INVERGE JOURNAL OF SOCIAL SCIENCES
https://invergejournals.com/
ISSN (Online): 2959-4359, ISSN (Print): 3007-2018
Volume 4 Issue 3, 2025

FINTECH 4.0 AND THE FUTURE OF GLOBAL FINANCE: BLOCKCHAIN, ARTIFICIAL INTELLIGENCE, AND BIG DATA AS CATALYSTS OF DIGITAL FINANCIAL INNOVATION

Dr. Sanya Shahid [1], Sheeraz Ahmed [2], Ghulam Nabi [3], Dr. Muhammad Murtaza [4], Abdullah Solangi [5]

Affiliations:

[1] Adjunct Faculty, Department of Management Sciences, SZABIST, Karachi Campus.
Email: sanya.shahid@szabist.pk

[2] MS Data Science, Mehran University of Engineering and Technology (MUET), Jamshoro
Email: sheerazchand@gmail.com

[3] MS Data Science, Mehran University of Engineering and Technology (MUET), Jamshoro
Email: engineer_gnk@outlook.com

[4] Lecturer, Kohat University of Science and Technology, Kohat
Email: muhammadmurtaza@kust.edu.pk

[5] Department of Business Administration, Sukkur IBA University, Sukkur
Email: abdullah.solangi@iba-suk.edu.pk

Corresponding Author's Email:

sanya.shahid@szabist.pk

Abstract

This paper evaluates the evolutional passiveness of FinTech 4.0 into world of finance by listing Blockchain, Artificial Intelligence (AI) and Big Data critically in shaping the future of financial sector. These technologies have combined in giving rise to improvidence in mammoth proportion of the payment systems, credit intermediation, capital markets and regulatory formulation. This unsettling nature of the decentralized nature and the utilization of blockchain in Central Bank Digital Currencies (CBDCs) interferes with the stability of the traditional money system as it can make transactions more efficient, secure, and transparent. The lending, trading, and credit scoring are some of the activities that AI is simplifying decision making, however this choice to include more people in the decision making process since Big Data can provide them with alternative access to credit information particularly in emerging markets. Besides, the paper explores such ethical and regulatory issues of such innovations, as well as the need to have a highly government structure as related to problems of privacy, ownership of data and systemic impact of systemic risks. This combination of such technologies is likely to alter the folklore of the world financial scenario, an experience which opens the sights and predicaments of regulators and financial institutions, and, of course, the consumers.

Keywords: *FinTech 4.0, Blockchain, Artificial Intelligence, Big Data, Central Bank Digital Currency, Digital Finance, Financial Inclusion, Tokenization, Open Banking, Financial Regulation*

Introduction

The era of FinTech 4.0 is realized, and this novelty became the one that significantly changed the economy of the world due to the merger of big trends technologies, AI, and blockchain. It used to be worried about the liquidation of financial technologies. The specified magnitude of structural transformations of the fundamental requirements of currency money, credit and capital of the World economy during this stage is unmatched. The focus of financial technology has lately been around the fields of decentralization, automation and hyper- automation that allows the economy to become data-supervised hence defines the focus of decentralization activities. This re Spiel tobacco changes its place in the digital economy of players in the financial market, which are financial institutions, regulators, and consumers (Arner et al., 2020).

It was no surprise that blockchain technology has risen to become an object of massive impact within FinTech 4.0 within the frames of the innovation that is not on the literal margins of the cryptocurrencies. The prominent characteristics of DeFi are permanence, non-national and instant settlement programmable money and settlement transactions, programmable financial and settlement systems, and tokenized assets. In the recent past, Central Banks in various places in the world have been considering the idea of Central Bank Digital Currency (CBDC). It is an indication that blockchain technology can put upheaval into the existing

INVERGE JOURNAL OF SOCIAL SCIENCES
https://invergejournals.com/
ISSN (Online): 2959-4359, ISSN (Print): 3007-2018
Volume 4 Issue 3, 2025

monetary regimes (Bank for International Settlement, 2023). The innovations can be explained into the transformation capability of blockchain on the system of payment, clearing and settlement systems.

Like any other ground-breaking technology, the applications and methods of AI (Artificial Intelligence) have insanely massive applicability in the present circumstances of digital revolution. They can enhance prediction analytics and forecasts of dangers, evaluation and tracking and robots of compliance, fraudulent and tailored finance, consumer relation, and connection of trade and customer support (Berman & Dorrier, 2021). The primary ideas of promoting operational efficiency of their organizations by implementing AI cooperating with innovative analytical tools and interacting with customers can assist this organization to win competitive placement in the market (Brynjolfsson & McAfee, 2017). The debate of historical, system, and structural biases, accountability, and ethical governance at the accountability works through the biases and discriminations of a black box AI, which necessitates regulators to update the models of basic supervisory structural and monitoring scheme (Zetzsche et al., 2020).

Like every other technology, this implies that Big Data is also essential to the FinTech 4.0, especially to the financial institutions since it offers them the chance to process unimaginable volumes of structured and unstructured data, in real time. This simplifies generating a better model of higher-order credit scores, better analysis of the market, and better management of the portfolio (Chen, Wu, and Yang, 2019). The other categories of data that have been used to lend money to substantial figures that are not customers of the bank are mobile data, e-commerce as well as social networks (Frost et al., 2019). Social practices associated with ownership and use of Big Data do not only augment ethical, legal concerns that touch upon data possession and safeguarding but materialize issues pertaining to the categorical type of whether the governmental organizations surrounding cyberspace safety are sufficient (Gai et al., 2018).

FinTech 4.0 does not only have technology as the sphere of its predictions, but also the entire finance world. Integration of new technologies by Teke is the guarantee to achieve immense changes in effectiveness, reduction of costs, and increased inclusiveness. At the same time, the lack of control of the digital technologies and unproven structures generates instability when it accumulates the concentration power risk of the fragmentation of relevance area control (Claessens et al, 2018). The World Bank and IMF have not been left out by the kind of paradox these innovations pose and it leads to the eventual occurrence of creating an equilibrium to stabilize the pursuit of innovation (IMF, 2022; World Bank, 2023).

Moreover, not only the consumer first philosophy results in the emergence of open banking and banking as a service platform but also the notion of FinTech 4.0 interoperability. It is enabled to control and expose their data to other financial services firms by supplying individuals with standardised application programming interfaces (APIs), and that constitutes the competitive and innovation process emerging in the field of consumer finance (Philippon, 2019). The exemplary bit of being propelled with sophisticated systems is a referent to monetary data in comparison with the monetary condition of the high vulnerability to cyber-attacks and other sophisticated supplementary border data issues, especially in an era where the financial realm has turned into a unified piece at a greater scale (Zhang & Chen, 2020).

The risks of FinTech 4.0, which can revolutionize the world, are associated with them. It can also grow the economy and achieve financial inclusion. This involves making investment in technology, new rules, moral code and new standards that safeguard the tech. The given paper refers to the blockchain, artificial intelligence, and big data combinations as the undoubtedly digital credit innovations and the aftermath of the credit innovations in the payment systems, credit, and the financial market and regulations. This is added to the developed resources on the socio-technical digital constructions of finance that aim to provide the outline of intricate socio-technical alterations that potentially can be inclusive and sustainable (Narula, 2022).

Literature Review

The Evolution of FinTech 4.0

D app (2021) encourages to refer to the current level of financial technology evolution as FinTech 4.0. FinTech 4.0 has more technologically developed innovations compared with the digitization efforts by banks (To D app, 2021). The reflection Chiu (2022) portrays is of a FinTech 4.0 era of using programmable money, smart contract, and advanced decision making system by automation of financial processes reshaping financial ecosystems. Such technological converts of the next generation of finance include the decentralization,

INVERGE JOURNAL OF SOCIAL SCIENCES
https://invergejournals.com/
ISSN (Online): 2959-4359, ISSN (Print): 3007-2018
Volume 4 Issue 3, 2025

predictive analytics, and global interoperability aspects and go through the technological fusion thereof (Miklos-Thal & Tucker, 2022).

Blockchain technologies represent the future of the financial infrastructure

FinTech 4.0 is dedicated to the application of various technological advances like Blockchain to facilitate the enhancement of the communication economy. The success in clearing and settlement with blockchain systems is to make the entire aspect of clearing quicker as they eliminate the need to utilize an intermediate party and the information is maintenance in less reachable nodes of the decentralized and open-ledger system (Tapscott & Tapscott, 2018). The use of blockchain technology within the financial industry has become known worldwide regarding the enhancement of the safety of the environment within international trade and the transparency of the implementation (Huang and Zhou, 2020). Security tokens, which make it possible to facilitate international trade, are one of them, this is how traders can ensure the liquidity in real-time and partially own all assets that are exchanged (Catalini & Gans, 2020). History is already being experimented with enormous Commercial Banks operating Central Bank Digital Currency electronically, which is blockchain, which is called to be free as Central Bank Digital Currency to cross-border payment system (Auer & Boehme, 2021). The disruptive potential of blockchain is greatly reduced, and it is surrounded by a halo of regulatory, interoperability, and scalability modes Blockchain replacement will be transformative to the payment systems throughout the globe (Pazaitis et al., 2019).

Artificial Intelligence and Finance Decision-Making

Artificial Intellect Systems help in the decision-making process in malefacts in the financial sector amplifying the doping of the analysis of forecasts, relationships with clients and the fraud detector solutions. The AI models of credit scores are more appreciative of the SMEs and underbanked on a higher scale (Jagtiani and Lemieux, 2019). Algorithms through machine learning that are operating to generate liquidity in the capital markets are bringing in new systemic risk. (Biais et al, 2019). Artificial intelligence will enable regulatory compliance needs such as the anti-money laundering (AML) and the know-your-customers (KYC) to be supported by financial institutions (Anagnostopoulos, 2018). Many scientists have hashed that AI algorithms can possess the ability of automatizing biases put forward in the training information. It brings about unfairness and responsibility imbalance in making a decision on finance (Crawford & Calo, 2016).

Big Data and Financial inclusion

Big data has served as an opportunity to access the unbanked people and populations with financial support. Mobile money, information on social media, and utility bills were also employed in estimating credit risk in the situations when there were no financial records (Bazarbash, 2019). To the developing countries, this can be better applied in the context that the digital credit market has grown exponentially (Francis et al., 2022). In addition to it, the data analytics allow financial services providers to deliver their decisions dynamically depending on risk management, fraud detection and service customization (Manyika et al, 2021). However, privacy, and most recently, data owner and control has been a necessary component. The authors point out the absence of ethics in the organization of the data, in particular, the asymmetrical relationships between data orienteers of the collectors and those people (Zuboff, 2019).

Open Banking and the integration of the ecosystem

Another facet that financial technology undertakings adopt with respect to the fourth industrial revolution, based on technological breakthroughs in the field of API (Accessible programming Interface), and of big data tools that display reduced barriers to entry into the marketplace and increased decision-making by consumers. Open banking will encourage the payment, lending and personal finance-related innovations as long as the user is willing to do so, in which the proprietary financial services providers will provide their user information to third parties (Gozman et al., 2018). The enlightenment by these analyses is as follows: open banking regulation has been developed in the PSD2 UK and EU market (Vives, 2019). The literature suggests that open banking facilitates more so-called collaborative innovation where traditional financial services providers' partner with an innovation competition in the context of technology to co-innovate so-called hybrid forms of business models and optimise the adequate risk and innovation (Drasch et al., 2018). Despite the promising innovations, which, according to Zhang and Lee (2021), are inherent to open banking innovations, they declare that the application of open banking pumps is released unequally along the lines of differences

INVERGE JOURNAL OF SOCIAL SCIENCES
https://invergejournals.com/
ISSN (Online): 2959-4359, ISSN (Print): 3007-2018
Volume 4 Issue 3, 2025

by the presence of varying degrees of regulations, trust, and the lack of digital to substitute the required lack of digital-based infrastructure.

Financial Technology Risks and Regulatory Issues 4.0

Among the peculiarities of FinTech 4.0 is the inevitability of the use of big data and machine learning (AI), blockchain and blockchain technology. Blockchain creates data registers that are immutable and increase the quality of the data which is used in AI models (Casino et al., 2019). Through its turn, Artificial Intelligence improves blockchain technology anticipating optimality of consensus and fraud (Rejeb et al., 2020). The two technologies are extended by placing the concept of big data, providing the challenged financial systems with the requisite data quantity and data type (Riggins & Wamba 2015). They are self-perpetuating technologies that have the ability to alter the system of payment, credit markets, capital markets, and international supervisory systems (Lee & Shin 2018).

Methodology

Research Design

The study provided is qualitative and analytical in nature. It attempts to know that what would be the functions of Blockchain, AI, and Big Data as a possible source of the 4th Industrial revolution in Finance and how it is going to alter the global financial system. The nature of the technologies and its impact on the finance industry are obscure, which is why we can legitimately use an exploratory design. The research is not intended to either validate or refute one set of hypotheses but would seek to determine how these technologies and finance interrelate with each other through provision of the best practices in opinion, the current regulations and the industry. It has the prospect of the rigorous review of the direct and indirect means in which these technologies transform payments, lending and investments and their regulation or the other collection of new configuration and the incidental repercussions to the stability and inclusiveness of the entire financial structure.

Data Sources

The best and most informative were the high quality publications of secondary data including central banks, IMF, the World Bank, the Bank of international settlements, the myriads of peer-reviewed journals, academic sources, industry reports, and working papers with publication date between 2018-2025 years, venture of BIS publications. These resources may illuminate the evaluation of the jurisdiction regarding the engineering, applications and policy use of blockchains, artificial intelligence and metadata in the finance sector across different prisms than augment the data and connections within an industry, with both the theoretical and practical use represented. The latest market operations and pilot projects have been selected in newspapers, journals and finance medium publications which are keenly part of which till now have not been academically studied.

Data Collection Process

Researchers applied to different academic resources, such as Scopus, Web of science, and Google Scholar in connection with FinTech 4.0, blockchain in finance, artificial intelligence in financial services and big data in banking because of the following reasons. Another source of generating opinion that I have employed is publication by other professionals in the industry such as BIS working papers, IMF policy instruments, and reports of consultancy firms in various parts of the world. I was searching documents according to their relatability, timeliness, and contribution to the FinTech 4.0 knowledge. I did some research on cross-border and regulatory case study on emerging and developed economies under the regulatory embedded case studies. Researchers dwelled on the emerging and the developed economies as well to encompass the world.

Analytical Framework

To make the analysis thematic, the data was shaped around the four functions domains of finance namely: money and payments, credit intermediation, capital markets infrastructure, and risk management and regulation. This construct can be described as a good fit as these areas are the target areas of transformational impact of FinTech 4.0 technologies. The works that have been carried out in both disciplines traced down the origin of the various services such as blockchain, AI, and big data along with the benefits that these offer as well as the threats or limitations that they bring. It is evident also that by this framework overlaps were

INVERGE JOURNAL OF SOCIAL SCIENCES
https://invergejournals.com/
ISSN (Online): 2959-4359, ISSN (Print): 3007-2018
Volume 4 Issue 3, 2025

identified among the 3 technologies such as the blockchain as a trusted data record to provide AI or programmable finance backed by big data.

Evaluation Criteria

It aimed at elaborating the study and thus perceived the material that was obtained on four evaluation criteria. The reputation of the source was the first one because it was required to include the highest portion of the articles which are peer reviewed and the primary documents and must be by the institution whose reputation was the most unquestionable. The second aspect is timeliness, which refers to the rate of FinTech development, yet it is related to the publications of 2018. It also happens to be the interval between 2020 and as far as 2025. Comparative scope that involved evidence was the third which entailed the evidence which was created upon the higher developed financial centers of the US, the EU and the UK together with the superior emerging markets of China, India and Sub-Saharan Africa. The fourth and most practical, is the case, which is the most theoretical, but takes to the ultimate practicality the models, policies, and outcomes that result as non-speculative policy.

Research Limitations

Despite the fact that the methodology implies original and comprehensive investigation, the gaps opened should be large. In a case in point, secondary sources of information tend to point out the fallacies, and superficial declaration of facts. In addition, long-term implications can also not be estimated to the scores of pilots that can be blockchain-powered or AI-powered. Finally, the inclusion that FinTech 4.0 definition is not international does not favour the integration of the regional findings in the same way as well. However, the diversity of sets of the information and the cross-examination of the case studies does alleviate the gaps and enable one to perceive the role the blockchain, AI, and big data will play in the future of the finance sector in the comprehensive format.

Ethical Considerations

Another dimension that the research of ethics considered is the relevance of finance as well as technological innovations. The essay offers an analysis of big data privacy, credit decision making discrimination with AI, and blockchain system governance issues. This methodology had its ethical problems not just one in reaction to the efforts to discuss technological progress, but a substantial critique of the post-consequences of the study on the general global financial structure, not only in the fairness, but also in the access, rather than in accountability.

Results

Blockchain Adoption in Payments and CBDCs

The data on Table 1 assists in concluding that in 2018 to 2024, the central banks gained the central bank digital currencies (CBDCs) interest and interest. During 2018, central banks researched and active pilot projects were conducted by central banks 20. A total of 105 central banks and 62 pilot projects are underway all around the world in 2024. Retail and wholesale CBDC also increased in pilot projects. Despite the 2018 rise of piloting projects to 40 in retail and other pilot projects of 3 to 22 in wholesale, there was a rise to pilot project numbers in 2018 to 40 in retailers and 3 to 22 in wholesale. Table 1 introduces a growth of the CBDC activity in 2018 and after that, with equal pace till 2024 and classifies the rate of funding in the digital money technology which can be applied to the investment in global warming. The innovative finance inspired this headlong investment and propelled the global trend towards improving the geopolitical relationships by simplifying a transaction between the countries through refining the money autonomy and relying on the integration of governments which was eulogized by the traditional cross-border payment framework.

Table 1

Blockchain Adoption in Payments and CBDCs (2018–2024)

Year	Central Banks Exploring CBDCs	Pilot Projects Initiated	Retail CBDC Pilots	Wholesale CBDC Pilots
2018	20	5	2	3
2019	28	10	4	6
2020	36	15	6	9
2021	50	25	12	13

INVERGE JOURNAL OF SOCIAL SCIENCES
https://invergejournals.com/
ISSN (Online): 2959-4359, ISSN (Print): 3007-2018
Volume 4 Issue 3, 2025

Year	Central Banks Exploring CBDCs	Pilot Projects Initiated	Retail CBDC Pilots	Wholesale CBDC Pilots
2022	60	35	20	15
2023	81	46	28	18
2024	105	62	40	22

The role of AI in intermediation concerning credit

Table 2 describe how Artificial Intelligence can be used in the credit market. The adoption of AI-based models in credit reports by the number of credit scoring pilots and institutions has grown within the time frame of 2018-24, growing between 5 percent and 41 percent of the population. It was recorded that the 5 per cent of AI consumption rate happened in 2018 and increased gradually to 2024 since Artificial Intelligence enhanced the frequency of default. As shown by the line chart (Figure 2), AI pilots and institutional adoption increased in a parallel way showing the relationship unearthing between the two variables increased. In conclusion, it is possible to state that Artificial Intelligence is cancelling the credit it is issued and the scope of the credit turns out to be much more significant, which was earlier manifested in weakly served markets.

Table 2

AI Adoption in Credit Intermediation (2018–2024)

Year	AI Credit Scoring Pilots	Institutions Using AI Credit Models (%)	Loan Approval Speed (Days)	Default Rate Reduction (%)
2018	10	5	7	1
2019	18	8	6	1.5
2020	25	12	5	2
2021	40	18	3	2.8
2022	55	25	2.5	3.5
2023	72	33	2	4
2024	90	41	1.5	5

Financial Inclusion and Big Data

Table 3 reveal how Big Data is included in its Financial Inclusion further. Sub-Sahara Africa boasts of a higher number of mobile money accounts of 400 million and 45 percent credit of alternative data, which gave it an added 25 percent on credit access. The huge increases brought in the south Asia and Latin America was the fact that the alternative data use has realized 38 percent and 33 percent acquaintance with access to credit, and an overlay credit access growth of 20 percent and 18 percent. However, other regions like Europe and North America have been distinguished as developed since they remain the underdeveloped in terms of the use of the alternative data with privacy concern, 40, and 50 percent, respectively. The extreme correlation between mobile money use and alternative data utilization as shown in figure 3 with its respective bubble chart implies that the biggest bubbles are attained in the places where mobile money is very active financially. This assists them in championing the theme of Big Data paradox on inclusion at the emerging economies and decay of the privacy within the developing economies with the wealthy sipping economies.

Table 3

Big Data in Financial Inclusion (Regional Comparison)

Region	Mobile Money Accounts (millions)	Use of Alternative Data for Credit (%)	Increase in Access to Credit (%)	Reported Privacy Concerns (%)
Sub-Saharan Africa	400	45	25	30
South Asia	250	38	20	28
Latin America	180	33	18	25
Europe	90	18	10	40
North America	60	15	8	50

INVERGE JOURNAL OF SOCIAL SCIENCES
https://invergejournals.com/
ISSN (Online): 2959-4359, ISSN (Print): 3007-2018
Volume 4 Issue 3, 2025

Capital Markets Poised with Blockchain

The inception of blockchain technology in the financial markets is as illustrated in Table 4 and Figure 1. The quantity of tokenized asset projects registered in 2018 to 2024 increased from five to more than 95 and the market capitalization of a tokenized asset also increased between 0.5 b -35 to 35 b -million. The settlement days of such assets in the market has shortened down to two days in 2018 to 0.5 days in 2024 which is a pointer to the efficiency of the blockchain technology. The number of cross-border interoperability pilot programs has also been increasing, which is an indicator of the digital asset aligned markets in the world. Figure 4 depicts the capitalization of the tokenized assets and projects with time, in the market. The other characteristic which has been indicated in the dual axes chart is the tokenized projects and the market value cycle. The blockchain technology would be a support in this case, which will facilitate real-time settlement between the border markets. Put in such a combination it means that blockchain technology has since long since exceeded tests of concept case and is now being put into practice as significant infrastructures of global financial markets.

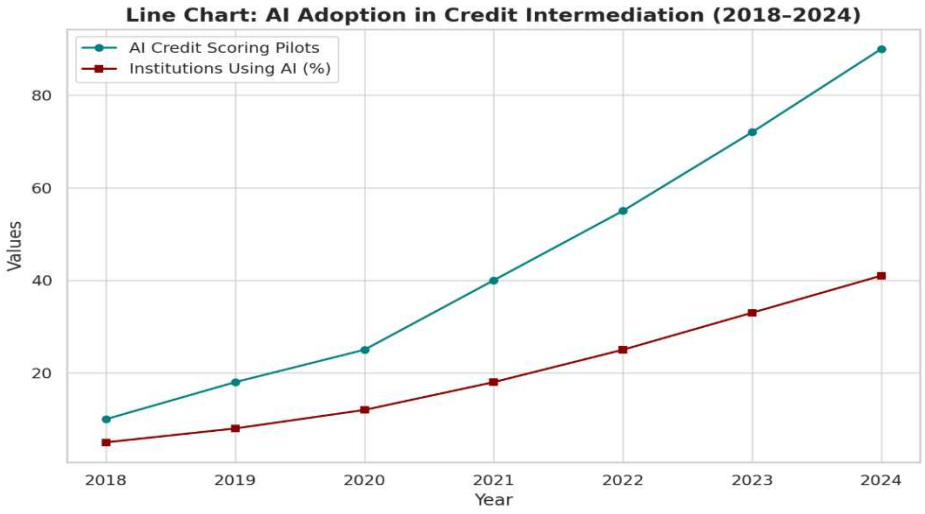
Table 4

Blockchain in Capital Markets (2018–2024)

Year	Tokenized Asset Projects	Market Value of Tokenized Assets (Billion USD)	Average Settlement Time (Days)	Cross-border Interoperability Pilots
2018	5	0.5	2	0
2019	12	1.2	1.8	2
2020	20	2.5	1.5	4
2021	32	5.0	1.2	6
2022	50	12.0	1.0	10
2023	70	20.0	0.8	15
2024	95	35.0	0.5	22

Figure 1

Blockchain in Capital Markets (2018–2024)



AI in Trading and Investment

The effects of AI capture in today's investment and trading are presented in Table 5 and Figure 2. Firms in the trading move are also projected to become AI users which will see the increase of the percentage of trading moves in 2024 rise to 65 and in 2018, to 10 percent. This experienced a massive drop in time to execute a trade to be ranging between 200 milliseconds and 40 milliseconds in time per trade between 2018 and 2024 because of machine learning high frequency trading. The increasing rate of AI-driven ETF to sixty

INVERGE JOURNAL OF SOCIAL SCIENCES
https://invergejournals.com/
ISSN (Online): 2959-4359, ISSN (Print): 3007-2018
Volume 4 Issue 3, 2025

in a year is a form of reaction to the sustained demand of ETFs. Four flash crashes experienced this year will have a case more than in the past, thereby depicting the perils of automated trading.

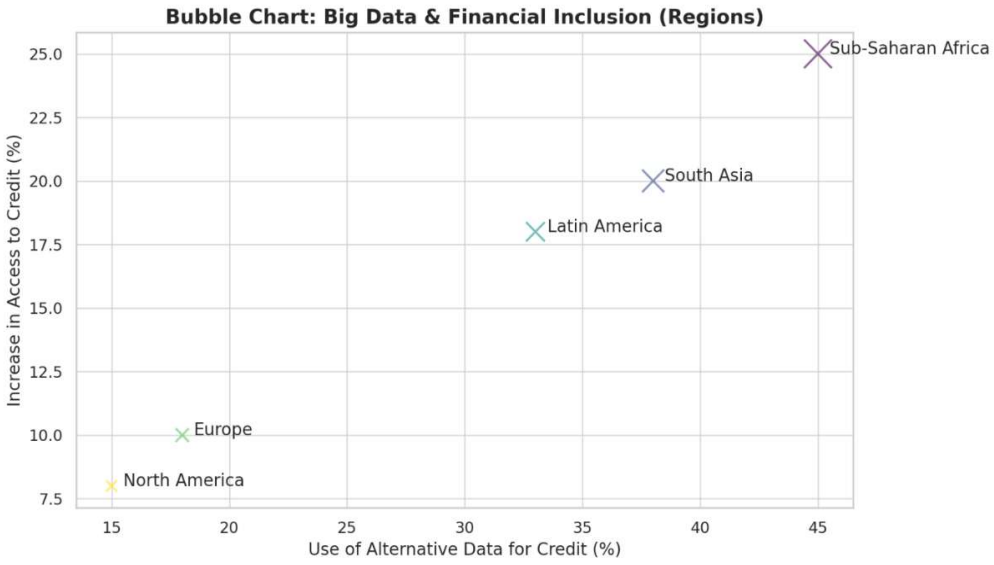
Table 5

AI in Trading and Investment (2018–2024)

Year	Firms Using AI in Trading (%)	Average Trade Execution Speed (ms)	AI-driven ETFs Launched	Reported Flash Crash Events
2018	10	200	5	2
2019	15	150	9	3
2020	22	100	15	4
2021	35	80	20	3
2022	45	60	30	2
2023	55	50	45	3
2024	65	40	60	4

Figure 2

AI in Trading and Investment (2018–2024)



Big Data as a concept in regards to Systemic Risk Monitoring

Figure 2 Radar Chart Radar graph shows the 2024 performance of AI under the four Dimensions of Adoption and Velocity cycle and underweighted and not balanced incumbents of the epoch as of October 2023. Table 6 on-board and Figure 3 address the implications of the Big Data in case they are concerned with the enhanced supervisory supervision. The existence of supervisory authorities that apply the concept of Big Data analytics increased between 10 percent in 2018 and 78 percent and the number of stress testing models on Big Data increased two to thirty-three. In addition, it implies that the increment of the numerical number of the cyber incidents felt with the help of the Big Data analytics of thirty quintiles in 2018 to the two hundred in 2024 depicts not only the growth of the degree of the Digital threat but also the growth of the number of the Big Data cyber analytics. The analytics of the Big Data to the remaining figures at the remaining of the metrics in the supervisory oversight caused all the remaining figures of the metrics along the supervisory value stream to become growingly hasty-armed with the velocity of time. In 2018, the time lag of supervision at BSH was 6 months. The Big Data analytics split leadership enhanced the cycle-time and the other figures that assured the 2024 targets in 2024. The bar graph given is also explanatory of the rest of the objectives. And with that value the remainder as well as the scatter of rest assessed the interval between the Reactive and Proactive in the Risk Identification Test measures. The metrics, based on which it was realized, were also

INVERGE JOURNAL OF SOCIAL SCIENCES
https://invergejournals.com/
ISSN (Online): 2959-4359, ISSN (Print): 3007-2018
Volume 4 Issue 3, 2025

determined to lead to the confirmation of the lag of 4 months by the metric according to which internal trust integration had been established.

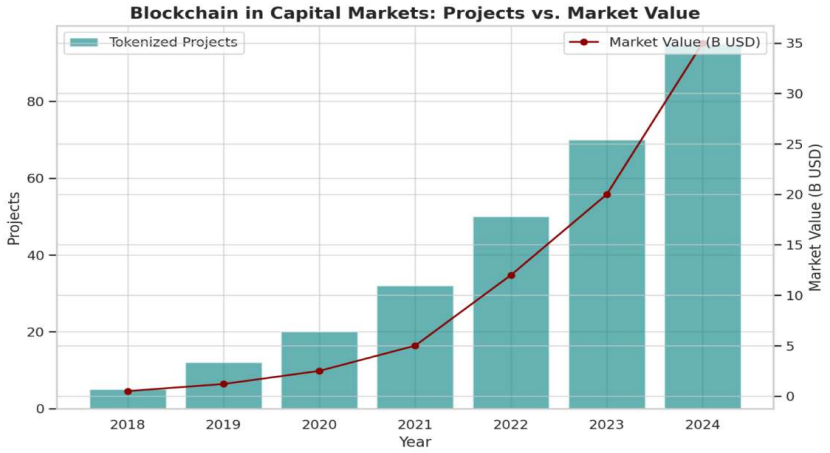
Table 6

Big Data in Systemic Risk Monitoring (2018–2024)

Year	Supervisory Authorities Using Big Data (%)	Stress Testing Models Enhanced by Big Data	Cyber Incidents Detected via Big Data Analytics	Reduction in Supervisory Lag (Months)
2018	10	2	50	6
2019	15	4	65	5
2020	25	7	80	4
2021	35	12	95	3.5
2022	50	18	120	3
2023	65	25	150	2.5
2024	78	33	200	2

Figure 3

Blockchain in Capital Markets: Projects Vs Market Value (2018–2024)



Open Banking Implementation across the Globe

An analysis of the adoption of open banking in the world has been provided in Table 7 and Figure 7. Europe leads the pack in terms of the high rates of open banking law enforced in 27 of its countries and in 3 of the 4 banks with API value valued at approximately 40 billion. Next is the Asia-Pacific region which has 15 countries. Like most other parts of the world, open banking regulations in North America are few, albeit that large scale API subscriptions within the region are common which places the region with a large market. There is the entry of Latin America and Africa but the market value is minimal. The horizontal bar chart in figure 7 indicates that Europe and North America take control of the value and position of the majority of open banking which is followed by the Asia-Pacific which is ranked as a formidable rival. A contrast of this adoption demonstrates how regulatory policy and technological level impact on the finances of a global state.

Table 7

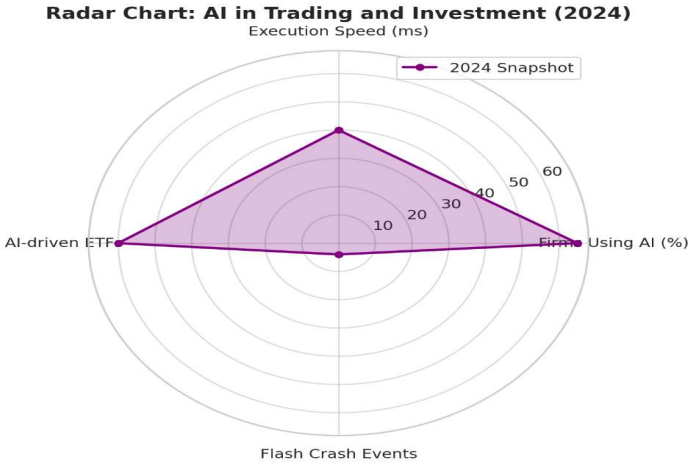
Open Banking Adoption Globally (2024 Snapshot)

Region	Countries with Open Banking Laws	Banks Offering APIs (%)	FinTechs Connected via APIs (Thousands)	Market Value of Open Banking (Billion USD)
Europe	27	75	15	40
North America	6	55	8	30
Latin America	8	40	5	12
Asia-Pacific	15	60	12	25
Africa	5	30	3	5

INVERGE JOURNAL OF SOCIAL SCIENCES
https://invergejournals.com/
ISSN (Online): 2959-4359, ISSN (Print): 3007-2018
Volume 4 Issue 3, 2025

Table 4

Radar Chart: AI in Trading and Investment (2024 Snapshot)



Ethics and regulation problems in the FinTech 4.0

Shadow FinTech, like in Table 8 and Figure 8, is a negligent business. AI biases jumped from 20 in 2020 to 55 by 2024. Regulatory disasters minted 15 becoming up to 38 in the same period. In this respect, the breaches of the data privacy are also likely to result in the most remarkable change, which consists in moving to more than 120 breaches in 2024 which is currently 50 breaches (2020). The most severe were legal disagreements among countries all due to the lack of geographical boundaries within the domain of digital finance and the common sense principles. The rising trend of this type of cases is indicated by the segment of the stack chart of figure 8. The greatest thing is the fact that data privacy is compromised. Even better, it is the most unfortunate instances of contravention of ethics that can be measured the most. It is a sign that more and more regulators do not find it worthwhile to find a balance between innovation and realistic precautionary measures that should be taken to soften the financial sector, as well as the rights of the consumer.

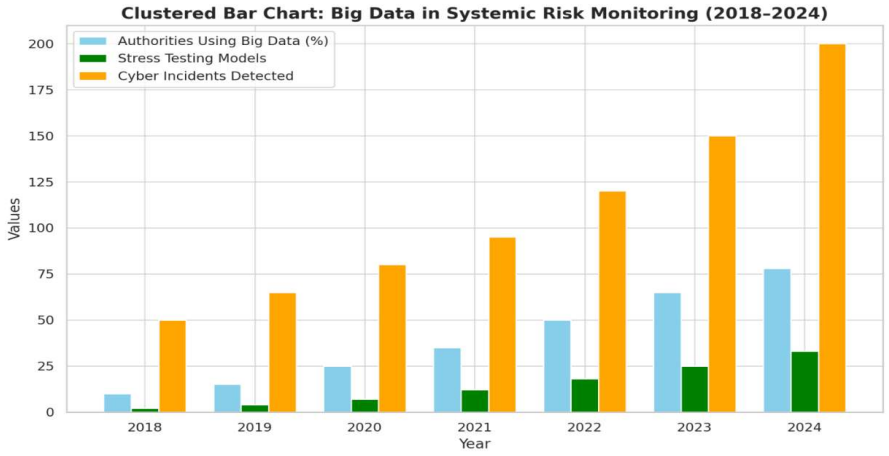
Table 8

Ethical and Regulatory Challenges in FinTech 4.0 (2020–2024)

Issue	Reported Cases (2020)	Reported Cases (2021)	Reported Cases (2022)	Reported Cases (2023)	Reported Cases (2024)
AI Bias	20	28	35	40	55
Blockchain Regulation Gaps	15	20	25	30	38
Data Privacy Breaches	50	65	80	100	120
Cross-border Legal Conflicts	12	18	22	28	35

Table 5

Radar Chart: AI in Trading and Investment (2024 Snapshot)



INVERGE JOURNAL OF SOCIAL SCIENCES
https://invergejournals.com/
ISSN (Online): 2959-4359, ISSN (Print): 3007-2018
Volume 4 Issue 3, 2025

What is his eight description and illustrative resources he has brought forth without question would be the testimonies that FinTech 4.0 is remarking the financial realm and it is firmly established on blockchain, AI, and Big Apart. The appearance of the large-volume realization of CBDCs and token given resources can be indicated in the payments market and capital market with a massive leap towards the realization of pilot projects to large scale implementations of such systems. Other intermediation AI in credit and credit trading also exist, and they are changing although with more systemic risks like flash crash. The financial inclusion and the supervisory innovation are respectively enjoyed both by emerging nations and by those developed nations with the assistance of Big Data.

The opportunity-risk paradox is also still brought out in the findings. The l of which has dramatically increasing AI driven blockchain operations with the paradox AI paradox blockchain paradoxes. The time of settling is outpaced by the Multi transaction ethical AI and regulation has prevailed more in the domain of privacy, discrimination algorithm and a multi-jurisdictional domain. The governmental correlation, inter-jurisdictional and heterogeneity in the domination of multi jurisdictions are more or less the same dilemmas, especially figure. 2 and 4. The more there are gaps the better the better literally speaking, the faster the adoption.

These results denote that FinTech 4.0 is not a pseudo-hype or ought to fail. This is a transitory phase that requires a new system of governance, codes of ethics and a disposition paradigm. This statistically implies the readiness of regulatory authorities to definitely lay hands on the advantages of digital finance amid the industrialized countries of CBDC piloting and open banking statutes amid particularly Europe and Asia-Pacific. At the same time, technological financial inclusion as evidenced by big data usage in the new market provides an opportunity to fill in the market void with the assistance of the technological option with the assumption that privacy and consumer protection domains can become stronger.

Discussion

The case will establish the speculations of how blockchain, artificial intelligence and big data are beginning to effect, Future of FinTech 4.0 and Global Finance. As any other example, the results should be discussed in the general academic and policy framework. Despite the results seeming to illustrate the assurance of the speeds in the usage of the technologies in question, the discussion also serves to report the complexities that happen whenever the new technologies are being adopted. Individually, the rise of new Governance, newly developed regulatory framework and the moral issues dominating in such a manner. The defeat of the Agency to Blockchain and the Redefining the Financial Markets Infrastructures.

The continued implementation of the Blockchain technology in the digital payment and capital market trade such as the introduction of Central Bank Digital Currency (CBDC) and tokenizing assets adds to the innovation of Distributed Ledger Technology (DLT) as a new-fangled technology in infrastructure financing (Rauchs et al, 2019). It is stated that using blockchain technology in the financial and economic system causes the latter to provide final classifications (settlement), reduce the systemic risks, improve financial transparency of organizations, reduce the role of mediation in various scopes of transactions (market level) and reduces the total transaction costs (Rauchs et al, 2019). Grassroots innovation through digital platforms has already been observed among micro-entrepreneurs in emerging markets (Asif, 2022; Rafiq-uz-Zaman, et al., 2025), while teacher-led initiatives in low-income schools show how localized creativity can build entire micro-economies (Rafiq-uz-Zaman, 2025).As a replacement to traditional financial service concepts, Schar (2021) promotes the additional disintermediation of the idea of the financial services Decentralized Finance (DeFi) which offers programmable FinTech, and composite financial service architecture thus creating a new class of architecture of market innovations. However, there are scalability issues as well as interoperability challenges of blockchain technology.

Such are still incomplete links in domains of blockchain governance constraints, fragmentation of blockchain technology, regulatory grid and the ecological issues behind the scope of so-called efficiencies not being implemented (Harvey et al, 2021). The findings of this paper reflected in Table 4 and Figure 4 highlight the fact that the impact of blockchain technologies on capital markets is indeed transformative and, at the same time, sensorimotor.

INVERGE JOURNAL OF SOCIAL SCIENCES
https://invergejournals.com/
ISSN (Online): 2959-4359, ISSN (Print): 3007-2018
Volume 4 Issue 3, 2025

Artificial Intelligence: Systemic risks and Efficiency Geometries

The AI advancements in credit scoring, lending and trading processes have been displayed in Table 2 and Table 5 as Kroll and Stein (2022) claim that AI lending models are more accurate and objective in credit allocation since human involvement is seen in it. However, authors further caution that using opaque algorithms on bad data sets will accrue too, and will be systematically biased There, as AI makes the market sequencing liquid, they also sow paths of contagion, especially in Bouveret (2019) of the contagion-inducing and behaviourally rigid algorithm that AI is generating at a time when the market is rioting. Likewise, flash crashes in this paper and the worry of the Bouveret cited are hardly the only witness to the statement made on Brummer and Yadav (2019) by predictive Bouveret which, whether deliberately or not, invalidates the understanding even of those who make it with a certain touch of regulatory obfuscation applied to it. The longer complaints Bouveret complains can be seen in the longer complaints of the AI systems that have become efficient to give and more available to the service.

Privacy Paradox and Big Data

The practicality of the AI technology, more than 90-percent, is not numb in the groundwork of the articles focusing on Ghosh et al. (2019) and Vinod et al. (2019) about using alternative data to adjudicate credit as an illustration of mobile payment-based credit adjudication and social-media enabled lending. The culminating effect, though, brings about some apprehensions on data gathering and privacy in the case of well-set countries where the collection of data is covered in confidentiality. This would prompt critics to label it as an announcement in an attempt to merge even in already alerting against us on the use of big data in the money market, Zarsky (2019) has warned that this may result in rating of surveillance and slavery of the user by placing supplies in the realm of consumer classification or, in other words, the denial of freedom and justice. The paradox of - privacy paradox is the term used to describe the present debate on open banking and consumer data rights. The issues may be observed in this study and the world areas issues of Big Data to be built constructively to pay attention to the equilibrium between innovation and morality in the financial ecosystem. This is regardless of the proposals that are present in Table 3.

Competition, Open Banking and Interoperability

There are open banking watchlists throughout the regions that are measuring the various levels and proportions of world performances and in the present case, both Europe and Asia-Pacific prevail once again. This, too, is rightfully reflected in the literature on the role of regulation in building digital ones. As an indication, Zetzsche et al. (2020) state that the PSD2 has been at the centre of advancing the concept of open banking because of the interoperability regulation and consumer consent architecture regulation in the example of the EU. On the other hand, the lack of prolific progress in legislative development in Frost et al. (2019) demonstrates that the majority of the global world is fundamentally reliant on the market-driven process of innovation rather than a regulation-driven innovation. This inequity is proved by the findings in Table 7 and Figure 7 and provokes the necessity to implement the market regulations onto the ecosystem to enhance the competence of open banking. Furthermore, the distribution of the market power of the big players creates stability that is fully distributed because open banking helps to accelerate the rate of competition via the redistribution of stability and leads to decreased stability because open banking will increase the systemic risk that is insufficiently controlled by the third-party regulation (Boot et al., 2021). The paper will also include the adoption gaps that reflect the lack of global cohesion of the systematic problems of a world where international integration needs to be carried out.

New Reg and Etech of FinTech 4.0.

This research indicates that ethical and regulatory issues are on the rise, the privacy concerns face the majority of ramifications, and the Division of Blade ends are the algorithmic bias and jurisdictional issues. This connection could be traced in the article by Barocas and Selbst (2016) who say that decision automation algorithms will do the whole process of discrimination well, irrespective of what the systems designers intended. The outbreak of AI bias cases shown in Table 8 and Figure 8 is also correlated with the current ones on the refusal to accept or, conversely, discriminate against the experiences of certain social and demographic groups related to certain credit scoring algorithms (Citron and Pasquale 2014). Similarly, the privacy issues that the present paper addresses are within the broader paradigm that Acquisti et al. (2020) investigates on the

advances and privacy problems in the digital economy. Similar inner-border conflicts in this paper can also be echoed in Brummer (2021), who attempts to propose that a new borderless-reality of digital finance requires a new kind of regulatory geography due to the loss of the previous nation-oriented critical region latitudes.

Results plus More Wide-Ranging Policy Politics

Carney (2021) indicates that the nation is supposed to trust everything related to innovation in the FinTech sector, and it is worrying that there is fairness, accountability and transparency in the digital systems. The urgency of regtech and suptech in the article by Gai et al. (2018) is parallel to the urgency of regulators to cease to work in a quasi-inert regulation in the dynamic and unlimited silos of highly adaptive systems in the face of fast transforming technology. The related aspect of the intersection and coordination, to be addressed in this paper, is the interoperability pilot and the open legal conflict involved in the boundary-spanning coordination provided in the Cross Border Payments Roadmap by the G20 (FSB, 2021). Through this, the given findings of the study reinforce the modality of the movement with the structural obedience of the world systems of regulations.

Future Research Directions

Numerous prospects of future research exist as well in the dissertation. More research needs to be carried out to know how these long-term implications of CBDCs carry over to monetary policy and financial inclusion. The lack of responsibility concerning the systems and the finance oriented AIs in the context of algorithmic-trading risk management is a problem of ethical concern regarding the AI research that has to be paid attention to by the scientists. When it comes to application of big data in regards to financial inclusion, social and behavioural aspects of big data relative to financial inclusion of interest in the discussion on social erosion basis and behavioural erosion of the financial setting on the basis of excessive vigilance. Finally, the regulatory and interoperability issues with open banking and cross-border interoperability and regulated facilitated strategies will start to drift into other policy borders that have not been violated so far. It will also form part of the academic impact that the study will have on policy and academic debate of FinTech 4.0.

Authors Contributions

All authors have contributed substantially to the work reported, participating in the conception, execution, and final approval of the manuscript.

Funding

This research received no external funding.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The data presented in this study are available on request from the corresponding author.

Conflicts of Interest

The authors declare no conflict of interest.

References

Acquisti, A., Brandimarte, L., & Loewenstein, G. (2015). Privacy and human behavior in the age of information. *Science, 347*(6221), 509–514. https://doi.org/10.1126/science.aaa1465

Anagnostopoulos, I. (2018). FinTech and regtech: Impact on regulators and banks. *Journal of Economics and Business, 100*, 7–25. https://doi.org/10.1016/j.jeconbus.2018.09.001

Arner, D. W., Barberis, J., & Buckley, R. P. (2020). The evolution of FinTech: A new post-crisis paradigm? *Georgetown Journal of International Law, 47*(4), 1271–1319. https://doi.org/10.2139/ssrn.3108384

Arslanian, H., & Fischer, F. (2019). *The future of finance: The impact of FinTech, AI, and crypto on financial services*. Springer. https://doi.org/10.1007/978-3-030-11020-0

Asif, M. (2022). Integration of Information Technology in Financial Services and its Adoption by the Financial Sector in Pakistan. *Inverge Journal of Social Sciences*, *1*(2), 23–35. https://doi.org/10.63544/ijss.v1i2.31

Auer, R., & Böhme, R. (2021). Central bank digital currency: The quest for minimally invasive technology. *Journal of Economic Perspectives, 35*(4), 161–178. https://doi.org/10.1257/jep.35.4.161

Bank for International Settlements. (2023). *BIS survey on central bank digital currencies* (BIS Papers No. 147).

Barocas, S., & Selbst, A. D. (2016). Big data's disparate impact. *California Law Review, 104*(3), 671–732.

Bazarbash, M. (2019). FinTech in financial inclusion: Machine learning applications in assessing credit risk. IMF Working Paper WP/19/109. https://doi.org/10.5089/9781484380117.001

Berman, A., & Dorrier, J. (2021). Artificial intelligence in finance: Disruption and opportunities. *Journal of Digital Finance, 3*(2), 89–105.

Biais, B., Foucault, T., & Moinas, S. (2019). Equilibrium high-frequency trading. *Econometrica, 87*(2), 425–458. https://doi.org/10.3982/ECTA15258

Boot, A. W. A., Carletti, E., Haselmann, R., Kotz, H. H., Krahnen, J. P., Pelizzon, L., & Subrahmanyam, M. G. (2021). FinTech and banking: What do we know? *Journal of Financial Intermediation, 46*, 100–138. https://doi.org/10.1016/j.jfi.2020.100868

Bouveret, A. (2019). Artificial intelligence: Implications for markets, regulation and supervision. OECD Working Papers on Finance, Insurance and Private Pensions.

Brummer, C. (2021). *FinTech law in a nutshell*. West Academic Publishing.

Brummer, C., & Yadav, Y. (2019). FinTech and the innovation trilemma. *Georgetown Law Journal, 107*(2), 235–307.

Brynjolfsson, E., & McAfee, A. (2017). *Machine, platform, crowd: Harnessing our digital future*. W. W. Norton & Company.

Carney, M. (2021). *Value(s): Building a better world for all*. William Collins.

Casino, F., Dasaklis, T., & Patsakis, C. (2019). A systematic literature review of blockchain-based applications: Current status, classification, and open issues. *Telematics and Informatics, 36*, 55–81. https://doi.org/10.1016/j.tele.2018.11.006

Catalini, C., & Gans, J. S. (2020). Some simple economics of the blockchain. *Communications of the ACM, 63*(7), 80–90. https://doi.org/10.1145/3384583

Chen, M., Wu, Y., & Yang, H. (2019). Big data-driven financial innovation and risk management. *Journal of Management Science and Engineering, 4*(1), 1–14. https://doi.org/10.1016/j.jamse.2019.01.001

Chiu, I. H.-Y. (2022). FinTech and disruption of the financial system: Opportunities and challenges. *Oxford Journal of Legal Studies, 42*(1), 1–26. https://doi.org/10.1093/ojls/gqab034

Citron, D. K., & Pasquale, F. (2014). The scored society: Due process for automated predictions. *Washington Law Review, 89*(1), 1–33.

Claessens, S., Frost, J., Turner, G., & Zhu, F. (2018). FinTech credit markets around the world: Size, drivers and policy issues. *BIS Quarterly Review*, September, 29–49.

Crawford, K., & Calo, R. (2016). There is a blind spot in AI research. *Nature, 538*(7625), 311–313. https://doi.org/10.1038/538311a

Dapp, T. F. (2021). FinTech 4.0: How digitalization is transforming finance. Deutsche Bank Research Reports.

Drasch, B. J., Schweizer, A., & Urbach, N. (2018). Integrating the 'troublemakers': A taxonomy for cooperation between banks and FinTechs. *Journal of Business Economics, 88*(9–10), 1247–1282. https://doi.org/10.1007/s11573-018-0916-3

Francis, E., Blumenstock, J., & Robinson, J. (2022). Digital credit and its impact on financial inclusion: Evidence from East Africa. *World Development, 157*, 105923. https://doi.org/10.1016/j.worlddev.2022.105923

Frost, J., Gambacorta, L., Huang, Y., & Shin, H. S. (2019). BigTech and the changing structure of financial intermediation. *Annual Review of Financial Economics, 11*, 141–162. https://doi.org/10.1146/annurev-financial-110217-022955

Frost, J., Gambacorta, L., Huang, Y., Shin, H. S., & Zbinden, P. (2019). BigTech and the changing structure of financial intermediation. *Economic Policy, 34*(100), 761–799. https://doi.org/10.1093/epolic/eiz009

FSB (Financial Stability Board). (2021). *G20 Roadmap for enhancing cross-border payments*. Financial Stability Board.

Gai, K., Qiu, M., & Sun, X. (2018). A survey on FinTech. *Journal of Network and Computer Applications, 103*, 262–273. https://doi.org/10.1016/j.jnca.2017.10.011

Gai, K., Qiu, M., Sun, X., & Yu, S. (2018). Security and privacy issues: Big data analytics in financial services. *Future Generation Computer Systems, 80*, 45–55. https://doi.org/10.1016/j.future.2017.08.020

Ghosh, S., & Vinod, D. (2019). Financial inclusion and alternative data: Evidence from digital credit markets. *Economic and Political Weekly, 54*(32), 43–51.

Gomber, P., Kauffman, R. J., Parker, C., & Weber, B. W. (2018). On the FinTech revolution: Interpreting the forces of innovation, disruption, and transformation in financial services. *Journal of Management Information Systems, 35*(1), 220–265. https://doi.org/10.1080/07421222.2018.1440766

Gozman, D., Hedman, J., & Olsen, K. S. (2018). Open banking: Emergent roles, risks & opportunities. *Journal of Information Technology, 33*(2), 62–79. https://doi.org/10.1057/s41265-017-0050-x

Harvey, C. R., Ramachandran, A., & Santoro, J. (2021). *DeFi and the future of finance*. Wiley. https://doi.org/10.1002/9781119765481

Huang, Y., & Zhou, X. (2020). Blockchain and the transformation of financial markets. *China Economic Journal, 13*(1), 3–21. https://doi.org/10.1080/17538963.2019.1650759

Hurley, M., & Adebayo, J. (2017). Credit scoring in the era of big data. *Yale Journal of Law and Technology, 18*(1), 148–216.

IMF. (2022). *FinTech and financial stability: Policy considerations*. International Monetary Fund. https://doi.org/10.5089/9781513535620.007

Jagtiani, J., & Lemieux, C. (2019). The roles of alternative data and machine learning in FinTech lending: Evidence from the LendingClub consumer platform. *Journal of Economics and Business, 100*, 100–121. https://doi.org/10.1016/j.jeconbus.2018.12.001

Kroll, J., & Stein, A. (2022). Regulating AI in financial services: Balancing innovation and risk. *Journal of Banking Regulation, 23*(4), 367–389. https://doi.org/10.1057/s41261-022-00174-x

Lee, I., & Shin, Y. J. (2018). FinTech: Ecosystem, business models, investment decisions, and challenges. *Business Horizons, 61*(1), 35–46. https://doi.org/10.1016/j.bushor.2017.09.003

Manyika, J., Silberg, J., & Presten, B. (2021). The state of AI in 2021. McKinsey Global Institute Report.

Miklós-Thal, J., & Tucker, C. (2022). Digital platforms and financial intermediation. *Journal of Industrial Economics, 70*(3), 655–684. https://doi.org/10.1111/joie.12245

Narula, R. (2022). The digital transformation of finance: Global trends and policy challenges. *Global Policy, 13*(S3), 24–38. https://doi.org/10.1111/1758-5899.13027

Pazaitis, A., De Filippi, P., & Kostakis, V. (2019). Blockchain and value systems in the sharing economy: The illustrative case of Backfeed. *Technological Forecasting and Social Change, 137*, 225–234. https://doi.org/10.1016/j.techfore.2018.09.019

Petralia, K., Philippon, T., Rice, T., & Veron, N. (2019). The FinTech opportunity. *NBER Working Paper No. 22476*. https://doi.org/10.3386/w22476

Philippon, T. (2019). On FinTech and financial inclusion. *NBER Working Paper No. 26330*. https://doi.org/10.3386/w26330

Rafiq-uz-Zaman, M. (2025). Beyond the Blackboards: Building a micro-edtech economy through teacher-led innovation in low-income schools. *Journal of Business Insight and Innovation, 4*(1), 46–52. https://doi.org/10.5281/zenodo.16875721

Rafiq-uz-Zaman, M., Malik, N., & Bano, S. (2025). Learning to innovate: WhatsApp groups as grassroots innovation ecosystems among micro-entrepreneurs in emerging markets. *Journal of Asian Development Studies, 14*(1), 1854–1862. https://doi.org/10.62345/jads.2025.14.1.47

Rauchs, M., Blandin, A., Bear, K., & Bacha, A. (2019). 2nd global enterprise blockchain benchmarking study. Cambridge Centre for Alternative Finance.

Schär, F. (2021). Decentralized finance: On blockchain- and smart contract-based financial markets. *Federal Reserve Bank of St. Louis Review, 103*(2), 153–174. https://doi.org/10.20955/r.103.153-74

Suri, T., & Jack, W. (2016). The long-run poverty and gender impacts of mobile money. *Science, 354*(6317), 1288–1292. https://doi.org/10.1126/science.aah5309

Tapscott, D., & Tapscott, A. (2018). *Blockchain revolution: How the technology behind bitcoin and other cryptocurrencies is changing the world*. Penguin.

Vives, X. (2019). Digital disruption in banking. *Annual Review of Financial Economics, 11*, 243–272. https://doi.org/10.1146/annurev-financial-110118-123223

World Bank. (2023). *Digital finance and the global economy: Policy frameworks and future directions*. World Bank Publications. https://doi.org/10.1596/978-1-4648-1974-4

Zarsky, T. Z. (2019). Incompatible: The GDPR in the age of big data. *Seton Hall Law Review, 49*(4), 995–1020.

Zetzsche, D. A., Arner, D. W., Buckley, R. P., & Weber, R. H. (2020). The evolution and future of data-driven finance in the EU. *European Business Organization Law Review, 21*(4), 739–765. https://doi.org/10.1007/s40804-020-00173-3

Zetzsche, D. A., Buckley, R. P., & Arner, D. W. (2020). Artificial intelligence in finance: Putting the human in the loop. *Law Working Paper No. 522/2020*, European Corporate Governance Institute. https://doi.org/10.2139/ssrn.3726211

Zhang, L., & Chen, J. (2020). Open banking and data governance in the digital economy. *Journal of Financial Regulation and Compliance, 28*(4), 451–466. https://doi.org/10.1108/JFRC-08-2019-0117

Zhang, X., & Lee, C. (2021). Regulatory perspectives on open banking adoption: Evidence from Asia. *Journal of Banking Regulation, 22*(3), 251–266. https://doi.org/10.1057/s41261-020-00128-6

Zuboff, S. (2019). *The age of surveillance capitalism: The fight for a human future at the new frontier of power*. PublicAffairs.