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FINANCE IN A DIGITAL AGE: FINANCIALS MARKETS AND THEIR INSTITUTIONS

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Abstract

Digitalisation of finance is a characteristic feature of todays' financial systems. Digital transformation affects financial systems and their individual elements in a variety of ways. It can have both economic as well as broad social effects, enhancing the possibilities of access to the financial services and improving the position of the poor. It can generate positive effects but it can also bring negative outcomes and generate unknown challenges. The developments taking place navigate finance into largely uncharted waters. The paper outlines some important changes induced by digitalisation in the financial area. Its focus is on macro and mezzo issues related to the operation of the financial markets in the digital age. In the first part we discuss changes introduced into the intermediating activities in finance with particular attention given to big tech.It is followed by the analysis of the structural shift in financial market organisation impacted by the decentralisation digital tools. Thereafter we focus on the new risk agenda of the digitalised systems, including cyberrisk, tech risk and data protection issues.

JEL Classification: G15,G21, G22, G23.

Keywords: datafication, digital transformation, decentralised finance, cyberrisk, fintech, big tech, suptech,

Introductory remarks

During the first two decades of the current century we are moving increasingly into the world of a digital economy. It is driven by the growing application of digital technology into the economic space by all participants of economic systems, both businesses, consumers and public institutions. Distinguishing feature of digitalisation is an introduction and spread of the specific virtual reality reflecting the real world via the digital representation. This virtual layer is represented by information flows, databases and networks(Dembinski,2019).Currently available technologies provide for the growing datafication of the economic systems which enhances the scope of digitalisation and connectivity of its participants.

Finance is at the forefront of this digital transformation due to the fact that financial production relies entirely on virtual reality. There are no material processes which are necessary to back up financial services. In this sense digitalisation of finance is easier than elsewhere. Due to its heavy regulatory load however it is more complex than elsewhere.

Digital transformation affects financial systems and their individual elements in a variety of ways. It can have both economic as well as broad social effects, enhancing the possibilities of access to the financial services and improving the position of the poor. It can generate positive effects but it can also bring negative outcomes (OECD2018).

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The purpose of this paper is to provide some clarification on some important aspects of digitalisation which is its impact on financial markets and their institutions. This issue has been largely absent from the existing academic literature until now. In the discussion that follows we are concentrating our attention on the impact of digitalisation on three key financial market related issues: the structure and governance of financial intermediation, digital risk agenda of the financial markets and digitalisation of supervisory activities.

We begin our discussion with short clarification of the terminology in use. Next we go to the issue of financial intermediation analysing changes that are taking place in the population of the financial providers. Thereafter we discuss the decentralisation of the financial provisioning and new risks challenging the financial market. Finally we focus our attention on the changing nature of financial supervision.

The concept of digital finance

Digital finance refers to the digital part of the financial system, including both financial products and services, including the internet, credit and payment cards, electronic exchange systems, home banking, home investment and the use of ATMs, as well as the infrastructure of the financial system. In addition, it also includes all mobile services and electronic applications.
Digital finance enables natural persons and legal entities to be active on the financial market via the internet, without having to contact the financial institution directly. It also enables different set up of back end and front end activities of the financial institution.

Historically, the term digital finance was preceded by the use of the term electronic finance or e-finance. It was first applied in a work published in 2001 by Erik Banks, an American banker from Merrill Lynch, who made the first comprehensive assessment of the development of such finance on a global scale (Banks 2001). A year later, an article by Franklin Allen, James McAndrews and Philip Strahan entitled "E-finance: An Introduction" appeared in the Journal of Financial Services Research and it also raised the topic of the impact of electronic finance on the financial sector. In this study, "e-finance" was also defined as the provision of financial services using electronic communication and processing (Allen et al. 2002). At that same time, according to Gattenio (2002), the term digital finance was already being used interchangeably.

In the current phase of discussions of the financial system and its evolution, the category of digital finance is starting to play an increasingly important role. Its delineation is not being given special attention in the literature, however. In a recently published work which reviews the state of research on fintech and digital finance, the issue of defining these categories does not appear at all, which is difficult to explain rationally (Allen et al. 2020). This seems to be an undeserved oversight.

In our paper we consider digital finance as a component of fintech, though there might be some inconsistencies here due to the absence of the universally accepted definition of both terms and also because of the dual meaning of fintech. Similar approach is represented by leading researchers in this area-Ross Buckley, Douglas Arner, Dirk Zetsche and Eriks Selga in their recently published study. They explicitly state that "Fintech is now defined by a long-term, global process of digitisation of finance, increasingly combined with datafication and new technologies" (Buckley et al 2020,p.35)

It should be noticed however that currently, fintech is usually defined with dual categorisation. On the one hand, this is how the use of a dynamically developing group of technical solutions to provide financial services is defined, and on the other hand, it is also how entities that create and provide them are called (Zetsche et al, 2020).

The very word fintech is a neologism created by combination of two words – "financial" and "technology". It has been most often defined as "technology-enabled innovation in financial services that could result in new business models, applications, processes or products with an associated material effect on the provision of financial services" (FSB 2017). In its second meaning, fintech means non-financial institutions, an alternative to the traditional financial circuit, providing financial services based on their technological advantage.

Historically, the term fintech was used for the first time in 1972 in the American magazine Interfaces by Abraham Bettinger, vice-president of the Manufacturers Hanover Trust, a well-known American bank. In a short two-page article, he stated that, among other things, the operational research department of the bank had developed over 100 models used at that time in banking activities. About 40 models had been set aside and named "fintech". He further explained that the word "fintech" is an acronym standing for financial technology which combines banking expertise with modern management science techniques and computers (Bettinger 1972).

This term has returned to widespread use over the last 10 years, with its popularity rising rapidly to an unprecedented extent. Research into the information resources of the well-known US database ABI/Inform Collection, which contains magazine articles, doctoral dissertations and the content of the most important business and economic periodicals, indicates that in the period 2008-2019 the use of the term fintech in publications around the world increased 25-fold, from around 40,000 times annually in 2008 to approx. 1 million publications in 2019 (see Fig. 1).

The enormous popularity of the term fintech was also noted in a recent Elsevier study regarding areas of research on the leading international SSRN database from 2016-2018. It turned out that fintech-related research papers were in first place with over 660,000 paper downloads, second came 'machine learning' with about 180,000 and 'big data' was third with 159,000 (Tucker 2018).

The term of digital finance in comparison to fintech is much modest in use. Simple detection of the papers uploaded in Social Science Research Network indicates that in the course of last three years the term digital finance was referred to in 230 publications whereas the term fintech was indicated over the same period in 714 papers.

In the current literature to date, the most comprehensive approach to the concept of digital finance and their systematics was provided in the study of P. Gomber, J. Koch and M. Siering (Gomber et al. 2017).

According to their concept, the digital finance space has been divided into three dimensions: business functions, technologies and technological concepts that provide their basis, and financial institutions delivering digital financial services.
These dimensions complement each other, and at the same time they interact and interpenetrate. The cube has been constructed so that each internal area can be described with properties from the three different dimensions. All areas are certain subgroups that relate to a specific combination of a business function, a specific technology and an institution. Not all areas need to be described by each dimension, just as one institution does not have to be assigned to one function or technology.

The important functional features of the cube concept are its high level of generality and granularity allowing for the flexibility of its construction. The dimensions can be expanded with new elements when new innovations appear or, if they already exist, they can find new business functions or new poviders.
 In our paper we enhance this model by supplementing the third dimension with digital financial markets, their governance, structure, supervision and risk dimension. All of these elements were largely overlooked in the original model which focused more on the corporate and technological perspectives without giving due attention to the systemic environment.

Digital finance institutions and markets

Digital finance institutions are currently a very diverse group of entities which mainly include traditional financial service providers such as banks, insurance, investment firms and asset management companies that operate using digital technologies. In recent years, they have significantly digitised their traditional services and offer online sale of products and services.
Already back in 1994, Bill Gates said that banks are dinosaurs, meaning that they will disappear soon. Since then, however, US banking system is doing quite well. Its assets have quadrupled, from $3.7 trillion in 1994 to $17.4 trillion in 2018. Over the same time, their number fell by half, from around 10,500 to approximately 5,000.

There are fewer banks, therefore, but they are much larger. The development of the internet led to the emergence of internet banks, but they did not replace the old banks as they also began to offer digital services to their clients (Stulz 2019).

They operate alongside enterprises coming from the fintech area. They comprise at least three distinct classes of entities (FSB, 2019, pp.2-5).

The first ones are fintech companies themselves,-bank like or insurance like or asset like companies-which rely on their ICT technological supremacy in some specific areas and may offer financial services in selected areas on their own, competing against existing incumbents. At the beginning, fintech companies invaded these financial services, which were perceived as niche and unprofitable for the old players. At present, however, these services have become often important from a business point of view and constitute a significant part of income also for traditional financial service providers. In response to this development, these companies often enter into business and capital relationships with companies in the fintech sector. Fintech companies are by far the most populous fraction of newcomers, bringing more diversity, volatility and competition to financial services provision. They are also bringing additional risks from the regulatory stand point as well as the market stability implications due to their competitive pressure on financial institutions margins. Its population is difficult to measure precisely as we are lacking their precise definition. According to the study prepared for the European Parliament in 2018 the global fintech sector was made up at that moment by circa 3.800 companies. Around 1.500 of them were domiciled in the US,1.000 were registered in EU,250 in India and about 100 hundred in China (European Parliament, 2018, p.33).

Fintech sector companies have significantly changed the structure of financial services offered, as well as their distribution and consumption. They have also changed the conditions of competition for traditional financial institutions. However, they have not been able to gain a dominant position on the financial market, and in particular the banking market. For example, they are still poorly represented in corporate banking of large and medium-sized companies. Fintech companies'loans still represent a small part of the global credit market. In China, where this share is the highest in the world, it doesn't exceed 3% of total non-banking loans (OECD 2020, p.13).Hence the decline of traditional banking, as expected by some analysts, has not occurred.

The second class of entities are Big tech companies, referred sometimes as techfins, which are most commonly defined as large, technology based entities, whose primary activities encompass provision of digital services. Financial services are, unlike in fintech companies, their secondary product so far. Unlike fintech, techfins begin their operations with technology and data, to which they subsequently add financial services. Big tech are also the most important providers of cloud computing services. As techfins, these companies have experience in e-commerce, social networks, entertainment and telecommunications. Large databases built up during this operation can be used to provide financial services, and they can also be offered to other financial companies.

It is estimated by BIS that Big tech revenues in 2018 were coming foremostly from communication services(above 46%) and only around 11% represented revenues from financial services (BIS 2019,p.56).

The population of Big tech companies in comparison to fintech entities is very limited and its global players include currently mainly American and Chinese corporations(see Table1).

Table 1 Big tech activities in financial services

Entity	Geographical area of activity	Main line of non-financial business	Main financial lines of business		
			Payments	Money market funds and insurance	Lending
Alibaba/Alipay	China	E-commerce, communication	Δ	Δ/√	Δ
Tencent	China	E-commerce, communication	Δ	Δ/√	Δ
Baidu	China	Internet search	Δ	Δ/√	√

Vodafone M-Pesa	Africa, India	Communications	Δ		√
MercadoLibre	ArgentinaBrazil, Mexico	E-commerce	Δ		Δ
Samsung	South Korea	Electronics	√		
Kakao	South Korea	Social network, communication	Δ/√		Δ/√
Google	Worldwide	Internet search, software	√		Δ/√
Amazon	Worldwide	E-commerce	√		√
eBay/PayPal	Worldwide	E-commerce	√		√
Apple	Worldwide	Electronics, software	√		
Facebook	Worldwide	Social network	√		
Microsoft	Worldwide	Software	√		
Orange	France	Communications	√		√
Groupon	Worldwide	E-commerce	Δ		
Rakuten	Japan	E-commerce	Δ	Δ	Δ
NTT Docomo	Japan	Communications	Δ	Δ	√

Δ – services provided outside traditional financial system.

√ – services provided in cooperation with traditional financial institutions

Source:Głogowski A(2021),p.69

The core business of these companies is information technology and business model of these companies rests on providing for direct interactions among a large number of users. Side effect of their business activities are established customer data and networks and advanced software development.

The future competitive impact of Big tech on the financial services market may be substantial. With their established customer networks and name recognition, technological lead as well as strong financial position they could become a real challenger to the existing incumbents. To put it into the financial perspective available statistics indicate that in 2019 stock market capitalization of the first seven largest Big tech have surpassed by far the stock market capitalization of the seven largest financial groups in the world.
The first Big tech on the list-Microsoft-have recorded market capitalisation 2,5 times higher than J. P. Morgan-the leader of the financial institutions list (FSB, 2019, p.4)
The third population of entities are the ones that are composed of third party service providers to the world of financial institutions, and which role is quickly growing. Part of them belong currently to Big tech and another part to fintech companies. New emerging trend is the presence here of government sponsored establishments which reflects growing security concerns and the search for national digital sovereignty.
Financial institutions rely on third-party service providers inter alia for data provision, physical connectivity, and cloud services. Particular relevant today are cloud computing services which refers in principle to the practice of using a network of remote servers, typically accessed over the internet, for the provision of IT services. It offers more convenient and frequently cost effective access to computing resources compared to the in house approach. Principal advantages are economies of scale, flexibility, operational efficiencies and cost effectiveness.
The overall spending of financial institutions on cloud services is estimated to reach in 2020 the level of $55 billion, up from $37 billion in 2017(Gartner, 2017).

The service could be offered in different constellation and different business models.(US Dept Of Treasury, 2018). It should be noted perhaps that as of now outsourcing services in cloud computing for financial sector entities are in most cases subject to regulatory consent. Cloud computing is strongly associated with the big data issue. Technological advances lead to increasing amounts of data collected, processed, shared and used in digital form at lower cost and on a larger scale. Big data generally refers to technological developments related to the area of data collection from a varied sources, storage, processing, verification, analysis and applications. It is often characterized by the increased volume, velocity and variety of data being produced. It typically refers to data coming from the internet, but of course it is not limited to them (EBA, 2020, p.12).

Big data offers particular advantages when processed with the advanced analytics tools, that is with the autonomous examination of data or content using sophisticated artificial intelligence technics. Advanced analytics techniques, based on artificial intelligence, may include a number of tools like text mining, machine learning, forecasting, visualization, semantic analysis, sentiment analysis, network examination of data or content, etc. This may assist in forecasting the future behavior of financial market participants, while transaction analysis may help in detecting some repetitive patterns. This may lead to the development of the technology of smart contracts and their automatic self execution,when ex ante defined conditions are met. This may result in lowering the total transaction costs and accelerate its implementation

Big data analytics seem to be nowadays particularly well developed in the insurance sector which has a long tradition and a strong demand for the use of statistics for business purposes, including underwriting policies, claims settlement or fraud detection. In the recent thematic study of European Insurance and Occupational Pensions Authority (EIOPA) on the use of big data analytics in medical and motor insurance in EU, it was revealed that traditional data sources such as demographic data, loss data, hazard data, mortality and morbidity rates are in a growing degree supplemented with other data coming from car telematics, internet of things, social media exploration, web searches and web comparators, data generated from third party vendors, bank accounts data or health genetic data (EIOPA, 2019, p.12-13).

In addition to the commercial institutions, the world of financial institutions also includes agencies responsible for the supervision of the digital financial sector, including financial prudential supervision as well as non-financial supervision. The latter includes supervision over teletechnical systems, in particular in the field of cybersecurity, and supervision over the protection of privacy and the use of personal data. The tasks and structure of market surveillance is different from that which dominated in analogue times. There are many more technical and horizontal elements in it. The issues of the protection of consumer rights and interests are of great importance. At the same time, supervisory instruments begin to use digital technologies to a much greater extent.

Digital transformation and the decentralisation of the financial market

Digital financial innovations are impacting not only the composition of intermediating institutions offering financial services. They are providing additionally a possibility of decentralising financial systems by eliminating or reducing the need for intermediating activities or centralized processes in the delivery of financial services. They are also effectively questioning the future role of the central banks and their monetary policy. In practice this means a democratisation of the whole system and growth of mutual reliance of the market participants on their own actions and decisions.

From the systemic point of view there are different types of decentralization in financial services which may effectively take place. In principle it may take three broad forms(FSB, 2019a):
• decentralization of decision-making, which involves a move away from a single trusted financial intermediary or infrastructure .Their powers are taken by systems in which a set of users is able to make decisions about the relevant financial transactions. Distributed ledger technology is a good example of the situation.
• decentralization of risk-taking, which involves the shift from the retention of risk on the balance sheets of individual financial intermediaries towards direct matching of individual users and providers of financial services. P2P services or crowdfunding may be quoted as an example.
• decentralization of record-keeping, which involves a move away from centrally held data and records, towards systems in which the ability to store and access data is given away to broader group.Again DLT technology provides this option.

There are currently two leading technologies effectively enabling decentralisation of the financial systems: distributed ledger technology(DLT),or blockchain, and on line peer to peer platforms (P2P),as depicted in Fig.4 (FSB, 2019a).

Distributed ledger technology (DLT) enables the decentralization of record-keeping and processing by organizing a network of cooperating computers, governed consistently by the adopted rules. Online peer-to-peer (P2P) or user matching platforms, allow users to interact directly and decentralise their risk-taking and decision making.

A vital component of decentralized finance are cryptocurrencies. Bitcoin was the first currency that was not issued by any country but through a decentralized technology. It led essentially to the situation in which central banking is considering a number of innovations in their activities, including introduction of their own digital currencies.

Traditionally, financial institutions used to play an important role in the economy by reducing transaction costs, connecting market participants and spreading the risk. Application of DLT and on line peers to peers platforms is creating entirely new situation in this respect. They can eliminate the need for intermediaries to facilitate financial transactions. Financial system becomes decentralized while it reduces the use of centralized institutions and processing and replaces them with decentralized autonomous networks.

Decentralized finance may signal the beginning of a shift away from industrial-era finance, based predominantly on big centralized financial institutions and systems, which remained basically unchanged for the last centuries (Lippel,2019). We are heading nowadays into the new era of network-based finance. Diffused and decentralized financial systems may be dominating the scene because of the advancement of the new technology.

Cybersecurity and data protection: new risks and challenges

Digitalisation and datafication of financial activities are introducing important changes into the financial markets risk agenda. Cybersecurity, data protection and technological risks are coming to the front of the risk agenda in financial systems(Buckley R, et al, 2019).They start to challenge prior orthodoxy based on Basel capital accord which focused on credit risk, market risk, operational risk and liquidity risk. Recent coronavirus experience proved how concurrent social and economic life in the world depends on the digital infrastructure and its uninterrupted operation(Buckley, et al 2020).

Cyber risk in a wide sense refers most often to the risk of financial losses, disruption or reputational damage to the organization resulting from the failure of IT systems. Most dangerous are cyber attacks where the harm is done intentionally(BIS, May, 2020)

Financial institutions are relying today broadly on digital assets and financial services are among the most-digitized sectors of the economy (Gandhi, et al, 2018).They are therefore highly exposed to cyber risk and cyber incidents. The financial services sector also owns a lot of sensitive personal information, which makes it highly attractive sector for data breaches. Cybersecurity incidents are growing in severity and frequency. As indicated by a recent study of IMF the number of incidents recorded worldwide in the financial services have tripled in the last 10 years and that, judging from Singapore experience, they were affecting various parts of the financial sector, but banks and securities in particular (IMF, 2020).

Cybersecurity risk could be regarded as a new form of traditional risk related to economic crime, espionage and service disruption, and as entirely new form of risk((Buckley R. et al, 2019, pp.9-11).It is indicated that cyber risk is emerging as the new source of financial systemic risk and therefore needs to be monitored by relevant financial regulatory authorities.

With respect to financial institutions successful cyberattacks can cause to experience various microprudential risks, including solvency, liquidity, market, operational, legal, and reputational risks.

Apart from microprudential risks for individual financial institutions, cyber events can also diffuse these risks through the entire financial system and cause systemic risk. This could be developed through different transmission channels, such as risk concentration, risk contagion, and risk of loss of confidence (IMF, 2020, pp.8-9).

The first one arises when a cyber attack affects a key financial market infrastructure, important cloud services provider or systemically important financial institution. This could lead to the loss of critical services that could not be easily substituted or replaced.

The second one takes place if a cyberattack on a financial institution would lead to financial difficulties that spill over to other financial institutions. The third one comes in a situation that widespread attack triggers a loss of confidence across several financial institutions or the financial system which endangers overall financial stability.

Additionally datafication and digitalization of the financial services and their growing dependence on technology leads to the creation of new sources of systemic risks related to IT systems, applied algorithms(model risk) and human failure (Buckley R. et al, 2019, p.19).

Last but not least it should be stressed that new features of financial services coming from automation, usage of big data and digitalisation result in the faster movement of the risk through the financial system than in the analog world (Brummer, Yadav, 2017, p.4).

Apart from cybersecurity issues generated by current wave of digitalization and datafication in financial services increasingly important role relates to data security and privacy risk which is in principle related to the proper handling of data. It refers to the issue of what data in computer systems and under what conditions could be collected, stored, processed and shared with third parties.

Its importance is reflected in a growing regulatory output in this regard. The most comprehensive data protection legislation enacted to date is the General Data Protection Regulation (GDPR), governing the collection, use, transmission, and security of data coming from residents of the European Union, regardless of the location of the entity collecting the data. According to its rules data subjects must be given the opportunity to give clear consent prior to the collection of personal data. The regulation establishes new important rights for individuals, like data portability, the right not to be profiled or the right to be forgotten. This issue becomes increasingly important both for national supervisory systems and international cooperation agenda.

Public supervision in finance in digital age

Public supervision of financial systems must take due account of new risk entourage stemming from the digitalization and the growth of technicality of finance. It takes also due account of the enhanced digital tools in performing supervisory functions. The totality of these tools are called suptech.

Basically the aim of application of suptech is more effective and proactive monitoring of risk and compliance issues in the supervised entities. Its development is a natural consequence of the digitalisation and computerisation of the financial markets activities.

Simply speaking suptech is a reflection of fintech in the area of supervision. It is defined by BIS as the application of innovative technological solutions in financial supervision to digitalize supervisory reporting and implementation of other supervisory processes like monitoring, predictive analytics and use of roboadvisors. (BIS, 2018).

Principal area of suptech application are concurrently two supervisory areas-aggregation of data and its processing. In the first case new applications are widely utilized for supervisory reporting, management of data base and virtual assistance. An example is the utilization of supervisory data directly from the information systems of the financial institutions, their automatic validation and consolidation. It may lead to the situation in which reporting for supervisory purposes be abandoned and direct "sucking" of data in a continuous manner from the relevant organisations will take place. Thereafter they could be automatically validated and consolidated. Automatic validation could include the test of their completeness and consistency. It would thus allow supervisors to improve their performance and lower the costs, and focus more on analysis and assessments. Additionally suptech can be used to communication with the customers and processing of their claims, to better detect eventual irregularities and fraudulent activities of the supervised entities.

Through the system of reporting suptech allows creation of macrodata via aggregation of microdata level, thus providing information on interlinkages between the financial institutions and their exposure to risk.

What is more suptech enables aggregation of data coming from different sources, both structured data bases as well as unstructured ones.It could be also applied to their visualization for the supervisory purposes.

Acting as virtual assistant suptech may be used for complaints handling and processing in order to detect potential irregularities in the activities of the supervised entities. Many supervisory agencies utilize already chatbox for automatic complaints handling and communication with the customers. It could be used also for consulting with the customers and checking their satisfaction. The same technology could be used in communicating with the supervised entities to answer automatically their simple daily questions related to supervision and compliance issues. It helps in better understanding of regulations and their interpretation.

In the second area-data analytics, suptech applications may be used for the monitoring of the processes taking place in the financial markets, detection of improper market conduct, utilization of the system of enhanced risk indicators or systems of early warning. Examples are detection of insider trading activities or identification of money laundering incidents. Finally it may find its direct application in micro and macro supervisory processes(BIS,FSI, August, 2019).

Suptech applications could be utilized both for microprudential and macroprudential purposes. Thus for instance Bank of Italy uses currently suptech applications for diagnostic of companies' insolvencies and credit risk assessment of commercial banks. It is carried out via application of machine learning algorithms through connection of several data bases such as Central Registry of Credits, balance sheets data of nonfinancial corporations and other publicly available information. Central Bank of Netherland (DNB)on the other hand applies suptech solutions for the detection of risks emerging in the financial markets using vast information sources of the payment institutions. Both ECB and US Federal Reserve Board are applying natural language processing technology (NLP) as a form of artificial intelligence for the detection of threats to financial stability (ESMA, 2019)

Application of suptech by supervisory agencies may lead to substantial advantages in financial institutions. It may in particular provide for the lowering of their compliance costs as well as improve their risk management process. Cost advantages might be particularly important(BIS, 2019, p. 6).

Concluding remarks

Financial systems are complex aggregates containing elements created in the past as well as new ones which are the product of the new possibilities and needs of today. These systems are also living creatures, under which constant competition processes occur and cooperation rules and networks are shaped. The directions of the future evolution of these systems are not known to us in advance and cannot be decreed by anyone, although regulatory interventions have a significant impact on the shape of existing systems. Understanding the reasons for change is an important circumstance that can allow to read upcoming events. Such a diagnosis is a complex issue. It requires an interdisciplinary approach and a broad, global perspective. It also requires constant observation of events and the use of new tools, models and analytical techniques.

Digitalisation of financial systems, its services and institutions as well as its regulation and supervision is a challenging experience, transforming the analogue reality into a digital one. It offers us on one hand new possibilities and chances however on the other hand it requires from us new competences and new actions. As observed recently by Paul Dembinski, in digital world virtual reality is not only passively reflecting the real world. It becomes to a large extent autonomous vis a vis the real world or even starts shaping the real world(Dembinski,2019).This is why digitalisation of finance is certainly a journey into uncharted waters.

References

Allen F., McAndrews J. and Strahan P.(2002), *E-Finance: An Introduction, Journal of Financial Services Research, 2002, 22, 1/2, pp. 5-27*

Banks E.(2001), *E-Finance: The Electronic Revolution, John Wiley and Sons, 2001*

Bettinger A., 1972, *Fintech - A Series Of 40 Time Shared Models Used At Manufacturers Hanover Trust Company*, Interfaces, 2, pp. 62-63

BIS(2018)FSI, Broeders D., Prenio J., *Innovative technology in financial supervision /suptech/ -the experience of early users, Basel 2018*

BIS,(2019)FSI, Coelho R., De Simoni M., Prenio J., *Suptech applications for antimony laundering,Basel 2019*

BIS(2019), *Bigtech and the changing structure of financial intermediation, BIS Working Papers, No 779,Basel,April 2019*

BIS (2019), *Bigtech in finance: opportunities and risk, Annual Economic Report, Basel 2019*

BIS(2020),*The drivers of cyberrisk, BIS Working Papers, No 865,Basel,May 2020*

Buckley R et al(2019)*The dark side of digital financial transformation, UNSW Law Research Paper ,no 19-89*

Buckley R, Arner D,Zetsche D, Selga E,(2020),*Techrisk, Singapore Journal of Legal Studies, March 2020,ss.35-62*

Brummer Ch, Yadav Y (2017), *The fintech trilemma, Georgetown University Law Centre,Draft.*

Dembinski P.H(2019),*Ethics in digital age, Keynote remarks,*31st Asia-Pacific Conference on International Accounting Issues,SGH,14th October 2019,Warsaw

EBA (2020), *Report on big data and advanced analytics. Paris 2020*

Eiopa (2019), *Big data analytics in motor and health insurance: a thematic review.*Frankfurt 2019

ESMA(2019),*Report on trends, risks and vulnerabilities,Madrid,No.1,2029*

European Parliament(2018)*Competition issues in the area of fintech, Study, Brussels, July 2018*

FSB (2017), *Financial Stability Implications From FinTech. Supervisory And Regulatory Issues That Merit Authorities' Attention,*Basel 2017

FSB (2019a), *Decentralized financial technologies. Report on stability, regulatory and governance implications, Basel 2019*

FSB (2019), *Bigtech in finance. Market developments and financial stability implications, Basel 2019*

Gandhi, P., Khanna, S. Ramaswamy S,(2016),*Which Industries are the Most Digital (And Why)? Harvard Business Review, April.*

Gartner (2017), Fred Ng and Rajesh Kandaswamy, *Market Insight: Value-Based Cloud Opportunities in Financial Services.*

Gattenio C.A(2002)., *Digitizing Finance: Views From The Leading Edge. (Special Section: Digitizing Finance). Financial Executive, vol. 18, no. 2, March 2002*

Głogowski A(2021),*Financial innovations and systemic stability-the problem of risk mitigation,in: Gąsiorkiewicz L., Monkiewicz J.(eds),Innovations in the development of the financial services: balancing private and public interest, Routledge(2021)*

Gomber P., Koch J. and Siering M.(2017), *Digital Finance and FinTech: Current Research And Future Research Directions*, Working Paper, January 2017, Journal Of Business Economics 87, 2017, pp. 537-580

IMF(2020)Goh J et al, *Cyberrisk surveillance: a case study of Singapore, Washington, February 2020*

Knewtson H.S. and Rosenbaum Z.A., *Toward Understanding FinTech And Its Industry*, 16 January 2020, ssrn.com/abstract=3542438

Lippel S, (2019) *Decentralized finance is a continuum, Facebook Twitter, March 5*

OECD(2018),*Financial markets, insurance and pensions. Digitalisation and finance, Paris,2018*

OECD (2020) *Digital Disruption In Banking And Its Impact On Competition, Paris 2020*

Stulz R.M.,(2019), *Fintech, Bigtech And The Future Banks*, Ohio State University, Fisher College of Business Working Paper Series, WP 2019.03.020

Tucker D.,(2018), *The Fast-Moving World Of Fintech Is Now A Fast-Growing Research Topic*, www.elsevier.com, October 8, 2018

US Department of Treasury (2018), Mnuchin S. T, Philips C.S,*A financial system that creates opportunities. Report to the President Donald J. Trump. Wahington 2018*

 Zetsche D., Arner D.W., Buckley R.P. and Attila Kaiser-Yücel, (2020,) *Fintech Toolkit: Smart Regulatory And Market Approaches To Financial Technology Innovation*, GIZ Gmbh, April 2020

International Centre for Digital Finance

Aims:

1. Developing activities promoting socially responsible digital finance
2. Initiating activities for better understanding and use of digital finance and financial innovations
3. Organising platforms for cooperation of digital finance stakeholders , its institutions, investors, consumers, public sector agencies and academic community .

Forms of activities:

- undertaking theoretical and applied research in the area of digital finance
- undertaking educational activities in the area of digital finance
- organising of seminars and conferences ,national and international
- supporting domestic and international cooperation in the area of digital finance
- monitoring of digital finance developments and its social and economic implications
- undertaking other actions and initiatives which relate to its aims

Strategic partners:

Fundation for the Promotion of Education,Chamber of Insurance and Risk Assessment, Interrisk.