintain UST's peg.

The tokenomics works in such a way that when UST's price dropped below $1, Luna Foundation Guard, a non-profit entity established to safeguard the network, imposed a contractionary monetary policy of buying the UST with its Bitcoin reserves and lifting the value of the UST back the $1 US dollar parity. Specifically, the UST keeps its peg to the US dollar through algorithms and trade incentives, including a sister token, Luna. The mechanism of exchanging UST is that, instead of exchanging UST for its dollar value, required to exchange it for LUNA and vice versa. The protocol effectively incentivizes users to keep the pricing stable. For example, when UST trades above $1, investors are incentivized to burn LUNA to manufacture UST. When UST falls below $1, investors are encouraged to burn UST to create LUNA (Koinly, 2022). Since Terra's inception, this mechanism has resulted in immense expansion. The mechanics of UST meant that it did not need to be overcollateralized like DAI, and the amount of LUNA burned to make UST reduced supply, sending the price of LUNA skyrocketing (Koinly, 2022).

Further, it grew in popularity partly since individuals could earn up to 20% interest by lending it over Terra's Anchor Protocol (Kharif, 2022). However, this mechanism works in both directions. When the scales tilt the other way, the exact mechanism that generated LUNA's quick price increase can also cause rapid price drops, particularly in the event of UST de-pegging or a rapid decrease in UST supply.

Crypto price stability allows predictability of Defi applications and creates investor confidence in the digital asset industry. Counterintuitively, in May 2022,

[23] https://decrypt.co/93577/terra-says-luna-token-sale-raises-1-billion-bitcoin-reserve Accessed June 2022.

the algorithmic stablecoin TerraUSD collapse challenged the stability notion tied to cryptocurrencies of this form and left investors and regulators skeptical.[24] The crash led to a decline of more than 95% in the price of Terra's algorithmic stablecoin UST in a few days. The crisis wiped out more than $40 billion in market value, instantly imploding the second-largest blockchain with over $20 billion in value locked like the Lehman Brothers crisis (Kharif, 2022).

One of the main problems with cryptocurrency-backed stablecoins of this form is the potential lag of algorithms with the short-term demand. A crypto bank run (liquidating with lines of codes) following the fall in the price of $TITAN, a multi-chain partial-collateralized algorithmic stablecoin of Iron Finance, from above $60 to zero is a typical example we can raise here.[25] The downturn of its value is related to Defi Rug Pull, a crypto scam where founders pull out early or abandon the project.

The TerraUSD mega crash validates the limit in the predictive power and design of algorithmic stablecoin for a steady price. This further substantiates the main issues raised in the chapter in relation to stablecoins. We will look into this crypto crush from three different angels:

Ponzi scheme in Terra's trading incentives: The stablecoin project is susceptible to predatory pricing with the offer of a high return of 20% to the crypto investors who buy and lend UST to the protocol for a network effect in Terra's Anchor Protocol. Critics perceived the Anchor as a "promotion machine" for UST and claimed a Ponzi scheme with the limited capacity of Terra to sustainably cover all the investors. On the contrary, the UST slid from the dollar peg leading to the historic crypto bank run. The death spiral from this market shock drained about $40 billion in the combined market value of Terra's UST and Luna[26] and further affected the cryptocurrency market in general.

The decline in the price of Bitcoin: The seed to the crypto crush is also within the chain effect that came through its pegging cryptocurrency, which Fed's monetary policy affected. Figure 5.4 depicts the spillover effect on UST, which lost its dollar peg due to Bitcoin's price decline following the contractionary monetary policy of higher interest rates of the Fed. After the Fed announced a 50 basis point increase in interest rates, the Nasdaq continued to fall, markets had a pessimistic perspective on the economy, and the price of Bitcoin declined by about 10%. This further created a

[24] See Terra's UST Stablecoin Collapse and the US SEC's investigation with a claim of Terra's potential violation of the federal investor protection regulations at Bloomberg report: https://decrypt.co/102460/sec-terra-ust-stablecoin-collapse-report Accessed July 2022.

In addition to the USA, the TerraUSD collapse is under regulatory scrutiny by other countries like South Korea and the UK; see Analytical Insights

https://www.analyticsinsight.net/terras-collapse-has-triggered-regulatory-scrutiny-across-stablecoins%EF%BF%BC/ June 2022.

[25] https://www.coindesk.com/markets/2021/06/17/in-token-crash-postmortem-iron-finance-says-it-suffered-cryptos-first-large-scale-bank-run/ Accessed May 2022.

[26] Bloomberg News at https://www.bloomberg.com/news/articles/2022-05-27/terra-s-woes-prompted-in-part-by-celsius-activities-nansen-says#xj4y7vzkg Accessed May 2022.

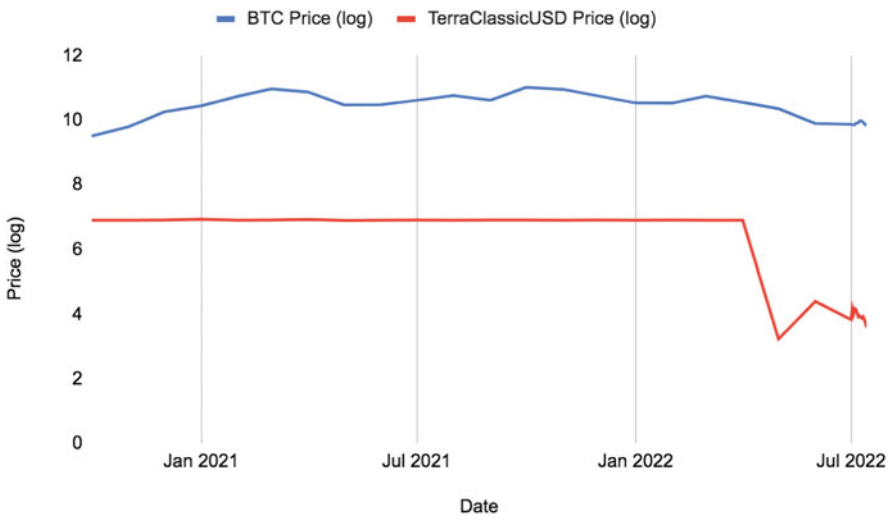


Fig. 5.4 Growth rate of BTC price Vs. TerraClassicUSD price. Source: Authors' composition based on CoinGecko's Bitcoin USD and Terra Luna Classic USD (Historical Data) until July 14, 2022

panic in the whole cryptocurrency industry. On May 8, the Luna Foundation Guard (LFG) announced they would make significant changes to their UST-3Crv liquidity pool in anticipation of a much stronger 4Crv pool. These created an arbitrage opportunity for the assailants. As more people withdrew UST from Anchor, the peg fell below $0.95. With the LFG using its Bitcoin reserves, the UST-3Crv pool swiftly smoothed. However, further price declines in Bitcoin led to a decline in the price of LUNA, similar to all other cryptocurrencies interacting with the bitcoin market. Market sentiment continues to deteriorate, culminating in a large-scale liquidation of LUNA and increased selling pressure on UST. This, in turn, shocked the UST-3Crv pool, where on May 10, Jump Trading and LFG ceased selling their Bitcoin holdings to stabilize the peg. As a result, UST fell to $0.60. Although the price eventually recovered, the UST-3Crv pool remained dangerously lopsided (91.37%/8.63%) (Briola et al., 2022).

The Celsius Network Effect: According to the Nansen research (2022), the de-pegging of terraUSD (UST) has more to do with the institutional inventors, like the Celsius Network, which withdrew a significant amount of UST from the Anchor protocol since April and more intensely on May 7. According to the Block, Celsius pulled about $500 million of funds from the Anchor lending protocol.[27] The on-chain evidence from Nansen shows speculative moves by "a small number of players" (seven identified wallets) pulling UST funds, bridging the funds to Etherium, swapping UST to other stablecoins, and exploiting the arbitrage

[27] Weeks R. at The Block https://www.theblock.co/post/146752/celsius-pulled-half-a-billion-dollars-out-of-anchor-protocol-amid-terra-chaos Accessed May 2022.

opportunities buying and selling positions between decentralized exchanges, and centralized exchange markets. This was partly a risk management strategy by the players that speculated turbulent macroeconomic and market conditions and arbitrage opportunities within the shallow liquidity in the market. Indeed, this is in line with the Fed's contractionary policy, which had a negative impact on the price of Bitcoin and the spinning effect on other cryptocurrencies.

Nansen research (2022) argues that this institutional bank run by concentrated players refutes the single hacker or attacker myth in the crypto market. Referring to the Celsius Network and another player on Ethereum, or the Curve UST inflow "initiator" wallet, Nansen stated that "The two identified wallets initiated significant outflow volume from Anchor Protocol during the de-peg event (May 7 to 10), totaling about 420M UST across 15 transactions. When cross-referenced with the bridging of UST from Terra to Ethereum, these two wallets were the top wallets that bridged through Wormhole."

The major lesson from this stablecoin collapse is that the market is prone to macroeconomic conditions (economic turbulence and stabilization policies) and microeconomic conditions (market forces and speculative measures by individual players). Moreover, the collapse was contagious with a spinning effect on some other related cryptocurrencies due to the crypto market panic. For example, Tether rushed to redeem $16 billion in USDT (another crypto bank run) and dropped below its $1 peg following Terra's collapse.[28] Such investor insecurities and prominent players' market responses that respond to the market shock will destabilize the market and further change the asset valuation dynamics across these crypto assets.

Although the USDT price quickly recovered to 1 USD, the market fluctuation depleted investors' confidence. Consequently, this led to crypto investor panic with a substitution effect where crypto whales in the USDT transferred funds to the USDC stablecoin (Fig. 5.5). In the graph, note the users' switches in May 2022 following the TerraLuna mega crash. According to Coinmetrix, during this time, crypto sharks (investors with sufficient skin in the game, which the firm identified as 147 Ethereum wallet addresses) increased their balances in USDC by more than $one million, while a proportional decline was observed in their USDT balances. According to Coinmetrix, about 14% of these crypto shark addresses (mostly exchanges, custodial services, or decentralized finance protocols) redirected at least $ten million balances from their USDS to USDC.

Thus, robust speculative and risk management mechanisms should be considered in these markets' design and investment decisions. Besides, clearly defined regulatory frameworks will shape the market with a centralized oversight of distributed value creations. For example, regulatory concerns for the crypto lending companies that operate decentralized networks remain open, with some not being regulated or underregulated. This has made the enthusiastic crypto investor vulnerable to

[28] See Canellis D. (July 2022), at Blockworks https://blockworks.co/the-historic-significance-of-tether-16b-bank-run/ Accessed July 2022 and Browne R. (May 2022) at CNBC https://www.cnbc.com/2022/05/12/tether-usdt-stablecoin-drops-below-1-peg.html Accessed May 2022.

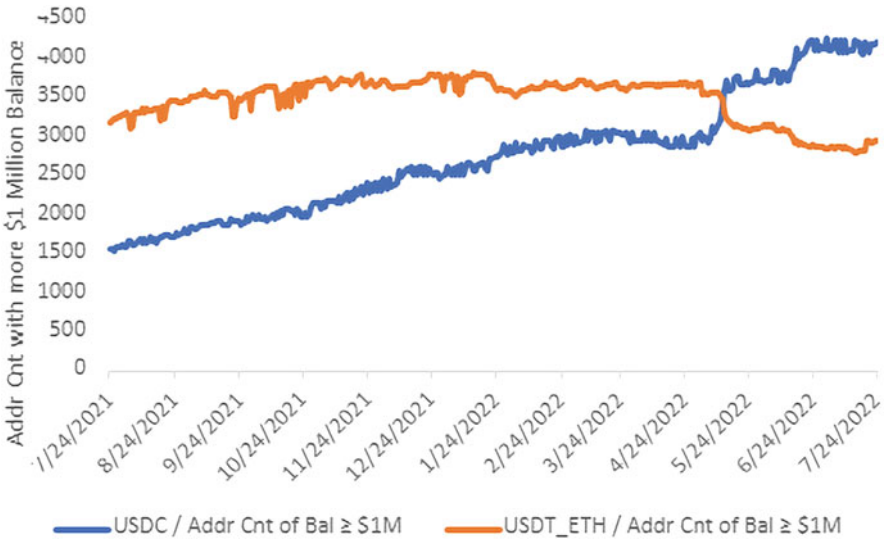


Fig. 5.5 Crypto substitution effect: UST market shock and the resultant stablecoin substitution between USDC and USDT the crypto sharks. Source: Authors' composition based on Coinmetrix Data for millionaire addresses in USDC and USDT https://charts.coinmetrics.io/network-data/ Accessed June 15, 2022

repeated crashes and resultant bank run insecurities across platforms.[29] While the regulatory sky in the crypto industry is not yet clear, the giant crypto lender, Celsius Network, and similar Defi providers BlockFi, Voyager, and Nexo are restricted from the banking industry following the cease and desist orders they received from the US regulators across different states.[30] As far as crypto bridging and Defi applications are concerned, traditional legal frameworks can be augmented in the context of the distributed network community.

Countries should consider a system designed to protect crypto investors against bank runs through (i) A strict deposit insurance that guarantees investors will be paid even if the platform cannot come up with the funds, up to a maximum amount per

[29] For example, *The Wallstreet Journal*, on May 27, 2022, covered a story "TerraUSD Crash Led to Vanished Savings, Shattered Dreams," reflecting on the crypto investor loss following Terra's "instant" market collapse. https://www.wsj.com/articles/terrausd-crash-led-to-vanished-savings-shattered-dreams-11653649201?mod=article_inline Accessed May 2022.

[30] Bloomberg News at https://www.bloomberg.com/news/articles/2021-09-23/kentucky-hits-crypto-lender-celsius-with-cease-and-desist-order#xj4y7vzkg Accessed May 2022.

The SEC "BlockFi $100 Million in Penalties and Pursue Registration of its Crypto Lending Product" https://www.sec.gov/news/press-release/2022-26 Accessed July 2022

Yahoo Finance, Voyagers' ban in Kentucky https://finance.yahoo.com/news/voyager-state-orders-voyager-continues-201700897.html Accessed June 2022

The Block, Nexo, and Celsius received cease and desist order from New York: https://www.theblock.co/linked/120972/new-york-joins-crackdown-on-crypto-lending-seemingly-targeting-nexo-and-celsius

account (remember the Ponzi scheme claim in Terra's trading incentives let alone the investor deposit insurance which is questionable); (ii) Similar to the traditional banking system, crypto lenders, have to be subject to capital requirements that the owners/founders of the platform hold substantially more assets than the value of capital inflow to the platform; (iii) reserve requirements that determine the minimum reserve ratio for crypto lenders to hold from in the capital inflow; and (iv) provided that the crypto platforms are integrated into the legacy financial system and that they abide by the banking regulation, a discount window arrangement is needed in the case the effect for the collapse is significant.

Moreover, transparency to investors and open data requirements for the stakeholders should be there in place. For example, in 2021, with the ongoing transparency issues, Tether, one of the crypto giants in the stablecoin market, was fined for misrepresenting its reserves, classifying it "a stablecoin without stability" (Canellis, 2022; Yaffe-bellany, 2022).[31] In such cases, regardless of the gray field in the developments of the market and advances in the protocol design underlying such markets, a clearly defined legal framework that fits into the dynamic crypto environment is needed.

7 Concluding Remarks

As economies migrate toward the digital economic system, the wave of innovation diffusion and digital transformation has stretched out to the conservative financial institutions redefining the notion of money and value creation. Following the "Satoshi Nakomoto monetary system," we have observed immense developments in the money market and clarification of the arsenal of digital assets. Despite all its promising features, the decentralized digital economic system suffered from extreme volatilities failing to resist internal and external shocks.

As a result, market volatility issues in the decentralized monetary systems have led to the emergence of the notion of stablecoins that aim at stabilizing this economic system through steady prices. Currently, multiple forms of stablecoins (both in protocol design and types of collateralization) circulate in the world of programmable money. In this chapter, by synthesizing the theories, practices, and empirical evidence in the area, we provide a holistic view of the stablecoins industry with an economic insight.

In spite of their intended goal of stability, over time, stablecoins suffered from volatilities in their primary pegging assets or algorithmic limitations to keep their peg. We identified six main concerns: crypto bank run, secondary market dynamics, spillover effects from the peg instability, regulation, market integrity, investor protection, a central point of failure, and potential manipulation risk. Moreover,

[31] See also, "Tether (USDT) has come under fire for being secretive about the assets in its reserve" at https://www.analyticsinsight.net/tether-will-disappear-soon-thanks-to-usdc-dominance-and-exchanges-dumping/

transparency issues on the side of the backers and investor maturity with the herding behavior remained open with regulatory oversight where investor protection is at the forefront of the crypto investment in general.

The recent Terra (LUNA) crypto crash will be a stepping stone to tighter regulation of the sector and further look into the industry's regulatory loophole. It is evident that the instant mega crash was spinning and stretched into the whole crypto market with significant crypto bunk runs and investor panic decisions. Similar to the conventional financial sector, the regulatory frameworks in this area have to be with due consideration for the approaches to financial stability. On the design element, stablecoins should adopt robust models of risk management for financial stability than the prominent practices of rug pulling or cross-platform migration of resources, leaving the investor vulnerable.

Regardless of the instabilities observed in the industry, the notion of stablecoins (even if not the ultimate solution concept in the field) is one of the most significant developments in the distributed economic systems observed. The notion lends opportunities to rethink programmable money design and neutralize market unrest through shock-resistant mechanisms. In a broader view, it holds promising features for countries where governments chase inflation by continually printing money that devalue their local currencies (for example, see the hyperinflation in Zimbabwe and Venezuela reflecting the limit in the Keynesian monetary policy).

A Systemic Review of Payment Technologies with a Special Focus on Digital Wallets

6

Tazish Fareed

Abstract

This chapter covers the digital payments' ins and outs, emphasizing digital wallets. Digital wallets are a relatively new phenomenon that has been keenly adopted by Gen Z, who have more comprehensive access to digital payment services than other generations. Some of the benefits of digital wallets include a reduction in crime, flexible means of payment, etc. Some of the costs include low financial and IT literacy and invasion of privacy. The chapter also illustrates the rationale for crypto wallets being the most popular form of digital wallets, which function through public and private keys and can be used conveniently to complete transactions. Furthermore, there are several categories of crypto wallets, namely chapter wallets, hardware wallets, desktop wallets, web wallets, and mobile wallets, which are either accessed in hot form (internet-based) or cold form (offline). The chapter also points out the privacy issues in a crypto wallet regarding losing the keys (addresses), which can largely be overcome through secret seed sharing or developing a multi-signature model. The chapter then suggests the critical implications of digital payments, which are rapidly moving towards a decentralized key management system (DKMS) in which the system can function through blockchain technology without any central authority commanding the execution of the transactions. In a nutshell, digital wallets are here to stay and expand in scope and size in years to come.

Keywords

Digital wallets · Payment Tech · Crypto wallets · Digital payments · Decentralized key management system (DKMS)

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1 Introduction

Digital finance has taken the world by storm. It is reliably predicted that mobile wallets are set to become the most popular source of point of sales transactions by the year 2024, accounting for one-third of POS transactions globally.

"According to data presented by Trading Platforms, digital or mobile wallet payment was the most used point of sale payment method globally, with a 21.5% market share in 2020. By 2024, mobile wallets are set to become even more popular, making one-third of all POS transactions worldwide."

The above statistics are mind-blowing for any reader but are not usually unexpected. As the financial world moves towards more and more digitization and less towards human reliance, the curiosity to innovate and provide technological solutions concerning efficient processing and payment of transactions is gaining strong traction today than ever before. It is commonly estimated that up to 21% of the world does not have access to banking services. On the contrary, the globalized world is now ready to leap beyond online banking, which is increasingly accessible to the majority of bank account holders across the globe. It is not unfathomable to gauge that the recent advances in newer digital payment options will change the lifestyle and income consumption pattern of many of us in the future. Instead of relying on traditional banking services, tech-savvy users are looking forward to the choice of creating their customized banks through the usage of digital wallets. Therefore, we need to delve into the details of digital payment technologies and understand the impact they will have on the global financial world in the coming years.

This chapter aims to inform the readers about the meaning, nature, and types of technological payment options, emphasizing digital wallets. Digital wallets typically use debit and credit services other than debit and credit cards. They use Near Field Communication (NFC), the internet, text messaging, or magnetic stripes to transmit the data. Some of the principal functionalities of a digital wallet include a photo, information and finger authentication, QR codes, and mobile and credit numbers saved on to the digital wallet.

The remainder of the chapter will focus on categories, challenges, and implications of digital wallets, including crypto-backed wallets. We will then conclude the chapter with a reference for the future direction of works in the field.

2 Background

According to some theories in behavioral finance, it has been established that an investor is not perfectly rational in decision-making due to various biases. The cognitive and emotional limitations would result in several biases affecting the ability to make prudent decisions in different situations. Digital wallets are a relatively new phenomenon that has captured the interest of many users, mainly from Gen Z, who are generally more tech-savvy than other generations. It is now being studied whether the existing behavioral investor biases could be mitigated with

the discovery of new payment solutions giving more freedom and control to the individual users. As per the theory of planned behavior (TPB), attitudes, perceived norms, and perceived behavior control could influence the behavioral intention in decision-making. It could also be used as a foundation for further testing in determining the intention of tech-oriented users towards using e-wallet transactions (Dalimunte et al., 2019).

Traditionally, legacy banking accounts have been the safest way to deposit and withdraw cash with personalized access. However, tech-savvy users are exploring various other means of online payment transactions. Those transactions can be made through modern accessories, including smartphones, watches, and other electronic devices. Therefore, we ought to cover the following areas to understand the increasingly popular phenomenon of digital wallets:

3 Traditional Payment Technology

The financial markets have undergone rapid transformation over the years, including deregulation, liberalization, and international capital flows. Cash being the most popular means of payment over many decades is no longer enjoying the same hegemony that it used to; other means of payment such as credit and debit cards have started squeezing cash out in the process. High denomination banknotes and coins are less in circulation due to rising minting and handling costs. The banks are scaling down their branches and sizes of assets to move towards a cashless economy (Fabris, 2019).

A traditional payment system typically involves the following parties: the consumer, the merchant, the consumer's bank, the merchant's bank, and the payment card network. The card stores the user's authorization data, allowing the consumer to use the credit or debit card. The cardholder transmits the payment authorization data, including the primary account number, to the merchant, which sends the information to the card network for authorization. Along each step, the funds being remitted will be reduced due to interchange, network, and merchant fees. It will then complete the payment flow to the intended user (Levitin, 2018).

4 The Digital Wallet Technology

Digital wallets make payments from credit and debit accounts using devices other than debit and credit cards. It increases the options for transmitting payment authorization data from a consumer to a merchant. The digital wallet can transfer data via Near Field Communication (NFC), the internet, text messaging, or magnetic stripes. NFC also offers the flexible usage of cryptocurrency; for instance, a tourist who does not have access to a reliable internet connection may be able to make a payment to the payee by utilizing the NFC payment. Digital wallets can also modify the nature of the information being transmitted to the merchant by masking the primary account number (PAN) to protect the consumer from being exploited by the merchant

through informational advantage. The wallet rules require merchants to accept card network payments from all devices without discrimination. The merchants cannot impose additional costs on the wallet provider, nor can they distinguish the type of wallet being used, which maximizes the flexibility and usage of digital wallets in comparison to traditional payments (Levitin, 2018).

5 Digital Wallets

A digital wallet can be defined as having public and private key access. A wallet essentially stores and gives the user the authority to access the key as the legal owner to buy and sell cryptocurrencies in different crypto exchanges.

Having a digital wallet gives the user complete control over the crypto coins. For example, a wallet can be used with an app to conduct all the necessary payment transactions with the log of all the transactions where the user can check the history of those sending and receiving payment transactions, including the updated balance, just like a digital bank account.

We will now discuss the nature of wallet keys. There are two main types of digital keys created by every crypto wallet, which will be discussed below:

5.1 Public Key

The public key hosts the "address" of your wallet, which is almost equivalent to the user's email address. Since it is public, it can be shared with anyone in the world without any hassle.

Any user can send some crypto coins or rewards by having access to your public key. It is akin to sending an Interac transfer with the help of an email address. Moreover, it can also be identified with a bank account number (public key), which can be shared with anyone to send and receive money.

5.2 Private Key

Unlike a public key, a private key carries password protection. The user must use the password to access the funds stored in her wallet. Just like we use the password to access online banking, the private key requires the user to enter the password to withdraw funds and send transfers through the wallet.

6 Literature Review

Levitin (2018) explains the main differences between a traditional payment system and digital wallets. It aptly identifies the conventional plastic cards as dumb wallets, whereas digital wallets work as smart wallets. Digital wallets are a two-way

communication between the consumer and the merchant, unlike plastic cards, which can only transmit one-way data to the merchants. Fabris (2019) describes the costs and benefits of a cashless society. The main advantages of a digital wallet include reduced crime, flexible means of payment, lower transaction costs, reduced black economy, and exponential growth of IT services.

On the other hand, low financial and IT literacy, cyber-crime, invasion of privacy, and other IT risks are the costs associated with these types of wallets. In India, e-wallets have been legally defined by the term "Prepaid Payment Instruments," where the stored value can be issued through instruments including smart cards, magnetic stripe cards, internet accounts, mobile accounts, and electronic vouchers, which can be used to access the prepaid amount (Pachare, 2016). Daragmeh et al. (2021) studied the relationship between the health belief model and continuous technology theory (TCT) to determine why consumers may continue to use digital wallets in the future. TCT is a robust technology acceptance theory that could help understand the motivations of digital wallet users post COVID as more and more users are adapting to a new normal, which largely relies on e-commerce and working from a home environment (remote work).

7 Functional Requirements of a Digital Wallet

Like any other user-friendly system, it is extremely important for a digital wallet to utilize those functionalities, which would make it easier to expand the base of wallet users. Some common functions that could be utilized in a digital wallet include photos, information fingerprint on a digital wallet, authentication with a fingerprint or a PIN, QR codes, top-up mobile numbers, and credit card numbers saved on to digital wallets. These features are also likely to enhance the credibility and integrity of the digital wallets' hardware/software/web-based system (Hassan & Shukur, 2019).

8 Digital Wallets: State of the Art and Innovation Diffusion

Cash payment has been the primary way of payment for many years; however, we have steadily moved towards other means of payment such as credit and debit cards. Visa and Master cards are the major market players in payments through card-based transactions. The card-based payment system has several advantages, including customer protection, installment payments, and the possibility of a refund. Since Information technology has been flourishing at a rate of knots, it has paved the way for other innovative products, including digital wallets, to grow their sphere in the world of online payment substantially. All of this has happened because our modern lifestyle is adapting to the acceptance and diffusion of information technology like never before.

In the age of Gen Z and millennials, it is not too surprising to notice the emergence of digital wallets (see Fig. 6.1 for the survey conducted on digital wallet

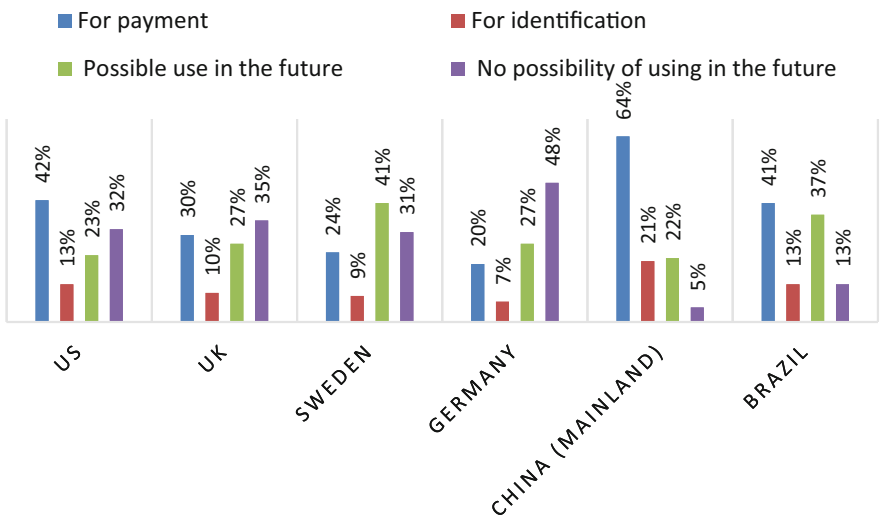

Fig. 6.1 2021 Digital wallet use in selected countries. Source: Author's development based on Statista Global consumer Survey as of GCS Special: E-commerce, 2021

use of selected countries, which shows the tests and preferences of digital wallets among respondents above the age 18). As the reach of the internet gets bigger and wider across the globe, most of us can easily use the internet and are increasingly using the online payment platforms to do a virtual transfer of money. The advancements in payment technology have led to the emergence and growth of digital wallets in cryptocurrencies. The industry involves sending keys to a user with every transaction recorded and stored in the blockchain.

If we compare traditional payment methods and cryptocurrencies, the biggest reason to use digital wallets is reduced transaction costs, much less than commissions paid to conventional payment systems. Compared to mobile banking, which does not provide PKI (public key infrastructure), decentralized cryptography networks may have a higher level of security from identity theft. The traditional payment system still has wider acceptance and centralized authority that approves the transactions, whereas the crypto payment system is limited in reach with the feature of a decentralized network. Crypto payment systems hold a substantial advantage over traditional payment, with the former making instant payment of transactions while the latter generally takes a couple of days to process the transactions (Jokić et al., 2019).

9 Categories of Wallets

We are now going to discuss the main categories of wallets: Hot Wallets and Cold Wallets. Hot wallets can be accessed via the internet only, whereas cold wallets can be accessed in an offline environment.

Furthermore, we can relate the hot and cold wallets to five additional types of crypto wallets, which will be discussed shortly.

1. *Chapter wallets*
   As per the research on online finances, there are more than 68 million users of global crypto wallets in the year 2021, and the number has been substantially increasing each year. The most basic wallet is referred to as "Chapter Wallet." A chapter wallet is created when a user writes/prints a public address and a private key(s) on a piece of the chapter. Since it works offline, a chapter wallet is classified as a cold wallet. However, the chapter wallets are not the best source of storing the private keys as they could be tempered with, and the writing could be indiscernible in some cases.
2. *Hardware wallets*
   According to Mordor intelligence, the global hardware wallet market was estimated at USD 202.40 in 2020. It is expected to reach USD 877 million by 2026 representing a cumulative average growth rate of 29%. Hardware wallets use secure hardware devices to store the keys. Since the keys are stored offline, they can also be classified as cold wallets. One striking characteristic of the hardware wallet is that it can remain connected and store keys despite being affected by malware. However, there is a cost to purchase the hardware wallets as they are trendy among the users due to their safety and security features while storing the keys for a long time. Some of the well-known hardware wallets include ledger nano-x, trezor model 1, safe pal, etc. It is estimated by finances online that Ledger Nano X and trezor, combined, support more than 600 cryptocurrencies through various means of systems and applications.
3. *Desktop wallets*
   Desktop wallets are software programs that are installed on computers. The user can store the private keys in the software and can access it just like any other software. The keys will also remain secure if the PC device remains unaffected by any virus. Some of the examples of desktop wallets are Guarda wallet, exodus wallet, coin-base wallet, wealth-simple wallet, etc. Guarda wallet is the most popular desktop wallet, supporting up to 42 cryptocurrencies.
4. *Web Wallets*
   Web wallets are functional through wallet-provided servers and can access via a web browser or application. These wallets are handy to use and accessible worldwide with internet connectivity; hence they belong to the category of hot wallets. While they are generally user-friendly, web wallets do not provide control over the private keys to the users. The third-party service provider is entirely responsible for maintaining the integrity of the users' private keys. In case of unforeseen circumstances where the servers become compromised, the users could lose access to the funds in their web wallets. Therefore, these wallets are at times vulnerable to hacking and cyber-attacks, making them less secure to secure private keys. CryptX wallet is the most dominant form of web wallet that caters to 90 different cryptocurrencies through different platforms.

5. *Mobile Wallets*
   Mobile wallets are software applications that can be installed through google play and the app store on android and ios. Private keys are stored in the device, classifying the wallets under hot wallets. Helium mining is a classic example of a mobile wallet. Some common examples of mobile wallets include unstoppable wallets, Freewallet, coinomi, and coin-payment wallets. Indestructible and free wallets provide access to more than 100 cryptocurrencies each through ios and android applications.

10 Privacy and Security Issues in the Digital Wallet Usage

Since the private key is crucial to the working of the wallet, what could happen if somehow it were lost? The answer is straightforward: one could lose all access to the funds stored inside the wallet.

For instance, every crypto wallet provides twelve list-of-words (also commonly known as "seed phrase") during the initial installation, which is used to regain access to the funds stored in the wallet. Hence, it is important that those words need to be stored in a very safe place, either in the form of a file, snapshot, or a piece of a chapter. Rezaeighaleh & Zou (2019) discuss that a hardware wallet is the most secure form of key management among all wallets. One option to safeguard the privacy and breach of wallet security is secret sharing which allows splitting seeds into multiple parts which can be stored separately. Another solution is having a multi-signature model where a user uses multiple private keys with a threshold (e.g., two of three) to sign a transaction; if the user loses one (or more) of the keys, she still can protect their funds.

10.1 Implications for the Payment Technology

Traditional payment technology has relied on centralized repositories, resulting in security breaches, loss of data, and substantial costs for the users. With the emergence of digital wallets, we are moving towards a decentralized key management system (DKMS) through which one party alone cannot jeopardize the entire system's security. The decentralized system can easily work with DKMS through blockchain without a central authority. It is also expected that in the future, we are moving towards a trusted and secure processing environment which is a combination of software, hardware, and protocols within a device/cloud-based environment to ensure safe storage of secret information (Soltani et al., 2019).

11 Conclusion

In this chapter, we have discussed the increasingly popular phenomenon of digital wallets that rapidly attract the attention of tech-savvy users. The chapter also highlights the differences between the traditional payment system and a digital

wallet system, essentially the application of centralized versus decentralized transmission and the processing of the transactions. The chapter describes the concepts of public and private keys and the functional requirements of the wallet system, which are managed through various platforms. The chapter also points out the role of technology and globalization, in leading to the acceptance of digital wallets, especially among millennials and Gen Z users. The chapter also discusses at length the various categories of crypto-based wallets that are supported by scores of cryptocurrencies. Due to the recent increasing usage and size, we can safely conclude that digital wallets have contributed tremendously towards society's larger benefits despite some unresolved privacy and legal issues. In the end, we expect the use of digital wallets to increase further in the years to come, and the focus is likely to shift towards the full-proof and efficient execution of transaction payments seamlessly.

Blockchain Tech-Enabled Supply Chain Traceability: A Meta-Synthesis

7

Amit Kohli, Pooja Lekhi, and Gihan Adel Amin Hafez

Abstract

This research conducted a literature review on blockchain technology in small and medium entrepreneurs. It is a vital revolutionary technique that recuperates the food supply chain traceability process. More than 50 research revolving around food traceability were analyzed. This paper discussed the complexity of food traceability and food safety, the technical aspects of implementing blockchain, and the benefits and boundaries in applying food traceability using blockchain revolutionary technology. A straightforward implementation blockchain food traceability plan is jotted for medium and small food firms.

Keywords

Blockchain · Contaminations · Transparency · Decentralized applications, immutability

1 Introduction

Related to the complexity of the food traceability system, many countries issued legal standards and regulations to protect the customers from contamination and foodborne diseases that affect the customers' health and even their lives, as mentioned by Research Blog (2020). At the same time, the high demand for an effective food traceability system that offers an integrated view of the system opened a wide door for the priority to implement the revolutionary blockchain food tracing technology that offers practical, decentralized immutability, pure transparency system.

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The chapter intends to demeanor a literature review on using blockchain technology in food supply chain traceability systems. More specifically, we aim to (1) catch a birds-eye view of the food supply chain traceability complexity and emerge a high priority to apply the revolutionary blockchain technology related to the food traceability system; (2) illustrate the core advantages and boundaries of implementing a blockchain food traceability system. And (3) draw a crystal clear plan in launching blockchain technology in small and medium food supply firms.

There are three segments in this research: the complexity of food traceability system, system design and implementation techniques, the driving benefits and challenges of using the blockchain in food traceability, and finally, draw precise, realistic plan requirements to embark on the blockchain food traceability system.

2 Literature Review

Food safety considers the core milestone in the traceability system because of the contamination of toxins that can spread so fast (Gisela & Blazekovic-Dimovska, 2017). Many types of research have focused on the role of blockchain technology in food traceability in giant food firms. While Alissa (2018) addressed using the effectiveness of using blockchain in one of the most sensitive foods—the Garber Baby Food produced by Nestlé, Agricultural Informatics (2020) declared the process and the steps of overcoming challenges concerning the mango tracing supply chain in Walmart using blockchain technology. Moreover, Wilson and Auchard (2018) emphasized food safety management and time-saving in applying blockchain traceability in the chicken and eggs lines in Carrefour. The Bumble Bee Seafood Company (2021) mentioned that a crystal clear transparency seafood traceability vision had been created by blockchain technology, and Shamla Tech (2020) emphasized on the secured, free contaminated and foodborne fresh food blockchain traceability system.

On the other hand, the role of blockchain technology in food traceability for SMEs has not been elucidated. More research has to be addressed related to this area. The medium and small food enterprise requires detailed information concerning the benefits, including cost-saving, challenges, and boundaries, and an exclusive implementing plan of adopting a blockchain food traceability system.

Food traceability considers the core value of the food supply chain. It has to be secured and transparent from the production stage until it reaches the end customers. This will allow the operation management to adjust and correct any problems immediately. At the same time, an ineffective traceability system may mainly cause contamination and foodborne to the exclusive products that lead to death or illness. Furthermore, it will increase the cost consumption and decrease profits related to the waste of the contaminated, spoiled products and the disappointed customers' experience. While the blockchain revolutionary technology worked to eliminate the above challenges and develop safety management in the large firms, the traceability of the food supply chain still confronts middle and small firms.

Table 7.1 Complexity in Food Traceability

Food Traceability System—considerations	Illustration	Reference
Legal standard and regulations	Every country settled its own mandatory traceability rules and regulations and dropped documentary requirements to protect its citizens and people living in its territory. The traceability system that may work in one country may face boundaries.	Behnke and Janssen (2020)
Food and Drug Administration (FDA)	It enables the operation team to deduct the food product one step behind or ahead only.	FDA (2020)
International Organization for Standardization ISO 22005: 2007	It is a tool that allows food firms to deduct the history of their products.	PECB, University, (2014).
High customers awareness	Nowadays, customers prefer to deal with ethical firms that serve the community and save the environment.	Alfian et al. (2017)
High customers demand	The customers may not receive a product of high quality at a reasonable price as before. Today customers are looking to know the whole story of their purchase product.	Opara and Mazaud (2001)
Enormous channels of big data	The large scale of ample data storage restricts and confines the flow of massive data exchange among all participants in the supply chain.	Jarschel et al. (2020)
High risk of food contamination, foodborne, and food waste	The cost of food containing foodborne and nation food waste is overwhelming legally, ethically, and monetary. Moreover, it extends to the firm brand name and may lead to complete bankruptcy.	Yu et al. (2020)
Open door for illegal aspects and fraud procedures	Food fraud requires attentive tactics to detect and avoid it before it extends to be rigid food crime.	Van Ruth et al. (2017)

Note. 7.FDA Food and Drug Administration, From FDA, 2020. Copyright 2020 by US Food and Drug Administration
ISO = International Organization for Standardization, From PECB University, 2014.

The dark effect of foodborne caused 76,000,000 illnesses and 325,000 hospitalizations. Moreover, it killed more than 400,000 adults and 18,000,000 children in 1998. Furthermore, The Government of Canada (2020) reported the leading causes of food contaminations. Food traceability is a complex critical process that has to follow varieties of rules and regulations, manage big data and entirely avoid or eliminate the risks of food contaminations, foodborne, and food waste while satisfying the customers' awareness, as illustrated in Table 7.1 and Fig. 7.1 depicts the high risks of foodborne and contaminations.

In Fig. 7.1, Graph 1 depicts the foodborne darkness effect in 1998. Adopted from "Food-borne diseases are caused by many agents such as bacteria, viruses, parasites, and fungus that enter the body and cause illness. Food Safety in the 21st Century,"

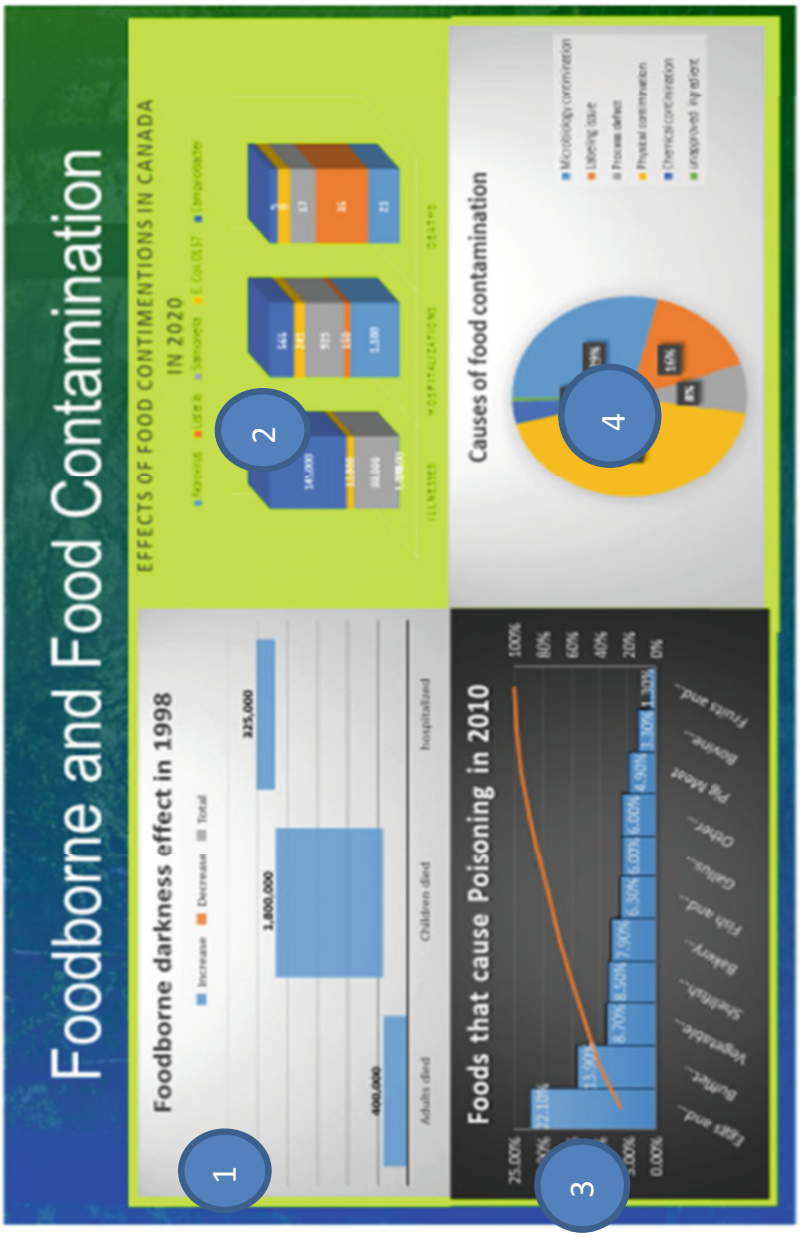

Fig. 7.1 The high risk of food contaminations and foodborne. Source: Composed by the authors

by Gisela & Blazekovic-Dimovska, 2017; Graph 2. Effects of food contamination in Canada in 2020. Adopted from "Fact sheet: Traceability Safe Food for Canadians Regulations Requirements for the Safe Food for Canadians Regulations," by Government of Canada, 2019; Graph 3. Main food types that cause poisonous. Adopted from Gisela & Blazekovic-Dimovska, 2017; and Graph 4. Causes of food contaminants. Adopted from "Why Our Food Keeps Making Us Sick America's food industry has a $55.5 billion safety problem," by Kowitt, 2016, Fortune.

3 The Advantages and Challenges of Implementing Blockchain in Food Traceability System

Many motivations can drive food firms to implement the revolutionary blockchain technology in tracing their food supply chain regardless of their size. Table 7.2 illustrates the main advantages of implementing the blockchain: transparency, decentralization, cost- and time-saving, effective food safety management, and high customer satisfaction. At the same time, Fig. 7.2 declares the effects of implementing blockchain technology in the food traceability system using a fishbone diagram.

The fishbone diagram in Fig. 7.2 below depicts the blockchain food traceability system in terms of managerial, cost and time efficiency, security and sustainability of operations.

On the other hand, the challenges that may restrict applying the blockchain in food traceability are high initial cost, limited knowledge, and regulatory issues, as illustrated by Nestor (2021) in Table 7.3.

4 Implementing Blockchain Food Traceability Systems in Small and Medium Enterprises (SME)

The execution of the blockchain food traceability system plan begins to settle the food firm's goal and determine the required data by answering the 4 W's questions as illustrated by TE Food (2020). What is the vital data that must be stored?

When can this data be collected? Where is the information that must be gathered? And why is this valuable data to all supply chain participants?

Once the above questions have been answered, the operation team has to identify the proper tools to pile up the required data as written by João & Pedro. These tools can be a variety of types of sensors, smart cameras, pallet-level tagging, barcodes, radio frequency identification (RFID), and even food-sensing technologies that deduct any contaminations as written by IGPS (2020) and Arrow (2020).

The technical tools that will support the system have to be identified, too, as illustrated by Microsoft (2020), followed by installing the Modum.io AG that will combine gathered data and implement it in the blockchain technology as written by Bocek et al. (2017). At this time, the hashed-related blocks will be created, and data stored there securely. Finally, output mobile devices will be required with all

Table 7.2 The driving advantages of applying blockchain in the food traceability system

Major Concern	Driving Advantages	Reference
Sustainability and transparency	Blockchain technology traces the food product from fam to fork using extreme visibility while the probability of changing stored data is eliminated.	Feng et al. (2020).
Decentralization	All participants in the food supply chain can interact directly without intermediates, which saves time, cost, and effort.	Prashar et al. (2020)
Secured	Blockchain is fully secured since data is stored in strongly connected sequencing blocks. Every block carries the data of the previous one, which in turn eliminates hacking procedures.	Tao et al. (2021).
Cost-saving and lower expenditure	The cost of contaminations, foodborne, losing customers are painful. Still, a blockchain-effective traceability system can be entirely avoided. It allows the operation team to deduct any defect in the supply chain within seconds and adjust it immediately.	Demestichas et al. (2020) and Panuparb (2020).
Time-saving	The clear vision deducting of any defect in the supply chain may take seconds while it may take hours or even days in the traditional traceability system. Furthermore, it eliminates bottleneck time-consuming.	David et al. (2022)
Immutability	Blockchain technology guarantees fixity traceability data that can't change by any participant. This eliminates fraud procedures and shapes a trustful energetic food traceability system.	Caro et al. (2018), Pearson et al. (2019).
Efficiency	Blockchain stores and shares data effectively while using smart contracts to facilitate the work and allow sustainability.	Friedman and Ormiston (2022).
Effective food safety management	By using blockchain technology, the detection and response time for any contaminations or foodborne will be within minutes or even seconds, allowing the logistic team to get the accurate decision to adjust the process immediately.	Lin et al. (2019); Feng et al. (2020).
Consensus	All data onto the blockchain requires a covenant from all participants where the sole control power is not restricted to one hand.	Yiannas (2018)
High customers satisfaction	While the main goal for any firm is to create and maintain loyal customers, this can be achieved simply by applying blockchain techniques that enable building trust in the producers–customers relationships by offering a clear vision about their products.	Tayal et al. (2021); Stranieri et al. (2021)

Source: Composed by the Authors

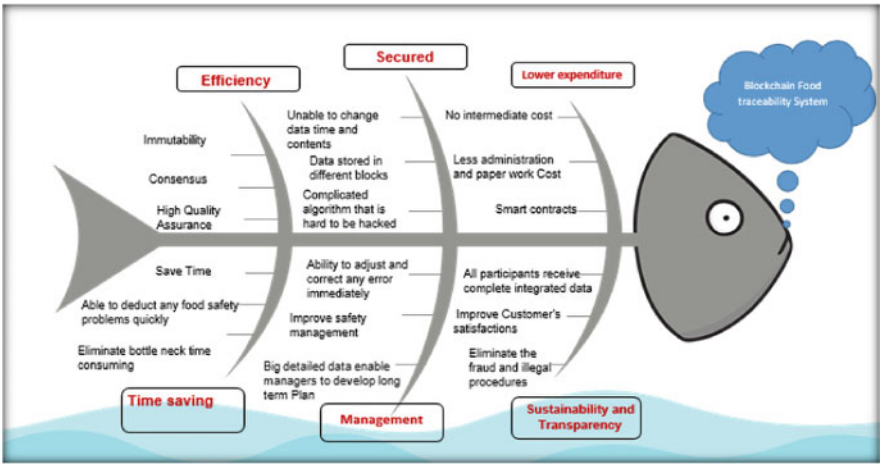

Fig. 7.2 Fishbone diagram: The advantages of blockchain food traceability system. Source: Composed by the authors

Table 7.3 The boundaries of implementing blockchain food traceability system

Major concern	Main challenges	Reference
High initial cost	While initiating any new technique is costly, the same concept applies to blockchain revolutionary technology.	Tan et al. (2020); David et al. (2022)
Limited knowledge	Since blockchain is a new technology, there are scarce professional human resources who know the process.	Hastig and Sodhi (2020); Stranieri et al. (2021)
Regulatory issues	Since the blockchain is a decentralized system that doesn't require intermediate to facilitate the process, it requires regulatory issues to manage the whole process among all participants.	Van Hilten et al. (2020); Van Hilten et al. (2020).
Privacy concern	Since the blockchain technique depends on high transparency among all participants, it faces redundancy and a lack of privacy.	Rejeb et al. (2020)

Source: Composed by the Authors

participants to integrate the system and reflect a crystal clear vision of the supply chain in all its stages, as written by Tapscott (2017). Table 7.4 briefly illustrates the putting into practice steps of the blockchain food traceability system. At the same time, Fig. 7.3 depicts the stages of launching a blockchain food traceability plan.

Table 7.4 How to implement a blockchain food traceability system

Implementation steps	Declaration	Reference
Determine the required data	What information is needed? When does it have to be collected? Where has it been gathered and recorded? Why is it vital information in the supply chain?	TE Food (2020).
Identify the tools of collecting data	PH sensors (soil type and condition) Accelerometer sensor GPS sensors Temperature monitoring Smart cameras Pallet-level tagging Barcodes Radio frequency identification (RFID) Food-sensing technologies that deduct any contaminations	IGPS (2020); Arrow (2020)
Technical tools	Enterprise resource planning Dashboards Business intelligence Internet of things (IoT) technology (inventory management) Automated storage and retrieval systems Warehouse management systems	Microsoft (2020); van der Lans (2019)
Modum.io AG	Combine the gathered database to the blockchain after issuing smart contract Ethereum blockchain network PostgreSQL HTTP servers that host an Ethereum node Application programming interface	Bocek et al. (2017); Bitcoin (2020); Start up (2016).
Mobile devices	For all supply chain participants to trace the food supply chain Send all the traceability details to the end customers.	Jason (2020); Research Blog (2020).

Note. Modum.io AG = Modum offers digital supply chain monitoring and analytics by Start-Up, 2016

5 Conclusion

A literature review on implementing blockchain revolutionary technology in food traceability systems that consider the effective strategy for medium and small firms' development and expansion was conducted in this paper. The complexity of the food traceability system and the high risk of food management created an urgent demand for transparency integrated and secured traceability techniques. Blockchain technology has fully offered this, driving fruitful rewards and a brief implementation plan.

Fig. 7.3 The steps of launching blockchain food traceability plan. Source: By author. Note. Modum.io AG = Modum offers digital supply chain monitoring and analytics by Start-Up, 2016

Furthermore, this paper mentioned the boundaries of implementing blockchain technology and illustrated how to reduce or eliminate it.

The limitations of this research are represented mainly by the scarcity of adopting blockchain technology in the food traceability supply chain in medium and small firms. Moreover, there is a significant gap in the research on how blockchain food traceability technology works as a vital key growth concept for medium and small food firms.

In addition, more consideration and research should be focused on plans, benefits, and challenges in implementing blockchain food traceability technology in medium and small firms. Future research can focus on how to integrate and enforce blockchain food traceability and logistics procedures to medium and small firms' growth and development.

Part III

Fintech and Defi-Issues, Policy, and Regulatory Insights

The Surge in Blockchain-Based Patent Applications: Booster or Bumps?

8

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Abstract

This chapter discusses the evolving distributed patent system built on blockchain technologies. By looking into the theories, practices, and empirical evidence, the chapter provides an in-depth analysis of the patent and property right schemes that create artificial excludability of resources with externalities using distributed ledger technologies. Here, we provided a holistic view of the blockchain-based patent system, emerging industry trends, and the relationship between the patent system and other markets under the technology life cycle. The relationship with other markets implies that a patent preserves initial incentives to make and commercialize inventions but could cause bumps slowing down the technology adoption and evolution. Further, we reassert the potential corporate blockchain-based patent systems hold for the financial stability of cryptocurrencies. These forms of currencies absorb the shocks in related markets; hence, corporate blockchain patents can help change the market dynamics and stabilize the market. Besides, we analyzed the allocative efficiency with self-enforcing protocols by changing the rules of the game through smart contracts and incentive designs that lead to an optimal outcome in the distributed patent system. This will lead to allocative efficiency as opposed to the conventional centralized Pareto optimal outcomes of the centralized patent system, which leads to sub-optimal outcomes. Based on our analyses, we argue that blockchain and its underlying features hold

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significant potential for traceability, timely retrieval, immutable records of the title of ownership for the lifecycle of property rights and patents, together with the smart contracts that help redefine the rules of the game in the patenting system.

Keywords

Blockchain patent · Digital copyright · Property right · Smart contract · Distributed allocative efficiency

1 Introduction

Although blockchain technology started with the cryptocurrency Bitcoin in 2008, relatively few blockchain technology patents have been issued in the early stage. Blockchain technology, separated from the currency in 2014, evolved into a new distributed, decentralized, trustless technical solution and expanded its application beyond currency, and afterward, worldwide capital investment actively swarmed into blockchain technology in 2015. All advances led to the surge in blockchain patent applications in 2016 from a handful to some 134, and the six consecutive years followed saw new records of blockchain patent applications by patent offices at the national and worldwide levels. Based on the World Intelligent Property Organization statistics database (WIPO, 2022), there have been a record 9973 global patents related to blockchain filed in 2021 (ending 30 September).

The World Economic Forum (WEF, 2020) believes technology such as blockchain "will benefit all countries currently impacted by COVID-19," as it provides an efficient approach to reducing trade costs on a global scale. Canadian spending on blockchain solutions is forecast to amount to over eight hundred Canadian million dollars by 2023, growing at a five-year compound annual growth rate of 73.3% (Kirkwood, 2019). Moreover, global spending on blockchain solutions is predicted to grow from 6.6 billion US dollars in 2021 to 19 billion US dollars by 2024 (Statista, 2022). Thus, the anticipation of sustainable, innovative solutions utilizing blockchain technologies across industries beyond financial institutions and technology sectors would contribute to the astounding amount of blockchain patents submitted, and patents are the best way traditionally to protect innovation and investment.

On the other side, blockchain patent applications experienced a low patent approval rate during the take-off phase of blockchain technology. In addition to time constraints (around 18–30 months from application to grant), the arguments about the patentability of blockchain technology (such as rejected as "abstract" and found to be simply "organizing human activity" or merely using generic computer functions) and anti-patent sentiment over blockchain's open-source nature complicated the patenting issues (Andrew Rapacke, 2022). Since blockchain technology continues to emerge and evolve quickly, making patent applications secure technological investment and when to patent are the essential questions confronted.

This study examined new trends in blockchain technology patents and preliminarily explored the location of patent activity in the blockchain technology development path, and suggested generating a panorama of the landscape of patent strategy within an ecosystem of the blockchain industry after rethinking the role of blockchain-based patent and barriers in the surrounding technology development.

Blockchain technology revolution, patent activity, and centralized patent system.

Blockchain technology originated as a disruptive innovation in the financial economy and provided a solution using its distributed nodes to store, verify, transfer, and communicate network data independent of third parties, such as financial institutions. The innovative importance of blockchain and the fact that it is an open-source technology has strongly encouraged the development and use of this technology in many applications. Currently, its applications go beyond the cryptocurrencies and finance field, ranging from supply-chain-related industries (Kshetri, 2021; Queiroz & Fosso Wamba, 2019), e.g., the airport industry or food industry, to management disciplines such as healthcare or production. Blockchain is expected to be available in Industry 4.0 with a new ecosystem building on the distributed ledger technology, smart contract, decentralized application, etc. Blockchain is more a change of concept and remodeling of some industries to some extent. Some researchers called the technology relating to the blockchain "General Purpose Technology" (GPT), that is, a key technology for the evolution of humanity. Such an essential technological field has a significant impact on patent applications.

A patent is an exclusive right granted by a government to the inventors to prohibit others from making, using, or selling their inventions within a certain period and, therefore, to protect the intellectual property rights of the inventors (WIPO, 2019). The original purpose of patents was to encourage innovation, which, in turn, is supposed to produce more innovation (Macdonald, 2004). A group of patents on a particular technology represents the scientific and technological knowledge accumulated in that technology (Kim & Bae, 2017). In the international business field, patent strategy is one of the business management strategies explored while facing competitors in the global market. The empirical studies have revealed that proprietary strategy, defensive strategy, and leveraging strategy are dominant with the various motivation of patenting activities in different products or industries (Somaya, 2012; Veer, & Jell, 2012; Ceccagnoli, 2009; Blind et al., 2006; Reitzig et al., 2007).

From an institutional perspective, several patent systems applied in US Patent and Trademark Office, European Patent Office, and World Intellectual Property Organization prevail and feature a centralized structure which leads to well-known inefficiencies, including production problems and low-quality patents. The dynamic growth of the technology frontier and the pursuit of efficient technology management challenge the current centralized patent system. Blockchain technology offers new opportunities to rethink how all relevant parties involved are organized and collaborate in patents, such as the inventor, the government body, the assignee, and any entity designated by the government regarding information about technological innovations and their rights of use. How blockchain technology leverages patent

management has been neglected, although it holds great promise (Denter et al., 2022).

2 Blockchain-Based Patents and Digital Asset Market Stability

The cryptocurrency market is responsive to the changes in the institutional blockchain-based patents implying that the shock in the related markets reflects with demand push effect on the side of the investors. According to Hu et al. (2021), institutional blockchain patent developments significantly affect the volatility of cryptocurrencies like Bitcoin, which absorb the shock rather than being transmitter. The largest share of patent volatility spillovers comes from established corporates like Microsoft, Mastercard, Intel, and Visa with patent development.[1] Hence, corporate blockchain-based patent developments have a spillover effect on the cryptocurrency markets, which reflects the positive patent market shock in their prices. It will be interesting to have institutional venues where corporates (as centralized tools of market adjustment) can influence the asset valuation and market stabilization of digital assets in the wildly volatile distributed networks. This is due to the speculative nature of this market. Note that the crypto market is known for its herding behavior and proliferate hype coins will tend to benefit from this with the investor confidence being boosted as it sees the big elephant in the game. Considerations in relation to this are potential corporate market manipulation risks and efficiency in the patented product and its connection with the target digital asset market.

3 Allocative Efficiency and Decentralized Patents

The economic intuition behind externalities arising from public good is to achieve allocative efficiency under the core economic problem of scarcity and further address the issues of free-rider and tragedy of the commons for non-excludable goods. The tragedy of the commons arises either due to the differences in social and private incentives or externality.

Property rights are one of the allocative efficiency methods used to achieve efficiency from common resources (Bade & Parkin, 2007). The absence of property rights causes a market failure; the government can potentially solve the problem by using permits, restrictions (like restricted hunting seasons), and public provisions (like national defense).

[1] See "Cryptocurrency Patent Examples from Top Companies," Blockchain Patents at https://arapackelaw.com/patents/blockchain-patents/cryptocurrency-patent-examples-from-top-companies/ Accessed July 2022.

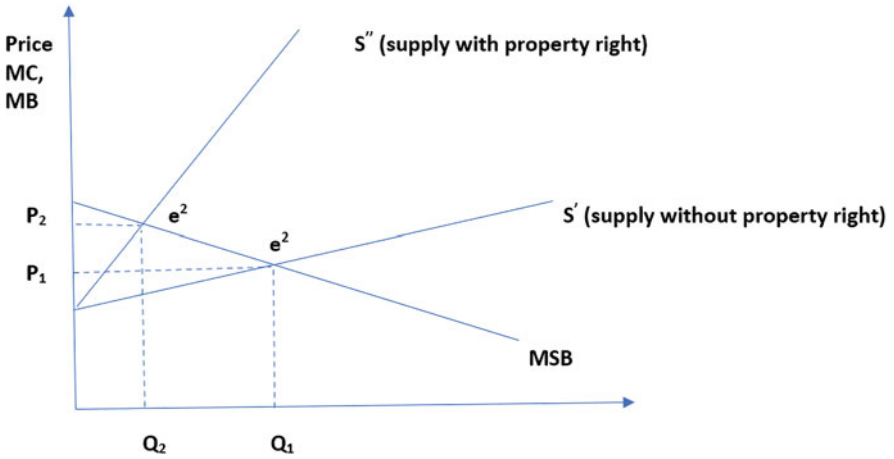

Fig. 8.1 Property rights in public goods and allocative efficiency. Note: S″ is the new supply with property rights which makes all costs private cost leading to the marginal (private) cost (MC) equating to the marginal social cost (MSC). This will lead to a new equilibrium with higher marginal social benefit at P_2 that reduces the overuse of the common resource. Source: Authors' development

Property Rights will help resolve the tragedy of the commons issues by converting the common resource into private property. This will make the right owner incur the full social cost of her actions and lead a competitive market to a Pareto optimal outcome. Based on the optimality analysis, the supply curve for the common good can be derived from the marginal social cost curve, which interacts with its twin force, the marginal benefit of ownership for the efficient allocation of the resource at equilibrium (see the graphical illustration in Fig. 8.1).

If property rights are not well defined, commonly owned resources lead to allocative inefficiencies resulting in the principal issues of free-rider and tragedy of the commons. In a centralized system, political equilibrium is achieved through two different governance theories for efficient public provision. These are (1) The Social interest theory: well-informed voters refuse to support inefficient policies leading to efficient public provisions and (2) the Public choice theory: centralized resource allocation through the government parallels market failure leading to allocative inefficiency (deadweight loss). Governments in centralized systems grow because of voters' income sensitivity to public goods, leading to over-provision of these goods. This has led to the privatization notion that allows for the shrinking of the oversized government. This will bring us to a decentralized economic system where self-enforcing protocols can achieve efficiencies.

In non-excludable goods, tragedy arises due to the absence of incentives to prevent the overuse and depletion of a commonly owned resource. The increase in the infringement of digital works and loopholes in the digital property rights protection techniques call for dynamic technological solutions that facilitate an efficient and timely determination and protection of rights. Besides, smart contracts

that run on such decentralized networks and immutability of records allow for the management of the complete life cycle of digital property rights. Hence, we see a growing demand in the application of blockchain technology for patenting systems. See, for example, the mapping of blockchain-based patents that have been extracted from the traditional patent system (the United States Patent and Trademark Office and the World Intellectual Property Organization databases) (Forestal et al., 2021a, 2021b).

In terms of distributed networks where the smart contracts define the property rights, we propose a co-utile self-enforcing protocol that leads to an equitable distribution of resources, unlike the conventional centralized Pareto optimal allocation (see Fig. 8.1), which does not consider the equality or the overall well-being of the system (Van Ruth et al., 2017). This requires changing the rules of the game in the centralized property right through distributed ledger technologies and smart contracts that suppress sub-optimal outcomes. Co-utile (win-win) outcomes for allocative efficiency of the title of ownership or artificial excludability can be achieved through incentive schemes that lead to an optimal outcome in a self-enforcing way. Blockchain technology, through its key features of transparency and immutable distributed ledger, will help the privatization process in the decentralized provision of such resources, improving the operation, payments, and contract management and execution Bourguignon et al. (2020). On the other hand, Atzori (2015) calls for the coordinator role of the government despite the decentralized algorithm-based consensus, which according to the study, is an organizational than a political matter.

There is a growing need for more robust patents, copyright rights, and intellectual property rights systems in our evolving digital world. Hence, distributed ledger technologies, with their underlying features of traceability, the immutability of records, distribution, and programmability, hold significant potential for the distributed patent system and copyright protection (Jiang et al. (2020).

4 Emerging Trends in the Patent Systems

In contrast to the exponential growth in blockchain patent filings, the number of patents granted remained a moderate increase. A significant number of the patent application are in pending status, so the patented blockchain technology would become obsolete by the time of patent approval. Globally, 3924 patents have been granted for blockchain technology up to 2020. Patents given to US companies accounted for 39% of all patents granted, followed by Korea at 21% (BGPA, 2020). China came in third with 19% (BGPA, 2020). The United States also ranks at the top with the number of blockchain filings. Top patent applicants include IBM, Alibaba, Bank of America, Mastercard, and Wal-Mart. Financial institutions, previously underrepresented in the patent world, participated actively in this round of patenting competition related to blockchain technology.

As innovative technologies continue to emerge, especially some in the early development stages, new guidelines are usually created in the patent office that

Table 8.1 IPC classification for main blockchain-based patent

IPC classification	Contents
H04L 9/00	Arrangements for secret or secure communications; network security protocols [2022]
H04L 29/00	Network arrangements, protocols, or services independent of the application payload and not provided for in the other groups of this subclass [2022]
H04L 65/00	Network arrangements, protocols, or services for supporting real-time applications in data packet communication [2022]
H04L 67/00	Network arrangements or protocols for supporting network services or applications [2022]
H04W12/06	Authentication [2021]
G06F21	Security arrangements for protecting computers, components thereof, programs, or data against unauthorized activity [2013]
G06Q20	Payment architectures, schemes, or protocols (apparatus for performing or posting payment transactions G07F 7/08, G07F 19/00; electronic cash registers G07G 1/12) [2012]
A61M5/00	Devices for bringing media into the body in a subcutaneous, intra-vascular, or intramuscular way; accessories therefor, e.g., filling or cleaning devices, arm rests (tube connectors, tube couplings, valves, or branch units, specially adapted for medical use A61M 39/00; containers specially adapted for medical or pharmaceutical purposes A61J1/00) [2006]
A61M5/172	Electrical or electronic [2006]

Note: Patentscope database https://www.wipo.int/patentscope/en/

may attempt to treat each patent application equitably, such as how each innovation is presented in its patent application. Patents are classified by their technological field, the most important classification scheme being the International Patent Classification. There is no International Patent Classification (IPC) or Cooperative Patent Classification (CPC) that clearly and unequivocally delimits the blockchain technology field. World Intellectual Property Organization (WIPO) published the latest version of IPC in Jan 2022, enclosing the reclassification of several blockchain-related sections as listed in the upper part of Table 8.1, which reflected their rigorous understanding of the updated technology.

A blockchain-based patent is concentrated in the technical field of transaction and security encryption and extensive application. The main subgroup consists of transmission of digital information (H04L), data processing systems or methods specially adapted for administrative, commercial, financial, managerial, supervisory, or forecasting purposes (G06Q), electric digital data processing (G06F), secret communication, jamming of communication (H04K), wireless communication (H04W) and ciphering or deciphering apparatus for cryptographic or other purposes involving the need for secrecy (G09C), etc.

Table 8.2 illustrates the selected related sections and the number of patent applications in the first three months of 2022 to demonstrate the technology distribution and preference among selected countries and regions. The USA leads in most technologies and focuses on extensive finance and currency applications.

Table 8.2 The number of published international patent applications in selected IPC classes and selected participating national and regional patent offices (From Jan to March 2022)

	EP		*US*		*CHINA*	
H04	H04L9/00	26	H04L9/00	10	H04L9/00	6
	H04L9/06	22	H04L9/06	5	H04L9/06	5
	H04L9/08	75	H04L9/08	33	H04L9/08	18
	H04L9/30	3	H04L9/30	20	H04L9/30	22
	H04L9/32	95	H04L9/32	33	H04L9/32	11
	H04L9/40	5	H04L29/06	18	H04L9/40	22
	H04W12/06	6				
G06	G06F21/60	4	G06F21/60	3	G06F21/60	4
	G06F21/32	8	G06Q20/36	3		
	G06F21/33	5	G06Q20/38	7		
	G06F21/57	6	G06Q20/40	3		
	G06F21/62	5				
	G06F21/64	28				
A61			A61M5/172	8		

Note. The sections are selected and listed when the number of patent applications exceeds 3
Patent scope database
https://www.wipo.int/patentscope/en/

Table 8.3 The number of published international patent applications in a class of H04L9/38 and selected participating national and regional patent offices (From 1900–2021)

	US	CH	JP	GB	FR.
2020–2021	6	6	0	0	0
2010–2019	7	7			
2000–2009	5	14	19		
1990s	1	0	10		
1980s	4		0		
1960s	8			1	
1950s	7			1	5
1940s	13			0	4
1930s	7			6	4
1920s	22			0	4
1900–1910s	0			2	2

Note. 8.H04L 9/38: Encryption being affected by mechanical apparatus, e.g., rotating cams, switches, key tape punchers [2006.01], Patent scope database https://www.wipo.int/patentscope/en/

Table 8.3 shows the numbers of patent applications for one subgroup H04L9/38 (Encryption being affected by mechanical apparatus, e.g., rotating cams, switches, key tape punchers [2006.01]) in five selected countries in the last 100 years. The evolution and transformation of the technology could be estimated based on the distribution of patents across countries and time. The rapid growth at the beginning of the 2020s signifies a promising start.

Locate patent activity in the non-linear technology development path.

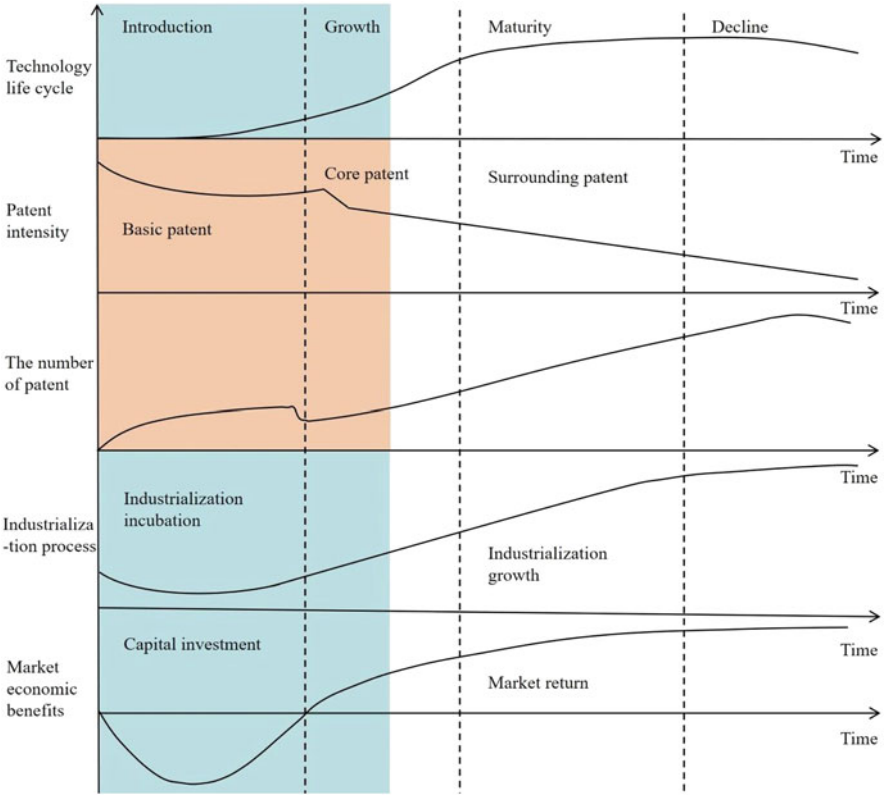

Fig. 8.2 The relationship between patent, industry, and market under technology life cycle. *Note.* Based on Klepper 1996, 1997

Researchers have argued the role of a patent in the process of technology advance and adoption within the dynamic system of technology and economy. In literature, controversy existed about how patents foster innovation and economic development in complicated scenario assumptions, such as in the developing or developed country, for a mature technology or emerging technology. From the perspective of technology progress and spillover, the patent could preserve initial incentives to make and commercialize inventions but could cause bumps slowing down the technology adoption and evolution.

Figure 8.2 displays the classical model describing the relationship between patent, industry, and market under the technology life cycle (Klepper, 1996, 1997). In the row of patents, a bump along the curve could be observed before the take-off of technology advances. In theory, the bump is located around the threshold of market economic returns. In the blockchain-based patent, it seemed that this bump or platform era did not occur outstandingly, although some anti-patent sentiments prevailed during the early stage, as we discussed. This figure assumed that all the barriers/frictions are known and expected, such as the speed of technology spillover.

In blockchain technology, the application fields and models are unveiled in succession in markets, some of which incubated a significant outlook and market value. A survey (Statista, 2022) shows that about half percent of the respondents worldwide stated that their organizations focused on a private blockchain model in 2019. And around 45% on the model as permissioned blockchain, public blockchain like Bitcoin or Ethereum and integration of multiple chains; 29% and 23% on the model like consortium and decentralized application. Only 2% of respondents stated none. The positive feedback in the market gains an advantage for the active patent activities accompanied by research and development.

Many challenges remain the same without exception to the emerging blockchain base patent, but more particular concerns or barriers gradually protrude the surface of benign growth.

One is how to correlate blockchain-based patents to firm value. One recent research reported that a firm's patent of blockchain originality and t-1 lagged effects for a firm's patent of blockchain generality are positively associated with the firm value in general (Kim, etc., 2020). Evaluating patent contributions in previously underrepresented sectors in patent activities will be a crucial step for patent strategy and sustainability in patenting.

The second is understanding the association between blockchain-based technology and the volatility of cryptocurrency prices. As discussed earlier, the young financial product Bitcoin is price sensitive with market shocks as a volatility receiver. Large corporations (such as Microsoft, Mastercard, Intel, and Visa) can influence cryptocurrency prices through their announcements of future technological intentions, and the inherent risks incorporated with Blockchain and cryptocurrency patent development is presented by Hu et al. (2021). Developing a better understanding of this association will help the company to identify the aggressive tainted patent activities with cryptocurrency price intervention. Blockchain technology has diverted from Bitcoin to the general financial industry and wider deployments. Therefore, it takes time to disentangle the linkage and underline blockchain's actual value.

The third one is how to handle the barrier/friction to investment in blockchain technology and patenting, including lack of regulatory clarity or legacy system as a new participant in the patent world, technology unproven, the uncertainty of patent value and returns, lack of compelling patentable application of the technology, risk of a claim from patent trolls, lack of dynamic patent strategy and time strategy.

5 Insights for Blockchain-Based Patent System

Several indispensable parties coexist in a representative ecosystem. In the projected blockchain industry ecosystem, two components are essential.

One is the industry alliances. Chamber of Digital Commerce (CDC) is an example of this practice, intending to develop an environment that fosters innovation, jobs, and investment in digital assets and blockchain-based technologies through education, advocacy, and working closely with policymakers, regulatory

agencies, and industry (CDC, 2022). CDC also created Blockchain Intellectual Property Council (BIPC), Smart Contracts Alliance, the Blockchain Alliance, and the Global Blockchain Forum. Industry alliance established a platform for all entities within the systems, from business to government, regulatory agencies, other related industries, and society, to communicate and cooperate on the industry standard consensus and dispute settlement. For example, it is supposed to develop a strategy for dealing with patent trolls to accommodate an increase in questions among the Chamber's 100 members about how to create a defensive patent strategy.

The second is to respect the open-source nature of blockchain technology and pursue sustainable technology advances, a critical feature of an ecosystem that builds trust and security, shares knowledge and creates disruptive innovation in a wide industry community. Open source is characterized by collaborative development, and the code is publicly available, intending to be a public good instead of a private asset. It provided favorable environments for technology explosion. Moreover, open-source related technology such as algorithms facilitates the government regulation of antitrust, such as monitoring the power of hidden algorithms backed by giant technology companies (Fry, 2019).

Financial Inclusion to Digital Finance Risks: A Commentary on Financial Crimes, Money Laundering, and Fraud

9

Patty Zakaria

Abstract

Financial technologies and financial product advancements are long rooted in the early twentieth century. Advances in this sector, adding to the financial infrastructure of the economies, have defined the performance of countries and reflected on the financial well-being of the economic units that interact in such markets with immense opportunities for financial inclusion. Yet, with the hasty technological advancements in the field, we observe an increase in the complexity and forms of digital financial risks and regulatory loopholes with poorly defined legal frameworks that struggle to meet the dynamic tech environment. By augmenting the fraud triangle approach for digital financial risks, we identified the motives, opportunities, and rationale of financial tampering, including fraud, money laundering, and financial crimes. Based on this and the potential Fintech holds for emerging economies, the chapter provides a commentary on the legal catch-up effect and further considerations for a healthy fintech environment.

Keywords

Financial inclusion · Digital finance risks · Fraud · Financial crime · Money laundering · Financial tampering · Fraud triangle

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1 Introduction: The Digital Revolution

In recent years, we are continuously hearing about financial technology [FinTech, hereafter]; however, it's not something new and dates to the 1800s. Early developments occurred with the transatlantic transmission [1866 and were later followed by SWIFT [1973] and ATMs [the late 1960s] (Douglas & Grinberg, 2016). This first wave of FinTech was followed by the evolution of the internet and the internet of things, and finally through data and digital technology (Leong and Sung, 2018, pp. 74–75). Leong and Sung (2018) defined FinTech as "any innovative ideas that improve financial service processes by proposing technology solutions according to different business situations, while the ideas could also lead to new business models or even new businesses" (p. 76).

Globally, the adaption and awareness of FinTech have increased. Ernest & Young (2020) Global FinTech Adoption Index found that the adoption of FinTech services has increased by 17% from 2015 to 2017 and 31% in 2019 from the previous surveyed year. Furthermore, the study found that "Worldwide, for example, 96% of consumers know of at least one alternative FinTech service available to help them transfer money and make payments" (Ernest & Young, 2020, p. 6).

The present chapter provides a commentary on the potential opportunities of FinTech, particularly for developing countries and marginalized groups in society. The emergence of recent innovations in FinTech, for example, through mobile phones and the internet of things, can significantly support the United Nation's Sustainable Development Goals, particularly targets dealing with poverty elimination and equality. However, despite the opportunities presented with FinTech, we also face many challenges, such as the increased risk of fraud and money laundering. The chapter will first discuss the opportunities that FinTech offers the globe, with a particular focus on the issue of financial inclusivity. Second, the chapter will explore the potential risks associated with FinTech technology and provide a recommendation to deal with these challenges.

2 Financial Inclusivity: The Present

The world is different; it's digital and connected, which has increased the likelihood of financial fraud. FinTech had many potential benefits for industrial countries, particularly the global south, through financial inclusivity. FinTech is creating new opportunities for the global south countries and individuals in rural areas by providing many financial opportunities such as online shopping, banking, and transactions. Financial exclusivity can further the inequality gap, pushing poorer households into poverty.

Looking at data from the World Bank on banking behavior in the developing world, we can see the changes due to technological advancement over the last two decades. According to Demirguc-Kunt et al. (2018), approximately 1.7 billion adults across the globe do not have traditional bank accounts. All the unbanked individuals are from the developing world, most notably from the following countries

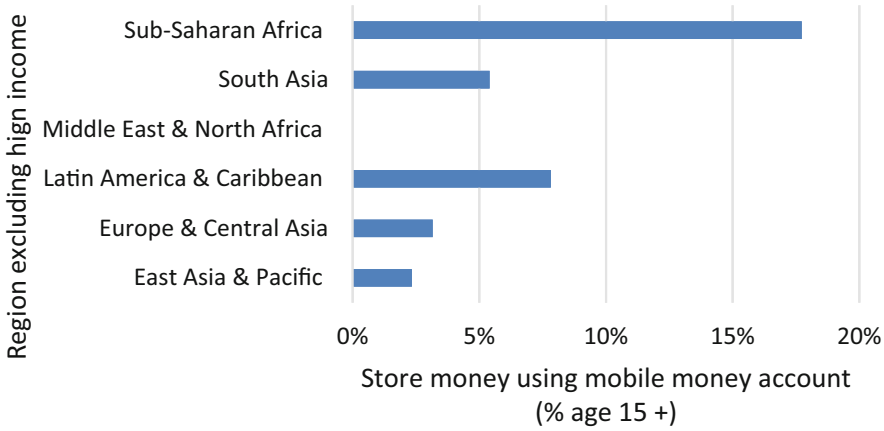


Fig. 9.1 World Bank's Global Findex Database 2021. Source: Author adaption of World Bank Global Findex Database, 2021

Bangladesh, China, India, Indonesia, Mexico, Nigeria, and Pakistan (p. 2). However, with the FinTech revolution, the inequities in account ownership are changing where "... 1.2 billion adults worldwide opened an account at a financial institution or through a mobile money provider between 2011 and 2017, including 515 million adults since 2014" (Demirguc-Kunt et al., 2020, p. 3). This change in usage of FinTech in the developing world can be attributed to the increasing proliferation of mobile phones, particularly smartphones, internet connectivity, and mobile data. A PEW Research study found that 83% of individuals in emerging and developing economies own mobile phones (Taylor and Silver, 2021). Figure 9.1 below illustrates the World Bank's Global Findex Database regarding mobile money in 2021.

Despite this change, bank account inequities and access to other financial services continue to persist, especially among the marginalized groups in society and the developing world.

So, why is financial inclusivity important? The poor, women, and individuals that work in the informal sector account for a disproportionate share of the unbanked in the developing world, which can further accelerate poverty and hardship for this group. Appiah and Song (2021) found that FinTech contributed to both economic growths in China, indirectly leading to poverty reduction, particularly in rural areas (p. 10). The authors furthermore found that credit history helped reduce poverty in China. Through financial inclusivity initiated by the FinTech revolution, for example, informal sector workers can use mobile phones for transactions such as making or accepting payments. Traditionally, individuals in the informal sector relied on cash payments, which limited their access to credit because of their lack of credit history. According to the World Bank's Global Findex Database (2020), "[a]bout 235 million unbanked adults worldwide receive cash payments for the sale of agricultural products—and 59 percent of them have a mobile phone." However,

through digital transactions, informal sector works can build a credit history, which can be used to borrow money to expand their business. In addition, Karlan et al. (2014) found that farmers in Ghana that were given access to weather-based insurance could then farm crops that yielded higher returns (higher risk). Thus, when farmers engage in this type of farming, the author found that revenues increased more than their non-insured counterparts in Ghana.

Galor and Zeira (1993) and Banerjee and Newman (1993) found that financial exclusivity prevents households from borrowing money for education and business opportunities. In Kenya, for example, Suri and Jack (2016) found that FinTech—mobile money, has helped uplift 2% of the population out of poverty. In Asongu and Odhiambo's (2018) study on the relationship between FinTech on poverty, they found that when individuals used "mobiles . . . to pay bills' [this] contribute[d] to reducing inequality in countries at the bottom and top ends of the inequality distribution while." Second, they found that "mobiles used to receive/send money have an appealing role in promoting inclusive development in all poverty distributions, except the top end or 90th decile" (p. 740). In a more recent study by Demir et al. (2020), they found that FinTech contributed to greater financial inclusion and that this inclusivity ". . .proxied by formal account ownership, formal savings, and formal borrowing—reduces inequality" (p. 103).

Finally, the digitization of payments not only helped informal workers and agriculture workers build credit and improve savings, but it has also acted as a measure to improve women's safety. In Bangladesh, for example, education subsidies were digitized, which benefited women (mothers) significantly because it eliminated the need to travel and wait for the subsidies (World Bank, n.d.). Thus, FinTech not only provides financial benefits, but it can also provide social benefits for individuals, such as empowerment and reducing gender inequalities.

3 Challenges of FinTech: The Future

Despite the benefits of FinTech discussed above, FinTech poses several challenges such as fraud and enabling money laundering, illicit or terrorist financing, and ransomware, to name a few. According to the Association of Certified Fraud Examiners (nd), "[f]raud is any activity that relies on deception to achieve a gain." Over the years, the literature on fraud has provided several definitions. For example, Ramamoorti and Olsen (2007) defined fraud as ". . .a human endeavor, involving deception, purposeful intent, the intensity of desire, risk of apprehension, violation of trust, rationalization" (p. 53). Furthermore, the World Bank (nd) defined fraud as "[a] fraudulent practice is any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain a financial or other benefit or to avoid an obligation."

As financial crimes continue to grow, we see increase in the market size of the fraud detection and prevention (FDP). Figure 9.2 shows the global market size of FDP based on Statista MarketStandards Markets survey, Fraud Detection and Prevention Market—Global Forecast to 2022.

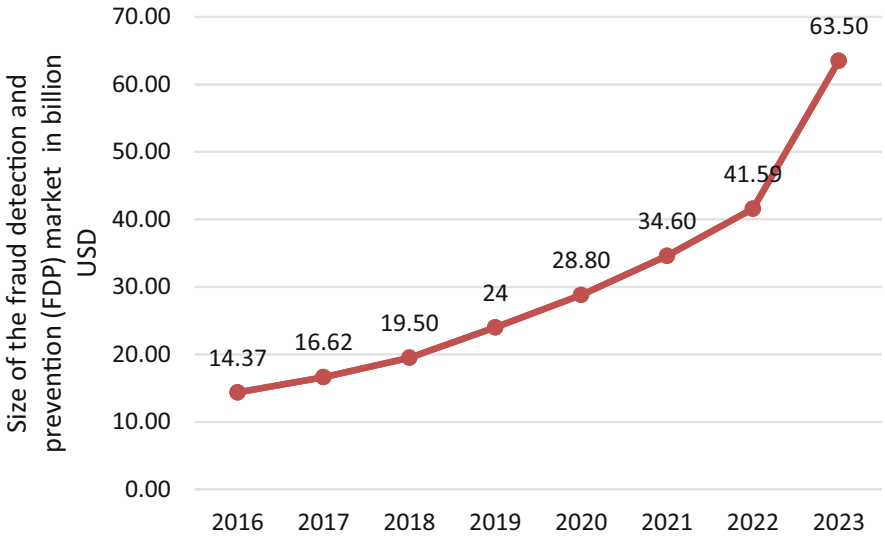
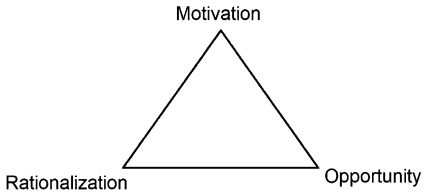


Fig. 9.2 The fraud detection and prevention (FDP) global market size from 2016 to 2022 (in billion USD). Source: Author's composition based on Fraud Detection and Prevention Market—Global Forecast to 2022

Fig. 9.3 The Fraud Triangle. Source: Author adaption of Cressey's Fraud Triangle



4 Financial Tampering: A Fraud Triangle Approach

A discussion of the fraud triangle (Cressey, 1953) is necessary to understand better the conditions that lead individuals to engage in fraud. Cressey developed the Fraud Triangle, which includes 3 components that he argued would come together to lead an individual to engage in fraud. Figure 9.3 adopts this fraud triangle to the digital finance identifying the motive, rational and opportunity in financial crime, fraud.

Below, I will explain these three driving wheels of fraud incidents in the context of fintech applications and the usage of digital financial products.

4.1 Financial Fraud Opportunities: The Loophole in Fintech Developments and Applications

In terms of opportunity, this refers to the opportunity to commit fraud. An opportunity comes from the regulatory framework, which can include but is not limited to a lack of consistent regulatory oversight, cross-border regulation differences, and gaps in regulation. Additionally, opportunities to commit fraud through FinTech can come from within an organization, such as the lack of stringent internal controls or auditing system, and perhaps more importantly for FinTech services, the knowledge and skills to detect fraud in non-traditional systems. Finally, excessive reliance on trust also can create an opportunity for fraud. Thus, when it comes to FinTech, if services lack effective regulatory and oversight systems, the opportunity to engage in fraud will likely increase. This, of course, will occur when the other triangle components are in place. Some have implemented stronger regulations to deal with cybercriminals, such as the European Union's GDPR and the Anti-money laundering Directives and Payment Services Directives, to reduce the opportunity to engage in fraud.

In developing countries, where criminal syndications and corruption tend to be high, and government regulations and the rule of law are weak, this would likely increase the opportunity to engage in fraud through FinTech services, particularly money laundering through cryptocurrencies. Feng et al. (2020) noted that "... the non-traceability of Cryptocurrencies has made it possible to move suspicious assets which ended up in the sights of the authorities. The exchange channel allows to bypass authorized financial intermediaries and transactions are not safe" (p. 30). Ng and Kwok (2017) noted that regulatory uncertainties exist, which increases the probability of opportunity to commit fraud through FinTech. Furthermore, the high cost and excessive (at times complicated) compliance measures, particularly for start-ups, can create an opportunity for fraud as FinTech firms lag in compliance measures or fail to do so effectively or in time.

Furthermore, the increased usage of mobile devices for financial transactions creates additional opportunities for fraud. Iovation, an online fraud-protection company, has predicted: "... that U.S. retailers and financial institutions will lose $7.2 billion due to fraud by the end of 2020" (Harrington, 2017). Figure 9.4, for example, presents a steady monetary loss per online purchase scam over the years 2015 to 2021. In that respect, consumers' awareness about financial fraud must increase, and FinTech service providers should educate clients about cybersecurity, thereby reducing the opportunity for fraud. The opportunity component is the most burdensome regarding FinTech and the fraud triangle.

4.2 Financial Fraud Motives

The second component of the fraud triangle is motivation, where some specific pressure leads an individual to engage in fraud. Such pressure can be internal such as time pressure, or external such as financial, authority, and illicit activities pressures.

Fig. 9.4 Median monetary loss per online purchase scam worldwide 2015–2021. Source: Author's composition based on Final 2021 BBB OnlinePurchaseScamsReport available at https://www.scribd.com/document/536296142/Final-2021-BBB-OnlinePurchaseScamsReport

Therefore, individuals facing these pressures are more likely to engage in fraud. Again, this works in concert with the other component of the triangle. When it comes to the motivation component, it's disconnected from FinTech because this driver of fraud is more of a personal choice.

4.3 Financial Fraud Rationale

The final component of the fraud triangle is rationalization, where individuals rationalize the unethical behavior as acceptable, and second, the gains/rewards from the activity outweigh the sanctions. Regarding FinTech, if harsher sanctions and punishment are to be implemented for financial fraud, this lowers the risk of rationalizing the activity. Thus, preventive policy measures and regulatory frameworks have to be in place. This must be accompanied by a robust digital financial crime traceability mechanism that fits the dynamic and continually evolving digital products and financial tech environment. Also, note that in this area, regulations lag behind the market as new business models and applications challenge the existing regulatory framework.

In short, the components of the fraud triangle work together to increase the likelihood of fraud; however, if measures are taken to weaken these components, the risk will decline.

5 Concluding Remarks: Where Do we Go from Here?

FinTech has been a disruptive force in the financial sector and has provided many benefits to those that have once been excluded from financial activities. Nevertheless, we cannot overlook the challenges that FinTech poses to start-ups, the

government, customers, organizations, and the community. Time and time again, we hear cases of identity fraud and phishing scams where customer payment information or fraudulent transactions occur. During the pandemic, we saw an upsurge in online transactions, and in turn, we saw an increase in the number of FinTech services attacked by cybercriminals. To decrease the likelihood of fraud in FinTech services, the government, individuals, and organizations need to close the gap in the opportunity to engage in fraud. To diminish the opportunity to engage in fraud, there is a need for more consistent regulations within countries and cross-border regulations because many fraudulent activities tend to occur across national borders, for example, as was evident with the case of Chime Financial in the USA and fraudsters in Nigeria. In addition to creating more stringent and consistent regulations to reduce the opportunity to engage in fraud, product managers need to design FinTech tools that consider any illicit activities that can or might occur through their services. When FinTech services are developed, the traditional approaches to internal audits and controls for fraud are inadequate. Thus, firms need to build the knowledge and skills of their employees to be better able to detect fraud through FinTech. As the proliferation of FinTech services increases in developed countries, particularly in developing countries, we must be diligent and prepared to deal with these and many other challenges.

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