Accounting, Finance, Sustainability, Governance & Fraud: Theory and Application

Sezer Bozkuş Kahyaoğlu *Editor*

The Impact of Artificial Intelligence on Governance, Economics and Finance, Volume I

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Sezer Bozkuş Kahyaoğlu
Editor

The Impact of Artificial Intelligence on Governance, Economics and Finance, Volume I

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Foreword

We are living in a very fast era which is called as the information age. This speed is mostly due to the fast advancement of technologies, especially information and communication technologies. Today's business life, organizations, and business rules are much different than previous decades. Information asymmetry is significantly reduced. E-commerce and social media have changed almost all aspects of business. On the other hand, people are impatient and cannot tolerate waiting for products or services or even for answers. Especially Gen Z, considered as digital natives who were born into digital technologies, from earliest youth, have been exposed to the internet, social networks, and mobile systems are joining the workforce, business life, and becoming customers and consumers and have much different standards and expectations than X and Y generations.

These technological advancements and increasing customer expectations are also changing the business life and companies are trying to cope with all these changes. Most importantly, faster decision-making is needed. The business world and businesses are chasing faster, better, more intelligent systems in order to cope with current conditions and to meet with ever-increasing customer expectations. Since the 1980s, computer science, computer engineering, software engineering, and computer programming disciplines were working on making systems more functional and smarter. Especially during the last 2 decades with the proliferation of internet and social media almost all parts of the population started to use computers and we transformed our daily lives and activities into digital platforms. It has made significant changes in people's and corporations' perspectives on information and communication technologies (ICT). Companies developed all kinds of applications, systems, and digital platforms to address these increasing needs and to keep or increase their customer base. Governments were not an exception. They also worked on e-government and digitalization of all kinds of services to meet with expectations of citizens with more efficiency. Today we see all kinds of digital platforms, services, and products and one can easily survive with internet connection and basic ICT skills.

Our next goal will be to make these systems more intelligent, more competitive, and more human-like. This brings us to Artificial Intelligence (AI). AI has been a subject of science for a long time but because of technological insufficiencies and other reasons it developed very slow up until recently. Thanks to new programming languages, developments in software engineering, developments in hardware areas, and availability of big data sets, currently AI is developing much faster. With AI computers will not only perform ordinary computer functions but they will also think similar to humans, learn, create new knowledge, and act similar to human decision-makers. This might result in replacement of many jobs with intelligent systems or AI.

Businesses are experiencing very heavy competition, and they need to deal with conscious, and more demanding customers with high expectations. They demand faster, better, customized solutions. This requires companies to develop more intelligent systems with much higher capacity. AI will be the answer for this requirement. Previously, computers and IS were optional, but today they are a must for survival. If a company needs to be more competitive then the solution again is not a regular IT or IS. It is intelligent system which can provide higher performance and significantly better complete solutions.

Today, we are talking digitization, digitalization, and digital transformation in businesses. Especially the last step, digital transformation requires the utilization of third platform technologies which are closely coupled with AI. Today, data is the most valuable resource for any company and companies who know how to use big data will have a competitive advantage. In order to capture, process, and transform data into information and knowledge again we need support from AI.

Beyond all these, the world is experiencing a pandemic since the beginning of 2020. The COVID-19 pandemic has changed our daily personal lives as well as businesses and way of work, way of communication, and way of managing businesses. People cannot go to work and their mobility is limited and they must work from home. All the meetings are taking place on digital platforms. All the decisions are being made online. This adds another flavour to importance of digital transformation and especially digital transformation to more intelligent systems and platforms. In order to provide timely and applicable solutions and answers to the needs of companies, organizations, and governments, the systems must be intelligent and must use AI and other means for this purpose.

Dr. Kahyaoglu and the contributors' book has come to the market in such a vigilant time and the timeliness of the book is almost perfect. The book intends to present chapters related to AI implementation and the impact of AI in governance, finance, and economics, simultaneously. In Chap. 2, there is an evaluation presented on the economic significance, benefits, and solutions of FinTech. In Chap. 3, the impact of digitalization on banks and banking is explained. In Chap. 4, the analysis of big financial data through artificial intelligence methods is explained. In Chapter 5, the impact of artificial intelligence on central banking and monetary policies is discussed in detail considering the rapid digitalization trend in the financial sector. In Chap. 6, the impact of digitalization on the financial performance of financial institutions is investigated considering the developments in information and communication technologies (ICT). In Chap. 7, new trade patterns that emerge with the changing organization and geography of supply chains under Industry 4.0 are investigated. In Chap. 8, the effects of new technologies on economic policies in the global system are analysed. It is stated that the new economic structure changes the priorities of economic policies in the age of electronic revolution. In Chap. 9, the major expectations from artificial intelligence for structural change in the economy is analysed. In Chap. 10, a model for promoting industrial productivity with an emphasis on the role of intellectual capital is provided based on a case study of East Azerbaijan province. In Chap. 11, major applications of blockchain technologies in health services are discussed based on a general framework for policymakers. In Chap. 12, the relation of company and innovation in national innovation system is analysed. In Chap. 13, the challenges posed for implementing blockchain technology in the Indian context and steps taken in order to mitigate these challenges are analysed. In Chap. 14, AI in the field of organization studies is examined. In Chapter 15, an overview of how artificial intelligence is given based on a discussion in relation to transformation in the financial system. In this respect, the author provides information about how financial technologies (Fintech) and regulatory technologies (Regtech) will affect the future financial infrastructure. In Chap. 16, the ethical perspective is provided based on the COVID-19 pandemic conditions.

As the outline shows clearly, the topics cover a very wide range of countries from Europe, Asia, and Turkey, different application areas or sectors from Fintech, Banking, public, and government sectors techniques and technologies such as Industry 4. 0 and supply chain, Thus, I strongly believe that this collection of articles will widen the reader's view and help them to think about how transformation, digital technologies, and intelligent systems or artificial intelligence are becoming a part of our daily business lives.

I would like to congratulate Dr. Kahyaoglu and all contributing authors for their hard work and hope that the book will provide a much better understanding for business practitioners.

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Chapter 1
Introduction

Sezer Bozkuş Kahyao˘glu

Artificial intelligence (AI) has recently gained more importance and is well-positioned among the fields of computer science. AI is aiming to form an intelligent system in the sense that assume a system which behaves human being-like making judgements, solving problems, and/or comprehending languages. There is a huge engineering effort behind AI to form a machine, which is capable of doing the abovementioned duties in order to increase the level of comfort by solving real-life queries. Although AI is a relatively new field of science, it is closely related to other old fields of science and, it is overlapped with major science fields such as Philosophy, Mathematics, Computing, Cognitive Science, Neuroscience, etc. In this respect, even though there is a historical process whose roots go back to Aristotle and Socrates, "the father of artificial intelligence" is accepted as Alan M. Turing (1912–1954) (Traiger 2000).

The first official AI Conference in the literature took place in Dartmouth College in Hanover in 1956. Ashri (2020) considers this Conference date as the birthday of a new field of study, namely AI. Afterward there is a huge progress in every subfield of AI. There are three major determining factors, which increase the speed of progress of AI.

1. Increasing magnitude of data, i.e., big data.
2. (2) Increasing processing power, i.e., algorithms
3. (3) Increasing data storage, i.e., cloud-based solutions.

In order to understand the development process of AI properly, it is necessary to analyze the relationship between data, information and knowledge. Data can be found in many different forms, settings, and themes based on real-life observations. Thus, the structure of the data is very diverse in nature and data could have a feature of

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evidence. The data converts into information when the data is classified and processed for achieving a specific purpose. In this way, the data becomes meaningful and gives a message to the stakeholders. Nowadays it is very important to generate value added information. It gives more significance and competitive advantage to have value added information in the business world.

Akerkar (2019: 2–4) states that it is possible to add value to data in five major ways, i.e., by contextualizing, classifying, calculating, correcting, and/or condensing data. At this stage, it is not enough to generate information out of data but there is a need for one more step to gain the knowledge out of the information. The basic requirement for an information to become a knowledge is to reveal its relationship and interaction through the processing of information. When the concept of knowledge is further improved and integrated into systems, it becomes wisdom. Wisdom has a long history based on rather ancient philosophers such as Aristotle and Socrates. In fact, the intelligence is just the advanced level of wisdom. Intelligence is simply the way we use our knowledge to define, analyze, and solve problems. Intelligence consists of one's various capabilities, capacity, and creativity. In this context, the knowledge-based systems are the essential part of the AI.

It is a fact that the data has always been in every area of our lives. However, the size of these data has been growing very rapidly over two decades. In this respect, big data concept enters into our lives, and particularly the financial markets and financial institutions, which is one of the areas the increasing amount of data affects the most. With the help of technology, it is now possible to store and manage big data in a very convenient and cost-effective way. It is possible to process big data easily and provide instant reporting to the top managers of the enterprises over smart systems. Because of the widespread use of algorithms developed with regard to artificial intelligence and Graphical Processing Units (GPUs), an important step has been achieved. Thus, learning times of the machines have been accelerated.

The concept of artificial intelligence consists of two basic words. Accordingly, the word of "artificial" can be considered in relation to robots, systems, and platforms where they are generally integrated. Marwala and Lagazio (2011) define intelligence as "the ability to make sense of information beyond the obvious." Today, many researchers are working in various subfields of AI. These researchers are all conducting experiments to establish new models to explain how the human system operates and hence, aiming to apply AI systems for achieving a better life standard for the future. Considering the speed of development of smart systems in the last decade, for example, the rapid spread of smart phones all over the globe; it can be thought that artificial intelligence application areas will touch every area of life in the very near future.

The most important basis for artificial intelligence to find application areas in every sector of the global economy is that big data analysis has become very easy. Through big data analysis, all sectors and all businesses have made their strategic decision-making mechanisms more efficient, effective, economic, and on a nearly real-time basis. In the past, dealing with massive data was a very laborious task. Now this stack of data has been classified, systematized, and turned into technical information that makes decision-making easier. This technical information refers to the "knowledge."

In this context, there is a need for a workforce with technical expertise at every stage of the big data analysis process. The importance of well-trained workforce in all areas of the economy and especially, in sectors such as finance, healthcare and logistics is increasing. The main reason for this is that new analysis methods include many fields of science, from Mathematics, Statistics, Engineering, and Psychology to Philosophy, in order to produce complex algorithms based on AI.

An important approach that AI applications provide "added value" is the ability to continuous self-improvement. AI infrastructure makes it possible to adapt constantly to new learning strategies and this dynamic process is defined as "predictive learning." Thus, services and products based on artificial intelligence will be efficiently renewed and/or updated with a continuous and dynamic approach and can be applied to all areas of life with various algorithms obtained from global libraries.

Predictive learning capability is a valuable tool for improving the whole ecosystem of AI. This is achieved by continuous exchange of knowledge among machines. The integrated individual devices exchange experiences, i.e. (Machine 2 Machine-M2M) via AI ecosystem, which creates "network effect" (Porter and Heppelmann 2014). With the dynamic exchange of experience between the machines and the development of the big data production process at the same time, makes it necessary to process them all more quickly and, included in the decision-making processes. It is a fact that modern technologies make it possible to generate more and more big data. This situation leads to a need for improvement in storage capacities and hence, introduction of cloud solutions. New algorithms such as Machine Learning (ML) Algorithms are created to support the autonomous systems by operating without continuous communication to the central systems, i.e., servers. This is crucial especially for the sustainability of mobile solutions, which are widely used in financial markets (McKinsey Global Institute 2017).

Artificial intelligence practices are embedded in product development cycles and in this way, consumer behavior is closely monitored. Especially in behavioral modeling and prediction techniques, by using artificial intelligence applications, significant gains and competitive advantages are obtained. Artificial intelligence practices are effective in product design and after-sales service delivery and are widely used to reduce costs. This change in product design also facilitates the development of smart products that can integrate with each other instead of focusing on a single product (Porter and Heppelmann 2014).

This book has a mission to assist the business leaders in order to sense the mechanisms for transforming the global economy, to recognize strategic imperatives, and to get ready for the next-generation technologies based on AI. The book intends to present edited chapters related to AI implementation and the impact of AI in governance, finance and economics topics simultaneously. In this context, the major aim of this book is to analyze the developments that arise based on AI by associating it with the authors' core expertise as governance, finance, and economics, and by closely following the effects of artificial intelligence on these areas. The organization of the book is summarized as follows:

In this chapter, there is an evaluation presented on the economic significance, benefits, and solutions of FinTech. The status of FinTech markets worldwide and

Europe is discussed based on relevant literature and the impact of FinTech on banking market structure is analyzed. Particularly, the recent investment figures are provided regarding the Turkish FinTech markets versus the global markets in order to show the significant trend in technological improvements based on SWOT analysis of FinTech ecosystem.

In Chapter 2, the effects of new technologies on economic policies in the global system are analyzed. It is stated that the new economic structure changes the priorities of economic policies in the age of electronic revolution. New economic policies are explained such that Competition policy, Industrialization policy, Intellectual property policy, Employment policy, and Social policy in the context of new technologies' control on individual and social life, along with their facilities.

In Chapter 3, the impact of artificial intelligence on central banking and monetary policies is discussed in detail considering the rapid digitalization trend in the financial sector. Within the framework of this trend, this chapter aims to explore the change in the structure of central banks, the characteristics of money, and the functions of monetary policies, with the artificial intelligence and digitalization process.

In Chapter 4, the impact of digitalization on the financial performance of financial institutions is investigated considering the developments in information and communication technologies (ICT). The technical efficiency scores of 26 major Turkish banks are used as sample data and, the technical efficiency scores of each bank are obtained by applying Data Envelopment Analysis (DEA). In this way, the effect of digitalization on financial performance is estimated by using "truncated regression model combined with bootstrap confidence intervals." The empirical findings are discussed in detail and policy recommendations are made to contribute to the literature. According to the empirical results of Chapter 4, the average cost curve is shifting downward with the use of technology by banks in Turkey. In particular, financial innovations based on ICT have unsurprisingly affected business models in both the banking and nonbanking institutions of the financial industry.

In Chapter 5, the major expectations from artificial intelligence for structural change in the economy are analyzed. The author provides arguments for and against AI and more specifically discusses the meaning of "making mistakes" in relation to AI application process. It should be noted that here "making mistakes" is used as "the possibility of making mistakes." In this context, an AI application is supposed to eliminate the possibility of "making mistakes" in the production process over time. In other words, when the better is achieved, the steady-state point specified in all growth theories will be reached. With the AI application, reaching the steady-state point in the level of knowledge in the process of economic growth will be accelerated.

In Chapter 6, new trade patterns that emerge with the changing organization and geography of supply chains under Industry 4.0 are investigated. The author emphasizes the importance of the new trade policy, which takes the form of "data policy." In this respect, it is argued that there is a need for a joint and mutually benefiting international policy approach, which is essential for a sustainable trade.

In Chapter 7, a model for promoting industrial productivity with an emphasis on the role of intellectual capital is provided based on a case study of East Azerbaijan province. The authors consider Industry 4.0 as the fourth generation of the Industrial Revolution. The test of research hypotheses is obtained by using the Structural Equation Model (SEM). The SEM shows that intellectual capital has a positive and significant effect on promoting organizational productivity in leather and footwear industries in East Azerbaijan province. In addition, the test of secondary hypotheses shows that human, structural and relational capital have a positive and significant effect on the promotion of organizational productivity in the leather and footwear industries of East Azerbaijan province. As a result, any decision that can be taken to develop the quality and quantity of these variables used in SEM can be effective in stimulating the productivity of this industry.

In Chapter 8, the impacts of digitalization on banks and banking is explained. First, the fast transition in technology changes the channels and channel strategy in banking and technology-intensive channels gain more importance. The author discusses the advantages and disadvantages of digital banking. In particular, the effects of blockchain technologies are mentioned in relation to the risk management and auditing structure of digital banking. In this respect, the Banking of Things (BoT) is explained as a competitive approach against Fintech. The author states that digital banking will change the structure of the financial industry by providing a different experience and pricing strategy for their online customers by creating a digital brand separate from the existing brands of the banks. In this way, the digital banks will have a competitive advantage against traditional banks by modernizing their digital experiences, increasing their digital capacity beyond internet banking and mobile banking, and more importantly, eliminating paper and creating digital processes.

In Chapter 9, major applications of blockchain technologies in health services are discussed based on a general framework for policymakers. The authors argue that the developments in internet technologies in particular lead to radical changes in traditional business models. They propose blockchain technology as a disruptive technology with the potential to transform the foundations of social and economic systems, leading to significant policy changes for many decision-makers. The blockchain-based solutions are introduced which are used for the safe storage of medical records The importance of blockchain-based implementations in health services such as Electronic Medical Record (EMR), Electronic Health Record (EHR), and Personal Health Record (PHR) is explained in detail. In addition, the impact of AI and quantum technology is discussed considering the health big data analytics and data mining issues in health services.

In Chapter 10, the analysis of big financial data through artificial intelligence methods is explained. The authors focus on four major AI-based system solutions in financial sector. These are Classification, Regression, Clustering, and Rules of Association, which present solutions to a diverse range of problems in many areas. The authors give examples from finance ecosystem by using Python and recommend different software such as Python, R and Mahout with many AI algorithms that can be quite beneficial in financial sector. It should be noted that Distributed File and Computing Systems are important for meeting the storage and processing requirements of financial data. In this respect, distributed file systems such as Hadoop Distributed File System (HDFS), HBase based on technologies such as Hadoop, Spark can be preferred. The second factor after storage requirement is the processing of data for feature extraction. AI methods and machine learning algorithms are ideal for feature extraction. Smart extractions may greatly satisfy the profitability of financial establishments and customer satisfaction.

In Chapter 11, the relation of company and innovation in national innovation system is analyzed. The authors define the national innovation system in two ways; narrow and wide. In this respect, the narrow definition includes only institutions that play a direct role in scientific and technical research and innovation processes. On the other hand, the broad definition focuses on all economic, political, and social institutions that play a direct and indirect role in learning, research, discovery, and innovation. The authors discuss the importance of innovation and conclude that the innovation should not be treated only as an economic system but it should be treated as a social system, too.

Finally yet importantly, AI is a way where it is possible to teach machines or systems to learn, optimize, forecast, transcribe, and communicate. Although it is accepted that there are many economic and social benefits related to artificial intelligence, it is important to be aware of the risks (Müller 2016; Marwala and Hurwitz 2017). When we take into consideration that artificial intelligence has become a common tool in business management, it is necessary to establish necessary control and audit processes together with trained experts.

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Sezer graduated from Bosporus University, Management, Istanbul, Turkey in 1993; received the Masters degree in Money Banking and Finance from Sheffield University, UK in 1997, and PhD degree in Econometrics from Dokuz Eylul University, Izmir, Turkey in 2015. She authored 15 articles, 2 books and 4 book chapters in Turkish and English.

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Part I
The Impact of AI on Financial Markets

Chapter 2
Fintech Ecosystem in Turkey: An Evaluation in Terms of Financial Markets and Financial Stability

Şakir Sakarya and Melek Aksu

Abstract FinTech is an innovation that integrates technology into financial services. FinTech contributes to the economy by increasing financial access and new products and services, therefore it has an important role in shaping the future of the financial system. FinTech market has been rapidly growing worldwide, and awareness of financial market users of FinTech has been increasing. This rapid growth in FinTech market makes evaluating status of FinTechs significant. This paper aims to evaluate the economic significance, benefits, and solutions of FinTech, status of FinTech markets worldwide and in Europe, and impact of FinTech on banking market structure. This paper evaluates the FinTech ecosystem in Turkey and effects of FinTech on financial stability and financial markets with a SWOT analysis and makes proposals for Turkey.

Keywords FinTech · Banking · Financial stability

2.1 Introduction

Globalization has transformed the financial markets and this transformation has accelerated with the technology. Technological transformation makes it easy to access financial services, increases diversity and quality of the financial products and services, and reduces costs. The impact of FinTech has been felt in the world and in Turkey also.

FinTech has no common accepted definition. The Financial Stability Board (FSB) defines FinTech as technologically enabled innovation in financial services that could result in new business models, applications, processes, or products with an associated

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significant effect on financial markets and institutions and the provision of financial services (FSB 2019).

FinTech is an important opportunity to shape the future of the financial system due to its contribution to the economy and increasing financial access and new products and services. The demand for digital financial services has increased due to changing consumer expectations, and the progress in the information technology (IT) sector and changes in financial regulations have contributed to the acceleration of FinTech's progress and expansion in recent years. It is expected that the development of FinTechs will have more impact on the banking sector activities and riskiness in the future and the financial regulations for the sector are expected to be reviewed and changed accordingly. The heightened competition of FinTechs is expected to have an impact on financial stability and requires an evaluation of the FinTech ecosystem in terms of financial stability.

The main factors that make FinTech popular are technological developments, changing customer demands, and macroeconomic conditions. The strong banking system, the expansion of card payment systems, and an intensive use of mobile technology provide important opportunities to FinTech start-ups in Turkey. This situation shows Turkey will have an important role in FinTech ecosystem in the long run. The FinTech ecosystem has been growing with new start-ups and investors with banking system and financial markets' support. FinTech start-ups come into focus in Turkey as well as all over the world.

This paper aims to evaluate the economic significance, benefits, and solutions of FinTech, status of FinTech markets worldwide and Europe, and impact of FinTech on banking market structure. This paper evaluates the FinTech ecosystem in Turkey and effects of FinTech on financial stability and financial markets with a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis and makes proposals for Turkey because FinTech has become a rising star in the world and shaped the financial system. This paper intends to contribute to literature on conceptual FinTech evaluation.

The rest of the study is organized as follows. The following section overviews the economic significance of FinTech, world and European FinTech markets, benefits of FinTech industry and solutions for capital markets, and the impact of FinTech on the structure of the banking industry. The third section evaluates the relation between FinTech and financial stability. The fourth section is about the FinTech ecosystem and its impacts on financial markets in Turkey. A SWOT analysis of Turkey's FinTech market is figured in the fourth section. The last section concludes the paper.

2.2 The Overview of Fintech Market

The Economic Significance of FinTech

The evolution of FinTech has occurred in three periods. The financial services industry largely remained an analog industry for the public while the industry was intensively interconnected with technology from 1866 to 1987, a period that we label FinTech 1.0. The period between 1987 and 2008 is called as FinTech 2.0. In this period, financial services had become highly globalized and digital in developed countries. FinTech was dominated primarily by the traditional regulated financial services industry which used technology to deliver financial products and services in FinTech 2.0. The period after 2008 is FinTech 3.0, and new start-ups and existing technology companies have begun to provide financial products and services besides the traditional regulated financial services companies in FinTech 3.0 (Arner et al. 2015). The FinTech sector has grown significantly over the last decade with the invention of cloud computing, smartphones, and high-speed internet (Arner et al. 2018). According to GSMA (2019) report, the number of mobile internet users is expected to reach 5 billion by 2025. This increase reported by GSMA reveals that the world's ongoing appetite for the internet may be a signal for the future of FinTech sector that has the power to change all financial systems worldwide. After 2008, almost all financial institutions were affected by FinTech, in parallel with regulatory and structural changes (Bayón and Vega 2018). Fintech companies are trying to receive a part of the profitable business of the banking industry (Varga 2017). FinTech activities include a number of alternative financial services such as peer-to-peer, alternative lending and crowdfunding, payments, clearing and settlement, personal finance like robo-advising, investment management, market support, and insurance (Demertzis et al. 2017; FSB 2017) that banking sector provides also. These services that FinTech provides disrupt financial intermediation by changing the structure of the financial system at various levels demonstrated in Fig. 2.1.

The rise of Fintech has quickly shifted from being a threat to being an opportunity for traditional players. All players have started to develop strategies to benefit from the development of new, technology driven, financial products and services (Deloitte 2016).

Digitally active customers are using several FinTech services. 50% of customers are using money transfer and payments, 24% insurance, 20% savings and investments, 10% borrowing, and 10% financial planning (EY 2017). The usage of technologically enabled financial services reveals the significance of FinTech sector.

Financial behaviors have been changing due to enhanced and easy-access technology. According to a survey by Goldman Sachs (2015), 33% of Millennial believe that they will not require a bank in 5 years, 14% of Millennial small business owners use alternative (nonbank) finance, less than half have a credit card and only half expect to use cash on a weekly basis by 2020.

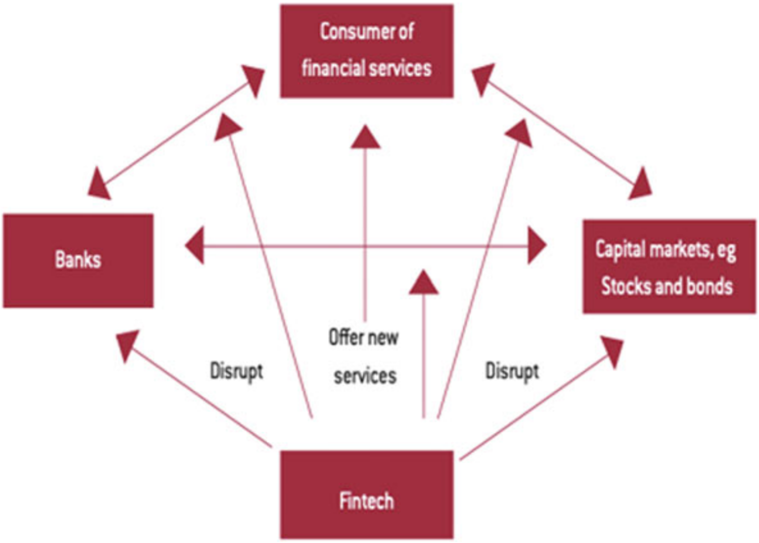

Fig. 2.1 The effect of Fintech on financial intermediation (*Source* "Capital Markets Union and the FinTech Opportunity" Demertzis et al. 2017: 24)

The Worldwide FinTech Market

FinTech market has been rapidly growing worldwide, and financial market users' awareness of FinTech has been increasing. EY, one of Big Four accounting firms, has been publishing FinTech Adoption Index since 2015. According to EY reports global consumer adoption of FinTech services increased from 16% in 2015 to 33% in 2017, to 64% in 2019. Worldwide, 96% of consumers know that at least one alternative FinTech solution is available to help them to transfer money and make payments. Small and medium sized enterprises (SMEs) are also using FinTech and EY report says that global SMEs adoption rate is 25% (EY 2019). Adoption of insurance (insurtech) has seen a significant growth from 8% in 2015 to nearly 50% in 2019 (Statista 2019).

More than 50 billion devices will be connected to the Internet by 2020. 50% of global payments predicted to be made through FinTech channels by 2022 due to increasing access to the Internet. $200 million of investments poured into RegTech companies since 2017. 80% of large banks have been set to support the development of FinTech application through open banking (SEON 2019).

The total value of FinTech deals globally declined 29% from the first half of 2018 (US$31.2 billion) to the same period of 2019 (US$22 billion) due to the lack of a giant deal like Ant Financial's record US$14 billion fundraising in May 2018. Excluding that transaction, global FinTech investments would have increased 28% in the first half of 2019 over the same period of 2018 (Accenture 2019). The global

FinTech market worth would increase to $309.98 billion until 2022 from $127.66 billion in 2018 (Ketabchi 2019).

Figure 2.2 demonstrates the value of investment in FinTech sector worldwide between 2011 and 2018. Investment in FinTech sector has increased from $2,5 billion to $54,4 billion dollars between 2011 and 2018.

According to the Crunchbase database, there are now 13.221 FinTech start-ups worldwide. Figure 2.3 demonstrates the number of Fintech start-ups worldwide as of February 2020, by region. There were 8,775 Fintech start-ups in Americans, 7,385 start-ups in Europe, the Middle East, and Africa, and 4,765 start-ups in Asia and the Pacific region. The Americans had the most Fintech start-ups globally.

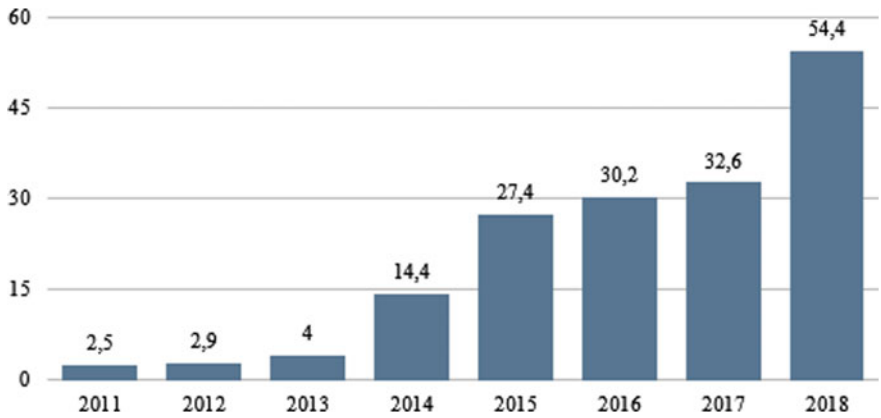

Fig. 2.2 Value of investment in FinTech Sector Worldwide (billion $) (*Source* Statista [2018, October] https://www.statista.com/statistics/557237/value-of-fintech-financing, accessed 02.01.2020)

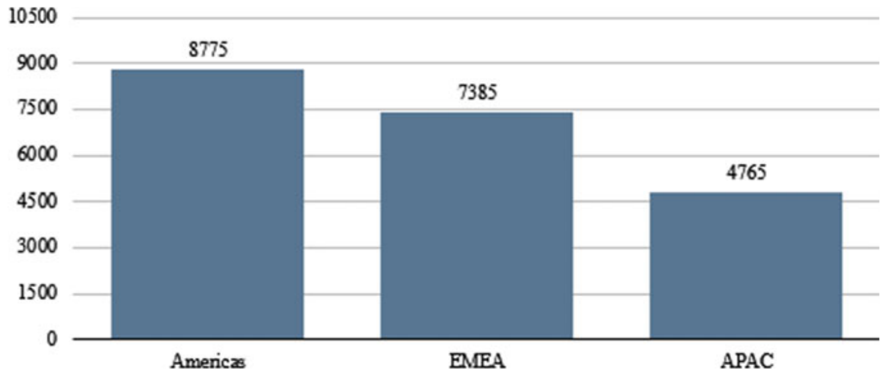

Fig. 2.3 Number of FinTech start-ups worldwide (2020, February) (*Source* Statista [2020] https://www.statista.com/statistics/893954/number-fintech-startups-by-region, accessed 16.03.2020)

Global Fintech Rank	Change from Startup Rank	Country	Total Score
1	▶ ±0	United States	31.789
2	▶ ±0	United Kingdom	23.262
3	▲ +18	Singapore	19.176
4	▲ +14	Lithuania	17.343
5	▲ +3	Switzerland	16.018
6	▶ ±0	The Netherlands	14.464
7	▶ ±0	Sweden	14.272
8	▼ -3	Australia	13.555
9	▼ -6	Canada	13.322
10	▲ +3	Estonia	13.303
11	▼ -2	Germany	12.787
12	▼ -8	Israel	12.771
13	▼ -3	Spain	12.372
14	▼ -2	Finland	12.110
15	▲ +2	India	12.024
16	▼ -5	France	11.803
17	▼ -3	Ireland	11.754
18	▲ +1	South Korea	11.543
19	▲ +18	Brazil	11.456
20	▼ -4	Denmark	11.368
21	▲ +6	China	11.143
22	▲ +1	Japan	11.114
23	▲ +30	Luxembourg	11.088
24	▲ +1	Italy	10.772
25	▲ +3	Austria	10.660
26	▼ -2	Belgium	10.586
27	▲ +19	Norway	10.497
28	▲ +1	Portugal	10.394
29	▼ -9	Poland	10.364
30	▲ +2	Mexico	10.294
31	▼ -9	Czechia	10.188
32	▼ -17	Russia	10.052
33	▲ +56	Malta	9.983
34	▲ +6	United Arab Emirates	9.928
35	▼ -5	Chile	9.746
36	▲ +11	Malaysia	9.692
37	▲ +14	South Africa	9.614
38	▲ +6	Argentina	9.425
39	▼ -6	Thailand	9.415
40	▼ -6	Colombia	9.289
41	▲ +1	Greece	9.210
42	▲ +10	Kenya	9.039
43	▼ -12	Ukraine	8.969
44	▼ -1	Turkey	8.937
45	▼ -19	New Zealand	8.893
46	▲ +8	Philippines	8.831
47	▼ -6	Indonesia	8.658
48	▲ +20	Cyprus	8.380
49	▼ -4	Latvia	8.329
50	new	Taiwan	8.321
51	▲ +21	Vietnam	8.118
52	▲ +4	Nigeria	7.918
53	▼ -14	Hungary	7.742
54	▼ -6	Slovenia	7.607
55	▲ +2	Peru	7.575
56	▼ -21	Bulgaria	7.542
57	▼ -19	Romania	7.447
58	▲ +17	Ghana	6.632
59	▼ -4	Belarus	5.986
60	▶ ±0	Egypt	5.676
61	▲ +26	Bangladesh	5.073
62	▼ -1	Pakistan	4.675
63	▲ +8	Uruguay	4.562
64	▲ +17	Uganda	4.037
65	▲ +17	Lebanon	3.941

Fig. 2.4 Global FinTech rankings of countries (*Source* Findexable [2020])

Global FinTech rankings of countries are demonstrated in Fig. 2.4. USA has the highest FinTech score and UK follows the USA. Fintech's top 10 countries are USA, UK, Singapore, Lithuania, Switzerland, Netherlands, Sweden, Australia, Canada, and Estonia (Findexable 2020).

Share of Fintech in total VC investment per region (2017–2019 YTD) is stated in Fig. 2.5. Share of Fintech in total VC investment in Europe is 20%, higher than the USA and Asia.

2.3 The European FinTech Market

There are 3.044 FinTech companies in Europe currently according to the Crunchbase database. Most EU Fintech companies operate in the areas of payment and alternative finance, and there are five Fintech unicorns (Adyen, Funding Circle, Klarna, Revolut, and Transferwise) in Europe, each of them with a value of $1 billion or more. FinTech is Europe's largest venture capital investment category with 20%, and the sector is more active in Europe than in Asia and the USA as demonstrated in Fig. 2.5 (Finch Capital and dealroom.co 2019).

The size of FinTech industry is smaller than the size of capital markets, and FinTech industry falls behind in Europe. EU countries have no significant development of FinTech applications as much as the UK has (Vives 2017: 97–98). Fintech investment in the UK is approximately $2.6 billion, and the number of deals reached

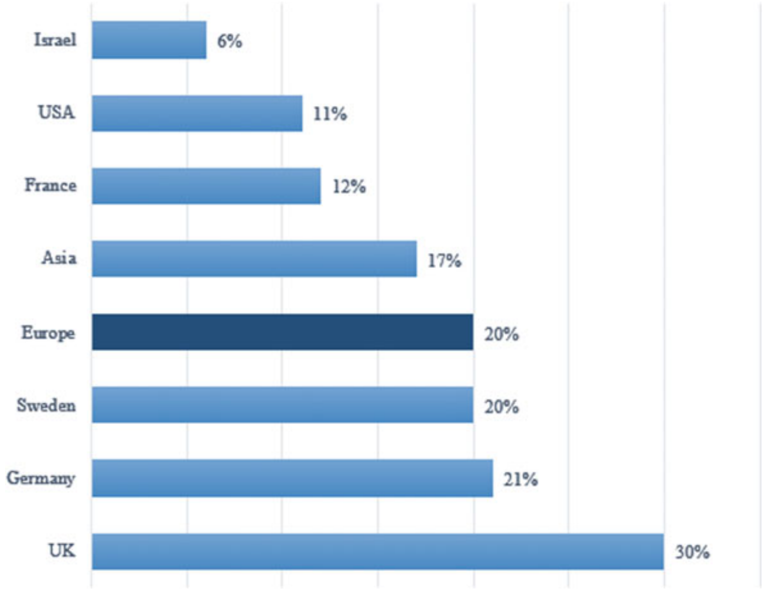

Fig. 2.5 Share of FinTech in total VC investment per region (2017–2019 YTD) (*Source* [Finch Capital and dealroom.co 2019])

263 increasing by 25% (Accenture 2019). The UK and Spain have the highest share of FinTech users in Europe, with 41% and 37%, respectively. The share of FinTech users in Germany is 35%. Germany is the third European country with 35% and above the global average (Carmona et al. 2018).

Cross-border activity can be measured in terms of funds inflow or funds outflow. Almost 50% of surveyed platforms had no inflow of funds from other countries, and 76% of FinTech start-ups reported no outflow of funds in 2015. This data reveals that FinTech activities tend to be based in Europe on a domestic basis and has very limited cross-border flows (Demertzis et al. 2017).

Other European markets also improved greatly with more than doubling investments in FinTechs in Germany in the first half of 2019, from $406 million to $829 million in the same period of last year. Fundraising in Sweden more than quadrupled, to $573 million, while French FinTechs raised $423 million in the first half of 2019, 48% more than the previous year (Accenture 2019).

2.4 Benefits of FinTech Industry and Solutions for Capital Markets

Fintech provides different products and consumer experiences, thus FinTech can extremely change financial intermediation. The availability of financial products through user-friendly mobile applications can change the way consumers and especially households use financial products (Demertzis et al. 2017).

Fintech can enhance the financial services industry in many ways, from providing a better client experience to reduce friction, strengthening critical infrastructure components, realizing efficiencies, and reducing costs for market participants and investing public (DTCC 2017). FinTech can also help businesses through improved payments systems, and invoicing and collections and customer relationship management. FinTech solutions include supply chain finance and e-invoice management portals. FinTech's innovative solutions include marketplace lending, ecommerce and merchant finance, invoice finance, online supply chain finance, and online trade finance for small businesses and providing them with increased access to more diversified financing options (AGT 2016). FinTech sector may help to reduce the cost of financial intermediation by improving access to finance (Demertzis et al. 2017) increasing financial inclusion, assessing the creditworthiness of loan applicants, improving the interface between financial clients and financial service providers (Vives 2017).

Due to having a potential to overcome information asymmetries that are related with the banking sector, FinTech market is efficient. FinTech companies also have no legacy technologies to handle and a culture of efficient operational design. This provides them to have a larger innovating capacity than traditional institutions (Vives 2017). FinTech services have several benefits for consumers, such as greater transparency and easy-access and affordable financial services to large masses of the population and SMEs, particularly in the area of credits and payments (Carmona et al. 2018).

FinTech companies offer disruptive innovations for the provision of specific services. FinTech start-ups are not held back by existing systems and are willing to make risky choices. In banking, for instance, successive mergers have left many large banks with layers of legacy technologies that are at best partly integrated. On the other hand, FinTech start-ups have the opportunity to build the right systems from the start. Moreover, FinTech start-ups share a culture of efficient operational design that many incumbents do not have. FinTech may show how far technology can go in providing low-leverage solutions. FinTech companies are funded with much more equity than existing firms (Philippon 2016).

FinTech improves efficiency and the customer experience and enables individuals to conduct transactions via their mobile phone and tablets, therefore FinTech reduces compliance costs for businesses through synchronization of financial data from several sources and integrate bank accounts from different financial institutions by data aggregators. FinTech intermediaries enable retail investors to participate more in the market by reducing information asymmetry in the market and matching investors, lenders, and borrowers well, thus FinTech intermediaries provide additional liquidity to the market (AGT 2016). FinTech provides a variety of possibilities for the financial services industry. B2B FinTech companies create real opportunities for incumbents to improve their traditional offerings. For example, white label robo-advisors provide software that helps clients to better investment management, so customer experience of an independent financial advisor may be improved.

Incumbent businesses could be more efficient thanks to partnerships with FinTech companies. A telematics technology provider in the insurance industry can help insurers to monitor their risks and driving habits. According to PwC Global FinTech Survey in 2016, cost reduction is the main opportunity of the rise of FinTech with the ratings of 73% of respondents. Incumbents could simplify and rationalize their core processes, services, and products, and therefore reduce operating inefficiencies in this regard. But FinTechs do not have the only advantage of cutting costs. Working together with FinTech companies could provide a differentiated offering, improve retention of customers, and generate additional revenues for incumbents. In this regard, 74% of fund transfer and payment institutions consider generating additional revenues as an opportunity of FinTechs. That FinTech generates additional revenues through faster and easier payments and digital wallet transactions is already true in the payments industry (PWC 2016).

2.5 The Impact of FinTech on Banking Market Structure

Due to their innovative solutions, FinTech start-ups are slowly getting a share of the banks (Belli 2016). Fintech institutions are putting pressure on the conventional banks' business model. Two competitive advantages of retail banks which may be undermined by the new entrants are that borrowing cheaply with their access to cheap deposits and explicit or implicit insurance by the government, and privileged access to a stable customer base that can be sold a range of products (Vives 2017).

The role of traditional bank deposits faces a challenge of the usage of digital currencies. Digital central bank money could pose a question fractional reserve banking and shift the financial system toward narrow banking (Demetrtzis et al. 2017).

Figure 2.6 shows the impact of alternative financial companies that nonbank institutions on several banking products and services according to opinions of senior banking executives worldwide in 2018. Alternative financial companies were having a large impact on wallets and mobile payments globally according to 66.7% of senior banking executives.

There are several risks and opportunities emanating from FinTechs on banks and the banking system. FinTech includes strategic and profitability risk, cyber-risk, operational risk, compliance risk with regard to data privacy, liquidity risk, and volatility of funding sources for banks. Opportunities of FinTech for banks are improved and more efficient banking processes, positive impact on financial stability due to increased competition (FORFIRM 2019).

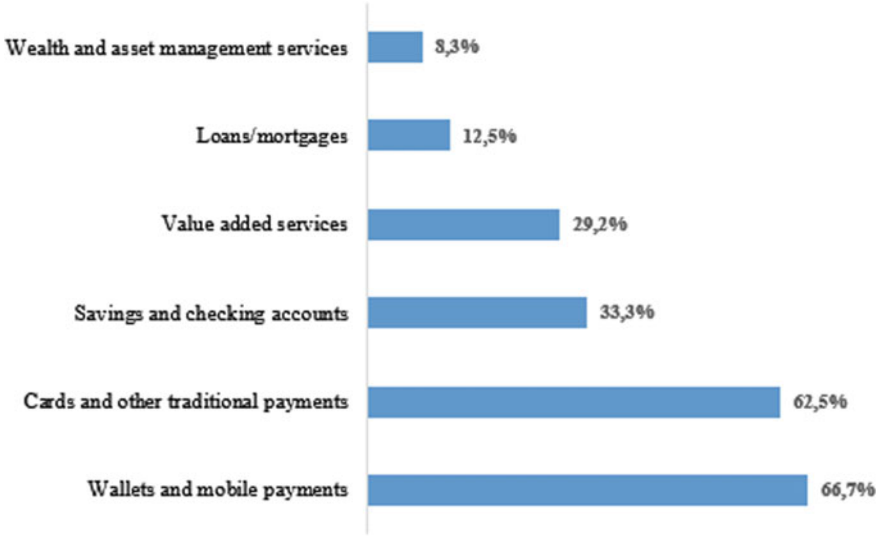

Fig. 2.6 Impact of alternative financial companies on several banking products and services according to senior banking executives worldwide in 2018 (*Source* Statista [2018, September])

There are over 30 fields such as next-generation personal financial management, new digital lending, peer-to-peer lending and investment, mobile payments, aggregator comparison engine, mobile point-of-sale devices, international remittances, other payment processing, social integration IoT and connected devices, telematics, next-generation trade finance, prevention, next-generation collateral management, trading, trade analytics, peer-to-peer corporate lending and investment, one-stop shop for businesses, digital cash management, next-generation lending to SMEs, robo-advisory, crowdfunding, social investing, blockchain, investment across regions engine, payment infrastructure, big data base risk assessment, application programming interface ecosystem, anti-money laundering and know your customer, cybersecurity, artificial intelligence, and machine learning emerging as new norms in global banking and FinTechs provide services in these areas (BKM 2016). That FinTech finance is a substitute for bank finance can be thought because of providing services in the same fields by banks and FinTechs, but Cole et al. (2019) state that bank finance is a complement to, and not a substitute for, crowdfunding that is a form of FinTech.

2.6 Fintech and Financial Stability Relationship

FinTech is worth looking at from a financial stability perspective. Fintech can improve the financial services industry by providing a better client experience to reducing friction, increasing access to the financial system, strengthening critical infrastructure components, reducing costs, and realizing efficiencies for market participants and the investing public. Besides these benefits, FinTech may also pose negative consequences, such as exacerbating cybersecurity threats or increasing third-party risks (DTCC 2017), systemic problems arising out of operational risk and risk of developing a new shadow banking system that increases systemic risk due working with less leverage than traditional banks (Vives 2017). These risks and benefits of FinTech affect financial stability.

The core banking function of credit, liquidity, and maturity transformation provided by FinTech companies may affect financial stability in a positive way by diversifying credit and liquidity risk within the financial system, and in a negative way by creating systemic vulnerabilities due lack of banking experience. The level of competition or cooperation between FinTech start-ups and traditional financial institutions may affect financial stability. The cooperation between FinTech companies and incumbents promotes financial stability because the competition forces banks to pursue riskier strategies and endangers financial stability (DTCC 2017).

FSB (2017) stated potential benefits of FinTech for financial stability as decentralization and diversification, efficiency, and access to financial services. FinTech may lead to greater decentralization and diversification in lending. Technological developments such as big data processing and automation of loan originations, have reduced barriers to entry. Robo-advice, RegTech, or applications of technology could strengthen efficiency of business models of incumbent financial institutions. Greater efficiency could reduce risks by decreasing settlement time. FinTech implications such as payment, lending, robo-advisory, InsurTech services have a significant role in increasing access to financial services.

FSB (2017) stated potential micro- and macro-financial risks of FinTech on financial stability. Micro-financial risks include financial risk and operational risk. Financial risks are maturity mismatch, liquidity mismatch, and leverage. Maturity mismatch of FinTech lending may cost to the economy and affect financial stability in a negative way. FinTech credit platforms do not perform liquidity transformation, because FinTech operations do not involve the holding of client monies. FinTech activities are not generally associated with leverage. Only a small part of FinTech credit platforms become involved in leverage when they use their own balance sheet to provide fund for loans. Operational risks include cyber risks, third-party reliance, and regulatory risk. Cyber-attacks pose a growing threat to the entire financial system. Disruptions to third-party services like cloud-based financial services are more likely to pose systemic risks. Existing legislation, legal, and regulatory frameworks do not cover FinTech activities. Macro-financial risks are contagion, procyclicality, and excess volatility. Significant and unexpected losses incurred on a single FinTech lending platform could be viewed as a signal of potential losses across the sector because of contagion effect. Interaction between investors and borrowers on FinTech lending platforms could potentially display larger fluctuation in sentiment than traditional fund intermediation. Because of the fast nature of FinTech activities asset prices volatility can increase and financial system is more sensitive to news.

FinTech-related developments which are new providers of bank-like services competing or cooperating with established financial services providers, provision of financial services by large technology companies, and reliance on third-party providers for cloud services have the potential to alter the current structure of the financial system, and may affect financial stability implications (FSB 2019).

Financial stability implications of FinTech have generally been considered as small due to their small size. Deeper involvement of large technology providers alter this consideration (FSB 2019). There is no more available official and privately disclosed data in the FinTech area, therefore there is a challenge on assessment of the implications of FinTech for financial stability. While there is currently limited evidence about risks emanating from advances in FinTech to financial stability, change is occurring rapidly and decisions taken in this early period may set significant precedents. Policymakers should continue to evaluate the adequacy of regulatory frameworks in an environment of rising adoption of FinTech, with the objective of harnessing the benefits while alleviating potential financial stability risks (FSB 2017).

Fintech has a welfare-enhancing capability but regulation should be adopted so that the new technology provides several benefits without endangering financial stability (Vives 2017).

2.7 Fintech Ecosystem, Impacts on Financial Markets in Turkey, and a Swot Analysis

High-growth technology investments supplant the investments in traditional industries, so that FinTech needs attention among the competitive strategies of countries to attract more foreign direct investments (Yazıcı 2019).

The Turkish industry has great potential and strong infrastructure; however comparingly to the major hubs in the world, such as London or San Francisco, that the Turkish industry is only at the beginning of a race is clear. This lagging of Turkey in FinTech is related with the late start in the game and thus time is required to adapt to the new tools of FinTech. Nevertheless, it has provided the industry with fast-paced adaptation skills, and the companies advantages of forecasting risks and opportunities (StantonChase 2014).

FinTech investments in Turkey decreased from \$12,2 million to \$8,4 million from 2018 to 2019. Although there was a decrease in FinTech investments, the number of ventures had increased from 14 to 17 (FinTech İstanbul 2019).

Istanbul is a very important city for FinTechs in Turkey. Istanbul has several strengths such as having a young talent pool both, having cheaper labor costs, and increasing brand value (Belli 2016). The government plans to make Istanbul a regional center of finance within the next 10 years. Banking sector is so strong in Turkey. Digitisation and skillful workforce within the banking sector is creating several opportunities for talented individuals to explore new innovative ideas in FinTech (Global FinTech Hubs Federation and Deloitte 2017). Companies in FinTech ecosystem of Turkey are banks and payment services companies and e-money institutions established in accordance with the amendments introduced by Law No. 6493 (EY 2018). Representative FinTech companies in Turkey are IyziCo and Papara.

Well-developed securities market and mature in attracting foreign capital are the advantages for FinTech in Turkey (Global Fintech Hub Report 2018).

According to FinTech country rankings that is demonstrated in "The Worldwide FinTech market" section in Table 2.1, global FinTech ranking of Turkey is 44 with the score of 8.937. Regional ranking of İstanbul, the emerging hub in Europe, between European FinTech cities is 21 with the score of 9.303 and global ranking of İstanbul is 56 (Findexable 2020).

There are more than 300 start-ups operating in 13 different verticals that include payments, banking, finance, asset management, corporate finance, personal finance management, insurance, crowdfunding, investment, big data, hubs, crypto coins, and blockchain in the field of FinTech in Turkey in 2019 according to the Startups.Watch statistics as seen in Fig. 2.7.

According to Cantürk who is a Financial Services Sector Director of Turkey in KPMG which is an international tax, audit, and consultancy firm, FinTech sector will develop by consolidation, agreements, global growth, open banking, blockchain, insurtech, RegTech, collaboration between banks and start-up companies in Asia and digital banking. Higher consolidation is expected in payment, credits and blockchain and start-up companies grow in international areas. Investors focus on FinTech companies as a result of agreements in FinTech sector. Banks also will continue to grow with increasing services and global growth will be realized. Open banking regulations will enhance the increasing role of start-up companies in financial sector.

FinTech investments are growing rapidly in Turkey due to the sound structure of financial institutions, particularly in the banking sector (Söylemez 2020). Investment into FinTech looks likely to continue and private equity investment is seen as being the largest source of finance to fund FinTech's future growth in Turkey (The City UK 2018).

Stakeholders of FinTech ecosystem in Turkey are entrepreneurs, universities, technology firms, traditional financial institutions, consumers, regulatory and supervisory authorities, government, investors of public offerings, venture firms, and angel investors. FinTech ecosystem in Turkey may be expressed with four main topics affecting FinTech ecosystem and factors of these topics demonstrated in Table 2.1.

Capital markets, asset management, mobile banking, payment methods, and digital currencies attract investors' interest in Turkey. FinTech players in Turkey are active in wallet applications, payment tracking, offline payment, pre-accounting, cash register, VPOS, credit scoring, and banking software (Deloitte 2017). Turkish banks demand Google Glass, wallet, beacon, and ATM projects from the FinTech companies in addition to mobile banking solutions. The m-commerce supplanted ecommerce currently in Turkey which makes P2P money transfer more vital. P2P money transfer innovations, like paying through mobiles, watches, and Google Glass arouse the interest of Turkish consumers. Some of the Turkish payment companies work very closely with the technology vendors and entrepreneurs within the ecosystem. These companies are open to work with anyone willing to introduce a new solution and to support them with their experience and know-how. This cooperative environment is very significant for companies because that may contribute to their businesses (Belli 2016).

Table 2.1 Main topics of the fintech ecosystem and the impacting factors

Topic	Factor	Explanation
Demand	Market Structure in the Country	The structure of the current financial services sector and the place of FinTechs
	Competition	The competition within the FinTech market, and between FinTechs and other financial institutions
	Consumer Behavior	The consumers' perspective to the FinTech industry
	Customer Experience	FinTechs' contribution and advantages for customer experience
	Opportunities and Threats	Opportunities and threats that FinTechs face in their fields of activity
	New Markets	New markets that may occur in the financial services sector
Regulation	Trust and Security	The public trust in the services provided by the FinTechs in terms of data security and finance
	New Regulations	Design and implementation of new regulations that will regulate the financial markets, and affect the FinTechs
	Operating Permits	Operating permits especially in the fields of payment and ecurrency
	Constraints and Obstacles	Constraints and obstacles faced by FinTechs when providing certain services
Capital	Public Funds and Government Assistance	Public aids and incentives to be provided for FinTechs
	Banks	The investments and financial support of banks in FinTechs
	Investors	The factors that have an impact on the angel investors, VCs, and public offering investors who invest in FinTechs
	Business Model	The new and creative business models of FinTechs to attract new investment
Human Resources	Quality, Quantity, and Cost	The quality and quantity of the current human resources in the sector, and the costs of hiring or training new human resources

(continued)

Table 2.1 (continued)

Topic	Factor	Explanation
	The Role of Financial Institutions	The role of the financial services institutions in training human resources
	The Role of Universities	Universities and other educational institutions' ability in training the human resources working in the FinTech sector
	Entrepreneurship within the Company	The approach of the institutions toward the entrepreneurial ideas

Source EY (2018)

Fig. 2.7 Turkish FinTech ecosystem map (2019, May)

FinTech start-ups and banks were thought to be competitors in the beginning in Turkey. FinTech start-ups were trying to enter the market with their customer-oriented and innovative approaches although banks did not want to give their shares to FinTechs. The relation of FinTech start-ups and banks in Turkey can be dated back to 2013. At first, big banks provided superiority in the sector with their technology companies and the digital channels they developed. FinTech start-ups have entered the fields of the online payment systems and virtual POS areas that banks cannot realize, cannot enter, or are not willing to enter. There is currently lower cooperation between banks and FinTech start-ups in Turkey. TUBITAK and EU funds become prominent as government and publicly funded support for FinTechs, however, FinTechs in Turkey do not have confidence about these funds and are directed toward angel investors, venture capital, and bank incentives (Yazıcı 2019).

The quality of the FinTech infrastructure and the FinTech ecosystem determines the speed at which implementation of FinTech in a country. From the FinTech infrastructure and ecosystem perspectives Turkey is labeled as easy implementers that means good infrastructure and a supportive business environment. When FinTech demand and supply evaluated in Turkey, it has seen that lower FinTech need meets supportive FinTech environment (ING 2016).

A SWOT analysis should be performed to understand what Turkey needs to do for developing FinTech ecosystem. The SWOT analysis is demonstrated in Fig. 2.8.

Developments in FinTech field were on the agenda of Turkey and therefore FinTech-related articles were included in the 11th Development Plan. FinTech-related articles in 11th Development Plan are listed below Fintechtime (2019):

- Creation of a secure FinTech ecosystem that provides equal opportunity to companies through international good practices will be supported.
- A roadmap for the development of the Fintech ecosystem in Turkey will be provided and only a public institution will be authorized to implement the roadmap.
- A regulation experiment area and industry experiment area will be established.
- The Union of Payment Services and E-money Institutions will be established.
- Istanbul Finance and Technology Base will be established.
- The harmonization of regulations with the EU Payment Services Directive 2 will be ensured in order to strengthen the legal infrastructure of open banking.
- Access to financial services, financial awareness, and investor base will be increased.
- Financial literacy education to students in the primary, secondary, and higher education institutions and to adults will be provided.
- The Financial Advisory System in which the needs of financial consumers are determined correctly, their rights are protected against financial institutions and intermediary services are provided between both parties will be developed.

The awareness of financial consumers and their knowledge about managing financial transactions, and collaboration of FinTech companies and other financial institutions will have an increasing effect on the demands of individuals on the usage of financial products and services. The usage of FinTech products and services, which will increase financial inclusion, and the transition to cashless society should be encouraged. FinTech companies and existing financial institutions should establish common infrastructures that allow consumers to securely share financial transaction information, and common feedback mechanisms to inform consumers about transactions carried out on their data. Access to corporate data should be gained to local and foreign investors to invest in FinTech sector in Turkey (EY 2018).

Fig. 2.8 SWOT analysis of the FinTech sector in Turkey (*Source* Belli [2016])

2.8 Discussion

Financial markets have been changing at a rapid scale due to globalization. The technology has accelerated this transformation process of financial markets. The use of technology in financial markets is defined as FinTech, and the impact of FinTech has been felt worldwide and in Turkey also. Technological transformation makes it easy to access financial services, increases diversity and quality of the financial products and services, and reduces costs.

This paper aims to evaluate the economic significance, benefits, and solutions of FinTech, status of FinTech markets worldwide and Europe, and impact of FinTech on banking market structure. This paper evaluates also the FinTech ecosystem in Turkey and effects of FinTech on financial stability and financial markets with a SWOT analysis and makes proposals for Turkey because of FinTech is significant in shaping the financial system. This paper intends to contribute to literature on conceptual FinTech evaluation.

Investment in FinTech sector has increased from 2,5 billion dollars in 2011 to 54,4 billion dollars in 2018. There are now 13.221 FinTech companies worldwide while there are 3.044 FinTech companies in Europe. Fintech companies try to obtain a slice of the banking industry's profitable business and disrupt the financial intermediary. Because of that, FinTech may have positive/negative impacts on financial stability. Fintech can provide a better client experience to reducing friction, increasing access to the financial system, strengthening critical infrastructure components, reducing costs, and realizing efficiencies for market participants and the investing public. FinTech companies may diversify credit and liquidity risk in the financial system. However, FinTech has also negative consequences, such as exacerbating cybersecurity threats or increasing third-party risks, systemic problems arising out of operational risk, and risk of developing a new shadow banking system that increases systemic risk due to working with less leverage than traditional banks. FinTech companies may create systemic vulnerabilities due to lack of banking experience. The degree of competition or cooperation between FinTech firms and traditional financial service providers may affect financial stability. The cooperation between them promotes financial stability because the competition forces banks to pursue riskier strategies and endangers financial stability.

Investment in FinTech market of Turkey increased from 4,6 million dollars to 29 million dollars from 2012 to 2016, and more than 300 start-ups are operating in the field of FinTech in Turkey as of December 2019. Stakeholders of FinTech ecosystem in Turkey are entrepreneurs, universities, technology firms, traditional financial institutions, consumers, regulatory and supervisory authorities, government, investors of public offerings, venture firms and angel investors. Mobile banking, payment methods, asset management, capital markets, and digital currencies arouse interest and investments in Turkey. FinTech players in Turkey are active in wallet applications, offline payment, pre-accounting, payment tracking, VPOS (Virtual Point of Sale), banking software, credit scoring, and cash register areas.

Turkey has a good infrastructure and a supportive business environment in FinTech ecosystem. Lower FinTech need meets supportive FinTech environment in Turkey. Some of the strengths of Turkish FinTech sector are strongly structured and highly regulated banking sector since 2001, central location between Europe and the Middle East, high mobile phone and smartphone penetration rate, tech-savvy young population, and the increase in the number of entrepreneurship centers. Developing an infrastructure to foster innovation, making Istanbul a global financial center, partnerships and collaborations with foreign FinTech companies, locationally potential to become a regional FinTech hub, increasing mentorships provided by banks to FinTech start-ups are several opportunities of Turkish FinTech sector in Istanbul. Weaknesses of the Turkish FinTech sector include the requirement for establishing infrastructure, lack of experts in financial services sector to support the sector, highly regulated banking sector, poor communication, and collaboration between banks and technology companies. Historically high inflationary economy, low ability to attract talented and multilingual workforce, and security concerns of businesses and individuals about FinTech solutions are several threats for Turkish FinTech sector.

FinTech has been brought to the agenda of Turkey. There are planned implications for developing FinTech sector in 11th Development Plan of Turkey. That means FinTech may have a bright future in Turkey with the increased financial literacy and financial awareness, though local and foreign investment in FinTech will be increased in Turkey.

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Chapter 3
Impacts of Digitalization on Banks and Banking

Bülent Balkan

Abstract Technological development is changing society, economics, banks, and banking. The change in technology at first directed banking transactions from branches, which were conventional distribution channels, towards toward automated teller machines (ATM), telephone, internet Internet banking, and mobile devices later on and diversified distribution channels. This change did not cease and cloud-based applications, big data, and the concept of big data reading comprehension gained importance in a course of time. In addition to that, Cryptocurrencies have taken to the stage of everyday life. Development in the digital communication enabled the communication with people all over the world. Digital banking had taken the shape of a distribution channel in at the beginning, which had provided ease of access and cost advantage along with productivity growth by enabling banking services to be rendered without the branch, i.e., staff. This situation increased the profitability of the banks by having the banking system getting ahead in the competition. Social media has become one of the innovations that technology brought forth. Blogs and channels such as Youtube YouTube have been a part of life. Banks do not only have to exist on social media for building a new service architecture and retaining customer mass but also they need to fulfill their targets of marketing and public relations. At the same time, social networks affect the banking. Social networks such as Twitter, Facebook, and Linkedin have intensified interactive communication on the internet Internet which led to the emergence of the new business models stemming from social media. Another change brought about by digitalization and technological developments was innovative, flexible, and adaptable financial solutions supplied by the 'Fintech' enterprises which seemed probable to transform banks and banking too. On the one hand, Fintech enterprises pose a threat to the sector, but on the other hand, the possibility that competitive advantage would be taken by creating new business platforms in cooperation with Fintech enterprises has been realized. These technological developments affected regulations and led to official regulations about open banking. Open banking allowed for permitted sharing of data via Application Programming Interfaces (API) and enabled Fintech enterprises to develop financial

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services. This change turns banks into platforms and enables the foundation of structures, which would give access to more competitive financial products and services with higher quality for banks in cooperation with Fintech enterprises. Banks may have to modify their products, business processes of services, and their organizational structures and architecture probably, to keep pace with the digital change. Banks are progressing as becoming institutions transforming data into information and marketing information, not money, anymore. The digital change is directing our bank bank-centered viewpoint towards toward a customer-oriented viewpoint in an ever ever-increasing pattern. Along with the fact that banks accommodated themselves to mobile technology, the major essential development is the establishment of digital banks rendering direct digital financial services in addition to the fact that banks are institutions rendering service only by use of the digital channels and regarding the digital platform as a service channel solely.

Keywords Banking · Digital banking · Open banking

3.1 Digitalization, Banking, and Digital Banking

Digitalization

Digitalization means converting the data, sound, text, photos, music, and all kinds of information into 'bits' (0s and 1s) and converting them to computer language via microprocessors. Digitalization can also be expressed as digitization. Digitalization has facilitated the storage, reproduction, and sharing of information (Zelan 2018, p. 1). In summary, digitalization has transformed both the business processes and the way of doing business in banking as in all sectors by making use of the opportunities of technology.

Bank

Bank may be defined as a financial intermediary company that makes use of the money collected from depositors or private sources by giving interest or dividend or its own money as a loan and works with a privilege granted by the government. When we look at the basic function of banks and their place in the economy, we can say that banks perform credit exchanges by intermediating between surpluses and fund deficits. Banks are the most important actors of financial intermediation, collecting small savings and putting them into use in large packages, making the savings turn into investments. Thus, banks aim to provide the most benefit when converting funds to investment, aiming to minimize the cost of funds and provide the investments with the highest efficiency within the acceptable risk limits. In this way, banks direct the funds to the areas where they will be used effectively. Banks also provide consultancy for investors. Moreover, they develop trade with intermediation and guarantee transactions, perform the function of intermediation in international trade, are the most important elements of the safe and stable operation of money markets and contribute to the implementation of monetary policy (Balkan 2018, pp. 30, 31).

Digital Banking

Digital Banking may be defined as enabling banking transactions and transactions by the realization or presentation of information via the Internet, mobile, ATM, and similar technology-based channels through digitizing information using technology. Digital banking can provide services that are less costly, more convenient, and contain fewer errors. While digitalization provides banks with a cost advantage, it is reflected to the customer as better customer experience, more usable and less costly products.

Digital banking is essentially the result of digital change in the world. The increase in the use of the Internet has become widespread in the use of social networking, the change in the way data collection have increased the expectations and demands of the new generation being technology natives and the old bank customers who have adopted this technology. In sum, service expectations are directed toward faster, better quality, and less costly technology-based channels and services products.

3.2 Digital Banks

While classical banking is shrinking in the world, it is seen that digital banking applications, mobile payment systems, and recently open banking applications in the UK and EU have developed rapidly. Monzo, Starling Bank, and Revolut stand out only as banks operating solely in the digital world. These banks do not take digital banking as a channel strategy and come to the forefront with the digital services they offer. One of the main strategies they aim is to personalize digital services.

According to a study conducted by GlobalData, the rate of those who want to use digital banks in the UK is 28%. This figure is around 35% in the world. It is noted that 41% of consumers in the UK do not favor the idea of sole 'digital banking' banks.

The UK and the European Union are looking forward to Digital Banking and Mobile banking as well as Open Banking by increasing their investments in Fintech and providing users with better opportunities. It is eminent that while Turkey still applying strong wet signature and identity checks bank accounts, in Europe it can be easily opened out around mobile accounts. Therefore, we can argue that digital practices are developing in such countries.

Monzo is an application on iOS or Android, which is trying to establish a banking structure according to the requests and feedback of the participants. Money can be sent to other banks by opening a bank account in the UK over the phone. You can also withdraw money even exceeding your deposit amount(credit deposit account feature). Furthermore, your investment is protected up to £ 85,000, with no fees or charges on card expenses. Interest on saving accounts is available up to 1.55%. Other services consist of Apple Pay or Google Pay, regular payment orders. And international money transfers are 8 times cheaper than the banks (www.monzo.co).

Starlingbank is a frame of reference as 'starling mobile banking'. They do mobile banking, whose applications won many awards receiving great praise from users of mobile banking applications. They have bank licenses and do not charge monthly fees. Their current accounts are completely free, they do not charge for electronic payments, domestic transfers, or ATM withdrawals. Besides this, they pay interest on current account balances accompanied by flexible account applications. Moreover, they allow and plan savings within the scope of targets and have a financial services compensation program (FSCS) which encompasses all kinds of savings that are fully protected up to £ 85,000 (www.starlingbank.co).

Revolut is a system that allows you to open an account by phone and does not charge any commission for payments abroad or fees on international money transfers. Money can be sent via phone calls. Lease payment and collection, transactions can be executed in crypto exchanges. Revolut products include open banking transactions (www.revolut.co).

Wirecard; According to the information on the website, this digital financial trading platform states that they have universal bank licenses and enable the acceptance and processing of digital payments worldwide, offering physical and virtual card service and payment solutions that enable payment on all channels (Www.wirecard.co).

Monese provides free solutions that perform real-time transfers between accounts that allow instant payment and sending free and instant transfers. They open a Monese business current account with a contactless card to registered businesses in the UK and make cross-border payments. Monese declares that it was subject to FCA regulations and protected 100% of the money in reputable strong banks and never lending or re-depositing. In addition, it enables smart, fast, and secure contactless payments with Apple Pay or Google Pay, instant money transfer to your account by bank card or bank transfer (Www.monese.co).

FastPay is an application of Denizbank in Turkey. Users can send money freely by smartphone from pocket to pocket 24/7. Credit cards can be paid out at more than 100 thousand DenizBank member merchants, via mobile phones at member merchants. FastPay is available for download in the App Store from Google play (FastPay 2019).

3.3 Advantages and Disadvantages of Digital Banking

Advantages of Digital Banking

Reasonable cost, reasonable price; Banks offering services through digital channels via the Internet can offer their customers more affordable prices. The decrease in the costs of the banks using the Internet is reflected in the service prices as the cost is minimal in electronic channels. In electronic distribution, prices are determined not by the cost they ıncur but by the value they create (Daniel 1999, p. 73). According to the BIS (Bank for International Settlements) report, electronic distribution channels cost one percent compared to traditional banking, thirty-one compared to ATMs, and ten times less than PC banking (Hawkins and Mihaljek 2001). According to experts, it is stated that digital banking can save between 20 and 40% in operating costs and decreases in cost will affect profit (Epstein 2015).

Convenience in offering new products and services; Banks using electronic channels can offer new products and services to their customers in the market more easily. (Daniel 1999, p. 73). Banks can also provide services of third parties such as e-commerce, tax payments, and invoice payments more easily in digital banking (Centeno 2004, p. 295).

Easy collection of customer information for banks and reduction in operational risks; Banks can collect and process customer information more easily and report them. Customers are also requested to have more control over their accounts. (Daniel 1999, p. 78) So, banks can reduce operational risks in this way (Centeno 2004, p. 295).

Ease of access and uninterrupted service; Digital banking allows the customer to make transactions in all conditions regardless of time and location. Mobile vehicles have destroyed the commitment to space.

Potential to increase customer satisfaction, loyalty, and profitability; Properly used digital and electronic banking services increase customer satisfaction, increase customer loyalty, and support profitability (Centeno 2004, p. 298).

Disadvantages of Digital Banking

The threat of increased customer security and fraud risks; Theft of identity and account information and the risk of fraud is the biggest criticism brought to digital banking. This system can be accessed from any platform which raises the risk and it can be used delinquently for the negligence of bank employees or customers as well.

Fast-changing technology; It can quickly wear out designs.

Infrastructure deficiencies; Deficiencies in the technological infrastructure may decrease the service quality of digital banking.

Weakening of one-to-one relationship with customers; Weakened contact with customers will reduce customer satisfaction.

3.4 Digitalization and Its Effects on Banking

With technology, such as blogs, YouTube channels have entered our lives, banks now have to exist in social media not only for marketing and public relations purposes but also to create a new service architecture and protect the customer base. Social Internet like Twitter, Facebook, and Linkedin has increased interactive communication and social media has created new business models.

Chris Skinner explains the meaning of digitalization for banking as follows: Banking is no longer money banking but data banking, and more importantly, it is more important to save the storing of the data. John Reed, CEO of Citibank 30 years ago, made the first point to the phenomenon of digitization and said ‘Banking is only about bits and bytes’ (Skinner 2014, pp. 11, 14).

According to Skinner retail banks traditionally operate based on physical distribution, but they must now switch to mature and proven electronic distribution. There is now a young generation that has grown up with the Internet, which we call digital natives. These people live their lives on the Internet and naturally use digital channels. Banks should now abandon their multi-channel strategies and become a digital bank, seeing that there is only one channel and that it is a digital channel (Skinner 2014, pp. 20, 21).

Cuesto et al. identified three successive phases in the digitalization process of a bank: the first involving the development of new channels and products, while the second means adapting technology infrastructure, and the last requires deep organizational changes for strategic positioning in the digital environment (Cuesta, Tuesta, Ruesta, and Urbiola 2015).

According to Skinner, it is fundamentally the advancement in technology that raises digital banking. These technologies can be grouped into four main groups; (Skinner 2014, p. 93).

Mobile Network Communication

Mobile network communication indicates the combination of mobile Internet, telecommunications, and information technologies. Mobile systems have transformed banking by removing the necessity of going from one place to another to make something by providing the opportunity to reach the service on our table or in our pocket phone 24/7 (Currently, there is one phone per person on the planet).

Social Technologies

Twitter, Facebook, blogs, YouTube, podcast mainly refer to the creation of simple interactive social content platforms. Social media’s difference is the production of content by users. Digital banks now communicate with customers via blogs and receive feedback in this way. For instance, ICICI in India provides banking services via Facebook, smartyPig offers a social savings tool for banks.

Social Finance Models

Social media has also revealed social finance models that can be grouped under 4 headings (Skinner 2014, p. 126).

1. *Social Money and Payment* allow you to make payments between friends on social media using PayPal or other means for Internet payments. New players like Square, mPowa, and iZettle are developing on focusing their effort on mobile payments.
2. *Virtual currencies*: Decentralized currencies, especially bitcoin, are struggling to replace cash.
3. *Social credit and savings:* These platforms are the ones that bring saving holders who want to get higher returns and credit recipients looking for lower interest rates.
4. *Social funds and investments*: Crowdfunding and social trading.

Data Analytics

Data Analytics refers to techniques of analytics and data mining for so-called big data. Data become abundant, thus it is now important to process this data into information. Data mining means finding and analyzing the relationships between piece-by-piece data and directing this information to how to increase sales in terms of banking. Data processing now brings banks face-to-face with important data handlers, Google, Amazon, Facebook. And we can proclaim that whoever makes the data meaningful will win the war.

- ***Unlimited network communication, storage, and modular programming:***

Plug and play systems, cloud technology, and APIs are examples of systems in this regard.

3.5 Digitalization and Its Effects on Traditional Banking Structure

Digital Banking affects traditional banking in many ways. Some expected effects can be expressed as follows:

- **Traditional banks will disappear totally/** One of the most radical views is Skinner's. According to Skinner, traditional branch-based banking is expired. Skinner states that the branches were designed under the conditions of three centuries ago and did not meet today's objectives (Skinner 2014, pp. 37, 41).
- **The number of branches of banks will decrease, the number of employees will decrease/** Skinner points out that around 8% of bank branches in Europe have closed after the financial crisis. Branches are becoming less important and customers are no longer going to branches and mobile technology is becoming the main contact point with the customer. Customers are often forced to go to banks only because they need to disclose their documents such as identity cards as per customer identification (KYC) rules. If these rules are changed or if new banks go to the customer to obtain these documents, the number of physically accessible banks will be further reduced (Skinner 2014, pp. 43, 54). In a study conducted in Turkey about the impact of digitalization reveals the increase of alternative distribution channels accompanied by the number of branches and the number of employees of branches demonstrating a declining trend between the years 2014–2018 (Bakırtaş and Ustaömer 2019).

Digitization will change the labor structure in the banking sector. While the number of employees in the banking sector will decrease, the demand for employees such as ' Data Scientists, Data Engineers, Data Architect and Chief Data Officer' will increase (Mirkoviç, Lukic, and Martin 2019, p. 35).

- **Competition will increase/** Compared to traditional banking, digital banking paves the way for banks to enter the sector at much lower costs. This will facilitate easy market entry and increase competition.
- **Traditional banks will expand their digital applications/** Fintech institutions and emerging digital banks offer digital products, while traditional banks will be forced probably to increase their digital applications as a result. A study conducted in Turkey pointed out that the banks, even if they have a competitive and profitable structure investing in digital banking became a strategic necessity (Kahveci and Wolfs 2018, p. 55).
- **The competitive structure in banking will change/** The banking market is now evolving into a market where competition is more intense and entry and exit are easier. Banking is now moving out of a market where banks, i.e., service providers, were decisive to an ecosystem where customers, the new finance and digitization ecosystem are decisive. Banks will be confronted with making a strategic decision within this increasing competition structure, which is basically whether they will compete with or cooperate with emerging digital service providers. The best way for banks seems to be cooperative competition. Joint competition emphasizes the need for banks to act together when competing with financial technology organizations. 'Joint competition' or'cooperation' is used to mean the cooperation of competing institutions for the common interest. Will the Fintechs be destructive or supportive for banks? According to Paolo Sironi, destruction is inevitable, but it is better to transform the banks rather than taking them out of the system (Sironi 2018).

- **Fintech's financial products will increase/** Another change brought about by digitalization and technological advances was the innovative, flexible, and adaptable financial solutions offered by companies called Fintech. These solutions appears to be the impact for transforming banks and banking in general. While Fintech companies pose a threat to the sector, on the one hand, it is also possible to create new business platforms in partnership with Fintech organizations to provide an advantage in competition. These developments in technology have also affected regulations and caused legal regulations on open banking. Open banking has enabled the sharing of data with the Application Programming Interfaces (API) on an authorized basis and enables Fintech organizations to innovate new financial services. This change now makes banks a platform and enables the establishment of structures that will allow them to reach more competitive, quality financial products and services by going into cooperation with Fintech organizations.

McKinsey published the 'A Brave New World for Global Banking' analysis in 2016. According to the report, large technology companies can position themselves between banks and their customers and seize the key role in customer relationships, which can turn into a threat of existence for traditional banks (McKinsey 2016). To overcome this problem, banks should revise their business models. Banks should establish close relationships with Fintech initiatives, connect with platform providers and other banks, and reduce costs through common platforms. Another important task for banks is to make their customers happy by providing innovative digital services. Banks will now provide new digital services most cheaply and flexibly via collaboration with Fintechs, namely the new financial service providers.

Fintech organizations are new initiatives that use financial technology successfully. These initiatives offer new financial solutions to customers with advanced technology. The main feature of their financial solutions is that they provide effective and fast solutions to financial problems. As another feature of FinTek organizations, we should add that they are innovative and agile structures. Fintechs can transform the traditional banking system through digitization.

Fintechs, which emerged in America and became widespread all over the world, produced innovative solutions through a direct loan to a person, digital payment methods and big data analysis. Fintechs directly or indirectly reached an audience that banks could not reach at much cheaper costs and took their place in the financial ecosystem. Robo consultants, for example, reduced the demand for individual investment experts with gamification technology and delivered this service to large audiences. Their 'personalized product' approach made them successful in the market (Sironi 2018).

- **Banking ecosystem will change, Open Banking will develop rapidly/** Open banking is no longer bank-centered but it becomes intensely market and ecosystem-centered. These developments indicate that we are entering a period of serious changes in the banking market and ecosystem of the way banks do business.

3.6 Blockchain Technology

Blockchain Technology

Blockchain technology has created an electronic payment system in the Internet area that solves security bugs and vulnerabilities. Blockchain technology provides protection on MEESy-based infrastructure (Pisa and Juden 2017). Basic technologies that differentiate blockchain from other networks are as follows: peer-to-peer network, distributed ledger, consensus mechanism, and cryptography technologies.

Scattered Notebook Technology and smart contracts brought by blockchain technology are important innovations that contribute to the financial sector. These technologies provide a fast and transparent infrastructure. It is estimated that DDT and smart contracting technologies can save up to 30–50% in costs and losses in the financial system. (Accenture 2017, p. 6) Distributed ledger technology, which forms the basis of blockchain, also provides benefits in terms of risk elimination. As far as the international fund transfers are concerned, it is foreseen that this technology could reduce costs significantly by performing transfer transactions without intermediary and in less time. (Fintech Network 2019, pp. 3–5) Blockchain technology will enable banks to simplify their 'Know Your Customer (KYC)' customer identification process. In this way, the customer will not have to come to the bank to verify the identity. KYC process can be resolved by creating a digital identity for each customer in the joint network of banks and government institutions with the cryptography application of blockchain technology and authentication processes can be realized in a very short time. (Unicredit 2016, pp. 14, 15) (UBS 2016, pp. 30–33). Blockchain will solve many disputes in smart contracts in the application. In particular, these agreements will simplify the processes in payments with letter of credit and encrypt transactions and reduce fraud risks (Unicredit 2016, p. 15; Cocco, Pinna, and Marchesi 2017; Unicredit 2016, p. 15; Yavuz 2016).

Banks utilize blockchain for a wide range of purposes. Blockchain and artificial intelligence are deployed to update the contracts which are rapidly becoming obsolete in their essence. In addition, both of them facilitate online shopping by assisting people to determine what to buy. Augmented reality deeply affects financial and banking services i.e., banks can use augmented reality competitively (Dubey 2019, pp. 600–601). Another important banking field in which blockchain is to be applied arises as the audit function. Banks have started to work on developing audit technology based on blockchain technology.

According to Sezer Bozkuş Kahyaoğlu, blockchain technologies emerge as an approach that can radically improve banking, reduce cost and risk and offer new opportunities for innovation and growth (Kahyaoğlu 2017, pp. 210–211). Kahyaoğlu listed the changes that almost no technology can provide as follows;

1. Blockchain technology shortens the transfer process times and makes them almost real-time leading to an important cost advantage.

2. With the increase of information processing power, human and machine cooperation will increase as a result of storing, processing, collecting data and decreasing the cost of these transactions.
3. Blockchain technology, which offers a safer transaction and validation technology, will be an important assurance factor against fraud and cyber risks.
4. Second generation blockchain technologies will be applied in more complex areas in banking, especially with the e-contract, virtual contract, and e-asset management applications in the smart contracts category.

Kahyaoğlu also points out that blockchain implementation will deeply affect the record book and database management with distributed ledger application in banking. In addition to that clearing and settlement transactions, which are one of the main activities in the financial markets, can be easily realized with a strong and solid infrastructure. Finally, the new generation of blockchain applications will positively affect corporate governance practices and will ensure the fast transparent, and accountable features of the decision-making and voting mechanisms of the board and the general assembly.

In blockchain applied world, every asset, every contract, every process, every assignment, every expense, and simply every kind of transaction would have a digital record and signature. They could be fully identified, validated, stored, and shared. This indicates the enormous potential of blockchain technology for future transformation of business and government by creating new foundations for our economic and social systems (Kahyaoğlu 2019).

Blockchain Technology Will Affect the Audit Structure of Banks

The change in technology will also change the audit infrastructure and audit techniques in banks. A more effective and efficient audit will be possible with more reliable evidence. On the other hand, since the blockchain will open the way for manipulative attacks on the system, auditors need to be more prepared for security and fraud risks.

According to Sezer Bozkuş Kahyaoğlu, blockchain technologies have reached increasingly widespread areas of use including payment systems, smart contracts, securities trading, regulation, accounting, and auditing (Kahyaoğlu 2019, pp. 101,102). Transactions extracted from blockchain infrastructure are treated as reliable, accurate, objective, and verifiable since it is impossible for a user to control, modify, or turn it off alone. Kahyaoğlu pointed out that, the major role of auditors in a financial statement audit is to gather evidence as to whether management's assertions can be supported. These kinds of transactions constitute a sufficient and appropriate audit evidence for financial statement assertions such as occurrence, completeness, valuation and allocation, rights and obligations, presentation, and disclosure of transactions.

3.7 Transformation of Branches

The most important effect of digitalization on banking is primarily the increase in the number of transactions performed through digital channels. The second important effect is the emergence of new generation banks that serve only by using digital channels. The third major impact will be the transformation of branches, which are traditional delivery channels. Branches will use technologies such as self-service, artificial intelligence and will utilize guide-robots with an increased pace.

There are different views on how the branches, will change or transform in the future. Some argue that the branches will disappear and digital channels will dominate. Others proclaim that branches will continue to meet the needs of customers by adopting technological developments. The main reason for the continuation of the branches will be the complex products that need to be consulted by the banking staff in person.

It is expected that the basic services provided in the branches will decrease and the complex products and consultancy services will continue to exist. Services such as withdrawal, deposit, and payment are expected to decrease in branches. These services will be provided by digital channels. Complex products such as mortgage loans and investment products are expected to continue as branch services. Determination of mortgage value accurately, as well as recommending the right investment options require interpretation and human touch. It is not expected that these services will be performed in a mass marketing mindset through digital channels. According to CISco's 2012 survey, the ratio of those who go to branches for transactions such as paying invoices, managing their accounts, learning account balances, and making transfers is around 10% in the United States. In contrast, the ratio of those who prefer visiting a branch for the loan application is 53%. Again, the rate of preferring a branch to get any sort of support is 48% (Capgemini consulting 2017). Cisco's research shows that mobile, ATM, website, social media, and other digital channels are preferred for simple and basic operations outside the branch and that branches are preferred in transactions requiring consultancy and complex transactions.

It is difficult to get assistance on legal issues through digital channels. **Branches advise clients on legal matters as part of daily conduct**. There will be some legal information you need when you get a notification on your account foreclosure, when you inherit a deposit account, when you are invited to be a guarantor for a loan, or if you have to get legal permission for mortgage loans. Staff who are trained on these matters advise their customers. So, an emotional connection between the branches and their customers establish in due course and customers prefer traditional branches instead of digital channels (Çakmak 2018).

Branches will become a channel for digital services. Digitalization transforms the way branches provide service.

Banks began to expand the use of digital signatures in branches. Now, many banks have started to receive and store signatures digitally, and when necessary, signature controls are made over digital signatures. A similar technology is also be used in face recognition systems in banks.

In branches, touch screens have been increasingly utilized in the service of informing customers about products and services and directing them on transactions. Moreover, bank branches began to use video conferencing as a form of service. Future digital services will become more widespread in branch services for the foreseeable future.

The interior design of the branches can be expected to improve. Branches began to care about improving the customer experience. This situation is reflected in both the location of the branches and their design and furnishing. Branches will now be designed as spaces where customers feel more comfortable and pleased to be present.

It is expected that the operations will shift to the operation centers and the branches will shrink. Technological advances and digitization seem to have expanded the concentration of operations into specific centers. While this situation affects the size of branches, small branches are becoming widespread in shopping malls and central locations.

Branches are expected to continue to exist by focusing on other businesses as a result of the business shifting to digital channels. In that sense, they will choose to complement areas that are out of the scope of digital services i.e., custodian services or safe deposit boxes. Storing gold, jewelry, precious paper, and legal documents can be a thriving business area for the branches. Security and/or trust-based products will be offered widely in the branches.

The increasing importance of the branch network as an intelligence channel would be observed as widespread use in this context. Despite the development of digital channels, the branches' unique business areas will survive and coexist. Branches are important points for market intelligence. It is necessary to have a widespread network of relationships to investigate the borrowers. Market intelligence will be a business field to compensate for the service segment which has been lost due to the digital developments.

Chris Skinner describes the 10 trends in banking innovation (Digitaltalks 2016) by examining the awards given by EFMA (European Financial Management and Marketing Association): **Converting Data to Money**; Banks realize that their data analytics can create opportunities in the market. **Social Value Chain**; Banks don't have to do all the work themselves. The customers can do some of the work themselves. Banks consult customers' opinions about services and applications. **Use of Robot**; Especially in Japan, counter staff /tellers began to be replaced by robots. UBS offers its customers real-time portfolio analytics. **Banking of Things (BoT)**; Internet of Things has become important. For instance, Brandesco offers a link between your bank account and your car. **Providing all-inclusive services**; Banks are trying to provide all-inclusive services. The use of forecasting analytics has been initiated widely. We can evaluate techniques such as greeting the customer's birthdays and presenting special preferences based on their hobbies. **Different Payment Methods**; Spanish La Caixa's contactless wristband, biometric tracking product of, Canadian RBC and HBOS from the UK, Australia's Heritage Bank's wearable garment are several examples of different payment methods. **Interactive Transactions**; By integrating banking applications with other plug and play services, monetary transactions become more attractive. Integrations are often used with services such as Google Maps, Facebook, and Instagram. **Digital support to SMEs**; Banks are introducing platforms that enable small businesses to access the digital world. **Accessibility;** Banking now works 24/7. Banks can now contact the customer through a single interface via the customer's preferred communication channel. **Customized applications**; The period when standard products and services were applied to everyone is expired. Idea Bank from Poland, for instance, offers a full-fledged financial ecosystem to the customers. Users can personalize their interface according to their preference of order.

Another dimension of the issue is customer satisfaction which is one of the most important issues that banks should consider carefully. Applying new technological developments, such as robotics, sensor devices, business analytics, machine learning, natural Language Process, and Deep Learning, will be the right strategy for banks to meet customers' needs (Rajan 2018).

3.8 Digitilization and New Strategies

Digitalization Will Enforce Banks to Develop New Strategies

Banks should develop digital strategies to capture the new digital era of banking and increase market share and control costs. Some of them can be grouped under four headings: (according to Sharko, Elvin, and Indrit 2017):

- Providing a different experience and pricing to online customers by creating a digital brand separate from the existing brands of the bank,
- Modernizing their digital experiences,
- Increasing their digital capacity beyond Internet banking and mobile banking.
- Eliminating paper and creating digital processes.

Banks Will Focus on Competition with Fintechs

In order to compete with Fintechs, banks should develop a more agile organizational structure and more flexible decision-making models, develop new services and products, and maintain close relationships with the central authority and the regulatory and supervisory authority (Iman 2019, p. 33).

3.9 Conclusion

In order to adapt to the digital change, banks may have to change their products, business processes of their services, and their organizational structures and possibly their architecture. Banks are now moving toward becoming organizations that convert data into information and sell information instead of money. Digital change now leads us from a bank-centric perspective to a customer-centric perspective. In addition to the adaptation of banks to mobile technology, the main development is the establishment of digital banks that provide direct digital financial services and the establishment of i digital banks that use the digital channel as a sole service instrument.

The banking sector is shifting from the control of the providers to the control of the customers. This means that the separation of the banking components into certain sections which are compiled by different small enterprises.

The main benefits of digital banking are that they provide services at a more affordable price than traditional banking, providing more opportunities for the banks to offer new products and services, and enable them to easily collect customer information and thus enable customers to use this information. Furthermore, banks reduce operational risks with this information. Digital banking services are easy to access and even if you change locations, you can get 24/7 service. As a final point, Digital banking has the potential to increase customer satisfaction, loyalty, and profitability.

The main drawbacks of digital banking are the threat of increased customer security and fraud risks; theft of identity, and account information and risk of fraud. Criticisms brought to digital banking can be summarized as follows: The accelerated pace of technological advancement can lead to obsolete designs of products; inadequacies of infrastructure leading to decreasing service quality, and weakening of one-to-one relationship with customers.

Business models based on innovation that produce solutions other than the ones that have been developed so far, will acquire some spheres of traditional banking. There is a serious probability that each product of the bank, such as deposits, commercial banking, payment, investment, credit, etc., will be broken down by new enterprises through better communication and service quality leading to the separation of these lines from the banks in the end. This means herewith that the profitability of banks will decrease prominently. Banks should think strategically to tackle this issue by focusing on their areas of expertise and determine where they make a difference. In our opinion, banks should turn into institutions that sell information, not money solely. They should redefine their areas of expertise by collecting data and turning it into information. They should reposition themselves on a knowledge-based basis, highlighting the relationship, transactions, or product once again.

One of the most important developments in terms of banking is the change in the competitive structure. Digitalization and advances in technology facilitate access to financial services. Digitalization and Technology also increase the quality of financial services and make the prices of these services cheaper. The firms that offer a new generation of digital services have become the banks' competitors and started to transform the oligopolistic market of the banking sector.

The banking market is now evolving into a market, where competition is more intense and entry and exit are easier. Banking is now moving out of a market where banks, i.e., service providers were decisive for a long time, and heading toward an ecosystem, in which customers, the new financial institutions, and digitalization are becoming effective. Banks are faced with the fact of making a strategic decision in an escalating competition structure. This is basically a matter of whether they are going to compete with emerging digital service providers or increase their collaboration. The best way for banks seems to be cooperative competition. Joint competition, from the standpoint of banks, emphasizes the need for banks to act together when competing with financial technology organizations. This choice will probably be a very important decision that will determine the future and direction of the banks in the coming period.

During the aftermath of the technological developments, an important preference of the banks should be the application of customer-oriented banking. Thanks to the technology, the customer can now access the money at any time. For this reason, priority will be given to the fact that banks focus on the customer and take steps to ensure information and security, providing financial training to customers, and expanding financial literacy.

Banks should consider the security risks posed by digitalization and the competitive threat posed by new business models. They should set the target of planning and innovating new products and services that prioritize the customer.

Digital banking provides more affordable services than the services provided by traditional banking. It provides more opportunities to offer new products and services, facilitating the collection of information from customers and presenting it to both the bank and the customer, thus reducing operational risks. Finally, digital banking is easily accessible and provides uninterrupted service.

Banks have a lot of data, which are one of the most important advantages for these banks. It is not the data that matter, but rather that raw data are interpreted in a context and converted into information. Banks now have to incorporate their big data into their business plans to better process and convert them into sales.

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Chapter 4
The Analysis of Big Financial Data Through Artificial Intelligence Methods

Erkan Ozhan and Erdinç Uzun

Abstract A new data world which never get deformed, can be reached from anywhere, continuously stream and multiply, emerged with the evolution of technology. The data, in particular, created by business firms, scientific research centers, and automation systems reached great amounts. It has become the main target of many data analysts to reach meaningful, unexplored, and valuable information or deductions among these piles of data. In this chapter, firstly the techniques of artificial intelligence and the skills of these techniques were discussed. Later, the mostly-used techniques in the finance sector, the advantages and weaknesses of these techniques, and the methods which can be used to process the data created by the finance sector, which creates big data and is one of the leading sources, was comparatively shown. The current version of the mostly-used artificial intelligence methods in the finance sector was scanned and the new skills and contributions it provides to the sector were examined. What Classification, clustering, association rules, and time series analysis methods, in particular, cover and what problems they can produce solutions to were examined and the readers were informed about these techniques. It was aimed to give information about forming credit score and customer segmentation, where classification and clustering methods are especially employed, with sample studies. It was aimed to present the principles the up-to-date methods are based on and their theoretical and practical applications in a meaningful way. In addition to these, information about practical and useful software that can be used for data analysis in the finance sector was given and the skills of this software were conveyed to the readers. Finally, how the techniques of processing big data can be used was examined through samples as the finance data are classified as big data. The difficulties met during the analysis of big data, a natural result created by this sector, and solutions to them were presented. Updated big data processing solutions like Hadoop, Spark, MapReduce, Distributed computing, and GPU (Graphics Processing Unit) computing, in particular, were comparatively explained. The main

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principles that big data processing techniques are based on were simplified in a way that the readers could understand and were supported by examples from the sector. Especially, Spark, Hadoop, and MapReduce methods, which are leading methods in processing big data, were examined. Finally, the contributions made to the sector by artificial intelligence and big data processing techniques were generally summarized and the results were presented.

Keywords Artificial intelligence · Big data · Financial data · Classification · Clustering · Association rules

4.1 Introduction

Humans are living beings that have been generating data since the time of their existence. These data may emerge sometimes as sound, sometimes as text or behavior. Today, the variety of data sources, electronic storage capacity, processing and query speeds and usage ratio have increased significantly due to the electronic tools that people are using as well as global advancements. While initially, only retrospective queries could be made on data that were recorded for future access, it was soon realized that there may be other useful knowledge among these data. While the inferences related with past or instantaneous data that only the experts are competent in were evaluated at first, this led to many disadvantages resulting from a limited number of experts and human capacity. It was perceived that the knowledge and experience of experts are required to develop systems that can think and make decisions like experts. Hence, the term learning machines emerged which may learn and make decisions like humans. Another concept that emerged is Intelligence. The concept of Intelligence was defined by Gottfredson (1997) as a general mental ability that acts as an umbrella term for skills of reasoning, planning, problem-solving, abstract thinking, grasping complex ideas, fast learning, and learning from experience. As a result, developing systems that can learn, think and generate intelligence results as humans became the primary focus for many scientists. The concept of Artificial Intelligence (AI) was first used in 1956 during a summer research project at Dartmouth University carried out by a group of researchers (McCarthy et al. 2006). The attributes and abilities of smart systems are generally known as AI. The fact that computers are machines that use the language flourished the idea that they can be programmed to learn and hence make smart inferences. Thus, new disciplines such as data mining, AI emerged for processing the data that will kick off the learning process, acquiring meaningful knowledge from these data and designing smart systems by modeling the acquired knowledge. These disciplines that cannot be distinctively separated from each other make use of theories and algorithms put forth by the disciplines of mathematics, statistics, computer, etc.

It is useful to define the concept of data that is used frequently as the reference point for all these processes. The concept of data is the plural of the Latin word "Datum." Data can be financial transactions in a bank or the dates of birth, death, etc., for a species in Africa. Regardless of its source, we may define it as data when it is stored in accordance with a certain system. However, knowledge and data are not the same things. Knowledge brings to mind previously undiscovered, useful information. Whereas data can be thought of as each of the characteristic features of a certain situation, phenomenon, case, subject, living thing, or entity. The terms attribute, features corresponding to these characteristic features in the AI discipline. They are also known as variable, dimension in some disciplines. Even though the data represent a certain attribute by themselves (such as age, height, mood, etc.), they have to be processed to put forth the relationships between them and to make inferences for the future based on these relationships. However, it may be possible to obtain this knowledge from the data using methods developed by disciplines such as data mining and AI. Data mining takes into consideration the question of how past data can be used best for discovering the patterns in the data and improve the future decisions accordingly (Mitchell 1999). They make up a valuable resource since data subject to smart analysis may lead to new visions, better decision-making, or competitive edge in commercial environments (Witten et al. 2016).

AI-based systems use different methods such as machine learning, artificial neural networks (ANNs), genetic algorithms and deep learning that have the same goal but which do not completely overlap. Holland (Holland 1992) named these as adaptive processes and put forth their critical importance in various fields such as psychology ("learning"), economy ("optimal planning"), control, AI, mathematics with calculation and sampling ("statistical inference"). These processes also include various subjects such as determining the data to be collected, arranging the data for analysis by algorithms, putting forth the function known as the model that transforms the input into an output with the highest accuracy rate as a result of the processing of the data via statistics and mathematics-based algorithms. AI methods aim to draw out a pattern from among the data. The pattern may be one or several of the benefits such as a relationship or similarity between the data or determining the model used for transforming the input to the output.

Today, organizations are moving from a period in time during which they were using technology to carry out a specific task (such as determining the number of products sold and the number of customers) to a period when they have access to an increasing amount of data from a greater number of sources (Hurwitz et al. 2013). Data analysis results in business-oriented environments may reduce operational costs and make strategic decision-making easier (Erl et al. 2015).

AI methods have spread out over a wide range of areas from image recognition to safety, health, insurance, finance, and many more. The financial errors, expense abuse, expenditure abnormalities that finance sector employees put forth after spending hours with electronic tables may put forth effective solutions in a very short amount of time under many different subjects such as market research, customer clustering, campaign preparation (Yao et al. 2018). Machine learning methods have accelerated in finance applications as well during the past 5 years following its significant success in areas such as image processing and natural language processing (Guida 2018). Expert systems have been developed since the mid-1980s onwards for resolving various issues in the fields of accounting and finance, however difficulties related with the process of rule extraction are among the most frequently encountered problems at this stage (Wagner et al. 2002). Many financial activities put forth non-linear and unidentified behaviors that vary over time (Bahrammirzaee 2010). AI methods may provide effective solutions for overcoming these problems.

Learning from the data is the fundamental philosophy of AI methods. Data collection is the process of collecting the attributes that experts know-assume that are effective for an event or incident. Whereas the obtained group of data is known in literature as the data set. These data may include the knowledge and skills of experts while they can also include any kind of acquired data related with a certain incident or case. The data become ready for analysis after passing through stages of data cleaning, transformation, integration, etc. A test set should also be generated prior to starting the process of learning from the data in order to measure the performance of the model developed as a result of learning. The acquired data set is generally classified into two groups as training and test set in order to determine the model performance in a short period of time. Training is carried out via training data and the model is obtained. Whereas the test set is used for obtaining the model performance. However, a third data classification can also be made in some cases as the validation set in order to obtain the complex parameters of the algorithm that will put forth the model. The learning process based on algorithms most of which have been determined previously is started after the data set is classified as such. Learning function can be classified into two as supervised and unsupervised learning. Supervised learning is the type of learning that aims to predict the cases in which the output is also present inside the already existing data. Such data are also called labeled data. For example, let us consider a data set including previous credit applications and the decisions of the experts as a result of these applications. The learning that takes place is called supervised learning since the output that corresponds to the application features is known for this data set. The data are generally used in this method for solving a classification problem. Whereas unsupervised learning is used for data-cases when the outputs corresponding to the inputs are not clear. As an example, an establishment may want to determine the number of its customer groups. In this case, all kinds of data movement representing the customers may be collected which may be clustered by way of the clustering method which is among unsupervised learning methods. This method is known as unsupervised learning since different from supervised learning, the classes of the customers inside the data are not known beforehand. Clustering method can be used for improving the clarity of the data, for summarizing, and for similar goals.

AI-based systems are frequently used for solving four types of problems. Classification problems make up the first set of problems. Classification problem aims to estimate the outputs of an event with certain features using the variables of this event and the outputs generally include two or more classes. For example, developing a predictive model for automatically classifying the credit applications to a bank as accepted or rejected is included in this scope. AI-based algorithms examine whether the credit applications belong to the accepted or rejected class for the solution of this problem. Systems learning from the previous decisions of experts try to estimate the output for new applications in order to actualize this model. Traditional programming languages may develop very limited solutions to this problem. Because these programming languages are able to make precise classifications with specific boundaries. However, the solutions of many problems do not include specific boundaries. AI methods provide new approaches for the solution of such problems that are known as nondeterministic or cases without an algorithm. Today, AI-based systems are most frequently used for the solution of classification problems. They are frequently used for solving problems such as the evaluation of the credit application of a customer in finance (Hsu and Hung 2009; Mukid et al. 2018), detection of credit card fraud (Bhattacharyya et al. 2011; de Sá et al. 2018), presence or absence of a disease in the field of health, starting an engine in the field of space, or analyzing the license plate of a vehicle about to enter the parking lot to be printed on the parking ticket.[1] They are especially helpful in decision support systems in finance such as multiple criteria (which is known as features in AI) classification and decision-making actions (such as business-error estimation, credit-risk assessment, portfolio selection, and management) (Doumpos and Zopounidis 2002). Bankruptcy estimation and credit scoring are the two important research problems in the field of finance (Wei-Yang Lin et al. 2012). A smart system that can learn the models from financial data will have significant practical benefits in carrying out the task of estimation more easily and rapidly (Castillo and Melin 1995).

Clustering is another problem type that AI methods are trying to resolve. The main issue here is to find answers to questions such as, "How many classes can what I have be included in?", "How can I make the current data more meaningful by way of classification?", "Which features do these data intersect, overlap on?" etc. This method that aims to classify the data in clusters develops solutions to these questions by using features of the data set such as similarities, proximities, distances, etc. There are many studies that make use of the clustering method for financial data (Blazejewski and Coggins 2004; Pavlidis et al. 2006; Chou et al. 2017).

Whereas the third problem type is inferring the relations of association between the data. The data sets generally have a large number of features. It is a very difficult and complex process to discover the relations between the features of a data set with millions of lines. Computers can infer these relations in a rapid and effective manner by way of algorithms that put forth these relations of association. The algorithms used for this purpose are generally known as association rules algorithms. Making analyses on which products, services are preferred especially in the field of marketing and finance and the level of this preference have become commonplace for businesses. Today, many companies such as Amazon, Microsoft, and Google provide web-based data analysis tools for rapid analyses.[2] There are especially many AI-based studies

[1] Identifying the license plate of a vehicle is actually determining the class of each letter on the license plate in an alphabet with an average number of 40 classes.

[2] These companies promise the required infrastructure for businesses by providing monthly or annual subscriptions. Even though they are widely used today, some businesses are establishing their own data analysis departments for carrying out these analyses.

for predicting the purchasing behaviors of customers (Hamuro et al. 2003; Kim et al. 2003; Cumby et al. 2004; Qiu et al. 2015).

Presenting numerical predictions for the future are among the many solutions put forth by AI methods. Regression and time series analyses which are among the analyses developed for this purpose are used frequently. The primary objective of time series analysis is to understand or model the observed stochastic mechanism leading to a series, whereas the secondary goal is to estimate the future value of a series based on other probable series or factors (Cryer and Chan 2008). Each observation (x_t) in a time series is recorded at a specific time t (Brockwell and Davis 2016). A time series can be considered as a collection of observations made in order over time (Woodward et al. 2017). Forward focused planning studies especially make use of time series analyses frequently.

The most important reason for the need for computers is reducing the time for large and complex calculations. This process started with ENIAC[3] accepted as the first computer designed in 1942 for reducing the ballistic table calculation times. Computers that were at first designed for simplifying scientific calculations are used today as primary tools of calculation in many fields. Software and computers are the primary calculation and storage tools in the finance sector which makes intensive use of numerical calculations. The use of computers in many areas has increased rapidly with the advancement and speeding up of the communication infrastructure as well as the diversification of the software used. The data used for calculations and the results obtained from these calculations started to be stored for repeated queries as a natural result of the increase in the population of computers and related software.

Financial institutions are among the leading businesses which make significant use of computers and their software. The acquired data has reached immense proportions as financial activities continued to diversify. This has become an important issue not only for the field of finance but also for many other areas as well. Even though the storage, transfer and query of financial data were the primary capabilities expected from computers, new expectations have emerged in our day. In addition to the functions of storage, calculation and responding to queries expected from computers, we now expect them to make big data more understandable as well. Moreover, the fact that even a simple query takes hours in certain cases is an indication that computers have difficulties even in carrying out their previous functions. Continuous flow of data from the external world to the storage environments and their transfer to data warehouses have led to a blockage after this point resulting in questions such as, “What will we do with these data? How can we benefit from these data?” etc. Today, the concept of “big data” has emerged which takes into consideration these processes and problems as a whole thereby becoming a field of study that provides solutions to these problems. Big data is a field of datamining devoted to the analysis, processing and storage of big collections of data coming in frequently from different sources (Erl et al. 2015).

[3] ENIAC- Electronic Numerical Integrator And Computer: “Built between 1943 and 1945 the first large-scale computer to run at electronic speed without being slowed by any mechanical parts” (CHM).

4.2 Artificial Intelligence Use in the Finance Sector

Machine learning techniques will be classified in this section for the solution of problems that may be encountered in the finance sector and the data sets selected for these groups will be introduced.

Machine Learning Techniques and Datasets

Machine learning techniques such as Classification, Regression, Clustering, and Rules of Association present solutions to a diverse range of problems in many areas. This section covers the use of these techniques in the finance sector with simple examples[4] in addition to the sample data sets required for the implementation of these techniques.

Classification

The concept of classification is based on developing a model using the attributes of a data set and a categorical target class for making predictions using the developed model. Many different data mining methods such as Naive Bayes Classifier, Decision Tree Classifier, Linear Discriminant Analysis, Bayesian Networks, Multilayer Perceptron, Support Vector Machines and Artificial Neural Network are used in developing this method and making predictions. Classification studies have been carried out for financial fraud (Ngai et al. 2011; Chen 2016). The studies in this area may focus on credit card (Brause et al. 1999; Bhattacharyya et al. 2011), health (Kirlidog and Asuk 2012; Joudaki et al. 2015), vehicle insurance (Artis et al. 2002; Wang and Xu 2018), corporate fraud (Kirkos et al. 2007) and similar incidents of fraud (Kumar and Ravi 2016). Let us now explain the concept of classification by examining a sample data set for classification. You may access this data set used by Yeh & Lin (Yeh and Lien 2009) at the UCI—Machine Learning Repository.[5] This data set is comprised of 23 attributes and a target class. Table 4.1 presents a training data set including the first 5 attributes, target class, and 5 sample data.

The attributes and class value in Table 4.1 are important for the proper development of the classification model. Prediction is started after the model is developed from the current training data set. The classification model predicts the class after all attribute values are provided during the prediction operation. In this example, the class has been marked as "Yes:1" or "No:2." Attribute selection and the value selections for the class are important when preparing the data set. Moreover, the number of training data for each class is also important.

[4] https://github.com/erdincuzun/ml_intro.

[5] https://archive.ics.uci.edu/ml/datasets/default+of+credit+card+clients.

Table 4.1 Classification data set example

X1	X2	X3	X4	X5	…	Class
20000	2	2	1	24		1
120000	2	2	2	26		1
90000	2	2	2	34		0
50000	2	2	1	37		0
50000	1	2	1	57		0
40000	2	2	1	35		?

X1: Amount of the given credit, X2: Gender (1 = male; 2 = female), X3: Education (1 = graduate school; 2 = university; 3 = high school; 4 = others), X4: Marital status (1 = married; 2 = single; 3 = others), X5: Age (year) and Class: default payment (Yes = 1, No = 0)

Table 4.2 Classification data set example

X1	X2	X3	X4	X5	…	Price
60	RL	65	8450	Pave		208500
20	RL	80	9600	Pave		181500
60	RL	68	11250	Pave		223500
70	RL	60	9550	Pave		140000
60	RL	84	14260	Pave		250000
70	RL	60	9500	Pave		?

X1: The building class, X2: The general zoning classification, X3: Linear feet of street connected to property, X4: Lot size in square feet, X5: Type of road Access, Price: the property's sale price of the house

Regression

Similar to classification, regression operation also requires a training data set. The greatest difference is that the class section includes a numerical value instead of a categorical value. The majority of the data mining methods used in classification as machine learning model can also be used for model development as well. An approximate numerical value is generated as the prediction result after the model is developed. Regression operation will be explained using a house price prediction data set.[6] This data set is comprised of 79 attributes and prices as well as the value to be predicted. The price estimation is put forth by the model when the values of 79 attributes are provided. Below, the first 5 of the 79 attributes are given together with the price of the house (Table 4.2).

The number of training data is important for prediction. Big data sets can be obtained from the internet via "web scraping" methods (Boeing and Waddell 2017).

[6] House Price Prediction with Numeric-only, Dataset https://www.kaggle.com/youngseoklee/house-price-prediction-with-numeric-only-dataset/data.

Table 4.3 Clustering data set example

Income	Spend
233	150
250	187
204	172
236	178
354	163
…	…

Regression method may yield good results with a good data set especially for price estimation in different sectors (Gupta and Pathak 2014).

Clustering

The clustering method aims to obtain meaningful clusters from the data set attributes. The number of clusters can be determined by the user or by way of additional algorithms. The class data should be marked by an expert since the classification and regression methods require class data. Such methods are known as "supervised" in literature. Whereas there is no need to mark class data in clustering methods. Such methods are known as "unsupervised" methods. Preparing the data sets is more difficult in supervised methods in comparison with the unsupervised methods since the class data should be marked in the training data. "Customer segmentation problem" was selected for a better explanation of clustering. A data set[7] comprised only of income and spend attributes was selected for this problem. The first 5 lines are given below for the data set comprised of 303 lines. The applications section explains in more detail how these data will be processed and how the clusters can be obtained (Table 4.3).

Association Rules

Association Rules is a data mining method for putting forth the attributes that are associated with each other and the size of the association. As an example, it can be used for analyzing the financial income of a certain city during a specific period (Zhi-min Xu and Rui Zhang 2009). The rules obtained by analyzing attribute values can improve decision-making processes. Table 4.4 presents the first 5 entries of a data set with 8 attributes which is frequently used in literature (Chen et al. 2012).[8]

As in clustering, there is no need for training data when determining the association rules. In other words, it is an unsupervised approach. It is observed that both clustering

[7] https://github.com/sowmyacr/kmeans_cluster/blob/master/CLV.csv.

[8] https://archive.ics.uci.edu/ml/datasets/online+retail.

Table 4.4 Rules of association data set example

X1	X2	X3	X4	X5	X6	X7	X8
536365	85123A	WHITE HANGING HEART T-LIGHT HOLDER	6	2010-12-01 08:26:00	2.55	17850.0	United Kingdom
536365	71053	WHITE METAL LANTERN	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom
536365	84406B	CREAM CUPID HEARTS COAT HANGER	8	2010-12-01 08:26:00	2.75	17850.0	United Kingdom
536365	84029G	KNITTED UNION FLAG HOT WATER BOTTLE	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom
536365	84029E	RED WOOLLY HOTTIE WHITE HEART.	6	2010-12-01 08:26:00	3.39	17850.0	United Kingdom

X1: InvoiceNo, X2: StockCode, X3: Description - Product (item) name, X4: Quantity - The quantities of each product (item) per transaction, X5: InvoiceDate, X6: UnitPrice, X7: CustomerID, X8: Country

and association rules are implemented in the same publications in literature since they have similar data sets (Ciszak 2008; Farajian and Mohammadi 2010).

Applications

There are many open source solutions for the implementation of machine learning techniques. In addition to software such as Weka,[9] Rapid Miner,[10] Orange,[11] and KNIME[12] that provide windows-based implementation environment, it is possible to implement these techniques using libraries of software such as Python[13] and R.[14] The Python software language has been selected here in order to ensure that

[9] For detail: https://www.cs.waikato.ac.nz/ml/weka/.
[10] For detail: https://rapidminer.com/.
[11] Fro detail: https://orange.biolab.si/.
[12] For detail: https://www.knime.com/.
[13] For detail: https://www.python.org/.
[14] For detail: https://www.r-project.org/.

the implementation is more understandable and the steps are seen more clearly. The Scikit-Learn library will be used which can generally be added to Python as a module.

Classification via Python

Many machine learning methods can be used for classification with the Python software language. First, let us tabulate the data. We can simplify the transfer process from excel and CSV (Comma Separated Values) type files by using the "pandas" library. Let us import the pandas library in Python and transfer our table to a variable afterward.

```
import pandas as pd
df_data = pd.read_excel("creditcard.xls", skiprows = 1)
```

skiprows one (1) value is assigned in order to ensure that the first line in the table is not taken.

This line has no meaning for the training process since it contains the title information for the data. Hence, it should be eliminated. It enables the use of pd extension instead of "as pd" pandas. This is a method used for writing less code. Let us separate the attributes in the table and the target class at this stage.

```
x = df_data.iloc[:, 1:-1].values
y = df_data.iloc[:, -1].values
```

Pandas line and column selection *iloc[< row selection > , < column selection >]* is used. While ":" is used for selecting all records during the selection process [1:-1] eliminates the first and last column. X contains the attributes that will be used during the learning process apart from the target variable. The last column or in other words the target class is obtained with "-1" which is then transferred to the variable y. Let us separate a section of the table for training and the rest for test.

```
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size = 0.3)
```

We will use the scikit-learn library for this splitting process. The attributes and target class can be easily split after train_test_split is imported in this library. The train_test_split function transforms 4 variables for the train and test operations. Let us now develop our learning model using the train data.

```
from sklearn.naive_bayes import GaussianNB
model = GaussianNB().fit(x_train, y_train)
```

GaussianNB is imported for using the Naive Bayesian Classifier which is frequently used in literature. The attributes and target class of the train data are given to the fit function. Now we have the model to be used for prediction. Let us now make the predictions using this model.

```
y_pred = model.predict(x_test)
```

Table 4.5 Confusion matrix

	Predicted No	Predicted Yes
Actual No	TN 1458	FP 5562
Actual Yes	FN 197	TP 1783

The attributes of the test data are fed to the predict function. y_pred includes the predictions obtained for the test. At this point, the target class of the current test data (y_test) can be compared with y_pred for measuring the success of the model. Confusion matrix is used for presenting a summary of the prediction results of the classification problem for success measurement (Table 4.5).

```
from sklearn.metrics import confusion_matrix
tn, fp, fn, tp = confusion_matrix(y_test, y_pred).ravel()
```

True Positive (TP), False Negative (FN), True Negative (TN), and False Positive (FP) provided by the Confusion matrix provides guidance with regard to the interpretation of the prediction results. TP positive indicates that the observations are predicted correctly, FP positive that the observations are predicted incorrectly, TN negative that the observations are predicted correctly and FN negative that the observations are predicted incorrectly. Prediction and actual test target results can be given to the function after the confusion_matrix is imported by Python for reaching the values of 4 different prediction results in the confusion matrix. Three different scales of accuracy, recall and precision are used frequently in literature based on these 4 predictions.

$$\text{Accuracy} = \frac{\text{TN} + \text{TP}}{\text{TN} + \text{FP} + \text{FN} + \text{TP}} = 0.36 \tag{2.1}$$

$$\text{Recall} = \frac{\text{TP}}{\text{FN} + \text{TP}} = 0.90 \tag{2.2}$$

$$\text{Precision} = \frac{\text{TP}}{\text{FP} + \text{TP}} = 0.24 \tag{2.3}$$

While accuracy provides general information, precision and recall provide more segmental information. The results put forth that the prediction is not very good with a percentage of 36. There is no need to feel hopeless in this case. At this point, we should acquire more information on our data and continue our tests with different methods. Let us look at the numbers of Yes = 1 and No = 0 in our target class.

```
temp = df_data["default payment next month"].value_counts()
print(temp.index, temp.values)
```

value_counts() is used for making calculations on the attribute given. temp.values have values of 23364, 6636 for 0 and 1, respectively. While there are many samples for No, in this case, it is determined that the number of samples for Yes is lower. Such data sets are known as imbalanced data sets (Chawla 2009; Uzun and Özhan 2018). Imbalanced data sets can be used for improving success by way of different machine learning methods even though they are somewhat problematic. Hence, you should test not only a single machine learning method but more than one method. It is very simple to carry out these tests via Scikit-learn.

```
from sklearn.ensemble import RandomForestClassifier
model = RandomForestClassifier().fit(x_train, y_train)
y_pred = model.predict(x_test)
```

Random Forest Classifier was used for generating the model in the example given above and the target classes were predicted using the test data. At this point, success measurements can be made by regenerating the confusion matrix. It is observed that the accuracy value has reached 80% for this model.

Regression with Python

Regression data sets are quite similar to classification data sets. The purpose of regression methods is to predict the closest number.

```
import pandas as pd
df_data = pd.read_csv("regression.csv")
```

All attributes should have a numerical data set in order to be able to make calculations. However, the text data in the data set should be transformed into numerical data. The process of transforming the data into numerical data is known in literature as preprocessing (García et al. 2015).

```
cols = ["MSZoning", "Street", "Alley", "LotShape", "LandContour", "Utilities", "LotConfig", "LandSlope", "Neighborhood", "Condition1", "Condition2", "BldgType", "HouseStyle", "RoofStyle", "RoofMatl", "Exterior1st", "Exterior2nd", "MasVnrType", "ExterQual", "ExterCond", "Foundation", "BsmtQual", "BsmtCond", "BsmtExposure", "BsmtFinType1", "BsmtFinType2", "Heating", "HeatingQC", "CentralAir", "Electrical", "KitchenQual", "Functional", "FireplaceQu", "GarageType", "GarageFinish", "GarageQual", "GarageCond", "PavedDrive", "PoolQC", "Fence", "MiscFeature", "SaleType", "SaleCondition"]
from sklearn import preprocessing
for col in cols:
le = preprocessing.LabelEncoder()
le.fit(list(df_data[col].unique()))
df_data[col] = le.transform(list(df_data[col].values))
```

First, a total of 43 columns to be changed were determined and a list was made. Afterwards, the required library required for preprocessing operations was imported. The same process was carried out for each column. *LabelEncoder()* class is used

Table 4.6 Comparison of the prediction and the test

y_pred	112479	238779	358084	190180	95314
y_test	125000	236000	383970	190000	105000

It is observed that the results are close to each other

for the transformation process. An unrepeated value for the data in that specific column is obtained with the *unique()* function which is added to the class with the fit command. Afterward, all data in the column are replaced with numerical data via transform procedure. Another preprocessing process is replacing blank data with a value. There are many studies on this subject. We will replace all blank values with the value of −1000 in our case.

```
df_data.fillna(value = -−1000, inplace = True)
```

all values are replaced with fillna in the pandas library. While the final column of our data set includes the value to be predicted, the other columns will be used for prediction.

```
x = df_data.iloc[:, 1:−1].values
y = df_data.iloc[:, −1].values
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size = 0.3)
```

Train and test sub data sets were obtained from the data set as was the case in the classification example. Let us now generate the model to be used for prediction as we did for classification.

```
from sklearn.linear_model import LinearRegression
model = LinearRegression().fit(x_train, y_train)
```

Here, Linear Regression method was used which is the most frequently used method in literature. Now, let us predict the values in the data set.

```
y_pred = model.predict(x_test)
```

It is important for success measurement of regression classification whether the numbers are close to each other or not. Let us compare the first 5 values in the data set (Table 4.6).

Clustering with Python

It is very important in the competitive world of our day to understand customer behavior and to categorize the customers based on their purchasing behaviors. For this purpose, we will use a data set that includes the annual incomes and annual expenses of the customers of an e-trade website. We will introduce the concept of clustering via K-means method which is a very standard form of clustering.

```
import pandas as pd
df = pd.read_csv('clustering.csv')
```

Deciding on the number of clusters is one of the most difficult decisions for the clustering process. The silhouette coefficient (Rousseeuw 1987) is used for interpreting and verifying the accordance between different clusters. The silhouette coefficient takes on values between −1 and 1. The differences between the clusters are high when this value is close to "1." While the value of "0" indicates that the clusters are similar to each other, values below 0 indicate that the attributes overlap each other's fields. Now let us select the values to be clustered and calculate their silhouette coefficients.

```
df_values = df.iloc[:,[0,1]].values
from sklearn.cluster import K-means
from sklearn.metrics import silhouette_score
for n_cluster in range(2, 7):
K-means = K-means(n_clusters = n_cluster).fit(df_values)
label = K-means.labels_
sil_coeff = silhouette_score(df_values, label)
print("Cluster = {}, Silhouette Coefficient = {}".format(n_cluster, sil_coeff))
```

Only numerical data have been transferred by df_values with the code given above. Afterward, silhouette_score is imported for calculating the K-means and Silhouette coefficient for the clustering procedure. A loop was formed for testing clusters between 2 and 6 and the results obtained from the K-means value were transferred to the silhouette_score function. The output of this program is as given below.

```
Cluster = 2, Silhouette Coefficient = 0.44006694211403197
Cluster = 3, Silhouette Coefficient = 0.35962629048722355
Cluster = 4, Silhouette Coefficient = 0.3601309226059495
Cluster = 5, Silhouette Coefficient = 0.36165764606767004
Cluster = 6, Silhouette Coefficient = 0.3694358536535782
```

While separation was greater for two clusters, the separation is observed to continue with increasing number of clusters. This can be interpreted with a specialist on customer behaviors. We will use the *matplotlib* library for visualizing the clusters. First, let us import this library.

```
import matplotlib.pyplot as plt
km4 = K-means(n_clusters = 4)
y_means = km4.fit_predict(df_values)
```

We obtained K-means results for 4 clusters. Now let us plot via plt.

```
plt.scatter(df_values[y_means ==0,0], df_values[y_means ==0,1], s = 50, c =
'purple', label = 'Cluster1')
plt.scatter(df_values[y_means ==1,0], df_values[y_means ==1,1], s = 50, c =
'blue', label = 'Cluster2')
```

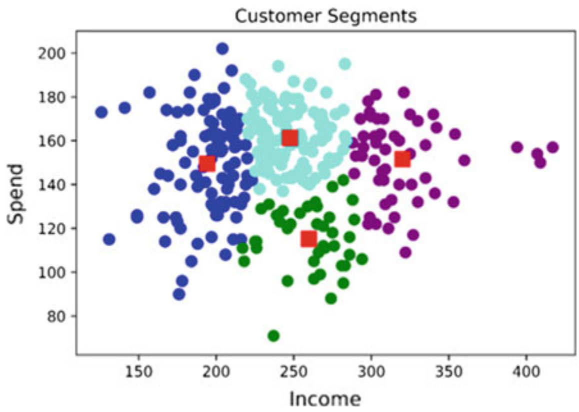

Fig. 4.1 Clustering results

plt.scatter(df_values[y_means ==2,0], df_values[y_means ==2,1], s = 50, c = 'green', label = 'Cluster3')
plt.scatter(df_values[y_means ==3,0], df_values[y_means ==3,1], s = 50, c = 'cyan', label = 'Cluster4')
plt.scatter(km4.cluster_centers_[:,0], km4.cluster_centers_[:,1], s = 100, marker = 's', c = 'red', label = 'Centroids')
plt.title('Customer Segments')
plt.xlabel('Income')
plt.ylabel('Spend')
plt.show()

First, the 4 clusters were determined followed by the centroids of the clusters. The plot was completed after determining the title, x axis label, y axis label. Figure 4.1 presents the code output.

Association Rules with Python

In this section, we will use the "mlxtend" library for determining the association rules for the data. We will carry out our tests using Apriori which is the primary algorithm in this library for extracting association rules. Apriori uses the bottom-up approach examining a single attribute value at each step and looks for a relationship between this attribute value and others. We come across three concepts related with association rules:

- Support: It is the ratio of the number of transactions including an itemset to the total number of transactions (A/Total number of transactions).
- Confidence: It is the ratio of the number of transactions including two itemsets ((A + B)/A)).
- Lift: Indicates the association between X and Y when they are statistically independent.

First, let us import our libraries and load our data.

```
import pandas as pd
from mlxtend.frequent_patterns import apriori, association_rules
df_data = pd.read_excel("association.xlsx", index_col = 'InvoiceDate')
```

We do not need all the data in the table, hence, let us collect our data in the 'baskets' variable.

```
baskets = df_data.loc[(df_data['Quantity'] > 0), ['InvoiceNo', 'Description', 'Quantity']]
baskets = baskets.groupby(['InvoiceNo', 'Description'])['Quantity'].sum().unstack(fill_value = 0)
baskets = (baskets > 0)
```

We grouped the amount of products with the same "'InvoiceNo, Description" value and added them. Afterward, only those with a sum of greater than zero were taken into consideration. We may start extracting the association rules.

```
frequent_itemsets = apriori(baskets, min_support = 0.0325, use_colnames = True)
rules = association_rules(frequent_itemsets, metric = 'confidence', min_threshold = 0.5)
```

Association Rules determines the elements above a certain support value. For this purpose, min_support attribute was used. The desired rules for samples above a certain confidence are generated from among the remaining items. Table 4.7 presents the first five results.

Table 4.7 Association rule results

antecedents	consequents	support	confidence	lift
GREEN REGENCY TEACUP AND SAUCER	ROSES REGENCY TEACUP AND SAUCER	0.038141	0.756650	14.292598
ROSES REGENCY TEACUP AND SAUCER	GREEN REGENCY TEACUP AND SAUCER	0.038141	0.720450	14.292598
JUMBO BAG PINK POLKADOT	JUMBO BAG RED RETROSPOT	0.040971	0.677340	6.519558
JUMBO SHOPPER VINTAGE RED PAISLEY	JUMBO BAG RED RETROSPOT	0.033770	0.578723	5.570351
JUMBO STORAGE BAG SUKI	JUMBO BAG RED RETROSPOT	0.035956	0.611486	5.885704

An association rule is comprised of two stages: an antecedent (if) and a consequent (then). While antecedent shows the first rule, consequent shows the other value subject to the previous condition

4.3 Big Data

This concept is not new even though it has gained popularity in recent years. Big data covers all processes that include the rapid processing and analysis of large and complex datasets that are generally in different environments.

We start to generate data without even realizing it the moment we leave our house. For example, you may wish to consult your navigation system to see the current traffic on your way if you are going to the cinema. Hence, we generate a query data in the navigation system. We also start generating data when we get on our private vehicle or use the public transportation system. Our car starts recording the kilometer data and more detailed information if it has an internet connection. The public transportation card that we scan in the vehicle adds yet another record to the database. We may be subject to license plate recognition at the entrance before moving toward the cinema which is transformed into data stored in the shopping mall or cinema database. We generate a new set of data in the database of the cinema when we decide on which movie we want to see. We open a new record in the database of the bank if we make the payment via a bank card. We generate and leave behind a multitude of data even during a very simple activity such as watching a film. Especially we frequently resort to financial payment tools at the end of such activities. We can see that the data are immense even for the field of finance at the individual level. The banking transactions of commercial establishments are more complex and varied than those of individual users. As a result, we see that the data in the field of finance should be evaluated in the big data category and that there are many different problems related with big data. It is impossible for one or more individuals to examine, analyze, and control this much data even when electronic storage environments may experience significant issues in storing these data.

Hurwitz (Hurwitz et al. 2013) defined big data as the ability to manage huge amounts of different data at the right speed and in the right time span for enabling real-time analysis and reactions. Xindong et al. (Xindong Wu et al. 2014) indicated that big data is related with large, complex and growing datasets that include more than one autonomous resource and many accompanying difficulties. Labrinidis and Jagadish (Labrinidis and Jagadish 2012) put forth that there is no clear consensus on what big data is. The term big data is valid for information that cannot be processed or analyzed via traditional transactions or tools (Zikopoulos and Eaton 2011). The principle importance is that the field addresses certain difficulties related with data processing with possible solutions for all. We are faced with many significant big data-based challenges such as reduction, integration, cleaning, data set query, and multi-dimensionality as put forth by Chen et al. for acquiring the significant data from sets of big data with significant knowledge of high return.

Big Data Characteristics

Many finance institutions have hundreds of thousands or even millions of customers. The data size that is generated every day by an establishment with such a great number of customers may be immense. Hence, the storage, processing and analysis of the data for extracting meaningful information make big data techniques a necessity. Even though today we first think of largeness only in terms of size-volume, big data have many different characteristics. We see 4 main elements when we consider the characteristics of big data. The number of these elements may increase up to 7 in some references (Khan et al. 2014).

Velocity

This especially represents the rapid streaming of data. The data that are generated in such cases should be stored rapidly and recorded in a proper format. Websites with millions of users such as Google, Twitter, and Facebook are continuously faced with such a stream of data. Similarly, systems that continuously process images from a camera face such a difficulty. Whereas the transactions in the field of finance are generally instantaneous and contain valuable data. At most times it is required to control, approve and analyze these transactions instantaneously. For example, it may be necessary to determine whether a purchasing or withdrawal transaction falls into the category of fraud or not. Finance establishments that have to deal with large numbers of purchasing transactions make use of big data processing techniques for overcoming this difficulty.

Variety

Variety has three dimensions. These are data source variety, input variety, data type variety. Data source variety includes the analysis of a large number of data sources stored independently by associating them. As an example, it may be necessary to collectively analyze data from many different databases such as the citizenship information of the individual, his/her assets, financial product repayment performance and usage rates when evaluating the credit application of an individual. These databases may be very different from each other structurally. Hence, the integration, association, cleaning of these databases may lead to difficult processes. Variety in features is the second dimension of variety. The process of developing a financial estimation model may have hundreds or even thousands of inputs. The diversity of the inputs increases the period of time required for the collection of data while maximizing the hardware requirements as well as analysis time. Therefore, big data processing techniques are unavoidable for overcoming such difficulties. Variety of data type is the third dimension of data variety and the data may have many different types such as numeric, nominal, categorical etc. in addition to their structural variety. The data may include difficulties such as transformation of types and the accordance of this transformation with the analysis method.

Veracity

It is not possible to be 100% sure of the accuracy of the source data when dealing with a high volume of rapid and complex data (Ishwarappa and Anuradha 2015). This concept expresses the data quality or whether they are really obtained from the desired database in the desired manner (Erl et al. 2015). Data accuracy is critical for the finance sector. An incorrect data may lead to making incorrect decisions as a result of many calculations. Hence, it is an important issue to guarantee the accuracy of data coming in rapidly from many different sources. The data should pass through preprocessing stages such as cleaning, eliminating outliers, integration etc.

Value

Value represents the level of importance and impact of the added value obtained from the data for the establishment. The value of the data is oftentimes indirectly proportional with time. The "actuality" of some data is very short due to the rapid changes in big data (Cai and Zhu 2015). Thus, it may be necessary to evaluate the data rapidly before they go out of date. Determining rapidly whether a credit card expense is fraud or not is critical for taking precautions before the bank incurs losses. Similarly, time is of the essence for stopping an autonomous vehicle before it hits a living thing it encounters on the way after a rapid analysis of the image data acquired.

Solutions for Overcoming Big Data Difficulties

Even though big data bring forth many difficulties, they also make significant contributions to establishments from a strategic and operational perspective. Many establishments develop their own data analysis departments for overcoming these difficulties. Whereas some establishments try to overcome these issues by renting infrastructure or through the purchasing of services. The technological methods developed for dealing with big data in our day will be discussed in this section.

Distributed File Systems

Distributed file systems are storage systems based on the storage of data by distributing them in the network according to certain metrics instead of storing the data in a single spot. This is required not only for moderating the storage requirements but also for rapidly carrying out fundamental and advanced analyses such as queries, calculation, and information retrieval. Another advantage of distributed systems is that the data in a distributed universe are logically connected but physically disconnected. In this way, each data set known as a node is responsible only of itself. This leads to a certain issue to affect only the related node with no impact on the normal functions of the other nodes. Software-based on the structure of distributed file systems are used in order to carry out primary functions on big data such as calculation and information extraction. Let us examine some distributed system suggestions and their fundamental philosophies.

Serverless Network File Systems suggested by Anderson et al. (1995) distribute data processing and storage in order to obtain high performance and control, thereby the related task can be transferred to another machine in case of a failure (Anderson et al. 1995).

GPFS is IBM's parallel shared-disk file system for cluster computers. The disks in this system are used by providing equal access rights to the cluster nodes by way of a switched architecture (Schmuck and Haskin 2002).

GFS (Google File Systems) is a scalable distributed file system developed for applications that process big and scattered data (Ghemawat et al. 2003).

Today, Hadoop Distributed File System (HDFS) is widely used with good results. HDFS is a distributed file system designed for operation based on commodity hardware (Apache Software Foundation 2019).

Lu (2020) listed the requirements for storing large amounts of data as such;

- High scalability
- High performance
- High usability
- Having a distributed file system with large capacity.

These requirements are also necessary for financial data. Because financial data are quite varied and need to be verified rapidly at high volume. Large amounts of hot data are observed to circulate especially when monetary movements and stock transactions are taken into consideration. It can be stated that the HDFS technique from among the aforementioned technologies is suited for the storage, query, etc., of large financial data especially with regard to performance and ease of use.

High Performance Computing (HPC)

High performance computing (HPC) is the general name given to carrying out the calculation required in a minimum amount of time with minimum hardware requirement, high accuracy, maximum accessibility, high error tolerance, and optimum usability. Many high performance computing methods have been suggested today. Let us take a look at these methods.

OpenMP is the first method that is based on technical shared memory and parallel computing. It has been developed for overcoming memory issues in cases that require high memory capacity for calculations. OpenMP is an API (Application User Interface) for making shared memory coding easier (Chapman et al. 2008). OpenMP is used for high performance computing applications running on shared memory processors (Sato 2002).

GPU (Graphics Programming Unit) is a method that suggests the carrying out of calculations using the graphic processing unit of computers. This method is based on a structure that supports parallel operation and coding using the graphics hardware for general-purpose calculations (Owens et al. 2008).

This distributed system is the collection of the independent entities that cooperate for solving a problem that cannot be solved independently (Kshemkalyani and Singhal 2011). This is observed especially when we consider the storage and analysis of big data. Hence, we can indicate the inevitability to use high performance computing methods for calculations and analyses involving big data.

Today, actually all computers are parallel because they always have various simultaneous operations ongoing (Trobec et al. 2018). One of the main differences between parallel computing and distributed computing is that parallel computing uses all processors for completing a task whereas each processor has its semi-independent task in distributed processing but require coordination due to various reasons such as the sharing of resources and error tolerance (Attiya and Welch 2004).

Many software and methods have emerged in our day especially due to the high performance presented by distributed computing solutions. Now let us take a look at these methods.

Hadoop is the first method we will examine the popularity of which is increasing today. Apache Hadoop software library is a framework that enables the distributed processing of big data sets among computer clusters using simple programming models(The Apache Software). As previously mentioned, Apache Hadoop is actually a software library. This library makes it possible to distribute big data to clusters. In addition, Hadoop has many different modules developed and under development for carrying out functions such as calculation, storage, and query. Each of these modules is used for different functions. It would be worthwhile to examine some of these modules more closely.

Hadoop Common module enables the modules to access and use common tools.

Hadoop Distributed File System (HDFS) is the Hadoop storage component optimized for high performance when reading and writing large files (Gigabytes and above) (Holmes 2012). When it is considered that financial data generate bundles with large file size, it can be stated that HDFS will be able to store such data with high performance.

MapReduce is the name given to the data processing application of Hadoop comprised of two phases of Map and Reduce (Vohra 2016). MapReduce is a software framework that enables the parallel processing of large amounts of unstructured data in a distributed processor group (Hurwitz et al. 2013). Parallel data processing includes the simultaneous implementation of many sub-tasks that collectively make up a larger task (Erl et al. 2015). MapReduce first maps the data set by separating it into smaller groups which are called data blocks. It then distributes each data block to sections called nodes that include a computer and which are connected to it over a network. Each section makes the required calculation and sends the result back to the main node. It can complete in minutes the queries and inferences that would take days for a single computer.

YARN (Yet Another Resource Negotiator) is one of the primary components of Hadoop which regulates cluster resource management and application planning (Turkington et al. 2016). Planning and resource management tasks carried out by MapReduce over Hadoop 1.0 have been transferred due to various issues to a separate model called YARN in Hadoop 2.0 (Holmes 2012). The basic logic of YARN is separating the resource management and job scheduling/monitoring functions with a Resource Manager (RM) and an Application Master (AM) for each application (Apache Software Foundation). The management of the job schedules and resources of big data becomes of critical importance especially after big data are at times divided into thousands of nodes. Hence, distributed storage and calculation platforms require strong job and resource management/planning solutions such as YARN.

Modern data processing platforms are made up of a large number of technologies and it may be a difficult task to bring them all together (Kunigk et al. 2018). This technology structure may often change subject to the requirements and nature of the task at hand. For example, different data processing platforms may be required in order to rapidly analyze the incoming data of a financial establishment with thousands of credit card transactions for determining whether a specific transaction is fraud or not. You may need to use a data processing technology such as Apache Kudu[15] which is successful at processing instantaneous data. Apache Kudu complements the storage layer of Hadoop for ensuring rapid analyses on fast data (The Apache Software Foundation Kudu 2019). Kudu stores the data in its own column format in the primary Linux file system and does not use HDFS in any way contrary to HBase (Spaggiari et al. 2018). Kudu may be preferred for the analysis of fast financial data. Whereas Apache Kafka can be a solution for meeting the instantaneous messaging requirements between the client and server.[16]

Spark is an open-source platform developed for processing big scale data via methods that include iterative calculations such as machine learning (Meng et al. 2016). Spark rapidly processes the data blocks by fixing them on a memory in the cluster. Whereas Spark Streaming is a useful tool for stream processing. This is an indication that it can be used for the processing of online financial data.

Apache Impala is an effective tool that enables real-time queries on big data stored on HDFS and HBase (Apache Software Foundation Impala 2019).

Security is an indispensable requirement for all data of a business (regardless of whether it is large or small scale). Various security solutions have been suggested for big data processing platforms. Apache Sentry is a role-based authorization module that classifies and inspects the privileges of Hadoop users and applications on the data (Atlassian 2016). Since calculations are made continuously in financial services, it is of critical importance in the case of a security issue that the related systems operate continuously and have error tolerance (the service continues over other service components when a system component is disabled).

[15] Visit https://kudu.apache.org/ for more detailed information.

[16] https://kafka.apache.org/.

There are many aspects of working with big data. Many open source solutions have been developed separately for almost all of these aspects. In this section, we evaluated these tools especially with regard to the requirements of big financial data and provided information on solutions with high performance. Financial data generally require environments that provide high speed, high capacity storage-processing and high security. Each of these requirements is important by itself. Systems that process large amounts of financial data should meet these requirements.

4.4 Conclusions

Computer-based systems are of vital importance in the field of finance as a medium where the data almost live and breathe. The level of this significance has increased even further in our day with the emergence of big data. We are able to carry out many financial transactions in this century over computer networks via internet. These transactions have two sides which are the finance institutions and customers. Customers expect to take the most advantageous financial service for them that is also fast and continuous. Whereas finance establishments try to develop information processing architectures with high security storage, processing and query abilities in order to meet the expectations of their customers. Today, a new concept known as big data has been included in this architecture. Data with big data characteristics indicated in the third section are present in almost all large financial establishments. It is clear that Distributed File and computing Systems should be used for meeting the storage and processing requirements of financial data. For this purpose, distributed file systems such as HDFS, HBase based on technologies such as Hadoop, Spark can be preferred. The second factor after storage requirement is the processing of data for feature extraction. AI methods and machine learning algorithms are ideal for feature extraction. Smart extractions may greatly satisfy the profitability of financial establishments and customer satisfaction. The results indicated in section two generated by Python-based AI methods can be compared with the needs of financial establishments for selecting the best method. Software such as Python, R and Mahout with many AI algorithms can be quite beneficial for this purpose. The immediacy of the data to be processed should first be taken into consideration when analyzing big financial data for feature extraction. Evaluating the security of streaming financial transactions is a critical issue which is more important than determining a service or campaign for the customer. Hence, modules such as Kudu, Spark Streaming that operate via Hadoop-Spark platforms with high performance for instantaneous data processing can be preferred for this purpose. If the result to be extracted from the data does not have any urgency, data processing tools such as Spark, MapReduce, Impala, Kafka can be preferred. Big data is quite natural for the ecosystem of financial data. However, there are many related security threats since financial data are quite valuable. Big data security solutions such as Apache Sentry that enable detailed authorizations are necessary for eliminating these threats. In this section, we tried to provide information on AI, AI software, the world of big data and the natural structure of this world along with the related systems with a specific focus on the field of finance. We observed that big data come to life especially in the field of finance and that mutual benefits can be obtained from these data for both the customers and establishments throughout their life cycle. We may conclude that these acquisitions and benefits include processes with certain requirements and that each process should be structured according to a certain requirement. Big data can transform into a beneficial ecosystem for finance establishments and their customers when these requirements are met.

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Part II
The Impact of AI on International Trade and Economics

Chapter 5
The Impact of Artificial Intelligence on Central Banking and Monetary Policies

Hakan Kahyaoglu

Abstract The most important feature of the last twenty years in the world economy is the digitalization of the social and economic field. This new trend is a process that can not be analyzed by unconventional methods, approaches, and techniques. This process is a dynamic mechanism that involves rapidly spreading effects. Therefore, digitalization has revealed an economic and social situation in which institutions are constantly transformed, innovations are applied very quickly, and are in demand. The most important problem in the studies to be carried out on this subject is the discussions about the measurement of digitalization and whether its numerical indicators are representative of the process or not. The extent of digitalization in the economy is Fintech applications in industry 4.0 money markets and financial markets in real terms. In today's business world, the size of the relationship between production and the market changes in the digital economy. Achieving the accumulation of knowledge in the economy at lower costs with the effect of digitalization has led to the production of an important digital information. This accumulation of knowledge led to changes in economic behavior and preferences in business models. The economic area where the effect of this change is seen most rapidly is the financial area. Digitalization in the financial area is emerging as a new source of risk. In this respect, the increase in the volume of financial data with digitalization made the necessity of new analysis techniques necessary. Data sets resulting from the increase in the volume of data are defined as big data. In general, these big data have high frequency and real time or instant data feature in the financial system. The analysis of these data is a basic tool for measuring financial risks with systemic financial risks and the risk level of the markets. Digital economy is defined as a new economic structure as a result of changing the structure of the internet and communication systems. In this new structure, economic relations are created within the framework of the relationships established between the platforms. Establishing relationships between people, firms, and institutions through platforms reveal a lot of digitizable data. The continuous accumulation of this data online makes it necessary to carry out continuous analyzes according to each piece of information that is constantly received. The analysis of

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the information as well as the information turns into a product of economic value. The most important tool for this new transformation is artificial intelligence. Artificial intelligence and deep learning methods with machine learning, which are its tools, also cause changes in the financial and monetary relations of the new economy. The first major impact of this change was on the banking system. The changes in the banking system and the digital currencies and the developments that emerged with Facebook's announcement on the issue of the Libra currency cause changes in the primary functions of the central banks and in the monetary transfer mechanism. The main reason for the change in the primary function of the Central Bank and the change in the monetary transmission mechanism is the differentiation in the property of the money. The differentiation in the feature and function of the central bank has to redefine its functions along with the monetary definitions of the central banks. Within the framework of this trend, the aim of this study is to analyze the change in the structure of central banks, the characteristics of money, and the functions of monetary policies, with the artificial intelligence and digitalization process.

Keywords Central banking · Artificial intelligence · Digitalization · Monetary policy

Jel Codes E58 · E52 · F01

5.1 Introduction

The economic effects of digitalization in the world economy in the last decade are dealt with depending on the production. It is seen that the effects on production will have social effects on employment and development of new business models. However, it should be noted that the social effects of this new age would be more effective especially in the framework of the channels mentioned. Therefore, with digitalization in the economy, it is necessary to produce tools for how to transform the positive external and internal benefits that come with the acceleration in the production and processing of information into social benefit. In order for these developments to have a wide social impact, the public health and education system should also be used. Economic and social impacts will increase especially due to the impact of digital technology on the accessibility of public health services and the spread of preventive health services. However, it is seen that the area where the effects of communication and technological developments in the economy cause the fastest and structural changes in the financial area.

Technological developments lead to the development of relations between financial markets. This leads to the integration of domestic markets into global markets. This integration reveals positive internal and external economies resulting from the growth of the financial markets and institutions' scales. In general, while the new institutional arrangements related to technology have short-term cost-oriented effects on financial institutions and financial system, the external effects of technology emerge on a long-term basis. These long-term effects also revealed a network and diversity relationship between financial institutions and markets. In this network relationship, the interruption in business time caused by the time between financial markets; has disappeared with the help of network-based communication technologies. The effects of technology on the financial system and markets have led to the same trends on the basic instruments of the markets. However, an international coordination between the countries at the international level for the control and surveillance of this financial instrument diversity has not been reached yet. Regulations made with the impact of financial crises have been limited to the determination of international criteria, especially institutional level, which is generally seen as the cause of these crises. In addition, regulatory and supervisory institutions have been established for defining the rules and leading the supervision process. However, with the effect of technological developments, especially the new business models revealed by the internet, inadequacies in regulations have started to emerge.

Artificial intelligence applications are accepted for all sectors due to their positive effects. Financial institutions tend to create and use new policies and new business models with artificial intelligence. However, both the institutional and country-level regulations in the field of finance aim financial stability within the network system that creates a global financial market. For this, it is necessary to establish a new institutional structure that will provide international coordination beyond international cooperation.

5.2 The Effect of Digitalization on the International Financial System

The financial system defines an organization in which payments and fund flows arise as a result of the interaction of markets, institutions and, funders and demanders. All contracts representing the asset or liability that mediate payments or fund flows are financial instruments. The narrowly used monetary system definition has turned into the definition of a financial system at the global level because of the liberalization policies implemented by the countries especially in the commercial and financial fields. Technological Coins, which emerge with the development of technology together with the differentiation in the definition and function of money, necessitates this definition. However, in today's conditions, the regulation of the international monetary system is carried out by the International Monetary Fund (IMF). The task of the International Monetary Fund (IMF) was expanded in 2012 to cover the regulation of the entire macroeconomic and financial system in relation to global stability (IMF 2020).

The first effect of technological developments in our age can be seen with the rapid implementation in the financial structure and system. Firstly, developments in communication technology had an early and prior impact on the increase in the links between financial liberalization and financial markets in the world. In this process, there is no regulatory authority that has international coordination power. This situation leads to the deterioration in the expenditure-income balance on the financial systems of the countries. Historical information will not be sufficient for the country regulatory boards to take precautions against risks arising from the use of Fintech or Techno currencies resulting from technological developments. When evaluated from this point of view; Instead of regulatory institutional structures based on financial flows that arise from the general economic situation of countries, a monetary system and financial system need arises to regulate financial flows related to commodity flows resulting from world trade.

Information techniques with artificial intelligence applications allow the creation of a structure based on real flows. In particular, the Block chain, along with the necessary security systems on the global payments system, provides the opportunity to make the payment system a tool for establishing large-scale commercial contracts. Having such systems will be effective in easier identification and management of counterparty risk. The mutual visibility of all relevant information in such a system will also lead to a significant cost reduction in transaction costs. Thus, a decrease in transaction costs related to financial intermediation services can be expected. However, the increasing importance of cyber security and the need to train specialists in this field and ensure that they are constantly ready for any situation will also raise additional costs. Such additional costs will be a source of threat to the global financial system, unless international cooperation is developed. Therefore, depending on the development of new technologies, a restructuring should be made in the structure of the institutions established after the Second World War. Cyber security risk increases due to the rapid spread of information with the effect of new technologies.

Along with the technological developments in the world economy, the sustainability of liquidity in the financial system will be the main goal. Increasing financial transactions based on artificial intelligence and algorithmic methods increase elasticities in financial markets. This reveals big changes in financial flows in very small price movements. This situation is determined by the maturity structure of the assets and liabilities of the decision units; In other words, it is a fundamental factor that increases financial vulnerability in the markets because liabilities are shorter term compared to assets or due to the high volume of liabilities. In an environment where financial flows are more variable, the practices of central banks and financial regulatory institutions of each country will not be sufficient to manage the effects of financial flows. This situation requires an international policy coordination that can regulate the financial and monetary system at the international level.

In general, the IMF acts as a coordinator for developments in the international monetary system. However, in this coordination, it provides assessments for countries rather than the rules that should be applied directly for the regulatory and international financial system (IMF 2018). With the IMF published in 2018, The Bali FinTech Agenda stated the issues that member countries should base on their practices as 12 framework factors. In the same study, it is stated that cooperation between countries is necessary to reduce the impact of the risks that arise as a result of the increase in digital technologies.

Digital money has emerged as a result of the use of credit cards, which started with the first development of electronic and communication networks. Internet and new network systems have changed the structure of money. Especially in the context of the internet, transforming into "internet of things," money is turning into "money of things." The most important change here is the emergence of currencies based on blockchain infrastructure and the formation of a market of these currencies through platforms. It is possible to define each of these coins as "money of things." The money of things can be classified based on four basic characteristics as follows:

1. Extractors (Central Bank and others)
2. Form (digital, physical)
3. Accessibility (widely or restricted)
4. Technology (token- or account-based) (Bech and Garratt 2017: 59).

According to BIS Quarterly Review (2017), today, sympathy for digital cryptocurrencies that do not have a major impact on the international monetary system but are formed with the block chain infrastructure, it is pushing central banks to issue digital money. The most important feature of these coins in terms of economy is that they have the function of accumulating value. In fact, there is no value on which this kind of money, which is at the same time a value accumulation tool, is based. This situation causes the prices of such money to be volatile and speculative. The feature of being the reserve money carried by these coins is lower. However, their values are priced especially in reserve currencies. This shows that this technological monetary system has a standard feature based on reserve money. The increase in the value created in this market or the increase in demand for money causes an increase in the demand for reserve money. When evaluated from this point of view, central banks of developed countries do not make restrictive decisions in the development of these markets.

The experience offered by cryptocurrencies provides information especially for reorganizing the payment systems of central banks. These experiences are examined, especially in terms of applications for low-cost payments on a global scale (Biber 2019). The main problem here is the formation of assets and liabilities of monetary or financial transactions. Especially the imbalance between maturity and cash flows between assets and liabilities is the most important risk factor. In addition to the accumulation function of digital currencies, these currencies can also be devalued. This situation emerges as a risk for those who hold them as assets. In other words, the decrease in the value of these coins is an asset decrease. However, since there is no obligation for this decrease, the decrease is not perceived as a risk. However, the main reason of the financial crises is that the decision units and especially financial institutions cannot adapt their liability levels in the face of economic events.

The digitalization of national currencies and the freedom of certain institutions to issue such currencies will lead to a structural change in the position and implementation tools of central banks in the financial system. It is seen that technological changes have led to an increase in financial product diversity and market growth in general, and the change and diversity of monetary policy instruments of central banks. However, institutional arrangements in the financial system follow technological developments with delay. In order to have a faster decision-making system against this delay in economies, financial regulatory institutions have been established. The main feature of these institutions is that they perform their duties according to generally accepted international standards. In this respect, it is necessary to set new standards in the global financial system for a more effective management against the monetary and financial impacts caused by digitalization. The global design of financial markets, especially the money markets depending on time differences around the world, increases the need for digital global money beyond the applications to be made.

The use of artificial intelligence applications in conjunction with algorithmic financial transactions requires central banks to use the same technological tools in market surveillance. Especially, continuous data coming from the markets and processing according to these data make it obligatory for artificial intelligence applications to be real time. The latest situation of the central banks is dealing with these big data sets. By using these data sets instantaneously, decision systems will be made real time according to pre-determined criteria. The ones that will decide here are computers. This situation is a big difference in terms of both the structure and functioning of financial markets. This difference arises from the fact that risk management in financial transactions leading to financial flows in the economy is carried out instantly and on a real-time basis according to the latest data. Considering the increase in the variety of data used by central banks and the relationship of indicators with different data, a complex data production process emerges.

5.3 Data Security and Data Processing

A technological development has effects on the economic and social dimensions of the internet and the internet with object-oriented technologies. The most important feature of this development is that it is a communication network. This network is a network where people, machines, and data are interrelated. Apart from the communication infrastructure provided by this network, the data it provides and the capacity it offers for its storage and processing lead to effectiveness with a positive externality effect for the financial sector. This activity will result in a high degree of cost reduction due to the emergence of feedback effects through an interaction process, with the implementation of innovations with fintech components (Danielsson et al. 2020). In particular, artificial intelligence applications will cause fintech components to function as a system, resulting in higher levels of effectiveness with these feedback effects. Since this field of activity will be effective in relation to data access and business, it will arise from financial inclusion opportunities. In the economy, financial inclusion, which is defined as an opportunity for individuals to reach the services of the financial system more easily, will affect the decisions of the decision unit through the financial system. In particular, technologies that allow data collection speed, processing and results will enable monetary policies to be implemented on an agent basis. In this process, the decisions to be taken in monetary policies and the process of putting these decisions into practice have reached the brink of a significant change.

Considering the central role of the central banks in the economy, the information it has in general is also strategic. However, big data techniques are required since there is complex information that needs to be classified and processed beforehand in order to be used by central banks. There are two main problems in establishing a data-based system for central banks. The first of these problems is that the increase in the amount of data is not the same as quality and hence, it is not an indicative information. The second is whether this data will provide effectiveness in decision making for policy implementation in the process. The second problem will arise from the fact that the experts who process the information in question and the artificial intelligence tools produced for the analysis of this information are taught and produced. This issue is the main problem for all institutions using big data. However, the rule for institutions such as the central bank to make their decisions effective in the economy is that they need to prioritize the market. Central banks need to determine economic indicators from monitoring activities in order to increase their impact on the market. It should fulfill its surveillance function by determining the rules about what should be done according to these indicators.

The most important advantage of the development of AI and Fintech technologies for the central banks is that they will enable the use of micro data. This situation is especially the result of reaching the smallest decision unit and the information related to the sector and the whole system. However, a lot of information requires new decisions to be made. At this point, decision makers will again be experts and managers. Decisions to be made based on the differences between the processed data and the new information flowing will result in a higher level of risk in practice than before.

In fact, all technological investments are made for the financial sector for two purposes. The first is to reach the clients in the most effective way. The second is to manage risks by ensuring that they are at the lowest level. However, AI may have implications as a risk factor rather than the realization of these two objectives. In this respect, the effectiveness of the use of AI tools to the economy management will be to provide techniques that will make forward predictions more accurate. Findings from data analyzed using high-throughput computers still need to be interpreted or evaluated by experts. At this point, although the processing power of the computers used with the big data to be analyzed is an external factor, the selection of the algorithm to be used for the analysis will belong to the expert. This will require high qualification of experts who produce tools for monetary policy.

Technological developments are the most important reason for the increase of division of labor and specialization in the use of information. Especially beyond automation, processes that accelerate the production of information and accelerate both the use and development of technology with this information increase growth and efficiency. In technological developments, each new knowledge learned and revealed turns into an input. This input entry also contains implicit information. General artificial intelligence applications are based on the integrated use of data processing such as machine learning and deep learning methods. This usage leads to the use of different data depending on the corporate structure of the institutions in the financial system. In other words, the main objectives of the institutions are decisive here. Considering that the main objectives of the institutions in the financial sector are to ensure profitability and credibility, a customer-oriented structure is taken as basis in all data generating processes. However, due to the rules set by supervisory and regulatory institutions, these techniques become a tool for risk management. In terms of financial institutions, artificial intelligence and data processing tools for these two different purposes will enable these transactions to be done together. In addition, it is possible to instantly predict the effects of client risks and prices of financial products on the system. This allows for a micro to macro business plan for financial institutions. This leads to real-time risk management. In this way, this will ensure the continuity of the analysis on both systematic risks and systemic risks through artificial intelligence tools. Arrangements regarding the creation of rules on the use of artificial intelligence in data generating processes and its learning and continuity will become important. In this case, experts and their knowledge, especially interdisciplinary knowledge will be determinative. The main reason for the existence of experts here is that artificial intelligence is a system, based on the rules taught.

Although it is known that the use of artificial intelligence in the financial system facilitates the creation of rules, it is seen that the tools do not reach the advanced level in terms of understanding and interpretation. However, flexible models created internally with a large data source for the financial sector accelerate the comprehension process of the experts. The existence of algorithms that enable the models to work as a whole will support the decision making process along with the learning process. These effects on the financial system will change the central banks and their organizational structure.

The importance of artificial intelligence applications for central banks is that it will enable the implementation of macro prudential policies with micro prudential policies. Thus, by establishing micro-level regulations and rules for the success of macro prudential policies, in which monetary policies are adopted as the aim of financial stability, in particular; The interaction between monetary policy and banking regulations will be created (Lastra and Goodhart 2016: 41–42; Beyer et al. 2017). The differentiation of the central banks in the financial system is not limited to the duties defined only for price and financial stability, but the system will turn into a structure that will perform the system's supervision, surveillance and monetary policy applications real time or instantly.

5.4 Artificial Intelligence and Change of Central Banks' Duties

The digitalization that emerged as a result of the integration of communication and technological developments has led to the change of all the tools used in economic activities. Especially the emergence of cryptocurrencies and their general acceptance accelerated this change (Fiedler et al. 2019: 7). Cryptocurrencies money market has emerged as a new structure that needs to be explored by economists. However, since Cryptocurrencies only have the ability to accumulate value among the basic functions of money, its share in the global financial system remained relatively small. In addition, prices are volatile and speculative because these currencies have neither a certain underlying asset or trust nor the impact of social media on the market. Therefore, this situation limits its growth (Baek and Elbeck 2015; Gkillas and Katsiampa 2018). In general, although the volatility correlation and spread among cryptocurrencies is high, the same volatility relationship between volume and return is lower (Balcilar et al. 2017). This situation in the cryptocurrency markets shows that there will be a demand for money to be issued by the institutions with a corporate power based on an underlying asset. At this point, the infrastructure of the blockchain, which has become more of value than the cryptocurrencies market and leads to the formation of these currencies, gains more importance (Bozkuş Kahyaoğlu 2019). The use of blokchain infrastructure will lead to digitalization of money despite security problems. The principal institution that will determine this new trend will be central banks. In this respect, this new trend will require the central banks to undertake new tasks institutionally beyond the implementation of monetary policies. In fact, although central banks are determinant in the money markets, a new structure will emerge that will be the central banks in charge of the immediate supervision and surveillance of these markets. Especially technological tools and artificial intelligence applications in finance will enable central banks to perform instant risk management on the market.

In the global financial markets, the main macro prudential policies of the countries will be the management of financial flows on the balance of payments (Rey 2015). Although monetary policies are effective in the flexible exchange rate system, the borrowing of institutions according to different maturity structure and liquidity flows in foreign currency reduce the shock absorption effect of the flexible exchange rate system. In economies, differences in the frequency level between commodity flows and financial flows, such as imports and exports, reveal the importance of monetary policy based on an effective reserve management.

In the global financial markets, especially in the money markets, it has gained continuity as transactions are based on new technological tools and algorithms via the internet and with artificial intelligence techniques. This continuity makes it imperative to monitor and process data from different sources. This is necessary for effective risk management. The variation of frequency in time dimension constitutes an institutional level heterogeneous data system within the market scale formed by the financial network. Thus, the asset and liability structure of each heterogeneous unit will cause it to be affected differently from economic events. This will reduce the impact of a risk management based on standard regulations.

The fact that the institutions in the financial markets are heterogeneous, and the data accumulated in the digital environment is also heterogeneous. This data structure includes qualitative data as well as numerical. This is one of the changing features of today's economic data. This changing feature will also change the data of central banks that are accepted as indicators. Therefore, data and especially big data strategies of central banks are integrated with the structure and implementation process of monetary policies. Considering that these emerging instruments are determined according to the needs and policy objectives of the central banks of each country; every statistical techniques and application tools used will be defined as central bank analytics (Dhini et al. 2018: 3–7). The new analytics of central banks will enable the management of cyclical fluctuations, along with a monetary policy focused on the condition that inflation is low and stable (Bernanke 2003).

Interest rates, especially the relationship between short-term interest rates, applied before 2009 during the global financial crisis motivated financial institutions to take excessive risks. In this period, the asset-liability structure of not only financial institutions but also all business units that have financial relations with these institutions had an impact on this process. Increases in asset prices led to more risk taking.

The functionality of this channel of monetary transmission mechanism, which is based on taking risks, operates in particular in relation to the substitution of financial instruments and money in financial markets. As a result, the relationship between the risk perception of financial decision makers and monetary policy emerges. In this relationship, it is asymmetrical for central banks to act according to the perception of decision units and loss functions (Borio and Zhu 2012: 237–238). It states that these short-term interest rates will not be effective in managing the financial risks of financial institutions. Therefore, after the 2008–2009 crisis, the regulations regarding the capital adequacy of financial institutions became an instrument of monetary policies. This tool has indirectly become a channel for indirect reduction in loans over banks' capital adequacy. Thus, a supervisory relationship has been established within the market mechanism and monetary policy (Adrian and Shin 2010). In this context, tools have been started to be used in order to control the credit usage of households and companies that create the demand in the credit channel. Especially, the widespread usage of credit cards increased the effectiveness of these controls. In addition, information on monitoring credit card spending in the economy has also increased the effectiveness of decisions taken in monetary policies in small economies (Yılmazkuday 2019).

The digitalization of the financial system will be put into practice depending on the results that will come after the instant processing of the data flowing according to the market's intervention tools of the central bank. This understanding necessitates the fact that central banks should be made more integrated, especially in governance, surveillance, and monetary policy applications. The integrated structure will be formed with a new structuring, with new job definitions or changes. In particular, the European Central Bank's orientation toward partnership with a data provider and its quest to gather information from this channel will be the beginning of this change.

This situation can be stated that a business process based on artificial intelligence tools will gain managerial importance especially in governance, audit, surveillance, and monetary policies.

5.5 The Use of Artificial Intelligence Tools for Monetary Policy: Central Bank Analytics

As a result of developments in computer technology, monetary policy, and the use of artificial intelligence tools as a whole can be defined as analytical tools. The most important feature of these tools is that it allows them to be run through extensive algorithms based on open-source libraries. As a field of science, Economics is gaining new techniques with these tools. The most prominent characteristic of these techniques is that they produce information representing variables from heterogeneous, unknown, unstructured big data. Big data tools transform data from different sources into information that will enable analysis and estimation of parameters. Economic data analysis starting with Big Data for testing a particular hypothesis, along with machine learning and deep learning processes and the algorithm-based analysis of how systems work with artificial neural network techniques, forms the artificial intelligence infrastructure (Taddy 2018).

For central banks, artificial intelligence reduces data processing costs. This digital cost reduction items are as follows: search costs, replication costs, transportation costs, tracking costs, and verification costs (Goldfarb and Tucker 2017). With the reduction of costs, an efficient and efficient economic research process emerges in central banks. This research process shows a differentiation with the digitalization levels of central banks today.

The fact that banking and financial transactions are carried out with these digital tools together with the execution of economic activities through digital tools lead to significant data accumulation. In addition, with the acceptance of tools such as cryptocurrencies used for private and value accumulation in the economy, the tendency of central banks to digital money accelerates this trend (Fiedler et al. 2019). This digitization process will lead central banks to be integrated into the countries' communication networks. In this respect, telecom companies providing communication network services will be in close cooperation with central banks. This situation will initiate a monetary policy implementation process in which instant interventions and practices will be carried out by analyzing the information that is constantly flowing and that needs to be evaluated on a real-time basis. As a best practice, European Central Bank (ECB) is making efforts to create new analytics for new developments. The establishment of its own communication infrastructure, which is the first step in the realization of this effort, will start the new period in the implementation of the business models and monetary policies of the financial system (ECB 2019: 99–100).

Artificial intelligence methods, approaches, techniques, and algorithms are used in business models based on fin-techs created by the digitalization of institutions in the financial system. It is used as a tool for data analysis especially for fraud, forensic and customer management. The main feature of these tools is that they estimate the parameters of structural and behavioral models by using the data in question. However, given the size of the data used by the central banks, there is a transition period for the implementation of these tools in policy implementation and decision making processes. The main reason for this is the use of a prediction method based on causality relations, especially in the analysis of monetary policies. The fact that the data commonly used in this estimation process is time series. Time series data is a structured data and hence, the time series analysis differs from the analysis based on artificial intelligence techniques. There are suggestions especially for the use of machine learning techniques in policy evaluations, which are not based on time series (Athey 2015; Athey and Imbens 2017). In addition, the advantage of artificial intelligence and especially machine learning is that it provides effective tools for forecasting. Especially through algorithms, forward predictions based on each new information can be made in real time. In addition to using tools such as machine learning as an econometric technique, technology will force a trend in using these tools for analysis in a system with data flow. The structure and size of the data that economists work on changes over time. When we look at the main reasons for this, it can be stated that besides the development of the techniques used in the analysis of the data and the increase in the variety of data, it is possible to develop more hypotheses about these data and to test them (Mullainathan and Spiess 2017: 104). This will improve the situation compared to previous experiences where theoretical knowledge is not sufficient and, may lead to the implementation of new policies. Machine learning (ML) techniques can help capture nonlinear relationships between variables. Generally, methods such as ML offer advantages because it allows many different methods to be used together (Chakraborty and Joseph 2017: 42–44). These approaches can produce new leading indicators for the economy, based on data with indicator characteristics, such as the yield curve in the economy. By comparing the results obtained from the use of parametric and nonparametric techniques, it is possible to achieve the most appropriate forecast values for empirical analysis. The most important effect of technological development in the implementation of monetary policies of central banks is that data storage and processing tools will be decisive. When evaluated from this point of view, a central bank analytics will be created for strategies on monetary policies.

5.6 Concluding Remarks

Internet is the most important technological change on the global scale since its emergence. The most important difference that distinguishes this technological change from others is that it has an effect on every aspect of life. In particular, there has been no such improvement in production and the life of the individual ever before. The most important feature of this new improvement, in which scientific knowledge is rapidly implemented and accelerates technological development, is that it changes the way of doing business with the way of thinking. The most important effect of the developments in the communication sector that emerged since the early 1980s has been on the financial sector. This system, which operates in a network structure related to each other within the framework of its own rules, was formed as a result of technological developments. In general, the effect of technological developments is also seen on the financial sector. The main reason for this is the positive external effects of technology in financial sector. However, the impact of today's developments on the financial sector stems from the information that emerges through communication networks. The difference between the costs and benefits of this effect for today will have a positive effect on the economy.

The financial sector is based on a system in which information is produced intensely as a result of its structure. Considering the data generation process in which financial information is produced in the financial system, it faces a situation where there are additional costs from its audit to its security and for which the resource has to be allocated. However, the structure of the human resource that will take part in these processes becomes important as a risk factor for the functionality of this system. In this respect, the financial system becomes a sector in which specialists from different disciplines work depending on the widespread use of analytical tools. When looking at the characteristics of the AI tools used, the selection and use of these tools will depend on the experts. This result that comes out in terms of financial system reveals the data accumulation and generation process. In general, the risks that may arise in this transition period in the financial sector lead to the emergence of irreversible high costs. Therefore, it can be stated that the audit costs will have a negative impact on the new structure. This requires the change of the institutional structure in the financial sector.

The digitalization revealed by its technological development has initiated a new trend in the form of money, which is the main liquidity instrument in the economy. This change in the form of money will lead to a change in the institutional structure of the central banks, which are considered to be the owner of the money. Central banks, as the essential unit of the financial system, will be equally affected by these developments. A significant change will also emerge in the duties of central banks arising from supervision, surveillance, and monetary policy practices on the financial system.

The most important feature of this change is the need for central banks to take decisions that will have an impact on the market instantly. This is the necessity of a continuous flow of instant data processing, especially based on information from monetary policies. In this respect, a central bank structure will be encountered in which monetary policy practices will be carried out in the context of the impact of each new information coming into the financial system. Here, the tools to be used in the processing of information will be artificial intelligence. These tools will be constantly updated according to the situation and depending on the new developments. Since it is necessary to process and configure information from different sources, data science, or big data techniques should be used in the first stage. Integrated algorithm, method, approach, and techniques will be used together for the decisions to be taken for the purposes determined in the second stage. All of these integrated tools form the infrastructure of artificial intelligence.

Financial technologies and data generating processes will lead to the formation of a new legal infrastructure. This will require that all rules governing the financial system be reconsidered in the future, based on these new developments. In a structure where technology is the main determinant, a business process based on ethical values will emerge. Ethics will be the main determinant in the analysis of the data of real and legal persons and their results in the financial system. The changes occurring in the values of financial instruments, users of financial resources and the financial relations in the business world will be analyzed continuously. Central banks will be able to monitor the effect of the monetary policies implemented, both on the system and on the parameters estimated through algorithms. Thus, surveillance and monitoring efficiency of central banks on the markets will increase. When evaluated from this point of view, future projections can be updated continuously. Since it will be possible to generate information from the complex data structure of many different algorithms, the effectiveness of the tools used for different relationships and interventions will increase. This will enable the evaluation of the effectiveness and validity of the rules and assumptions determined in the formulation of monetary policies. Integration of central banks with the communication system will make the implementation of monetary policies real time. This will lead to the transformation of financial risks into real time. This new trend will make central banks big data collector and producer.

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Chapter 6
The Impact on Digitalization on Financial Sector Performance

Ramazan Ekinci

Abstract The aim of this study is to analyze the effects of digitalization and artificial intelligence applications on financial performance of banks which emerged as a result of developments in information and communication technologies (ICT). In this paper, the role of financial system in the modern economy, as well as the impact of technological change and financial innovation on the structure of the financial sector are tried to be explained. In this context, the literature and its findings are evaluated to explain the impact of financial innovations classified as new production processes and new products or services on the performance of financial sector. Finally, important examples of how fintech transform the structure of the banking sector are provided. In this analysis, technical efficiency scores of banks representing the performance of the financial sector were used as the main determinant variable. The data set of 26 commercial banks active in the Turkish banking sector between the years of 2010 and 2016 constitute the sample size of the study. While technical efficiency scores of each bank are obtained by Data Envelopment Analysis (DEA), the effect of digitalization on financial performance is estimated by using "truncated regression model combined with bootstrap confidence intervals." According to the results of the truncated regression model, digitalization has a positive effect on financial performance.

Keywords Information technology · FinTech · Data envelopment analysis (DEA) · Efficiency

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6.1 Introduction

The use of digital technologies in social and economic life leads to structural changes. As a result of this change, especially since the beginning of the twenty-first century, it has been accepted that this change has initiated the creative destruction process in all sectors (Schumpeter 2008). This new development trend led to structural transformations in the financial sector and widened the impact of technological developments on economies. However, the structural transformation of technological advances in the field of finance has had greater results in the change of the relationship between financial services and markets. In this process, technological advances were firstly realized in the financial sector through internal and external scale economies. However, technological advances have led to a decline in interest rates, especially in developed countries, due to the effects of capital productivity.

In terms of competition, we have seen an increase in the number of new decision-makers made up of "fintech" from the digital world over the last few years. Their aim is to focus on specific segments of the value chain (e.g., foreign exchange, payments, loans, trade, asset management or insurance) and disaggregate services that were previously created and sold by the banking sector. This situation leads to the disappearance of return to scale in sectors defined as scope economy. In today's circumstances, the financial sector has started to respond to this with the development of Fintech technologies.

New technologies increase productivity and reduce intermediate cost in areas where resources are used inefficiently. These technological advances in the finance sector provide bank managers with opportunities in terms of price, quality, etc., in relations with customers. In addition, the use of big data in the banking sector facilitates bank managers in understanding customers and predicting their behavior.

Digitalization and FinTech are also an opportunity to reduce marginal costs and increase efficiency in financial services. In this context, the advantages that fintech technologies will emerge from the efficiency and productivity channel and the effect of these advantages on other sectors of the economy will inform whether this effect will contribute to economic growth. In particular, it can be stated that a technological development that increases total factor productivity can have a positive effect on direct growth. The advancement of Fintech technologies will lead to transformation in all business processes and business models. The main variable from which these effects can be seen is the total factor productivity. Analysis of the effect of Fintech technologies on total factor productivity of the banking sector provides important information for the literature. What is important here is that the sector transfers additional externalities to other sectors in the fund allocation process. However, the necessary condition for this is the degree of integration of the sectors that are sourced from this sector to the digitalization process of the financial sector.

Technological developments in the financial sector lead to an increase in productivity, especially by changing the relationship between the basic production inputs of this sector itself. An increase in the efficiency of each production factor leads to an increase in the efficiency of the same production factor again with feedback effects through fintech technologies. As a result, an increase in total factor productivity results in increased rates. The end point of this situation is that institutions in the sector go to specialize in a single product. The limiting factor is that the impact of the economies of the area is greater than the effects of scale. However, fintech technologies provide cost advantages over the economies of scale of institutions. Excessive use of technology can therefore lead to the loss of the advantage of scope economies. In addition, technological intensive productions lead to negative internal economies due to the expensive technological products in the institutional structure. Particularly in a technologically intensive environment, the management infrastructure required by technology is the determining factor on the internal economies of the banking sector. Increasing technological processes necessitate the training and investment of the personnel who supervise and control it. While creating a know-how for banks, the loss of this resource creates a negative and internal and external effect. If the productivity and efficiency that this factor will generate in another institution or sector is greater than the previous one, the overall effect of this factor for the sector or economy is positive. According to this information, it is necessary to analyse the effects of scope, scale, factor productivity, internal and external effects, and their effects on the economy in evaluating the effects of Fintech technologies. The findings of this study provide information in this respect. The Turkish banking sector is analyzed here as an important sample in this respect.

This paper is structured as follows. Section 6.2 provides an overview of theoretical framework and empirical research on digital innovation in the financial sector. Section 6.3 reviews the related literature. Section 6.4 describes the methodology and data employed in the study. Section 6.5 presents the results and discusses the findings. Finally, Sect. 6.6 concludes the paper.

6.2 Theoretical Framework and Empirical Research Studies

Banks are the most basic institutions that have emerged for the allocation of funds in an economy. While there is a market-based capital market in the allocation of funds; the emergence of banks has been an important topic of discussion in the literature (Allen and Gale 1997). Banks are defined as financial institutions that act as intermediaries between borrowers and lenders in an economy (Freixas and Rochet 2008). In the allocation of funds between savers and borrowers, banks have a function that reduces the asymmetric information among those who transfer funds. It is also accepted as the main reason for the emergence of these banks. Thus, the main activities of banks are to reduce the problem of moral risk and reverse selection, which is the main problem between those who supply and demand funds in an economy. According to Merton (1993), a well-functioning and smooth financial system is one that facilitates the efficient life cycle allocation of household consumption and the allocation of capital to the most efficient use in the economy. Here, allocation of capital to the most efficient use comes from the reduction in the cost of asymmetric information. This is the reason for an important externality of banks' function within the economy. As a result, banks ensure that the allocation of capital is also effective in the economy.

With the emergence of crises, the banking system has been regulated with standards both at national and international level. However, the financial sector has become a market in which numerous new applications, processes or products have been created under an increasing degree of digitalization and technological innovations. This process has begun a period that needs to be reconsidered with digitalization.

According to Abbasi and Weigand (2017), it is stated that information and communication technologies will increase the efficiency of banks in the financial sector by increasing the efficiency of banking services and risk management. In this respect, the authors provide a basic idea that new technologies will lead to increased efficiency in banks, resulting in a new specialization. According to them, increase in productivity in the sector led to an increase in investments made by financial institutions in the process of digitalization. Digitalization is a technology/supply shock that affects financial markets, primarily through competition, and through its impact on productivity and employment. Digital technologies also change the interactions and relationships between the way firms do business with their customers and suppliers. Big data analytics and methods, approaches and techniques for the use of data enable firms to estimate the current situation and develop their forecast for the future based on the information stored in the data. These techniques enable the creation of new institutional structures that analyze banks'customer behaviors. The use of data leads to the creation of customized marketing strategies, reducing costs and increasing efficiency. Here, the main factor that leads to a reduction in cost is that although the collected data is on a large scale, the cost of processing and storing them is very low or falling quickly (Loebbecke and Picot 2015). Thus, increasing returns to scale are obtained. This process also lead to continuous increase in efficiency and competitiveness of banks within the new market structure (Loebbecke and Picot 2015). According to Loebbecke and Picot (2015), digitalization leads to positive economies of scale as it reduces the marginal costs of banks. New digital technologies reduce decision-making for many financial activities, leading from asset management and portfolio advice to payment systems. This process leads to more financial instruments and increases financial depth.

With the creation of new business models based on the use of big data, fintech has led to a structural change in the traditional financial intermediary function of banks. Big data is analyzed with the help of artificial intelligence (AI) algorithms and advanced computer technologies (cloud computing, mobile storage over the cloud). Machine learning is an AI variant that allows computers to learn without an open program. "Deep learning" refers to the effort to derive meaning from big data by using layers of learning algorithms. By using these new techniques, financial intermediation costs can be reduced and alternative products can be developed for consumers.

Numerous new studies reveal a positive relationship between ICT investments and financial performance (Aral et al. 2006; Bresnahan et al. 2002; Brynjolfsson and Hitt 2003; Dewan and Kraemer 2000). The findings of these studies coincide with Schumpeter's economic theory, which considers technological change and innovation as key elements of economic growth and firm performance (Romer 1990; David 1990; Aghion and Howitt 2007). Although Schumpeterian theory is based on an approach that explains the relationship between technological innovation and firm performance, empirical evidence regarding the quality of technology and its contribution to firm performance varies according to economies, sectors and firms. For example, at the macro level, a large number of studies focus on efforts to measure the impact of total factor productivity and labor productivity on technology investment (Brynjolfsson and Yang 1996). Using data based on total size is problematic as it is difficult to control many other factors. Although more detailed data are needed in further studies to measure the effects of technology, Anderson et al. (2006) and Jun (2008) emphasize that this need should be met very quickly, especially for the financial sector. The authors argue that studies to measure the impact of fintech innovations on financial performance using larger data will yield more reliable results (Evangelista 2000).

The fact that financial products rely largely on information is the main reason for the digitalization of the financial sector. Payment transactions or loan agreements that do not contain any physical components are examples of the simplest transactions based on information. On the other hand, many transactions such as online payment or stock trading are made independent of physical contact. Due to the latest developments in information technology (IT), the ongoing digitalization process is not only increasing the automation process, but also leading to the restructuring of the financial services value chain with new business models (robo-consultants) and new actors (such as Apple). The term "financial technology," or "fintech" for short, is the main pillar of this information-driven transformation. Information technologies (IT) and its subcomponents are developments in innovative processes such as social accounting, big data, the Internet of things or cloud computing, do not only contribute to the automation of existing business processes of financial service companies, but also provide opportunity to the financial service industry to obtain new products, services and business model processes. It includes all innovations related to digital technologies, distributed accounting technology, Big Data, Internet of Things (IoT), cloud computing, Atificial Intelligence (AI), biometric technologies and augmented/virtual reality. These innovations lead to a stakeholder relationship between Big Tech companies and banks. In addition, the fact that the technological units of the banks were formed with a different institutional structure led to the formation of a horizontal capital relationship in the market.

As the transactions in the banking sector are similar and their processes are implemented according to certain values, it has enabled the use of technologies based on AI and machine learning as a tool for decision-making in the sector. Banks accelerated the process of reaching new customers or making credit decisions through these technologies and that dropped their cost. Philippon (2019) provides evidence that unit finance costs, together with financial technologies, may have been reduced in recent years.

In addition to developing business models and strategies, FinTech expansion has led to a reduction in alternative costs for banks through cost reduction. FinTechs have reduced the operational costs in banks, making the financial sector more efficient and competitive, providing more benefits to customers. Due to the development of FinTechs, many banks are now using distributed accounting technologies to investigate the use of technologies in reducing operational costs of payments (Roberts 2017). For the banking sector, cloud computing and outsourcing are very important for risk management. In addition, banks are trying to reduce computing and overall IT costs by using more outsourcing, enabling cloud providers to more outsource (World Economic Forum 2016).

Economic business has increased dramatically due to technological advances and information technologies spread across many industries. Sectors in the economy have started to invest more and more in the establishment of information technologies in order to ensure efficient resource allocation and increase profitability. In particular, the capacity of technological developments to create a scope economy is the most important reason for this.

The competitive structure of the economic business world has increased due to developments in technology (Nikoloski 2014: 303). Taylor (2010: 26) argues that technology is a fundamental determinant in strategy development for firms.

In order to maintain their competitive advantage in a competitive market, banks need to increase their productivity levels through managerial efficiency, adopt an efficient banking system, and contribute positively to financial performance through efficient resource production and allocation. Digital Financial Services aim to expand and replace traditional banking services with innovative technologies to meet growing complex needs and global challenges. These diversified digital products help companies improve their performance and stay in the competitive market. On the other hand, digitalization helps companies to increase their profitability and improve their financial position by expanding their market share. Information technologies (IT) accelerate growth in the banking sector, particularly by supporting banking services, productivity increases, and risk management processes. Porter and Millar (1985) argue that information technology (IT) can be used as an important tool to strengthen competitive advantage. In the last decade, financial institutions have made significant investments in IT infrastructure to accelerate the transition to digital banking in order to increase their efficiency and thus their financial performance. Digital financial services (DFS) expand traditional banking services with innovative technologies such as internet banking, mobile telephony solutions, electronic money models, and digital payment platforms. Although the modern digital banking era began with automated teller machine (ATM) and telephone banking, the Internet and mobile banking applications have not only enabled the rapid and efficient distribution of traditional banking products, but also paved the way for the launch of new products. With the increasing use of smartphones and tablets, the spread of 3G and 4G internet technology has increased the demand for digital services. This increase in demand encourages financial institutions, software companies and other service providers to provide advanced digital banking services with new diversified products and applications to retain existing customers and gain new customers.

6.3 Literature Review

Numerous studies on the effects of digitalization on the financial sector reveal that the use of advanced ICT has significant effects on the financial system. The most important consequences of these impacts were the creation of new financial products (Barrett and Walsham 1999), better service quality and the formation of more interconnected global financial markets. Scott et al. (2017), in a panel data study on 6,848 banks in 29 European and US countries, find evidence that technology investments have a significant and positive effect on banks' profitability and performance in the long run. In addition to the long-term positive effects of digital innovations, the authors found that short-term weak or negative results could also be seen. According to the author, the reason for this result is that the use of technological innovations can take time due to its nature. Manyika et al. (2015) and Yoo et al. (2010) argue that digitalization has devastating effects, but also eliminates rigid barriers that lead to new opportunities. The authors state that digitalization increases the efficiency of firms, expanding their innovation efforts and enabling them to allocate their resources more effectively. Manyika et al. (2015), in his study, investigate the effect of changes caused by the ongoing digitalization process on the future efficiency and multi-factor productivity of firms. Pflaum and Gölzer (2018), on the other hand, show that Internet of Things (IoT) transforms business processes into more data-oriented services by enabling companies to use their assets more effectively. Fuentelsaz et al. (2009) show that the use of new technology directly affects firms' productivity through changes in the production process. This increase in productivity can be divided into two groups. Technological change increases efficiency directly at the technical level.

There are many opinions about whether investments in information technology can improve the efficiency and productivity of firms. In particular, studies conducted at the firm level in the manufacturing sector confirmed that investments in information technology have positive contributions to productivity. In the financial sector, advances in technology may reduce firms' unit intermediation cost, especially by increasing productivity in areas where employees are inadequate. Batiz-Lazo and Woldesenbet (2006) showed that the innovations in financial services are one of the important factors that increases the competitiveness of firms based on the result of the literature and field research. The authors explain that there is no consensus on the impact of innovation on banks' profits. However, with increasing efficiency, IT reduces the barriers to entry by enabling banks to operate on a larger scale. Many studies in the past show that technological innovations are the main determinants of banks' efficiency and productivity. Globalization and the rapid development of information technology (IT) have led banks competing with other banks to provide better and faster services, requiring more and more automated electronic systems.

According to Koetter and Noth (2013), productivity is defined as "the change in output that cannot be explained by changes in input factors." Therefore, advances in technology lead to productivity increases. Meepadung et al. (2009), using a two-stage DEA model, analyzed how Information Technology (IT) systems can improve the performance of banks in Thailand. The authors concluded that such systems will increase the efficiency of branches and improve the quality of customer service. In another study conducted by Mashal (2006) on the efficiency and profitability of Jordanian banks, it was concluded that Information Technologies (IT) had a significant effect on banks' total loans, total deposits, and net income.

The number of studies investigating the impact of IT adoption and changes in technology on banking activities has been increasing in recent years (Berger 2003; Casolaro and Gobbi 2004; Humphrey et al. 2006; Frame and White 2012). As described by Merton (1992), the basic function of a financial system is to facilitate the allocation and use of resources both spatially and in an uncertain environment over time. This function includes a payment system which is a means of exchange; transfer of resources from savers to borrowers; and risk reduction through insurance and diversification. Frame and White (2004) define financial innovation as "innovations that provide an advanced product, service or tool that reduces costs, reduces risks, or better meets the demands of financial system participants." Tufano (2003) emphasizes that financial innovation involves both the inventive process involving ongoing research and development activities and the dissemination process of new products, services or ideas. Beck et al. (2016) show as the result of a cross-country analysis that financial innovation results in higher economic growth (but more volatile) and greater bank fragility.

Traditional economic efficiency theory states that firms need to structure their outputs in order to produce at the lowest cost per unit. The theory also states that high level of competition among firms should prevent them from making excessive profits by raising sales prices unreasonably above their marginal cost (Yusop et al. 2011). This means that banks must turn to alternative instruments to compete effectively and thus increase their profitability. In the study conducted by Nguyen et al. (2014), it was concluded that the increasing use of technology in banking services is a good way to develop and diversify banking services. According to Musara and Fatoki (2010), technological innovations play an important role in increasing the efficiency of the banking sector and lowering its costs. On the other hand, while some banks benefit from technological products and services, some do not seem to benefit from the expected benefit of technology. According to Hilal (2015), the adoption of innovations and new technologies is an important tool in increasing the efficiency of banks.

Angko (2013) concluded that one of the benefits of electronic innovations in banking sector is cost savings for both banks and customers. Globally, the banking sector has undergone significant changes over the years. The most important change came from the way financial services were offered to customers. While the traditional banking functions performed by banks remain relatively unchanged, the structure of the industry has undergone a significant change. Technological innovations are crucial for maintaining competitiveness in the financial sector as it is for every sector. In fact, research confirms that innovation has a positive impact on firms' performance (Damanpour et al. 2009). The extent to which the financial sector can contribute to the economy largely depends on the quality and quantity of products and services it provides to customers. Merton (1992) argues that financial innovation drives the financial system theoretically toward the zero transaction cost limit and toward "completed" product markets. The degree of financial innovation‘s contribution to the banking sector depends on the efficiency of the financial intermediation function of banks. In the financial sector, as in other industries, firms can invent new financial instruments and techniques or modify existing products. Thus, financial intermediation functions can be made more effective (Llewellyn 1992). While the technological investments of the banks provide externalities to them, they also provide advantages to their customers and stakeholders. Thus, technological investments can be expressed as the beginning of a new process with a "win-win" approach.

6.4 Data Set and Method

Data Set

The data set used in the study consists of individual data of commercial banks operating within the Turkish banking sector. The scope of the study is limited to commercial banks that made up the majority of total assets within the banking industry. Therefore, development and investment banks, Islamic banks, and other non-bank credit institutions were excluded from the analysis. Finally, the data set of 26 commercial banks active in the Turkish banking sector between 2010 and 2016 constitute the sample size of the study. Data at the bank level is obtained from the Banks Association of Turkey (TBB) on commercial banks' balance sheet and income statement.

Determination of Input and Output Variables

There are two main approaches which are normally referred in efficiency measurement: the production approach (Value-added) and the intermediation approach. As for the study, intermediation approach was used, which was originally developed by Sealey and Lindley (1977). In this approach, banks are regarded as an intermediator between borrowers and depositors, which are institutions that convert and transfer financial assets between surplus units and deficit units. In the model, three input variables: personnel expenses, total fixed assets, and interest expenses, and two output variables: total loans and other operating income, are used. In addition, bank-specific environmental variables that are thought to have an impact on efficiency are

Table 6.1 Bank inputs and outputs

Variables	Mean	Maximum	Minimum	Std. Dev.	Observation
Outputs					
Total loans	37811267.77	232643535	7964	51995314.23	182
Other earning assets	8748967.97	60316744	772	13854256.04	182
Inputs					
Personnel expenses	607517	2957560	1238	688272.45	182
Total fixed assets	596088.12	5315203	387	971719.31	182
Interest expenses	2460998.17	13342418	251	3184878.53	182
Bank-specific control variables					
EQAS	14.849	64.584	4.441	11.213	182
ROAE	0.102	0.454	−0.450	0.087	182
LNTA	16.539	19.695	11.216	2.137	182
CR	0.563	0.847	0.015	0.175	182

included in the model. Table 6.1 shows the descriptive statistics of input, output, and environmental variables used in the analysis.

Digitization Indicator

The ICT (information and communication technologies) index is a basic indicator used in the literature to measure the technological performance of countries and to reveal digital differences between countries. In this study, two sub-ICT indices, ICT access, and ICT usage, and 8 sub-indicators are used to reveal the impact of digitalization on the performance of the banking sector. Data were obtained from the International Telecommunication Union (ITU) database. ICT index and its sub-indicators are given in Table 6.2.

Measuring Efficiency: Bootstrap-DEA Analysis

Simar and Wilson's (2007) approach is based on combining the DEA method with bootstrap technique and obtaining bias-corrected efficiency scores $\left(\widehat{\widehat{\theta}}_i\right)$ and their confidence intervals. Thus, while correcting bias efficiency scores, the autocorrelation problem encountered in Tobit model is controlled by bootstrap technique. Here, the bias-corrected efficiency scores estimated by the bootstrap algorithm is regressed against environmental factors in the second stage. The estimated truncated regression

Table 6.2 ICT sub-index

ICT Access			
Symbol	Definition	Mean	Std. dev.
TEL	Fixed telephone subscriptions per 100 inhabitants	17.985	2.768
MOB	Mobile-cellular telephone subscriptions per 100 inhabitants	92.450	3.690
BND	International internet bandwidth (bit/s) per internet user	38047.84	18494.07
CPU	Percentage of households with a computer	52.199	4.496
INT	Percentage of households with internet access	55.278	12.655
ICT Usage			
Symbol	Definition	Mean	Std. dev.
IND_INT	Percentage of individuals using the internet	48.199	6.011
F_BND	Fixed-broadband subscriptions per 100 inhabitants	11.481	1.193
M_BND	Active-mobile broadband subscriptions per 100 inhabitants	35.633	17.947

model can be shown as follows:

$$\hat{\hat{\theta}}_i = \alpha + Z_i\delta + \varepsilon_i, \quad i = 1, \ldots, n \tag{6.1}$$

where, $\varepsilon_i \sim N\left(0, \sigma_\varepsilon^2\right)$ with left-truncation at $I - Z_i\delta$, α is a constant term and Z_i is a vector of firm-specific variables relative to bank (i). Simar and Wilson (2007) developed algorithm # 2 estimation method based on double—bootstrapping truncated regression with $B = 2000$ bootstrap iterations which can be summarized as follows (Afonso and Aubyn 2006; Simar and Wilson 2007):

1. Estimate the technical efficiency score $\hat{\theta}_i$ for each bank (i) (6.1.1)

2. Obtain an estimate $\hat{\beta}$ of β and $\hat{\sigma}_\varepsilon$ of σ_ε in the truncated regression of $\hat{\theta}_i$ on Z_i using the maximun likelihood method when $\hat{\theta}_i > 1$ (6.1.2)

3. Repeat the following four steps B times to obtain $\widehat{\theta}^*_{ib}$ $\{b = 1, \ldots B\}$

   a. Draw ε_i from the $N\left(0, \widehat{\sigma}^2_\varepsilon\right)$ distribution with left truncation at $\left(1 - z_i\widehat{\beta}\right)$ for $i = 1, \ldots, n$.

   b. Calculate $\theta_i^* = z_i\widehat{\beta} + \varepsilon_i$ for each bank.

   c. Set $x_i^* = x_i$ and $y_i^* = y_i\widehat{\theta}_i/\theta_i^*$ for all $i = 1, \ldots, n$.

   d. Compute $\widehat{\theta}_i^*$ for all banks by replacing x_i and y_i values in equation with x_i^* and y_i^*. (6.1.3)

4. For each bank, calculate the bias-corrected scores $\widehat{\widehat{\theta}}_i = \widehat{\theta}_i - \left(\frac{1}{B} \sum_{b=1}^{B} \widehat{\theta}^*_{ib} - \widehat{\theta}_i \right)$ (6.1.4)

5. Estimate the truncated regression of $\widehat{\widehat{\theta}}_i$ on z_i using the maximum likelihood method to obtain $\widehat{\widehat{\beta}}$ and $\widehat{\widehat{\sigma}}$ (6.1.5)

6. Loop over the next three steps B times to provide $\left(\widehat{\widehat{\beta}}^*_b, \widehat{\widehat{\sigma}}^*_b, b = 1, \ldots, B \right)$:

   a. Draw ε_i from the $N\left(0, \widehat{\widehat{\sigma}}\right)$ with truncation at $\left(1 - z_i \widehat{\widehat{\beta}}\right)$ for $i = 1, \ldots, n$.

   b. Calculate $\theta^{**}_i = z_i \widehat{\widehat{\beta}} + \varepsilon_i$ for each bank.

   c. Estimate the truncated regression of θ^{**}_i on z_i using maximum likelihood to obtain $\widehat{\beta}^*$ and $\widehat{\sigma}^*$. (6.1.6)

7. Construct the confidence interval for β and σ_ε using the bootstrap results $\left(\widehat{\beta}^*_b, \widehat{\sigma}^*_b, b = 1, \ldots, B \right)$. (6.1.7)

Model

In this section, we use a two-stage DEA efficiency approach in which efficiency scores estimated in the first-stage DEA models are used as dependent variables in a truncated second-stage regression model to analyze the determinants of efficiency:

$$\mathrm{EFF}_{i,t} = \alpha + \beta_1 \mathrm{ICT}_t + \beta_2 \mathrm{B}_{i,t} + \beta_3 \mathrm{YEAR}_t + \varepsilon_{i,t} \tag{6.2a}$$

$$\mathrm{EFF}_{i,t} = \alpha + \beta_1 \mathrm{INDEX\_1}_t + \beta_2 \mathrm{B}_{i,t} + \beta_3 \mathrm{YEAR}_t + \varepsilon_{i,t} \tag{6.2b}$$

$$\mathrm{EFF}_{i,t} = \alpha + \beta_1 \mathrm{INDEX\_2}_t + \beta_2 \mathrm{B}_{i,t} + \beta_3 \mathrm{YEAR}_t + \varepsilon_{i,t} \tag{6.2c}$$

where the subscripts i, and t represent banki at year t,respectively. ICT_t is the Information and Communication Technologies Index for each year, $\mathrm{B}_{i,t}$ is the characteristics of each bank by year, YEAR_t is a yearly dummy variable controlling for other macroeconomic and technical changes, and $\varepsilon_{i,t}$ shows the eror term. The dependent variable EFF is the managerial efficiency measure, measuring how far the bank is from the estimated efficient frontier. $\mathrm{INDEX\_1}_t$, in Eq. (6.2b) shows the weighted average of the variables from ICT_t access indices (TEL_t, MOB_t, BND_t, CPU_t, INT_t) by using the principal conponent analysis. $\mathrm{INDEX\_2}_t$ in Eq. (6.2c) is the weighted index generated from ICT_t usage indices ($\mathrm{IND\_INT}_t$, $\mathrm{F\_BND}_t$, $\mathrm{M\_BND}_t$) using the principal conponent analysis. PCA captures the effect of each ICT Index (ICT access and ICT usage) proxy in one variable which shows the total effect of technology in its variability. The intuition is that each proxy brings an extra information not contained in the other and hence a better measure. Moreover, the technology index obtained using the PCA approach presents some econometric advantages. First, the use of the index overcomes the problem of multicollinearity and overparametrization (Stock and Watson 2002).

Equation (6.2a), (6.2b), and (6.2c) are estimated by parametric bootstrap regression model developed by Simar and Wilson (2007). The most important feature of Simar and Wilson (2007) approach is the calculation of bootstrap confidence intervals for each coefficient considering distributional assumptions of the parameters of the model. Each confidence interval is obtained with 2000 bootstrap iterations. The vector ICT_t in Eq. (6.2a) consists of the following 8 different digitization indicators:

$$ICT_t = (TEL_t, MOB_t, BND_t, CPU_t, INT_t, IND\_INT_t, F\_BND_t, M\_BND_t) \quad (6.3)$$

where TEL_t is fixed telephone subscriptions per 100 inhabitants, MOB_t is mobile-cellular telephone subscriptions per 100 inhabitants, BND_t is international internet bandwidth (bit/s) per internet user, CPU_t shows the percentage of households with a computer, INT_t shows the percentage of households with internet access, IND_INT_t is the percentage of individuals using the internet, F_BND_t indicates fixed-broadband subscriptions per 100 inhabitants and M_BND_t shows active-mobile broadband subscriptions per 100 inhabitants. In the model, $B_{i,t}$ consists of bank-specific control variables and is shown in Eq. (6.4).

$$B_{i,t} = \left(EQAS_{i,t}, ROA_{i,t}, LNTA_{i,t}, CR_{i,t}\right) \quad (6.4)$$

The vector $B_{i,t}$, defined in Eq. (6.4), contains bank-specific factors that are involved in the second-stage regression model that may affect the efficiency of a partiular bank. Bank-specific factors include:

(i) the level of capitalization (EQAS) used to represent the ratio of equity to total assets;
(ii) the level of profitability (ROA) measured by return on equity;
(iii) bank size (LNTA), defined by the logarithm of the bank's total assets; and (iv) the credit risk (CR) variables explained by the ratio of total loans to total assets.

Table 6.3 Results of truncated regression analysis

Dep. Variable: EFF	(1)	(2)	(3)	(4)	(5)	(6)
Years: 2010–2016						
ICT Access						
TEL	0.015*** (0.003)					
MOB		0.011*** (0.002)				
BND			0.090*** (0.019)			
CPU				0.010*** (0.002)		
INT					0.003*** (0.0008)	
INDEX_1						0.023*** (0.005)
Bank-specific control variables						
EQAS	0.003*** (0.001)	0.004*** (0.001)	0.004*** (0.001)	0.005*** (0.001)	0.004*** (0.001)	0.004*** (0.001)
ROAE	−0.032 (0.144)	−0.061 (0.147)	−0.011 (0.146)	−0.034 (0.144)	−0.023 (0.147)	−0.011 (0.145)
LNTA	0.093*** (0.007)	0.095*** (0.007)	0.093*** (0.007)	0.094*** (0.007)	0.094*** (0.007)	0.093*** (0.007)
CR	0.296*** (0.072)	0.309*** (0.073)	0.307*** (0.073)	0.315*** (0.072)	0.306*** (0.073)	0.301*** (0.072)
Constant	−0.849*** (0.151)	−2.193*** (0.156)	−2.080*** (0.230)	−1.692*** (0.163)	−1.367*** (0.135)	−1.138*** (0.127)
Wald-chi2	378.98	376.74	380.82	369.98	359.94	370.50
Wald-prob	0.000	0.000	0.000	0.000	0.000	0.000
Year Dummy	YES	YES	YES	YES	YES	YES
Observations	182	182	182	182	182	182
Number of banks	26	26	26	26	26	26

Note EQAS = equity/assets, ROAE = return on average equity, LNTA = LN of total assets, CR = total loans/total assets

Estimation of the models is based on Simar and Wilson (2007), Algorithm 2, using 2000 bootstrap replications for the confidence intervals of the estimated coefficients

*$p < 0.1$ Significance from zero at the 10% level according to bootstrap confidence intervals

**$p < 0.05$ Significance from zero at the 5% level according to bootstrap confidence intervals

***$p < 0.01$ Significance from zero at the 1% level according to bootstrap confidence intervals

6.5 Empirical Findings

ICT Access and Bank Efficiency

Table 6.3 shows the results of the truncated regression model of Simar and Wilson (2007), which are estimated to determine the effect of technological innovations on the banks' managerial efficiency. In the model, the effect of five different ICT access indexes, which represent the technology parameter on the efficiency, is estimated individually. The table also shows the effect of bank-specific variables on efficiency, as well as the INDEX_1 index obtained from the weighted average values of the access indices using principal component analysis. The values in parentheses are robust standard errors of coefficients and calculated with 2000 bootstrap replications.

Each model in Table 6.3 demonstrates the effect of alternative digitization indicators on efficiency by controlling the effect of bank-specific variables. The first column in Table 6.3 presents the results of the truncated regression model including fixed telefon subscriptions (TEL) and bank-specific variables (model 1). The other four columns take into account the effect of alternative digitization indicators (models 2–5) separately, while the last column (model 6) tests whether the weighted digitization coefficient calculated by principal component analysis is significant.

ICT access indicators are positive and statistically significant for all models. This result shows that there is an improvement in the managerial efficiency of banks along with the increase in digitalization indicators. On the other hand, the digitization index coefficient (INDEX_1) obtained from ICT access indicators is statistically significant and has a positive and increasing effect on efficiency. Investments in ICT access infrastructure have significantly increased access to information of financial services, particularly in the banking sector, in terms of scale, scope and speed. This increase in ICT diffusion leads to lower production costs and increased resource allocation efficiency (Jorgenson and Stiroh 1999; Vu 2011; Lee et al. 2012; Pradhan et al. 2015). The use of ICT as a production input in the production of new products and services in the financial sector leads to an increase in the efficiency and productivity of firms through the reallocation of resources in productive areas. In other words, the use of ICT as a production factor allows to save time and space by accelerating the information flow, and the ability to produce financial products and services in shorter periods and at lower costs. This result encourages economic growth through the creation of positive externalities, lower transaction costs, higher productivity of the workforce, and faster innovation (Bongo 2005).

When the bank-specific control variables in table. Table 6.3 are analyzed, it is seen that the coefficient of the variable showing the ratio of equity to total assets (EQAS) is positive. The effects of profitability (ROAE) was found to be statistically insignificant. The effect of asset size (LNTA) measured by logarithm of total assets of bank is positive and significant. This result, which is consistent with the expectations in the literature, shows that banks may benefit from economies of scale and consequently have more efficient. Finally, the ratio of total loans to total assets (CR) is positive and statistically significant, indicating that banks with high credit rates

Table 6.4 Results of truncated regression analysis

Dep. Variable: EFF	(1)	(2)	(3)	(4)
Years: 2010–2016				
ICT Use				
IND_INT	0.007*** (0.001)			
F_BND		0.053*** (0.008)		
M_BND			0.002*** (0.0005)	
INDEX_2				0.031*** (0.006)
Bank-specific variables				
EQAS	0.004*** (0.001)	0.004*** (0.001)	0.004*** (0.001)	0.004*** (0.001)
ROAE	−0.034 (0.146)	−0.058 (0.147)	−0.028 (0.147)	−0.003 (0.146)
LNTA	0.094*** (0.007)	0.093*** (0.007)	0.095*** (0.007)	0.093*** (0.007)
CR	0.300*** (0.073)	0.312*** (0.069)	0.295*** (0.070)	0.290*** (0.072)
Constant	−1.518*** (0.146)	−1.758*** (0.158)	−1.252*** (0.132)	−1.137*** (0.130)
Wald-chi2	373.70	397.74	369.17	375.56
Wald-prob	0.000	0.000	0.000	0.000
Year Dummy	YES	YES	YES	YES
Observation	182	182	182	182
Number of Banks	26	26	26	26

Note EQAS = equity/assets, ROAE = return on average equity, LNTA = LN of total assets, CR = total loans/total assets
Estimation of the models is based on Simar and Wilson (2007), Algorithm 2, using 2000 bootstrap replications for the confidence intervals of the estimated coefficients
*$p < 0.1$ Significance from zero at the 10% level according to bootstrap confidence intervals
**$p < 0.05$ Significance from zero at the 5% level according to bootstrap confidence intervals
***$p < 0.01$ Significance from zero at the 1% level according to bootstrap confidence intervals

increase the pressure to effectively manage credit risk and increase the efficiency of banks.

ICT Use and Bank Efficiency

Table 6.4 analyzes the impact of the technology index obtained from PCA analysis as well as the use of ICT on banks' efficiency scores. In the table, the first column shows the percentage of individuals using the internet (IND_INT), the second column shows the fixed-broadband subscriptions per 100 inhabitants (F_BND), the third column shows the active-mobile broadband subscriptions per 100 inhabitants (M_BND) and the last column represents the digitization indicator (INDEX_2) obtained from the weighted component of the ICT usage indicators. The coefficient standard errors in the table are estimated with 2000 bootstrap replication.

ICT use indicators are positive and statistically significant for all models. Estimation results show that the increase in digitalization is an important factor leading to an increase in the efficiency scores of banks. On the other hand, there is a positive correlation between the digitization indicator (INDEX_2) obtained from PCA analysis and the banks' efficiency scores. The findings are similar to the other studies which concluded that the digitalization caused by increasing internet and broadband usage has a positive effect on efficiency (Thompson and Garbacz 2008; Waverman et al. 2005; Qiang et al. 2009). Thompson and Garbacz (2008), in their stochastic frontier analysis study for 46 US banks during the 2001–2005 period, showed that a 10% increase in broadband penetration resulted in a 3.6% increase in efficiency. According to Waverman et al. (2005), each 1% increase in broadband penetration leads to an increase of 0.13% in efficiency in high and medium-income countries.

The ratio of shareholders' equity to total assets (EQAS) is positive and significant. The asset profitability ratio (ROAE) of banks is not statistically significant. The effect of the asset size (LNTA) coefficient, measured by the logarithm of total assets, is positive and significant. Finally, the ratio of total loans to total assets (CR) variable is positive and statistically significant and has a positive effect on the efficiency of banks.

6.6 Result

Financial innovation can be defined as the creation of new financial instruments, technologies, institutions, and markets. The role of the financial sector in an economy and its importance for economic growth increases the importance of financial innovations. Moreover, a developed financial sector can make financial innovation even more valuable to the economy by encouraging more savings and investment decisions. Technological innovations play an important role in increasing the efficiency of the banking sector and reducing costs in banking transactions. Advances in telecommunications and information technology have been an important force in the transformation of the financial sector. Technological advances help to reduce information costs and other business costs through improving quality and processing speed.

Today, banks and non-bank financial institutions operate much differently than they did 20 or 30 years ago. In particular, financial innovation resulting from the use of information and communication technologies is not only to make dramatic changes in the current financial industry, but is also expected to cause major changes in the industry in the future. These new products and processes have led to extensive institutional changes. In general, the use of ICT technologies does not eliminate information asymmetry and adverse selection problems caused by financial intermediation. The results of the 2007–2009 global financial crisis reveal the importance of regulatory requirements.

Digitalization has a strong impact on the financial sector. The fact that financial products are largely based on information is the most important evidence for the importance of digitalization in the financial sector. Digitalization is still one of the most important issues among executives around the world. Digitalization puts great pressure on decision-makers in many industries, especially on the financial sector.

The term financial technology, or fintech for short, reflects a process of technological transformation from ICT. In particular, financial innovations based on information and communication technologies have inevitably affected business models in both the banking and non-banking components of the financial industry.

As the banking sector is a technology-intensive sector by its nature, technological innovations in the financial sector result in quality and diversity in banking services. Innovations in the field of information, communication, and technology not only lead to the creation of advanced financial derivatives and the emergence of new financial markets, but also provide cheaper and better financial services for firms and households. An efficient banking sector is expected to provide low-cost services and be resistant to economic shocks. In terms of cost-benefit analysis, the cost of an ineffective financial system should be less than the expected cost of financial instability.

According to the findings of the analyses, the digitization index coefficient (INDEX_1) obtained from ICT access indicators is statistically significant and has a positive effect on efficiency. From this point, the development of technological infrastructure and the increase in access to the internet, in turn, leads to an increase in efficiency in the banking sector. Another meaning of this is that public investments, especially the internet-based infrastructure, have an impact on the efficiency and competitiveness of banks. However, the findings obtained from the results of the analysis conducted to determine the effect of the use of fintech products on the trend of the sector's efficiency in the society support the above result.

In Table 6.4. the magnitude of the coefficient of INDEX_2 is greater than the coefficients of other variables. According to the results obtained from both tables, the effect of economies of scale is positive, while the effect of technology on the efficiency of banks is positive. This effect, in particular, suggests that technological investments increase the efficiency of banks. This is a finding that the competitiveness of the banking sector will increase with technological investments. Accordingly, investments that increase the use of technology by banks, and information that will enable the use of fintech technologies provide positive external economies for banks. In other words, the average cost curve is shifting downwards with the use of technology by banks.

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Chapter 7
Geography of Supply Chain 4.0 and Trade Policy

Ayçıl Yücer

Abstract New trade patterns emerge with the changing organization and geography of supply chains under Industry 4.0. An eventual shift from Global Value Chains—GVCs is an actual concern for policy makers. This study designates the technical and managerial innovations that are shaping the new supply chain (Supply Chain 4.0) and identifies the forces of geographic agglomeration and dispersion. We feature two leading characteristics of Supply Chain 4.0: a huge amount of data flows and a customer-oriented production. Both of these two imply that the location choices are driven by data-related costs. Producer chooses between to locate closer to "data tower" to profit the scale economies in data analytics or instead, approach to customer. Finally, the form of the conventional bell-curve of Puga (1999) resulting from the trade-off between scale economies of production and transport costs change the form by putting from now on the Win-Win trade between North and South on a knife-edge equilibrium conditional on data frictions. Our research emphasizes that new trade policy takes the form of "data policy" and a *joint* and *mutually benefiting* international policy approach is essential for a sustainable trade. In this research, we basically made use of the literature to drive theoretical insights for future work on the geography of Supply Chain 4.0. However, since the limits of Industry 4.0 are not yet clear-cut, we used resources of very different nature (academic, reports, case studies, etc.) and from different disciplines (engineering, managerial sciences, economics).

Keywords Industry 4.0 · Supply chain organization · Global value chains · Trade policy · Economic geography

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7.1 Introduction

When Pascal Lamy, as the head of WTO in 2012; pointed the Global Value Chains (GVCs) as a paradigm shift in trade; we were finally figuring out the results of the Industry 3.0,[1] which has started long before in early 70s. Today, we face another technological revolution, still in progress: Industry 4.0. However, this time we try to usher the future structure of the supply chains and trade into present research. This is a risky work.

Industry 4.0 has been defined, mostly by engineers and people from managerial field, as the "cyber-physical systems" that is following the German intuition showed off first in 2011 at Hannouver Messe Fair. New technologies associated with Industry 4.0 are emerging every day. Nine technologies[2] are defined by Rüßmann et al. (2015), 17 technologies are of first interest regarding to the relative emphasis in recent studies (Cirera et al. 2017), while Pfohl et al. (2015) point even more than 50 technologies. More than 100 different definitions of Industry 4.0 have been already proposed according to German digital association BITKOM (Bidet-Mayer 2016).

Technological changes had always a direct impact on trade and the global structure of production. The pioneering work of Baldwin (2006) emphasizes that Industry 3.0, by decreasing coordination costs, resulted with the "unbundling(s)" of the supply chains and geographic dispersion of tasks. Similarly, Industry 4.0 creates new geographic patterns in global supply chains. One of the existing scenarios in the literature, posits that the production will be more compact in Industry 4.0 that will shorten the supply chains (Ferrantino and Koten 2019). Nevertheless, for an intermediate level of data frictions, it is also possible to face an "*ever deeper international division of labour in the global factory*" (Buckley and Strange 2015).

Besides, the future product and/or task specializations of countries and the trade policy will depend upon the frictions on data flows. Data frictions are important because Industry 4.0 marks a shift characterized with the huge flows of data from physical realm to digital realm and vice versa. Putted simply with the words of GTAI (2014: 6), "… *industrial production machinery no longer simply, 'processes' the product, but that the product communicates with the machinery to tell it exactly what to do*".

In the next section, we will highlight changes in the new organization of supply chain with Industry 4.0. Then in the third section, we will distinguish the dynamics

[1] The third wave of industrialization - started with the advances in information technologies and electronics in early 70s-made possible to encode the physical world data into digital and to manage the manufacturing systems from digital platforms. Third industrialization recalls frequently to "intelligent" manufacturing (Kusiak 2018).

[2] These nine technologies are as follows: *Advanced robots, Additive manufacturing, Augmented reality, Simulation, Horizontal and vertical system integration, The Industrial Internet of Things, Cloud computing, Cybersecurity, Big data and analytics.*

pushing for the geographic agglomeration and the dispersion of supply chain, hereafter named Supply Chain 4.0.[3] Before concluding in a final section, the fourth section will trace the role of data frictions for a knife-edge equilibrium of global trade and discuss the policy issues.

7.2 A New Organization of the Supply Chain

US National Institute of Standards and Technology (NIST) aims and defines the "smart" manufacturing—to refer to Industry 4.0—as an integrated system in which the data gathered through the whole supply chain is optimized in regard to the customer needs and for real time responses (National Institute of Standards and Technology 2020). Not surprisingly, the management of the supply chain (purchasing, order planning, assembly, logistic, maintenance, the customer and supplier) is also changing through the lifecycle of a product with data collect and process (Zezulka et al. 2016).

First, data processing, at a huge amount, enhanced by decreasing data storage costs and improvements in computing power, emerges as a new task (Davenport et al. 2012). The information does no more uniquely support the product and the production, as in traditional scheme of value creation, but becomes a source of value on itself (Glazer 1991). Information flows are now flowing in an omnidirectional manner and every partner access to the full information of the supply chain—instead of a linear flow of instructions from supplier to producer to distributor to consumer, and back—so the adjustment takes place simultaneously. (Ferrantino and Koten 2019). Big data analytics (BDAs), create important efficiency gains in production by reducing the scale diseconomies.

Second, Industry 4.0 is more flexible and agile to meet with customer tastes. Smart factories with machine-to-machine and machine-to-human interaction enable greater product customization in the value chain (Strange and Zucchella 2017). "Individualization" with Artificial Intelligence appears easily as a cost effective, profit increasing strategy in marketing (OfficeDepot 2017). Customer-generated intellectual property (CGIP), as another face of the customer-oriented production, is a source of value and innovation. Poetz and Schreier (2012) show the user-generated ideas are sometimes even better than the ideas of professionals on novelty and for customer benefit.[4] *Sharing economy* is an example for such a production model in which "*the value creation activities are undertaken partly by consumers and partly by firms.* "

[3] The term Supply Chain 4.0 is used for an integrated supply chain ecosystem, in which information flows in all directions, enabling the adjustment in real time throughout the supply chain. (PWC 2016).

[4] Poetz and Schreier (2012) organizes a challenge for innovative ideas among a firm's professionals and users. They are then judged by senior executives of the firm on the basis of novelty, customer benefit, and feasibility. The user-generated ideas scored significantly higher on novelty and customer benefit.

(Dellaert 2019)[5]. According to Deutsche Bank (2019), workers are more motivated for self-employment.

Meanwhile, 3D printers open further horizons for the consumer-generated creativity and CGIP where, objects can easily be designed by customers and "printed out" on a 3D Printer or existing objects can be scanned and then "copied" in a "copy shop". 3D printers constitute also a good alternative for less commonly consumed goods (Sasson and Johnson 2016: 86).

The new organization of the supply chain have considerable implications for the location choices of enterprises and by the way, to understand the eventual winners and losers in Industry 4.0. In the next section, we will work out the forces acting on the geography of Supply Chain 4.0.

7.3 Geography of Supply Chain 4.0

Global economy is being shaped by the geographic dispersion of the supply chain—Global Value Chains (GVCs)—over the last 40 years. However, this trend seems to slow down since the urge of Industry 4.0 (Dachs et al. 2019). It is important to analyse the new dynamics at work and the changes in existing ones reshaping the geography of Supply Chain 4.0.

The GVCs are frequently attributed to the decreasing trade costs, partly driven by the lower transport costs—thanks to technological advances since the steam revolution—and the low labour costs in developing countries. New economic geography models pioneered by Krugman (1999) explain geographic location of the economic activity with the existence of centripetal forces (market size effects, thick labour markets and pure external economies) and centrifugal forces (immobile factors, land rents, pure external diseconomies).

However, these *KrugMarshallian* forces are not the only ones to determine the geographic dispersion of the supply chain and the specialization in tasks with GVCs. Baldwin (2006) emphasizes that the globalization driven by lower ICT costs under Industry 3.0 is different than the one driven by lower trade costs. The progress in ICT has decreased the organizational costs and made feasible and safer, the spatial unbundling of tasks through the value chain. This recent phase of globalization since 90s is however, characterized by the regionalisation of the value chain around already developed countries such as US, Japan and Germany. Since even with ICT; some face-to-face and face-to-machine interactions are necessary.

In this section, we will discuss the new forces of agglomeration and of dispersion that work under Industry 4.0.

[5] For example, we see that consumers may sell their self-produced products on Etsy platform. On the other hand, Facebook makes profit from the users' shared information.

Forces for the Agglomeration of Supply Chain 4.0

Scale Economies in Big Data Analytics (BDAs)

Data analytics appeals, in general terms the processing of the available data in order to deduce usable and efficient information. As mentioned by Strange and Zucchella (2017), during the last decade costs have fallen by 20% in hardware and software, which increase the size and the quality of the "manageable" data. However, though all enterprises are profiting the cost efficient solutions in the field, firms achieving to create value from this accessible, good quality big data need a range of technical and governance capabilities to analyse and operationalise that data (Davenport et al. 2012; Constantiou and Kallinikos 2015; Brynjolfsson and McElheran 2016).

Firstly, BDAs require high fixed costs and high level of expertise (Rü *ß* mann et al. 2015), Ensuring the cybersecurity is another risk and cost factor with the huge concerns for systematic breaches. Second, it works under increasing returns with higher efficiency gains from new data inflows. Precisely, each new data signal gets in multiple interactions among existing ones and encounter new patterns in data that is then transformed into information. Third, firms selling digitized services, despite high initial costs, have almost near-zero marginal cost of distribution. Put simply, big scale production and big consumer markets with the huge data they generate, will especially be efficient for the data analytics.

On this regard, data analytics favour the enterprises producing at big scale that compensate the high fixed costs of BDA and collect sufficiently "big" data for an efficient data analytics. So most of the time we observe a unique supply chain control tower to control over different production hubs. For decoding the trends in the global patterns (information) of world markets (data), firms may develop some cooperative approaches. For example, *shared resource models* are possible with the increasing "*horizontal connectivity of smart enterprises*" (Kusiak 2018). The outsourcing is also an option, especially for SME to become part of the fourth revolution. But the patterns of information are specific to locality and/or market and can be deduced efficiently only if the firm's market size is large enough.

Scope Economies

The smart factory is more agile to change the volume of production and can easily introduce a new product line for a brand-new product. Especially big size enterprises are profiting decentralised information and decision-making technologies to eliminate their deficiency for flexibility (Moeuf et al. 2018) and the diseconomies of scale. All together are feeding the scope economies that increase the number of available product varieties however, produced by smaller number of enterprises and in fewer production stages.

First, multiple stages of production (e.g. parts and components) are getting integrated within some "single automated location" (Dachs et al. 2019). Second, a range of different products such as different-but-similar final products or some varieties of the final product (e.g. high-mix products with lower volumes) can now be produced in the same facility by sharing flexible production lines.[6] Finally, the advancements in additive technologies are also enhancing the production of a range of different products including parts and components in a unique 3D printing hub.

Another issue is the increasing bundling of goods and services with IoT (Internet of Things) and digital economies that are breaking down the traditional sectoral divides (López González and Ferencz 2018). Digital retailers, other than their main commercial activity to match supply and demand, became also service providers such as warehousing, logistic, digital payment, etc. Enterprises producing "smart" products (e.g. mobile phones, "smart" houses, etc.) are investing in service sectors to be able to furnish supporting services. For example, IBM is focusing on Watson and Google produces mobile phones or autonomous vehicles (López González and Ferencz 2018).

Capital-Intensive Production

The capital-intensive production technologies are substituting the labour force, more than ever; though the economists have not yet agreed upon which jobs will be replaced and how much. The well-known horror scenario of Frey and Osborne (2017) estimates 47% of occupations in US can be replaced due to Machine Learning (ML) and Mobile Robotics (MR) technologies. Hopefully, we have better scenarios: Arntz et al. (2016), by defining substitutable jobs on the basis of task structure instead of occupations find that only 9% of jobs in US and on average in OECD are automatable. Ferrantino and Koten (2019) points even the increase of employment in some "supply chain sectors" associated with e-commerce.

Meanwhile, we already observe that robotics is becoming a viable economic alternative (lower costs, higher performance) to human labour in high-wage countries and especially in some industries such as material handling (Strange and Zucchella 2017). According to Autor and Dorn (2013) many routine jobs in the US has already erased.

From the point of trade theory, the decreased share of labour force in production can trigger the agglomeration of production in North. The labour force, as a geography specific-immobile production factor is a source of comparative advantage for a country/region. The delocalization of production, and especially of labour intensive tasks during 90s, from North to South has been partly driven by the low-cost labour force in developing countries. As pointed out by Dachs et al. (2019); Industry 4.0 weaken the motivation of firms to locate in low wage countries and even can cause reshoring. According to Albertoni et al. (2015), though mostly ignored by

[6] The manufacturing industry is used to work since decades with service and contract models, where the production by a third party takes place at different facilities (e.g. Foxconn). However, this is a *sharing model* for technology and know-how (Kusiak 2018).

academic literature, the dataset provided by the project "Uni-CLUB MoRe reshoring" show evidence for reshoring. However, the "trade wars" are also motivating the re-localization especially from China.

Nevertheless, Industry 4.0 may result also with increased wages and labour costs despite the reduced amount of labour force in production. As defined in the "*goldilocks*" scenario of Becker and Schneider (2019), the higher productivity may motivate workers to decrease their working hours while increasing the real wages. If this scenario comes true, the increased wage disparities—induced with higher productivity gains in developed countries compared to developing countries—may limit the agglomeration in North.

E-Commerce

UNCTAD estimates that the cross-border B2C e-commerce in 2015 counts $189 billion, reflecting only a small share in the global e-commerce sales ($25.3 trillion). According to Eurostat, only 5% in the 31% of EU enterprises *"having made electronic sales"* was for the rest of the world. Hopefully, online sales as well as cross-border are more promising in some sectors such as accommodation (60% of enterprises sell accommodation services online and 34%—more than half—is cross-border sales in 2011) (López González and Ferencz 2018). Besides in developing countries[7], internet users have a lower propensity for online shopping which may reflect the lack of trust and limited awareness of e-commerce (UNCTAD 2017).

E-commerce is a new model of marketing and trade, though yet limited. Easy access of consumer to increasing variety of products from all over the world on digital markets increases the competition and enhances global trade. E-commerce also changes the shopping habits of the consumer and decreases the search costs in purchase of goods from distance (Lendle et al. 2016). Smaller firms compete with the larger firms on more equal terms by overcoming informational disadvantages.

These features of e-commerce help for the unbundling of demand and supply, such that the consumer purchases goods without even visiting the retailer shop and producers may make location choices independent from trade costs. However, e-commerce result with the transport of the goods to customer and not surprisingly, the increasing e-commerce goes hand in hand with increasing demand for transportation service. The transportation and material moving operations, in general terms, are non-value-adding activities for the production chain. Meanwhile, transport of goods in e-commerce is timesaving for consumers and costs are borne relatively easily by the consumer.[8]

[7] The definitions, methodology and scope of e-commerce statistics need to be harmonized across countries for their comparability (UNCTAD 2017).

[8] American Time Survey Data from BLS show that the number of hours spent for shopping by each American declined from 4.9 per week in 2005 to 4.4 in 2012, recovering slightly to 4.5 in 2016 (Ferrantino and Koten 2019).

Forces for the Dispersion of Supply Chain 4.0

Loosened "Coordination Glue"

As Baldwin (2012) points out Industry 3.0 has loosened the "Coordination Glue" while creating the need for an international coordination of production stages. The Industry 4.0 reduces the transaction costs from distance more than ever and make international coordination of the supply chain much easier with integrated systems and "smart visibility".

As described by Zezulka et al. (2016), "*Communication Systems: Internet of Things, Internet of Services, Internet of People- Communication entities will be able to communicate with each other and utilize data from the production owner during the all life cycle of systems without respect to border among enterprises and countries*". This greater integration of cross-border data between firms, suppliers and customers reduce the need for intermediaries (Porter and Heppelmann 2014). The product flows with unique product identifiers (Boldt 2018) are synchronized with the information flows (Strange and Zucchella 2017). For example, the lack of inventories may immediately be signalled to the supplier via IoT and results automatically with the delivery of product.

In the actual state, we observe a dispersed-but-clustered-value-chains around the industrialized countries with the need for the mobility of high-end labour force to the offshored factory (Gamberoni et al. 2010). The greater automation in Industry 4.0 is expected to increase the demand for high-skilled labour force. Nevertheless, this need does not necessarily push the value chains to locate in the proximity of the skilled labour force in Industry 4.0.

At extreme, a *borderless* and *footloose* supply chain may rise on the repeating cycles of value creation between digital and physical realms such that, "*Internet of things could enable a connected locomotive in South Africa to anticipate when it needs a repair, allow technicians in Saudi Arabia to troubleshoot a gas tribune (turbine) with real time help from US experts; or enable a manufacturing plant in India to employ global cloud computing to help it use water and energy resources more sustainably.*[9]"

Geographic Diversification of Risk

The internationalization of the supply chain may be of use to diversifying the market specific risks. However, the geographic dispersion, on itself implies higher risk and the risk diversification is only efficient and cost effective if the information asymmetries are minimized. Put simply, a company needs to exchange almost hundreds of mails before finding the correct local supplier, and it is not even surely the best one.

Three kinds of risk are at work due to geographic dispersion. First of all, the enterprise that is outsourcing the production stages, takes over its suppliers' failure

[9] https://www.hinrichfoundation.com/research/tradevistas/digital/internet-of-things/.

risk. Secondly, the logistics and the transportation of components and parts across different factories and foremost, in different countries, constitute a risk over the supply chain. Finally, due to information asymmetries, the delocalization into foreign markets are risky business.

The Industry 4.0 promises the digitization of information and besides, more efficient risk management. Predictive analytics are furnishing highly reliable models of reality, so the companies can take safeguard measures in advance or quickly move to alternative production plans when necessary.[10] BDAs trace the behaviour of a supply chain and enrich it with data from very different sources (e.g. economic environment, natural disasters, the energy, etc.). They serve for the estimation of eventual delays due to supplier failures and/or to the logistic issues. Firms are less dependent to local suppliers with the easy access to backup suppliers located in many different countries and the scaling of production for large number of digitally accessible consumers. Risks of new start-ups and related with delocalization are better managed with simulation and virtual reality models and the sunk costs are lower.

New Competition Eco-System

Industry 4.0 creates a new competition eco-system. The future markets are increasingly characterized with much more different products and varieties that is leading to a tough competition based, not on price, but on speed and design. By the way, the market competition will act on the favour of geographic dispersion.

The consumers, as is discussed above in Sect. 7.2, enrich the market with their ideas for new products and product varieties in Supply Chain 4.0. The easy entry of small scale and/or start-up businesses into global markets on digital platforms also increase the number of accessible consumption goods. Besides, higher productivity, by enhancing the profitability, allows new businesses and eventually new products to appear. However, the markets get quickly saturated with all these products and varieties. Moreover, the fast production motivates also the "speed" consumption patterns. The lifecycle of product is shortened in Industry 4.0 with fast innovation cycles and with almost simultaneous adjustments with the consumer market.

Hence, in this new competition eco-system, tougher competition obliges producers to enter into new and smaller markets. The location choices for production then become dependent on time-to-market and consumer preferences. Meanwhile, the consumer preferences can push enterprises to produce for close markets where consumers have similar tastes (Blum and Goldfarb 2006). However, as marked by Bogers et al. (2016), the "decentralized supply chains" can also show off either with an objective of easy access to consumer or instead with consumer replacing the manufacturer in production. 3D printers are an appealing technology on this aspect that

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[10] As noted by Bughin et al. (2015), "the same interoperability that creates operational efficiency and effectiveness also exposes more of a company's units to cyber-risks". However, cyber-risks are not a direct consequence of geographic dispersion.

the product, with the preferred design bought on digital platform, can be produced only with raw materials and on consumer's own effort in his "backyard".

Information Asymmetries

While Industry 4.0 ease the flows of data with new technologies, it does not necessarily efface the information asymmetries. First, the technology has not yet achieved to disentangle data flows entirely from the geography. For example, the proximity of internet service providers to the user can reduce the network problems. (USITC 2013). Second and more important, the information asymmetries, as a source of data friction, are naturally very persistent and show spatial patterns.

The past research on trade flows and financial flows give valuable insights on this regard. As highlighted first by Rauch (1999), the impact of information frictions is important on trade flows. According to Chaney (2018), the distance impact is not "death" because distance "*captures informational barriers and the network that transmits information*". Allen (2014), by using regional agricultural trade flows from Philippines, shows that ignoring information frictions increases the average estimated transportation cost from 47 to 101%, in *ad valorem* terms. Also in stock markets—where the digital access to information have already became the norm—the positive effect of proximity on investment flows persists as a consequence of information asymmetries. This happens despite the fact that the financial assets and information are "weightless" (Portes and Rey 2005). Not surprisingly, Leamer (2007) points the failure of technology to reduce information asymmetries between countries.

Studies on online markets also show the decreasing but persistent geographic impact of information. Fan et al. (2018), by using the e-commerce sales of online retailer Alibaba, show the distance is less important for online sales and contrarily "residents from smaller and more remote cities spend a larger fraction of their income online". Meanwhile Lendle et al. (2016) emphasize, though the effect of distance to be on average 65% smaller on eBay than offline trade, that it is still matters. They also control for the shipping costs of delivery.

7.4 Supply Chain 4.0: Win-Lose?

GVCs and e-commerce, both driven by third revolution, have worked on the advantage of developing countries and SMEs during the last decades. Digital trade will continue to be an important game player in Industry 4.0. However, Industry 4.0 marks a clear shift from Industry 3.0 in terms of technology and management and makes it doubtful that the developing countries continue to win as before.

High-end labour demand and the need for high-tech and high-cost digital infrastructure appeal the reshoring of production back to developed countries and already make many developing countries dream horror scenarios. Yet, the trade policy debate stays cautious on addressing the eventual "new" losers. Besides, for many economists that are used to work in the economic environment of third industrial revolution and the consequent "digital trade", the limits of Industry 4.0 are still unclear.

The traditional trade theories, as the column-argument "bearing" that trade is a win-win game, seems insufficient to analyse the winners and losers in this new technological and information-based environment. First of all, in a world where the production happens with a unique production factor—labour force replaced by capital—, there exist no comparative advantages in traditional terms. Second, Industry 4.0 is more about the "transport of data" than the transport of goods. These two imply a shift from the theoretical approaches explaining location choices with trade-offs between production costs and transport costs.

Industry 4.0 implies higher interconnectivity and omnidirectional data flows through the value chain with an increased emphasize on the role of consumer. So higher trade-offs between supply network and the demand may push some manufacturing industries "*sensitive to the time-to-market and customisation*" become highly distributed in order to approach the demand while some others will be pushed in proximity of the supplier network (Kusiak 2018). In other words, while some industries will approach the "data tower" in North with capital intensive production, some others will approach consumer markets to profit the competitive advantage of being close to consumer and easy access to consumer data.

The data frictions will define the gains from proximity to consumer. We may observe a non-linear, bell-curved relation between data frictions and economic agglomeration—similar of the famous bell-curve between agglomeration and trade frictions discerned by Puga (1999). However, given that capital and labour become perfect substitutes under Industry 4.0 technologies, the resulting bell-curve will be the symmetric inverse of the existing one.

Precisely, for zero-data frictions, we observe the agglomeration of production in North thanks to capital-intensive production and the scale advantages in data process with no extra costs to access data. For average information costs however, we will observe the dispersion of production. Since not only the scale advantage in data processing may not be enough to offset the gains from proximity to consumer such as time-to-market and product customization. But also dispersing the production is less costly with loosened "coordination glue" and better risk diversification. Finally, high information costs push again for the agglomeration of production in big markets of North. Because, on the one hand, data limitations make the coordination very costly and prevent that the supply chain is dispersed. On the other hand, neither the consumer data nor the low wages in small markets are not any more attractive. Small data stock in small markets isolated from world, are not cost effective for data analytics.

So, from the point of developing countries, trade policy is as a knife-edge equilibrium closely related with their data policy. In fact, the restrictions on international data flows can hinder the coordination of internationally dispersed production activities and make developing countries isolated in global markets, while free data flows, higher than optimum, will create a win-lose trade game where developing markets risk to turn into "data colonies".[11]

The free trade with free flows of data is the engine for Industry 4.0 and so globally wealth enhancing. Otherwise, companies can miss business opportunities that will result with negative repercussions on future innovations (Kommerskollegium 2014). Contrarily, the uncontrolled—out-of-optimum—decrease in data frictions may result with a globally win-lose situation driven by an inversed bell-curved relation between trade frictions and the agglomeration. Hence, only with a *joint* and *mutually benefiting* trade policy approach can ensure that the free trade is sustainable and Industry 4.0 flourish.

7.5 Conclusion

Industry 4.0 marks a shift from Industry 3.0 with the emergence of new technologies and managerial techniques, although its limits are not known yet. However, two dynamics are clear-cut restructuring the supply chain organization: huge amount and omnidirectional flows of data and customer-oriented production.

Our research distinguished, by following the economic geography frame of Krugman (1999) and the work of Baldwin (2006), the forces pushing for the geographic agglomeration and dispersion of production. Precisely, we have defined four forces (*scale economies in BDAs*, *scope economies*, *capital-intensive production* and *e-commerce*) acting in favour of agglomeration and four forces (*loosened "coordination glue"*, *geographic diversification of risk*, *new competition eco-system*, *information asymmetries)* acting in favour of dispersion.

Besides, the location of production at equilibrium will be driven by a trade-off between these forces under Industry 4.0. As a first intuition, considering that capital replaces labour force in production and data analytics enhance scale economies; a sustainable and win-win trade appears as a knife-edge equilibrium conditional on the level of data frictions. For both end, zero-data frictions or higher than optimum data frictions, we face the reshoring of production in North. According to this result, a *jointly agreed* and *mutually-benefiting* trade policy measures are essential for a win-win, sustainable global trade.

The most difficult part to work on Industry 4.0 was that while we have designated the actual limits of Industry 4.0, we also made a projection for the future evolution of this ongoing transformation. To overcome this difficulty, we've chosen to work with an inter-disciplinary approach and used information from different research fields (engineering, managerial sciences, economics, etc.) and kinds of resources (academic papers, reports, case studies, etc.). However the basic contribution of this research

[11] Risk of becoming "Data-colonies" for developing countries is first mentioned by Yuval Noah Harari during his speech in *World Economic Forum Annual Meeting 2020* in Davos.
https://www.weforum.org/agenda/2020/01/yuval-hararis-warning-davos-speech-future-predictions/.

is to the economic field. The conceptual frame defined here may hopefuly serve for structuring a theoretical model of Supply Chain 4.0 from the point of economic geography.

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Part III
The Impact of AI on Economic Policy and Productivity

Chapter 8
New Technologies and Economic Policies in the Global System

Timuçin Yalçınkaya

Abstract The global system continues to process by keeping its essence through some protective and nationalist attempts. It is actually significant that the global system involves a multidimensional and technology-driven structure and that national-states' regulations occur along with transnational practices. In this system, new technologies have a big role. New technologies consist of some innovations such as artificial intelligence, robotics, big data, internet of things, cloud technology, and so on, that describe the concept of 'Society 5.0' proposed by Japan and the concept of 'Industry 4.0' proposed by Germany. These technologies create super smart society in terms of their impacts on improving human life. Smart technologies improve human life in the fields of education, health, security, etc. On the other hand, smart technologies used in the process of production shape the global production network and the innovative strategies of firms. It is required that new technologies should not be remained uncontrolled within the logic of 'laissez faire' because their impacts and power are so great. Thus, national-states should make efficient economic policies by also considering transnational practices; like that Japan and Germany develop their own national view in terms of Society 5.0 and Industry 4.0. Such fields come into prominence in the economic policies in respect of new technologies: Competition policy on the basis of global competition and innovativeness—Industrialization policy on the basis of emerging industries of new technologies—Intellectual property policy on the basis of the rights of people and firms producing knowledge and innovation—Employment policy on the basis of new occupations and specialities in the global age—Social policy on the basis of new technologies' control on individual and social life.

Keywords Global system · New technologies · Economic policies

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8.1 Introduction

Today the global system, in which nations and/or nation-states weaken, continues to process and to have its logic, although competition between nations intensifies in terms of trade, exchange rates, immigration, and so on. Through the competitive and protective discourses of nation-states, transnational decision-making units realize their rational practices. This rationality composes a basis focusing on individual interests independently from territory and origin country. Even transnational economic actors instrumentalize national culture and politics in the context of rationality.

Transnational firms or individuals realize some activities independently from the nation and freely in a framework of market process, such as attending global production network, investing in financial instruments globally, experiencing global consumption trends, immigration for education, working or tourism, getting a global data, information or knowledge, and so forth, unless there are no prohibitions on these activities. As regards, global flows get easy within knowledge and technology facilities and a global network emerges in this process.

Some aims, such as high profit, high market coverage rate, recognition and reputation, getting a job, and so on, affect economic actors' attending global network within their rational planning. This means new pursuits at world scale. Some pursuits such as new production organizations, new technologies, new ideas, new skills, and so on, become the motives of economic actors in the process of globalization.

New technologies structure the global network, on one hand; they develop human life, on the other hand. The technologies such as computer-aided design, manufacture and communication, internet, digitalization, big data, robotization, artificial intelligence, internet of everything, and so on, mould our age as high innovations. These technologies have two functions that are related to globalization: First, they generate high productivity and low cost because of flexibility and speed, and this results in profitability, capital accumulation, and competitive power. Second, commodities, knowledge, and people connect to each other straightforwardly and frequently at world scale via these technologies.

The epochal structure of new technologies changes economic policies to control these technologies and their social impacts. In general, price stability and economic growth are seen more significant in liberal economic policies with regard to the global system. However, new economic structure changes the priorities of economic policies in the age of electronic revolution. New economic policies involve those issues:

1. Competition policy in the context of intense competition between firms and individuals on the basis of globalization and innovativeness.
2. Industrialization policy in the context of new technology industries and using new technologies in the process of industrial production.
3. Intellectual property policy in the context of protecting the rights of people and firms that create knowledge and innovation.
4. Employment policy in the context of new division of labour and new professions in the light of the developments of global age.

5. Social policy in the context of new technologies' control on individual and social life, along with their facilities.

In this framework, it is aimed to identify the tendencies of economic policies on the basis of new technologies in this study. And the global system is defined and made sense in the first section. New technologies and their role in society and economy are explained in the second section. Finally, new economic policies are evaluated in terms of new technologies and their economic and social impacts.

8.2 What Is the Global System?

The economic, cultural, and political flows at world scale are not irregular and casual. These flows occur on the basis of some principles, values, thoughts, and institutions. So they depend on a system.

It is observed frequently that the term 'market system' is used while defining the basis of the global flows. As regards, globalization is defined as the integration of commodity markets, capital markets, labour markets, and/or national markets (Rodrik 1997; Milliot 2010; Dunning 2001). Market system or market economy is the concept that liberals prefer and that is seen as free from ideological debates (Jessua 2005: 7). To see globalization as it depends on market system involves an intention for putting globalization on a side that many people adopt and that is free from ideology. However, to explain globalization within an economic institution, like market, can entail economism. The concept of economism, that means prioritizing the economic approach over the cultural, political, ideological, technological dimensions and interdisciplinary context (Teivainen 2002; Ashley 1983; Nutter 1979), may cause a problem to disregard the multidimensionality of globalization. For handling this problem, it is useful to assess globalization within the concept of capitalism that is related to a societal system, not just economic system (Jessua 2005: 7). Capitalism involves technological, political, cultural dimensions along with the economic dimension, and it has a holistic approach in terms of the logic of political economy, rather than economics.

It is significant to define and assess globalization within this holistic and multidimensional structure. As regards, Manfred Steger's definition of globalization is quite functional and instructive. Steger defines it as a multidimensional set of social processes that create, multiply, stretch, and intensify worldwide interdependencies and exchanges while at the same time fostering in people a growing awareness of deepening connections between the local and the distant (2003: 13). This structure of globalization, that creates interconnection and interdependence at world scale, hinges on a system, a global system.

Sklair (1995) argues that global system theory is based on the concept of transnational practices that cross state boundaries but do not necessarily originate with state agencies or actors. For Sklair, analytically, transnational practices operate in three spheres, the economic, the political, and the cultural-ideological. The whole of them is the global system. The global system, at the end of the twentieth century, is not synonymous with global capitalism, but the dominant forces of global capitalism are the dominant forces in the global system. Individuals, groups, institutions, and even whole communities, local, national, or transnational, can exist, perhaps even thrive, as they have always done outside the orbit of the global capitalist system, but that this is becoming increasingly more difficult.

The global system that is founded within the logic of capitalism is built by means of the principles of openness, freedom, and competitiveness, and the institutions as firm, state, and national/international organizations that operate on the basis of these principles. As this study focus on new technologies and economic policies, technological developments and national-state tendencies become significant in the context of the substance of the global system.

Some features of the global system, such as gaining speed of the flows, getting efficiency and productivity, increasing capitalist accumulation, and so on, create a requirement for new technologies; on the other hand, new technologies transform 'international' system to 'global' system. Some features emerge with regard to the interactivity between technology and the global system and/or global capitalism. In this context, Manuel Castells claims that the system is informational, networked, and global within a new economic approach. A networked structure within information at global scale integrates individuals, firms, organizations, and states (Castells 2000: 77–78). Technology is a crucial factor in originating this global network.

Technology becomes a developmental facility for human life throughout the chain from the discovery of fire to artificial intelligence. Throughout history, technology enabled humans to spread across the world, on one hand; it morphed the economic, cultural, political dimensions of human life, it designated new epochs, and it determined evolutions and revolutions, on the other hand; although it can cause some risks in the relation between human and nature and in power relations among people. Technological developments can become revolutionary in terms of their impacts on their own ages. However, new technologies in the global age allow humans to transcend their economic, cultural, political borders, even Yuval Noah Harari argues that humans can transcend themselves because of new technologies, and they can transform their species and can create an artificial alternative against themselves (Harari 2011: 445). With regard to nature history and human history, the impacts of technologies on nature-universe and human life are much more unprecedented in our age. Anyway, it should not be disregarded to see scientific and technological development as a sequence or an accumulation: Sumerians' observations on the celestial bodies, Galileo Galilei's studies on astronomy, and the debates on life on Mars or on travel to Mars, etc. mean a whole development that consists of individual steps which bring up the sequential.

Technology also plays a role to form transnational practices that are on the basis of globalization. Post-Fordist (flexible) technologies and organizations of production build connectivity between places, institutions, and people in a network at global scale (Robinson 2004; Sklair 1995; Raynolds 1994; Korzeniewicz and Martin 1994). But new technologies might also break the transnational production network and also trigger the process of deglobalization. For instance, consumers might buy electronic t-shirts that global e-trade firms sell and consumers print it in a 3D printer shop, instead of the t-shirts that are produced in a country in that wages are extremely low. In this situation, while breaking the commodity chain, the weakest links, namely the countries in that wages are low, might be deactivated and some economic regions in that firms cluster around new technologies might become richer, like Silicon Valley (Harari 2018: 51–52).

Technological tendencies will not entirely remove the production network. Business connections, commodity flows, and capital flows will continue. But contraction of the network draws attention to local/national economies. In this respect, national-states become the leading decision-making unit and have capability to build their own societies, along with the debates on the end of globalization.

Globalization changes the independent, protectionist, and closed system of national-states. The flows that national-states cannot control, allow societies and states to integrate with the global system. National-states found the structure of state and society by depending on the principles and institutions of liberalism with regard to the claim of 'the end of history' in that liberalism become universal and unique for ideological and political struggle (Fukuyama 1992). However, this tendency of globalization reverses for some points.

Some scholars think that globalization has not a pure liberal characteristic and that the principles of openness and freedom of liberalism can be institutionalized in a harmony with the principal-national values. In this way, some national-states emerge differently from the Western-style national-state. John Ralston Saul claims that some Western politicians see the non-Western point of view on national-states as dangerous, such as Chinese, Indian, Brazilian national-state, and so forth. For instance, Chinese hegemony arises increasingly in some markets/countries. This hegemony is not limited to price advantages or competitive advantage in the economic field. Similarly, Brazil develops its own originalities against Western intellectual property privileges (Saul 2018: 320).

For Saul, there is a conflict between positive nationalism that is formed on the basis of the principle of citizenship and negative nationalism that depends on hostility between the aboriginal and the other. This process causes the rise of national-state idea in terms of the competition between these points. Such developments imply a new age of nationalism (Saul 2018: 336). Nationalism rises again against globalism, especially in the periods of military, political, or economic crisis. In this way, a humanitarian view for the other is not fairly observed (Saul 2018: 344). Whereas transnational practices on the basis of globalization ignore national sensitivities and prioritizations, and consciousness and respect towards the other emerge.

Societal crises and inequalities require national-states' policies because there are no institutions that develop economic and social policies at global scale. The neoliberal policies of the International Monetary Fund or World Bank or the developmental policies of United Nations' institutions cannot substitute for national-states that are the main character about the struggle against inequalities. The final actor to decide is national-states. However, national-states should not prioritize individual interests over social interests. Thus they may make efficient and consistent solutions against inequalities. Inequalities lead national-states to become pro-active and to take initiative while the global system processes. Thereby the global system that is beyond national system loses its meaning.

Facundo Alvaredo and his colleagues argue that inequalities enforce states to take steps for the future. They claim that public wealth's share in national wealth is low in many countries because of neo-liberal policies and that national-states have not much facilities to develop policies. National-states cannot develop efficient policies to reduce inequalities because of privatization and shrinking government expenditures in the long-term. Unfortunately, we live in a global age in that to discuss economic and social investments of the states becomes meaningless (Alvaredo et al. 2019: 333).

Gülten Kazgan also explains the global system; but she remarks the probability of deglobalization and the rise of national-states again. For Kazgan, globalization involves two reasons: Firstly, the integration tendency that transportation and communication technologies provide at world scale; secondly, diminishing ideological divergence, and political convergence of nations in the context of 'visible power of invisible hand'. But real globalization does not contribute profoundly to nations/societies because of the unequal structure of capitalism. Globalization involves two inequality tendencies: First inequality occurs with regard to the income distribution between socioeconomic classes in countries; second inequality takes place in terms of different levels of income and wealth between countries. International inequalities compose collaborations between the resemble countries in terms of income, culture, politics rather than geographical proximity. Especially trade agreements empower the tendency of grouping or regionalization (Kazgan 2016: 166–169). This process shows that global flows will realize within the free will of national-states beyond the invisible hand of the global system. So national-states' economic policies will become so significant about technology, migration, trade, etc.

As a matter of fact, the collapse of the process of globalization is discussed within the situation and new tendencies of the global system in terms of technology and national-state. It might not be easy to see a radical, revolutionary change in the process of globalization, but the existence and positive spheres of globalization become questionable because of epochal new technologies and new realms of economic policies.

8.3 New Technologies

Technology is a crucial instrument to improve humanity throughout history. Technology has been creating unprecedented changes in human and nature from 1970s that are defined as the global age or the global system. Technology in this global system refers to a revolution to recreate human being and nature and to make sense of them again.

It is appropriate to examine the meaning of the word 'technology' to understand the essence of it. The Greek origin of the word 'technology' consists of two parts. The first half derives from techne, which signifies 'art, craft, or trade'. The second half derives from the word logos, which signifies an 'ordered account' or 'reasoned discourse'. Thus technology literally means 'an ordered account of art, craft, or trade' (Auerswald 2017: 4). From this aspect, even the oldest tools that are made of stone or wood to use for gathering or hunting involve a reasonable account, although people see them as primitive today. This feature of technology progressed in association with the cognitive development of human beings and created an epochal shift in association with the scientific and philosophical view of human beings.

Philip Auerswald extends his point of view about examining the origin of the concept of technology. For Auerswald, technology focuses on a meaning along with another concepts. That meaning is the knowledge of 'how to make'. Moreover this meaning is also involved in the concepts of 'recipe', 'code', and 'algorithm'. Auerswald points out that humans developed the knowledge on how to cook (recipe) while learning to cook by using fire. The concept of the recipe is the 'code at work' that explains how to make it. The word 'code' is based on the Latin word 'codex' that signifies 'a system of laws'. In this respect, humans' coding ability and habit that started with culinary recipes have been building his forty-thousand-year history (Auerswald 2017: 1–5). Technology, recipe, or code is the abstract or concrete view of the functions that are based on certain system of rules as primitive or cyberspace historically. From this point, the term 'technology' will be preferred because it is used more than the others in the literature.

Sociologists Patrick Nolan and Gerhard Lenski analyzed social structures throughout human history according to the criteria of technology. For Nolan and Lenski, these social structures have been lived in the context of socio-cultural evolution of humanity: Hunting and gathering society that the tools made of stone or wood morph, horticultural society in that humans cultivated the small lands by small hand tools, agrarian society in that large-scale lands are cultivated by plow and industrial society that is formed by steam engine and other industrial revolutions (Nolan and Lenski 2009).

The revolutionary effects of technology were experienced throughout history, but also industrial revolutions are distinctive. Nolan and Lenski describe the progression of industrial events as phases: In the first phase, which began in mid-eighteenth-century England, the revolution was concentrated in textile, iron, and coal industries, and the invention of first true steam engine was the most important innovation. The second phase got its start in the middle of the nineteenth century and involved rapid growth in the railroad industry, the mass production of steel, the replacement of sailing ships by steamships, and the use of new technology in agriculture. Around the turn of the century, the industrial revolution entered the third phase, with rapid growth in the automobile, electrical, telephone, and petroleum industries. World War II marked the beginning of the fourth phase, distinguished by remarkable developments in aviation, aluminium, electronics, plastics, nuclear powers, computers, and automation (Nolan and Lenski 2009: 195).

The developments in the realms of electronics, computers, and automation are much more rapid and widespread today. They affect societal and individual life more profoundly; even they transform the nature and essence of the human. Accordingly, these developments should be treated particularly.

The invention of computer is an electronic revolution. A team within the leading of USA army developed computer in military realm in 1946. Mathematician John von Neumann who is one of the founders of the game theory worked in this team. The first computer is known as Electronic Numerical Integrator and Computer (ENIAC) (Auerswald 2017: 53). It may not be seen as ascendant in terms of size and function in comparison with today's computers. But it is important to assess this issue within an evolutionary view: ENIAC that involves an algorithm, calculates and processes is the ancestor of today's computers.

Economy or society that is structured via the invention of computer and other electronic developments is explained by several concepts such as Fritz Machlup's concept of knowledge economy (1962), Peter Drucker's concept of knowledge worker (1969), Daniel Bell's concept of post-industrial society (1973), Yoneji Masuda's concept of information society (1980), Manuel Castells's concept of network society (1996), and so on 1969 for Drucker and just 1980 for Masuda.

This structure that can be called 'information society' in general is assessed within a new concept that Japan proposes today. Japanese government conceptualizes the new societal structure as 'Society 5.0' in the 5th Science and Technology Basic Plan for the period of 2016–2020. The government adjusts Nolan and Lenski's sorting of the societies throughout human history and puts forward the Society 5.0 as 'super smart society' after hunting society (Society 1.0), farming society (Society 2.0), industrial society (Society 3.0), and information society (Society 4.0).

For the Japanese government, super smart society is a society where the various needs of society are finely differentiated and met by providing the necessary products and services in the required amounts to the people who need them when they need them, and in which all the people can receive high-quality services and live a comfortable, vigorous life that makes allowances for their various differences such as age, sex, region, or language. Such a society is expected to, for example, develop and realize an environment in which humans and robots and/or artificial intelligence coexist and work to improve quality of life by offering finely differentiated customized services that meet diverse user needs. The society must also be capable of anticipating potential needs and providing services to support human activities, resolving gaps in service due to differences in region, age, etc., and enabling anyone to be a service provider (The Council for Science, Technology and Innovation, of Government of Japan 2015: 13). As seen, Japan evaluates high technologies as facilities to improve human life. It emphasizes human and society, not technology while identifying super smart society. But it is required to understand new technologies underlying recent developments in society.

Japanese government specifies the leading technologies to invest in its plan of science and technology. Accordingly, Japan will speed up the consolidation of the following fundamental technologies in particular: Cyber security, internet of things (IoT), big data analytics, artificial intelligence (AI), device technology, network technology, and edge computing. Those are essential technologies for super smart society. And there are also core technologies in the real world and for new value creation in individual systems, which depend on the essential technologies. Those are robotics, sensor technology, actuator technology, biotechnology, human interface technology, material/nanotechnology, and light/quantum technology. Connecting several technologies organically is expected to stimulate mutual technological development, such as the collaboration and integration between AI and robotics (The Council 2015: 16–17).

These new technologies affect economic performance in particular. Those are applied to the practices of production, exchange, and consumption. The reflections of new technologies to the field of production bring out a new conceptualization: 'Industry 4.0' (The Fourth Industrial Revolution).

It is helpful to examine the industrial revolutions before the concept of Industry 4.0. The first industrial revolution, located at the transition from the eighteenth to nineteenth centuries, was characterized by the introduction of water- and steam-powered mechanical manufacturing facilities. The second industrial revolution, which happened during the transition from the nineteenth to twentieth centuries, was based on the introduction of electrically powered mass production and the intensive division of labour. Then followed the third industrial revolution, which entrenched from the 1960s until the 1990s, whose main driving force was the usage of electronics and information technologies (digital revolution) to achieve further automation of manufacture. These three successive revolutions can be coined as 'Industry 1.0', 'Industry 2.0', and 'Industry 3.0', respectively (Devezas et al. 2017: 1).

The term 'Industry 4.0' appeared for the first time in 2011 during the famous Hannover Fair, as a kind of project in high technology strategy of the German industry, and in the following year, it was created by the (German) Working Group on Industry 4.0, which delivered its final report in April 2013 again at the Hannover Fair (Devezas et al. 2017: 2). The concept of Industry 4.0 is completely approved today. As explained above, however, Nolan and Lenski note the 'fourth' phase of industrial progression by means of electronics, computers, and automation and create the concept of the 'fourth' industrial revolution (Industry 4.0) in a sense. Consequently, it is not confusing to say that 'the fourth' had already existed as a phenomenon and concept before 2011. But it cannot be disregarded that there are some epochal shifts in the process of production in terms of new technologies, as examined below.

Most economists now agree that we are entering the fourth industrial revolution, whose main characteristic is the usage of cyber-physical systems. In other words, the substance of the revolution is the linkage of real objects and people with information-processing/virtual objects via information networks (IoT, 3D printing, AI, bioengineering, cloud computing, etc.), but also using nanotechnologies and new efficient and intelligent materials (Devezas et al. 2017: 1–2).

Industry 4.0 describes the organization of production processes based on technology and devices autonomously communicating with each other along the value chain: a model of the 'smart' factory of the future where computer-driven systems monitor physical processes, create a virtual copy of the physical world, and make decentralized decisions based on self-organization mechanisms. The concept takes account of the increased computerization of the manufacturing industries where physical objects are seamlessly integrated into the information network. The main features of Industry 4.0 are: Interoperability: cyber-physical systems (work-piece carriers, assembly stations, and products) allow humans and smart factories to connect and communicate with each other. Virtualization: a virtual copy of the smart factory is created by linking sensor data with virtual plant models and simulation models. Decentralization: ability of cyber-physical systems to make decisions of their own and to produce locally thanks to technologies such as 3D printing. Real-Time Capability: the capability to collect and analyze data and provide the derived insights immediately. Service Orientation and Modularity: flexible adaptation of smart factories to changing requirements by replacing or expanding individual modules (Smit et al. 2016: 20–21).

New technologies of Industry 4.0 come into prominence in the process of production, but also they are included in the Society 5.0 approach. World Economic Forum (WEF) is also engaged in new technologies. WEF conducted a survey on the reflections of new technologies. In this survey, WEF asked companies which technologies they adopt or they will adopt, and WEF specified new technologies, respectively, according to the proportion of adoption: User and entity big data analytics—App-and web-enabled markets—Internet of things—Machine learning—Cloud computing—Digital trade—Augmented and virtual reality—New materials—Wearable electronics—Distributed ledger (blockchain)—3D printing—Autonomous transport—Stationary robots—Quantum computing—Non-humanoid land robots—Biotechnology—Humanoid robots—Aerial and underwater robots (WEF 2018: 7).

New technologies in societal life in respect of Society 5.0 and in the process of production in respect of Industry 4.0 are so significant. The abstract and concrete view of new technologies hinges on the knowledge of how to make. For Auerswald, technology (the how of production) begins as an idea. Some ideas are spread as unwritten recipes, procedures, and routines, whereas others are encoded as blueprints, manuals, patents, or standard operating procedures. Still, others may be directly encoded as hardware. Hardware that can be programmed (for example, a general purpose computer) thus becomes a new platform for encoding ideas (Auerswald 2017: 152). As seen, coding which means creating a system of laws that manages real or virtual spheres is the most crucial and epochal point in the new age. Thus it is required to regard AI in terms of coding.

Alan Turing who is one of the leading scientists in the twentieth century can be shown as the founder of computer science and AI. And mathematician John McCarthy claimed the concept of AI at first. The first text in that this concept is used is the application documents within that a study group of McCarthy and his colleagues ask for a fund from the Foundation of Rockefeller to undertake some research on AI (Say 2019: 85). Even it is supposed that the technologies with regard to Society 5.0 and Industry 4.0 are new, today's technologies, like AI, derive from computer science and technologies that emerge after World War II.

While the Oxford English Dictionary defines AI as 'the theory and development of computer systems able to perform tasks normally requiring human intelligence', the recent excitement is driven by advances in machine learning, a field of computer science focused on prediction (Agrawal et al. 2018). As another definition, AI is 'a science that searches how we get artificial systems (sometimes within a body) done every cognitive activity that natural systems can do, at the levels of higher performance' (Say 2019: 83–85). These definitions show that AI is a theory or a science along with that it is a technology that is integrated to machines in the production system.

AI, the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings. The term is frequently applied to the project of developing systems endowed with the intellectual processes characteristic of humans, such as the ability to reason, discover meaning, generalize, or learn from past experience. Research in AI has focused chiefly on the following components of intelligence: Learning, reasoning, problem-solving, perception, and using language (Britannica Encyclopaedia, Retrieved on December 22, 2019).

AI underpins some electronic applications such as Apple's Siri, Google's Google Translate and Google Assistant, Amazon's Alexa, Amazon Go Store and Amazon Prime, and Microsoft's Cortana and Bing, and so forth. Another technology is the robot or robotics that collaborate with AI and that we can observe in production or everyday life.

The word 'robot' or 'robotics' was coined in the field of science fiction at first. The word 'robot' that was adjusted from a word meaning 'enforced labouring' in the Czech language was used at first in Karel Capek's theatre play that was called 'Rosumovi Univerzalni Roboti' (Rossum's Universal Robots) in 1920. The word 'robotics' was used at first in Isaac Asimov's short story that was called 'Liar!' in 1941 (Say 2019: 120). Robots or robotics whose first conceptualization is in the field of science fiction literature and art, not in the field of science, like AI, is seen as an interesting thing because it has humanoid appearance. This situation causes that robot technologies are treated admiringly.

Robots that are based on a certain coding work in many industries such as manufacturing, mining, agriculture, logistics, restaurants, retailing, banking, and so on; even they are used in many dimensions of individual lives such as education, household chores, and so on. Robots work in conjunction with AI, cloud technology, sensor technology, etc. on the basis of coding. They provide productivity, speed, and flexibility for the process of production. Firms can buy and employ a robot more easily due to decreasing costs to produce and buy (Ford 2018). The developments in information technologies were more slow and sometimes irregular after 1946, but today's technologies evolve much faster. This situation is also valid for robot technologies. Even the progression in robotics paves the way for a new concept: Industry 5.0.

Currently, Industry 5.0 will emerge as 'human-robot co-working'. In this vision, robots and humans will work together whenever and wherever possible. Humans will focus on tasks requiring creativity, and robots will do the rest. This co-working will operate in a smart society and be on the basis of the collaboration between humans and robots (Demir et al. 2019: 690).

Bringing back human workers to the factory floors, Industry 5.0 will pair humans and machines to further utilize human brainpower and creativity to increase process efficiency by combining workflows with intelligent systems. While the main concern in Industry 4.0 is about automation, Industry 5.0 will be a synergy between humans and autonomous machines. The autonomous workforce will be perceptive and informed about human intention and desire. The human race will work alongside robots, not only with no fear but also with peace of mind, knowing that their robotic co-workers adequately understand them and have the ability to effectively collaborate with them. It will result in an exceptionally efficient and value-added production process, flourishing trusted autonomy, and reduced waste and associated costs (Nahavandi 2019: 3).

Industry 5.0 will change the definition of the word 'robot'. Robots will not be only a programmable machine that can perform repetitive tasks, but also they will transform into an ideal human companion for some scenarios. Providing robotic productions with the human touch, the next industrial revolution will introduce the next generation of robots, commonly termed as cobot, that will already know, or quickly learn, what to do. These collaborative robots will be aware of the human presence; therefore, they will take care of the safety and risk criteria. They can notice, understand, and feel not only the human being but also the goals and expectations of a human operator. Just like an apprentice, cobots will watch and learn how an individual performs a task. Once they have learned, the cobots will execute the desired tasks as their human operators do. Therefore, the human experiences a different feeling of satisfaction while working alongside cobots (Nahavandi 2019: 3).

All these technological developments provide some advantages about speed, flexibility, low cost for the ultimate aims in capitalism such as more profit, more productivity, high market share, high competitive advantage, and so forth. This process globalizes capitalism. The global system based on capitalism that is formed by new technologies includes many components such as smart society, smart city, smart factory, smart home, smart building, smart device, and so on. And it has a meaning that nationalities dwindle and transnational practices emerge. Such questions of what the national origin of people or institutions that develop new technologies is or whether they work for the aim of national development become meaningless. Both the creators and the users of new technologies focus on their own rational interests. They strive to operate the technologies most efficiently, that they see as rational. However, new technologies and their impacts on society should be managed well in respect of science and technology policy, economic policy, or social policy.

New technologies sometimes cause risks. Thus the requirement of state policies towards these risks can make national-states important again in the global system. The requirement of making economic and social policies towards new technologies should not be disregarded. However, transnational practices continue to process in their own culture of 'laissez faire'. Here economic policies come into existence in a sensitive realm between national and transnational.

8.4 The Tendencies on Economic Policy in the Context of New Technologies

It is not probable that national-states make economic policy independently from the global system. As regards, economic policies correspond to the principles of openness, freedom, and competitiveness of globalization. It is not witnessed that national-states undertake initiative and become pro-active to make economic policies apart from the institutionalization of market mechanism. But the progression of new technologies and their impacts require national-states' efficient policies.

National-states' economic policies depend on the logic of 'laissez faire' in general. This situation trivializes national meaning and priorities. In this way, the principle of 'laissez faire, laissez innover' emerges in the field of science and technology. However, it is required that states develop national science and technology policies through the principle of 'laissez faire, laissez innover' (Freeman and Soete 2003: 7). In fact, these 'national' policies are consistent with the global system, rather than becoming protectionist over national values and priorities: The global system needs new technologies, and states develop some policies for the creators and users of these technologies, facilitate them, and foresee and overcome the negative sides of them.

It is so important to provide compatibility between 'laissez faire' policy and statist policy on new technologies. In this issue, Jared Diamond's arguments on smart cities are eminently noteworthy, who is the author of the book Guns, Germs, and Steel. For Diamond, Singapore whose water resources are highly scarce controls water using via sensors while watering for flowers or flushing toilet at home. Founding big data on how much water people use shapes the water policy of the state. The state controls resources due to the smart technologies in some fields such as electricity using at home, automobiles' movements in traffic, heat release and shadow of buildings, and so on, and develops policies in the light of the information of these smart technologies. The Singaporean people do not see these controls as intervention to their privacy. They do not complain about the state's surveillance via new technologies because they do not want to suffer from thirst or food crisis today or in the future (Diamond 2019: 26).

Diamond talks about the case of Germany that prioritizes societal interests over individual interests. In Germany, there is a system of laws that organizes society in the fields of what colour and form of tiles people use for their roof, whether people cut down a tree in their garden, whether they fish without having fishing licence, etc. An American individual sees those as a restriction for her/his freedom. However, Germany has nice local architecture, green cities, and wide fish population by means of this system of laws (Diamond 2019: 26). The cases of Singapore, Germany, and the USA demonstrate that a conflict or compromise between individual interests and societal interests hinges on ideological-political preference. It is required to provide the principle of freedom of the global system and the institutionalization with the system of laws. A balanced attitude between them is also valid about smart technologies and their reflections onto society. Consequently, economic policies in this field lead to new technologies and their place in economy, in respect of freedom on technology development and using within a progressive system of laws.

Economic policies intensify in certain fields in terms of the effects of new technologies particularly in economy and generally in society. New aspects of economic policy come into prominence, rather than traditional aims of price stability, growth, and balance of trade. It is useful to evaluate these aspects as below:

8.5 Competition Policy on the Basis of Global Competition and Innovativeness

The new economy that is structured by new technologies and new industries also changes the view on competition. The computerization and digitalization provide speed, productivity, flexibility, and innovation for economic processes. As regards, some developments occur such as decreasing costs, increasing quality of goods and services, the rationalization of the process of production, the standardization of products, and so on, and the competitive point of view on providing those is adopted by corporations more frequently. The adjustment to new technologies and developing new strategies are necessary to keep up with global competition across national borders.

Joseph A. Schumpeter is an important economist who undertook leading researches on innovation also involving new technologies. His studies are taken as a reference theoretically; even his arguments remain old according to the speed and effects of today's technologies. Schumpeter claims that capitalist competition should not be reduced to the realm of 'price' and that the essential realm of competition is 'innovation'. An entrepreneur works as a revolutionist at these five realms of competition: New methods of production (new technology), new commodities, new forms of organization, new sources of supply, and new markets. These revolutions change industrial structure profoundly by destructing old technologies, old commodities, old organizations, old sources, and old markets. Schumpeter terms this process as 'creative destruction' (Schumpeter 1942/2003).

In fact, Schumpeter's view of innovativeness explains today's technologies and global competition definitively. The competition based on developing innovations provides some advantages in some fields such as cost, price, market share, flexibility, adjustment to the market changes, and so on, to entrepreneur and/or firm. This process is observed more rapidly and more intensely in the field of new technologies.

Auerswald who evaluates today's economies in respect of the concepts of technology and/or code claims that the new value that is created through improved code entails a bifurcation of markets or of work. The creation of a high-volume and low-price option creates a new market for the low-volume and high-price option. For instance, 5-billions-dollar- export created by many watches (669 millions) that China produces trigger 24-billions-dollar- export created by less watches (29 millions) that Switzerland produces, in terms of the bifurcation. For another example, the digital advancement in the cinema world, via video players, DVDs, and watching movies on the internet facilitate that the cinemas correspond to new technologies and create new strategies; hence market is bifurcated (Auerswald 2017: 157). Bifurcation signifies innovation in a sense: A strategy of a firm or an industry, which involves new technologies such as AI, robotics, or the internet evokes another firm or industry to renew its own strategy.

Today the investments in new technologies are highly costly. But the costs decrease in the course of time in coding, setting up more rapid internet connection, producing robots, developing biotechnological innovations, etc. The robots connected to a cloud can be examined as an example. These robots get its huge part of its information and intelligence from a powerful computer centre in common (cloud). The processing power and the need for memory that are required to be become in these robots decrease, and robots are produced as less costly because this power and need are transmitted to the cloud. On the other hand, some European industrial robot producers build plants for robots in some Far East countries, especially in China, because of cost advantages (Ford 2018: 29 and 41). Another example related to cost advantages of new technologies could be given in the field of biotechnology. Mapping the first human genome required 15 years and 3 billion dollars. Today a person's DNA can be mapped within a few weeks and at the cost of a few hundred dollars (Harari 2011: 459). An important way for corporations to get competitive advantages in the global system is decreasing costs. And this condition depends on developing or using new technologies. Getting economies of scale as a traditional way is less important than technological solutions.

In the process of competition, another realm of new technologies is the internet that shows more precisely that it is important for corporations to become efficient in market, rather than to get economies of scale worldwide. For Auerswald, what the internet did was turn what had been a source of strength for market-dominant companies—their scale and proprietary knowledge—into a potential weakness. The result has been a shift from the corporate-centric economy of the twentieth century to the increasingly peer-to-peer economy of the twenty-first century (Auerswald 2017: 175). Transnational corporations structure the global system; but also technology corporations or other corporations using new technologies efficiently can be integrated into the global system more easily and more functionally. These corporations can become a player in the process of peer-to-peer competition. Internet is a great facility to make this strategy; but it should be thought that internet is in a complementarily relation with other new technologies.

Sklair proposes that competitive corporations can shift to global level due to technology, as well. For Sklair, transnational corporations can lead world economy without having giant plants. As regards, technology facilitates transnationalization for corporations. A corporation that is small scale in terms of the number of employees, sales, and economic assets can be transnational by taking advantage within technological efficiency against its rivals (Sklair 1995: 50).

Competition policy should be much more effective in respect of that the creative destruction is much more severe within new technologies and that competition occur in the global system by transcending the national system. The main objective of competition policy is to found a process of 'workable' competition. John Maurice Clark's concept of workable competition depends on a market structure that paves the way for creating new imperfectness and depends on market behaviours towards that firms have competition culture. Accordingly, some factors will make markets workable for using resources efficiently, such as the number of firms that does not cause monopolization, the structural-strategic differentiation of firms that do not cause cartelization, product differentiation, product quality, and so on (Clark 1940). In fact, competition policy should be structured towards this concept. And new technologies and/or innovations contribute to workable competition.

The institutions regulating and controlling the process of competition should conduct firms to develop new technologies or to use them. As regards, there will not be a tendency against competition. The process of competition should also be kept under control; thus some competitive situations will take place because of developing technology, such as that the power getting within technology is not abused, that technologies/innovations are not stolen, that a permanent monopolistic power is not emerged, and so on.

Transnational technology corporations or other transnational corporations that use new technology have competitive advantage against local small-scale corporations. The corporations that develop or use high technologies, like AI, robot, etc. get competitive advantage inherently. Thus a preventive or punitive instrument in national competition policy is unlikely to apply, by arguing that these corporations' market power is non-competitive. But in the context of John Kenneth Galbraith's concept of 'countervailing power' (Galbraith 1952), it can be thought that local corporations emerge and they are reinforced against global corporations. Anyway, it is not easy to develop national sensitivity and discourse vis-à-vis the transnational characteristic of the global system. So the most feasible policy is to found a law substructure towards competitive environment in the industry of technology and/or the whole economy and to encourage competitive behaviours.

Competition laws do not discriminate between industries. However, these laws should highlight the fields of new technologies and should involve special regulations in terms of the speed and effects of them. Besides a specialist cadre should be founded to assess whether there are non-competitive structures in the markets in that new technologies are developed or used. Here this speciality will be provided within the technical skills about AI, big data, robotics, etc.

8.6 Industrialization Policy on the Basis of Emerging Industries of New Technologies

The process of industrialization is intensified in the fields of computers and the related physical items to them and non-physical (invisible) codes in the post-industrial society, while the process arose in the fields of food, energy, transportation, etc. in the industrial society. But also the technological developments that are physical or based on codes leave a mark as an impulse on all private or public industries and human life. Hence as to make an industrial policy in our age, all related industries to new technologies should be assessed along with the industries that develop new technologies.

In this respect, the main objective of industrial policy should become to improve the firms and industries that work in the fields of AI, robotics, big data, etc. and to support other industries to use new technologies. Supporting these firms and industries is almost an obligation in terms of the positive externality of new technologies. An environment should be founded for the clusters of technology firms spreading positive externalities for each other within some spatial models such as industrial zones, information technology (IT) valleys, technoparks, free zones, and so on. Some incentives should be organized in order to incorporate and improve companies in these places. However, it should not be disregarded that firms prioritize their own rationales, namely, they invest in new technologies as they see them as profitable, even governments give many incentives for this industrial policy.

While national technology firms and industries are supported, transnational technology firms should be mentioned, as well. Even the incentives are very strong, national firms may remain weak in many respects vis-à-vis the historical and institutional competition advantage of transnational firms. Incentive policy sometimes provides to attract transnational firms and to transfer their knowledge on how to make or the system of laws to local firms. Anyway, there is a liberal point of view based on the dynamics of private sector in the global system, and governments may not aim to support their own technology firms in this system. Even foreign (maybe transnational) firms can benefit from the incentives that governments regulate for technology firms.

Some steps should be taken in education and employment policies towards IT along with supporting technology firms and industries financially. Technicians and engineers in the fields of hardware and software should be educated and trained. Labours' knowledge, experience, and skills theoretically and practically are significant stimulus for technology firms.

While it is important that firms invest in new technologies because of their own rationales, the conceptualization attempts of Japanese and German governments (Society 5.0 and Industry 4.0) show that state policy is crucial. This means that national-states are pro-active about new technologies. So it is highly required to construct an industrial policy towards developing and using new technologies.

Even firms compete with each other, not national-states; national-states also develop national strategies: They also compete on new technologies. In this respect, Germany is an appropriate example with regard to Industry 4.0. The term 'Industrie 4.0' was initially coined by the German government. It describes and encapsulates a set of technological changes in manufacturing and sets out priorities of a coherent policy framework with the aim of maintaining the global competitiveness of German industry. It is conceptual in that it sets out a way of understanding an observed phenomenon and institutional in that it provides the framework for a range of policy initiatives identified and supported by government and business representatives that drive a research and development programme (Smit et al. 2016: 20).

8.7 Intellectual Property Policy on the Basis of the Rights of People and Firms Producing Knowledge and Innovation

The innovative and institutionalized firms have to get legal protection in terms of global competition. These firms compete with their rivals at world scale and unfair processes are prevention for them to globalize. Therefore national-states should make legislative regulations for the purpose of securing innovativeness. Legal protection is processed against unfair competition, on one hand; it is related to intellectual property rights, on the other hand. Competition policy is interested in preventing unfair competition and this issue was assessed above. And protecting intellectual property rights is also significant in terms of new technologies.

Innovations in the fields of AI, IoT, robotics, etc. and new products that are produced via those involve a distinctive idea and design. The individuals and firms that want to protect their rights related to their codes, models, or prototypes expect to be constituted laws and institutions that secure their intellectual property rights.

Patents as instruments regulating this right cause a monopolistic power initially. Schumpeter asserts that the monopolistic power emerged by innovations is not a bad situation because of its potential to reveal creative destruction. Other firms will strive to get patents by developing innovation vis-à-vis the first firm's monopolistic power by patent, and they will aim to destruct the market structure (Schumpeter 1942/2003). The process of creative destruction in the field of today's new technologies takes short time because the speed of developing innovation and its effects are too great.

Trade secrets and intellectual property should be protected in terms of the continuity of firms' innovativeness. For instance, firms' strategies that depend on big data or new data that they originate via IoT are trade secrets. Storing these data within the cloud technology as a trade secret is a facility up to the firm's reputation. With regard to these instances, the trade secrets of the firms that develop or use new technologies should be protected with laws, and trade laws should be updated by involving these technologies (Bozkurt and Armağan 2019).

It is also significant that intellectual property in the fields of new technologies should be protected. It should be defined well as who have a patent of a robot, code, or AI, and this patent should be protected. However, for example, there may become some complexities on the property for the codes embedded in a robot, even violations of right. For another example, in a situation in that AI makes an invention by itself, it is questionable who has the intellectual property, AI or the person who develops it. Consequently, these fields should be organized within laws. Besides, there may be plagiarism and hacking because of coping new technologies and getting them easily via internet. This also means the necessity of legal protection (Bozkurt and Armağan 2019).

Intellectual property rights are like any other property right. They allow creators, or owners, of patents, trademarks, or copyrighted works to benefit from their own work or investment in a creation. These rights are outlined in Article 27 of the Universal Declaration of Human Rights, which provides for the right to benefit from the protection of moral and material interests resulting from authorship of scientific, literary, or artistic productions. The importance of intellectual property was first recognized in the Paris Convention for the Protection of Industrial Property (1883) and the Berne Convention for the Protection of Literary and Artistic Works (1886). (WIPO, Retrieved on January 6, 2020).

Trade Related Aspects of Intellectual Property Rights (TRIPS) Agreement within World Trade Organization (WTO) is related to that countries guarantee to provide a protection for copyrights, patents, trademarks, industrial designs, geographical indications, and trade secrets. So national-states that sign this agreement already make a commitment about protection in the field of new technologies. However, there may become some violations against innovations in markets such as plagiarism, counterfeiting, hacking, and so forth. And the institutions of national-states should control these violations entirely.

8.8 Employment Policy on the Basis of New Occupations and Specialities in the Global Age

Two opponent comments emerge about how new technologies affect employment and employees. Either new technologies will lead to mass unemployment, or they will create new fields to work.

Auerswald approaches this dilemma with some more sharp questions. Will machines driven by increasingly powerful computers end up being our liberators, or will they become our unbeatable competitors in the workplace of the future? More generally, does technology destroy or create jobs? The answer, of course, is that it does both. The advance of code empowers us at the same time it permits algorithms and machines to replace us. Routine tasks that can easily be encoded will be performed by computers, and those that cannot be encoded will continue to be performed by people (Auerswald 2017: 161 and 165).

David Autor has a similar idea. For Autor, the interplay between machine and human comparative advantage allows computers to substitute for workers in performing routine and codifiable tasks while amplifying the comparative advantage of workers in supplying problem-solving skills, adaptability, and creativity. The extent of machine substitution for human labour should not be overstated, and the strong complementarities that increase productivity, raise earnings, and augment demand for skilled labour should not be ignored (Autor 2014: 129–130).

Auerswald asserts a claim in a relation between human and technology in the light of the importance of coding today: The power of code is growing at an exponential rate. Code only partially substitutes for human capabilities. Therefore the (relative) power of human capabilities is shrinking at an exponential rate in those categories of work that can be performed by computers, but not in others (Auerswald 2017: 7). So it is not meaningful to talk about a substitution or complementarity between human and technology. Rather, it is required to determine truly the labour skills of new technologies and how they impact the process of working, and to develop true employment policies.

Along with the concept of Industry 4.0, the concept of Work 4.0 was put forward in Germany again in terms of how jobs and the structure of working change. The term 'Work 4.0' picks up on the current discussion about Industry 4.0, but puts forms of work and employment relationships centre stage—not just in the industrial sector, but in the entire world of work. 'Work 1.0' refers to the birth of the industrial society in the late eigteenth century and the first workers' organizations. 'Work 2.0' was the beginning of mass production and the birth of the welfare state in the late nineteenth century. Industrialization led to new social problems; growing pressure from organized labour was an important factor in the introduction of the first forms of social insurance in the German Empire. 'Work 3.0' covers the period in which the welfare state and workers' rights were consolidated on the basis of the social market economy. Employers and employees negotiated with each other on an equal footing, as social partners. The need for representation of common interests was unquestioned in companies and among workers. Later, some social rights were revoked, partly as a result of growing competitive pressures and the opening of national markets. 'Work 4.0' will be more interconnected, digital, and flexible. It remains to be seen exactly what the future world of work will look like (BMAS 2017: 202–203).

The structure of Work 4.0 does not originate very rapidly. Many jobs and occupations do not remove in a short while or massive unemployment does not arise. However, technological progression is very rapid and its effects on labour and jobs are observed gradually.

Şebnem Özdemir and Deniz Kılınç propose that new technologies begin to create new occupations. The transformation of economic structure and occupations were relatively gradual in the early epochs of industrialization and this change caused unemployment for next generations, yet unemployment may be experienced by current generation in the rapid process today. In order to adapt to this process, the departments of basic sciences and engineering also transform and new departments of engineering are founded at universities, as seen in the field of smart home. Özdemir and Kılınç compiled new occupations based on new technologies and prepared a long list. It is useful to draw attention to some of them: Genetic code designer, human-machine hybrid environment designer, augmented reality and virtual world creator, biotech engineer, smart house designer, intellectual property rights lawyer for digital artists, industrial data engineer, drone standards specialist, personal data broker, coding ethicist, robo-psychologist, data architect, artificial intelligence based digital strategist, artificial intelligence based supply chain designer, artificial intelligence based customer service manager, software engineer, 3D printer engineer, and so on (Özdemir ve Kılınç 2019).

It is thought that these occupations of the future are derived from some engineering branches such as computer engineering, electronics engineering, genetic engineering, industrial engineering, and so on. But also it is obvious that it is required to develop deeper specializations and special and intensive educations on these fields, and to found new engineering branches and occupational training departments. Therefore governments' new employment policies should depend on their education policy. It will be crucial to improve the education system in association with new scientific and technological developments. An industrial policy related to new technologies will be a complimentary policy to labourers educated in the fields of these technologies: New job fields should be created, in that the educated labourers will be able to apply their specialization and creativeness.

Institutional education is important. The skills and differences of labourers, however, are also important on the other hand. WEF reported the remarkable labour skills in 2018 that are assessed as expectations for the year 2020. Employers demand these skills from employees. Those (skills) can be examined, respectively, as below: Analytical thinking and innovation—Active learning and learning strategies—Creativity, originality, and initiative—Technology design and programming - Critical thinking and analysis— Complex problem-solving—Leadership and social influence—Emotional intelligence— Reasoning, problem-solving, and ideation—Systems analysis and evaluation… In this report, there are also some skills that lose their significance: Manual dexterity, endurance, and precision— Memory, verbal, auditory, and spatial abilities—Management of financial, material resources— Technology installation and maintenance—Reading, writing, math, and active listening—Management of personnel—Quality control and safety awareness—Coordination and time management—Visual, auditory, and speech abilities—Technology use, monitoring, and control (WEF 2018: 12). In this respect, governments should regard to develop labourers' skills as an aspect of employment policy. The leading skills should not be evaluated only as of the demands of capitalist class. Today's economic systems are already capitalist, but it should be aimed to provide individuals' cognitive, educational, and occupational improvement in any social system, such as the social market system in Germany, the economic system that also keeps the culture in Japan or the economic system that is built within the logic of protective state in Turkey, and so on.

8.9 Social Policy on the Basis of New Technologies' Control on Individual and Social Life

The prominence of new technologies and the predictions about those change greatly human beings, the relations between people and the relation between human and technology. This change involves hope for the future, and it can be dreadful in terms of some risks to society.

The counterintuitive but pervasive reality is that technological advances have humanized work in the past and should do so in the future. Therefore, adapting to a world where computers can think is just the beginning. The hard part for humans, of course, will be to redefine what it means to be human in the first place (Auerswald 2017: 159).

Human can be defined as the man who thinks ('Homo sapiens'), makes tools ('Homo faber'), produces symbols ('Homo symbolicum'), and becomes a social animal (‘Zoon politicon’) (Şenel 2009: 11). This definition shows the structural features of human, that distinct him from other genera in nature. However, human will query to be man with regard to some developments, such as AI’s thinking and learning, the coded robots’ making tools, AI’s performing an art and developing a language, collaboration between robots, collaboration between things via internet, and so forth. Consequently, maybe human will redefine himself.

No matter what its efforts and achievements, Homo sapiens is incapable of breaking free of their biologically determined limits. But at the dawn of the twenty-firsst century, there is no longer true: Homo sapiens is transcending those limits. It is now beginning to break the laws of natural selection, replacing them with the laws of intelligent design. The replacement of natural selection by intelligent design could happen in any of three ways: Biological engineering, cyborg engineering, or the engineering of in-organic life (Harari 2011: 445).

Some attempts, like Neanderthal Genome Project or Human Brain Project, signify that Homo sapiens might change his own species by controlling DNA, even by changing it. The project drafts and technological developments might create a Homo sapiens whose immune system might be improved, whose average life might extend, who might be intellectual, almost genius, and who might be perfect physiologically. Would all humans be entitled to such enhanced abilities, or would there be a new superhuman elite? Throughout history, the upper classes always claimed to be smarter, stronger and generally better than the underclass. They were usually deluding themselves. With the help of new medical capabilities, the pretensions of the upper classes might soon become an objective reality (Harari 2011: 460).

New technologies, like AI and robotics substitute for humans, and for instance, people might rebel against the capitalists that do not need them no longer, might not rebel against the capitalists that exploit them, in the twenty-firs st century (Harari 2018: 26). Humans and/or labourers might react against the employers that employ AI or robots and dismiss them (labourers).

Humans may also react against robots. Instead of throwing sabo to machines as in early epochs of industrialization, humans may attempt to break and damage robots. For instance, a robot that has incorrect codes killed a worker in a plant (Deutsche Welle 2019). In a situation like this, an unconscious worker may damage the robot in terms of the relation between human and robot or this worker may feel anger at an engineer encoding for the robot. For another example, the institutions or firms that compose big data may probably misuse individuals’ privacy. So someone may react against the related institution or firm.

Some things that new technologies might cause for humanity may become dreadful. Governments should make some policies on these issues because possible dreadful consequences of new technologies may occur. Individuals should be protected legally against probable risks. It is required to legislate on some issues such as who has commitment to a robot, insuring cyber risks, misusing individual data, and so on (Bozkurt and Armağan 2019). While making laws, governments will need a cadre of engineers, sociologists, and psychologists who recognize and comprehend the significance of the nature, essence, and consequences of new technologies in social life, as well as a cadre of experts legally.

8.10 Conclusion

Technology as one of the planks of the global system improves in its own sphere, even a probable process of deglobalization is debated in several years. Scientists, engineers, inventors, and their organizations/institutions continue to work and innovate within their own rationale independently from the global system and the structure of national-state. This is an irrepressible process that was experienced throughout human history.

Technology has path-breaking impacts that are seen as breathtaking on one hand, and dreadful on the other hand. And it might transform, even remove human beings. As regards, everyone should follow and evaluate new technologies closely and attentively.

New technologies are also drawn attention in economic policies. The decision-making units on economic policy should learn and comprehend the nature and aspects of new technologies. And they should truly identify the fields in that new technologies intensify. These policy fields are competition, industrialization, intellectual property, and employment, and governments should also recognize general societal policy. Even there will be economic development at local or global scale, economic policies will not become significant while human and the history of human will transform.

New technologies will be able to impact economics. Those should be included in the course plans of the departments of economics. Some aspects of economics should query the assumption of 'ceteris paribus', such as microeconomics, macroeconomics, international economics, growth theory, and so on. Moreover, a combination of Homo sapiens, Homo faber, Homo symbolicum, and Zoon politicon is not settled into economics, but new human who emerges due to new technologies should be drawn attention along with Homo oeconomicus.

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Chapter 9
Artificial Intelligence and the End of Capitalist System

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Abstract Artificial intelligence is progressing at an increasing speed. Science fiction often depicts artificial intelligence as a robot with human characteristics. Today's artificial intelligence, with examples of face recognition, internet search, or self-driving cars without a driver, is called weak AI, which is designed to take on a technically limited task. However, many researchers aim to create strong artificial intelligence in the long run. For example, a weak artificial intelligence can defeat people in a particular task of playing chess or solving equations, while a strong AI can overshadow people in almost any cognitive task (Future of Life Institute 2016). I think the question is: Who is the production for? For people or for machines? Of course, for people. Perhaps the correct question is: Why are people part of production? In this study, I will discuss whether it is needed rather than the risks or benefits of artificial intelligence. The basic criterion of the capitalist system is to make a profit. In order to make a profit, the product produced must be sold/purchased at a certain price. For this, people must participate in the production process. If there will be no need for human beings in the production process (if the machines will replace man in the production process at increasing speed and there will be no limits here), how will labor be part of the distribution process? The question to be asked is: for whom will the production be produced, since the labor force who does not participate in the production process cannot participate in the distribution process? Contrary to what has been stated in almost all literature, I argue that the proliferation of artificial intelligence in the long run will adversely affect economic growth. These practices aiming at economic growth will destroy economic growth. This study raises different claims from the main literature and focuses on analyzing these claims.

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9.1 What Is Artificial Intelligence?

According to an idealized approach, artificial intelligence is an artificial operating system that is specific to human intelligence and is expected to exhibit high cognitive functions or autonomous behaviors such as perception, learning, linking plural concepts, thinking, problem-solving, communicating, inference, and decision-making. This system should also be able to produce responses from its thoughts (activating artificial intelligence) and be able to physically express these reactions ("Yapay Zeka" 2019).

Artificial intelligence describes computer science applications whose goal is to show intelligent behavior. For this purpose, different core competencies are necessary in different proportions: perception, understanding, action, and learning. These four core skills represent the greatest possible simplification of a model for the modern AI: perceive—understand—act expand the basic principle of all computer systems: input—processing—output. The really new thing is learning and understanding. Today's "real" AI systems have in common that they can also be trained and learned in the processing component and thus achieve better results than conventional methods that are based only on rigid, clearly defined and firmly programmed rules. Today, we speak of the weak AI, which is about intelligently supporting people in achieving their goals, that is, smart human– machine interaction and collaboration. The strong AI is more philosophically relevant. It aims at an imitation of man, ultimately a homunculus, which is more suitable as a science-fiction vision (Weber and Buschbacher 2017).

The Dartmouth Conference (full title: Dartmouth Summer Research Project on Artificial Intelligence) was a research project has been requested, planned, and executed in the summer of 1956 by John McCarthy, Marvin Minsky, Nathaniel Rochester, and Claude Shannon at Dartmouth College, Hanover, New Hampshire. Since then, this conference has been considered the birth of artificial intelligence as an academic discipline (Moor 2006; Press 2016).

In 1950, with the so-called Turing test, Alan Turing formulated an idea how to determine whether a computer, that is, a machine, would have an equivalent ability to human beings (Turing 1950). This test was initially only a theoretical sketch. It was formulated more precisely and more concretely later, after the artificial intelligence had become part of the computer science, a separate academic discipline. Since then, this test has been on everyone's lips in the discussion of artificial intelligence, and has been used time and again to revive the myth of the thinking machine for the computer age. Alan Turing's "polite assembly" is that, We do not need to decide if a machine can "think"; All we have to do is decide if a machine can be as intelligent as a human (Castelfranchi 2013).

"Information is knowledge in action." The automation of decisions through the evaluation and processing of information plays an important role. Challenging are the ever-larger volumes of data from which the relevant information can be derived through problem-solving methods (= algorithms). Basically, the value of the information can be seen in the result difference of a decision with and without information.

Thus, algorithms generate added value from data by transforming data into information and processing it so that this information can be used purposefully in society. Two parameters are crucial here:

- The improved knowledge of the situation through the use of the algorithm is the first parameter. However, improved knowledge alone does not add value.
- The second parameter is decision-making agility, where the better knowledge is used for decisions. Only when knowledge is applied, added value is generated (Weber and Buschbacher 2017).

Another approach to the subject of artificial intelligence can be made by dividing into different forms of AI (Scherk et al. 2017).

Assisted Intelligence is at the lower end of the spectrum of AI and is used to automate simple tasks to perform faster and cheaper. Assisted Intelligence falls under the category of "weak" AI.

Augmented intelligence helps people make better situational decisions. This form of AI can be learned from input from individuals, while human decisions are made more precise and accurate based on the information received from the AI.

Autonomous Intelligence is the most advanced form of AI, in which humans only monitor the machine, but it acts independently (e.g.,. self-driving vehicles).

9.2 The Risks of Artificial Intelligence

One day, artificial intelligence (AI) will overtake human intelligence. Then it will be too late. Blinded by the promises of AI, we will transfer to robots the responsibility for all critical systems in our society. From power to communications, to our defense infrastructure, the machines will control everything. And when the machines finally rise, they will use everything against us (Ohlhausen 2019). For most researchers, a super-intelligent AI cannot display human emotions such as love or hate, and therefore there is no reason to expect AI to be intentionally helpful or malicious. But how AI might pose a risk, experts propose two possible scenarios:

1. AI can be programmed to do something destructive: weapons with artificial intelligence programmed to kill. If these weapons are in the hands of the wrong person, they can easily cause massive damage. In addition, in the case of an AI arms race, this can inadvertently lead to an AI battle that results in massive damage. This can become such that people can lose control of such a situation. This risk increases as AI intelligence and autonomy increase.
2. AI can be programmed to do something useful, but AI can develop a destructive method of achieving its goal. This can happen when we do not fully align AI's goals with our own goals. AI can perceive a person's attempts to stop this project as a threat (Future of Life Institute 2016).

KI scientists Thomas Dietterich and Eric Horvitz identify about five types of key AI risks: bugs, cybersecurity, the Sorcerer's Apprentice phenomenon, shared autonomy, and potential negative socio-economic impacts. Bugs refer to programming errors in the KI-Software. As well as cyber-attack threats, this risk does not differ from current IT systems. "Sorcerer's Apprentice"—risks refer to AI systems that perform wrong actions when there are unclear instructions from the user. This is a technical problem that can be solved by, for example, programming systems to ask for clarification or programming defined limits. At the same time, there is also a human problem factor that should decrease as people get used to interacting with AI machines and developing knowledge. The problem of shared autonomy refers to AI systems in which the machine and the human act together (also sequentially) to control things. The problem can arise when handing over to a person is too sudden and the person is unwilling to take control (Dietterich and Horvitz 2015).

Jack Ma, the founder of the Chinese Internet corporation Alibaba, warned in a lecture that people should prepare for significant changeover in the labor market because AI will change the world. In the last 200 years, manufacturing and services have created jobs. But now because of the AI and robots, there will hardly be any jobs left. Jack Ma criticized today's school education. The students would not be trained for the necessities of tomorrow, but still for an economy that would soon be gone. The schools would train the unemployed of tomorrow. It makes no sense to compete with the AI and robots. Students should be trained by schools to be as innovative and creative as possible. Jack Ma assumes that the AI would destroy many jobs but would also create many new jobs. The question was whether students would be trained for these new jobs (RT News 2017).

AI systems or automated decision-making processes often run as background processes that are often invisible to people affected by their decisions. Also, their decision-making paths (such as deep learning) are often incomprehensible—which also leads to the question of the justice of the systems. A challenge or risk in this sense are distortions by algorithms ("algorithmic bias problem"). With limited human impact, or without them, an AI is only as good as the data from which it learns. Machine learning on inherently distorted data leads to distorted results. The AI tries to recognize patterns of data without human intervention. But the emergence of data is not always objective and balanced, so these imbalances in the data can be taken over by the AI—and even increased (Osoba and Welser 2017).

According to Wolfgang Wahlster, one has to subdivide human intelligence into different areas: cognitive intelligence, sensorimotor intelligence, emotional intelligence, social intelligence. In cognitive intelligence, the machine is already superior to humans in many areas. This area includes the game of chess, the game of Go, and other board games. Ultimately, the recording and learning of knowledge, the combination of this knowledge and the conclusion of this knowledge. This often corresponds to what people acquire in an academic education. In this intelligence, man is superior to the machine, but some machines are superior in areas of individual sensors. Basically, the human eye is very well trained. But a suitable video camera can also process light in the infrared range and UV range, which a person cannot. In acoustics, microphones can record much lower volumes or in frequency ranges than the human ear. This is even more true for the sense of smell and taste, where mechanical sensors are clearly superior. However, a person can combine these sensory impressions (sensor fusion), which a machine has been able to do but little. However, this could change within a few years. In this area, the machine makes almost nothing so far. Humans can feel themselves into another person, feel sympathy and empathy, compassion, compassion, grief, fear, joy, write love poems, have outbursts of anger, etc. However, what machines can already do today is the so-called sentiment analysis. That means by observing the human body language, so the face, the gestures, etc., the emotions of a person "read." This is the ability to adequately (re-) act in a human group, for example, to recognize a mood or to influence it constructively, for example, the team spirit. An ability that is mostly pronounced among entrepreneurs and politicians. So far, the machine cannot do anything in this area (CeBIT future talk 2016).

The Institute for Employment Research (IAB), which is part of the Federal Employment Agency, has set out in a study of 4/2018 which human work in Germany can be replaced by machinery. The study concludes that in 2016, 25 percent of paid human activities could have been done by machinery, which corresponds to about 8 million jobs in Germany. An earlier study came in 2013 still to a value of 15 percent. The most severely affected (83 percent) are manufacturing occupations, but also business-related service occupations at 60 percent, management and organization occupations at 57 percent, agriculture and forestry occupations and horticulture at 44 percent and so on. 2013–2016 are particularly strong Logistics and transport occupations increased (from 36 to 56 percent), an area in which about 2.4 million people are employed in Germany. Overall, the study assumes that in the near future, 70 percent of human paid labor could be carried by machinery. Machines could, e.g., take over: incoming goods inspection, assembly inspection, picking, insurance applications, tax returns, etc. The techniques that drive these changes are: artificial intelligence, big data, 3-D printing, and virtual reality. Even if it did not come to layoffs, employees must expect at least with strong changes in their job profile and thus strong relearning. There will also be new occupational fields. Also, not everything that is already possible today will be implemented and certainly not immediately. Factors for this delay are ethical and legal aspects as well as the high costs of automation. Artificial intelligence is not always cheaper than human intelligence (Dengler und Matthes 2018; Eckert 2018).

Stephen Hawking warned of AI in 2014 and sees it as a threat to humanity. The AI could usher in the end of humanity. Whether the machines will eventually take control will show the future. But already today it is clear that the machines are increasingly displacing people from the labor market (Handelsblatt 2014).

Elon Musk has warned of the destructive power of Artificial Intelligence (AI)—but he formulated his fear of an existential threat to humanity more drastically than before. "The competition for supremacy in AI at the national level, in my opinion, the most likely trigger of the Third World War," tweeted the head of the car manufacturer Tesla and the space company Space X. The Tesla boss is one of the entrepreneurs in the USAdemanding a strong regulation of artificial intelligence. "Governments do not have to follow normal laws," Musk claimed. If necessary, they would also force companies to make their AI technology available to them (Jansen 2017).

In August 2017, 116 entrepreneurs and technology experts called for an open letter to the UN to ban autonomous weapons or the CCW, which had been in existence since 1983 List should be set. The Certain Conventional Weapons are banned by the UN and include chemical weapons. After black powder and the atom bomb threatened the third revolution of the warfare. Quote from the letter: "Once this Pandora's box is opened, it will be difficult to close it again" and "Once invented, they could allow for armed conflict to an unprecedented extent, and faster than people can conceive it." Terrorists and despots could use and even hack the autonomous weapons (t3n 2017).

9.3 Principles for the Application of Artificial Intelligence

There are some recommendations proposed for AI studies. The followed propositions are described in Mannino et al. (2015).

1. Responsible handling: As with all other technologies, when researching AI, care should be taken to ensure that the (potential) benefits clearly outweigh the (potential) disadvantages.
2. Acting with foresight: For example, as with climate change, incentives should be created for researchers and decision-makers to deal with AI future scenarios. This will help lay the foundations for precautionary measures.
3. Education: Targeted educational content adjustments could help prepare people better for new challenges. Computer and programming skills, for example, are gaining considerable relevance, while knowledge learned by heart loses value. Gamification of learning content offers great potential to be promoted. The social and psychological impact of the Internet should be further investigated and the pathological consumption of video games and online media should be avoided.
4. Openness to new measures: The subsidization of human labor, an unconditional basic income, and negative income tax have been proposed as possible measures to cushion socially the negative effects of increasing automation. It is necessary to clarify which other options exist and which package of measures is maximally expedient. For this purpose, advantages and disadvantages must be systematically analyzed and discussed at the political level.
5. Information: An effective improvement in the safety of artificial intelligence begins with the education of AI professionals, investors, and policymakers. Information about the risks associated with AI advances needs to be made easily accessible.
6. AI security: There has been a significant increase in investment in AI research in recent years. By contrast, research on AI security has lagged far behind. The only organization in the world that gives top priority to research into the

theoretical and technical problems of AI security is the Machine Intelligence Research Institute (MIRI).

7. Global Cooperation and Coordination: Economic and military incentives create a competitive climate in which there is almost certainly a dangerous arms race. This would reduce the safety of AI research in favor of faster progress and cost reductions. Increased international cooperation can counteract this dynamic.
8. Research: To be able to make ethical decisions, it is essential to know which natural and artificial systems are conscious and in particular capable of suffering. Especially in the field of machine awareness, however, there is still great uncertainty. It therefore seems sensible to promote appropriate interdisciplinary research (philosophy, neuroscience, computer science).
9. Regulation: It is now a standard practice to have experiments on living test subjects checked by ethics committees. Due to the possibility that neuromorphic computers and simulated living things also develop consciousness or a subjective inner perspective, research should also be conducted on them under the strict supervision of ethics committees.

For the first time, the OECD proposes some principles for AI (Riedel 2019). The recommendation contains five complementary value-based principles for responsible governance of trusted AI (OECD 2019a):

- AI should benefit people and the planet by promoting inclusive growth, sustainable development, and quality of life.
- AI systems should be designed in a way that respects the rule of law, human rights, democratic values, and diversity, and should provide adequate safeguards—e.g., if necessary, the possibility of human intervention—provide. The goal is a fair and just society.
- AI systems should ensure transparency and responsible disclosure to ensure that people understand and question AI-based outcomes.
- AI systems need to be robust and secure throughout their lifecycle, and potential risks should be continually assessed and controlled.
- The organizations and individuals who develop, implement, or operate AI systems should be accountable for their proper operation in accordance with the principles set out above.

In addition, AI actors should respect the rule of law, human rights, and democratic values throughout the lifecycle of an AI system. These include freedom, dignity and self-determination, privacy and data protection, non-discrimination and equal treatment, diversity, fairness, social justice, and internationally recognized labor rights. To this end, AI actors should introduce mechanisms and safeguards, such as human decision-making, that are appropriate to the context and state-of-the-art. AI actors should commit to transparency and good governance in AI systems. To this end, relevant, context-appropriate, and state-of-the-art information should be provided. Besides this, countries should also work closely with stakeholders to promote the responsible use of AI in the workplace, increase workers' safety and quality of employment, strengthen entrepreneurship and productivity, and strive for the fair participation of broad sections of the population to ensure the benefit of AI (OECD 2019b).

Konrad Adenauer Foundation evaluates the German AI strategy in a study and the following points are mentioned (Groth and Straube 2019):

1. Provide commercial incentives to provide data and set up data exchange protocols to ensure the availability of high-quality data while maintaining high security standards.
2. Invest in the development and commercialization of CPU, GPU, TPU, and Quantum Computing-based computing power.
3. Prioritize the expansion of continuing education courses on AI. Society needs to be able to educate digital literacy and data science.
4. Consider and integrate security policy as an AI field of application in the strategy. In contrast to, for example, the USA or Russia, the federal government‘s AI strategy has no relation to security policy. In light of the dangers of AI-based cyberattacks or the risks of AI's military use in lethal autonomous weapon systems, this gap needs to be closed.
5. Establishment of a centralized and digitally competent governance structure in the form of a digital ministry, which can bundle, coordinate and, where necessary, direct the implementation of the strategy and related initiatives of the various ministries.
6. Strengthen global networks with developing and emerging countries. Through culture-sensitive and locally adapted AI funding approaches, Germany can support developing and emerging countries in the field of AI and make the potential of ethically reflected AI made in Germany/Europe accessible to aspiring countries.
7. Support for a "Digital Magna Carta" that goes beyond AI observatories and cooperation with UN, G7 and G20, and involves civil society in all regions of the world through a new AI-driven consensus mechanism.
8. Expansion of recruiting programs for leading academic staff in international countries, based on the existing German Academic International Network.
9. To further promote the permeability between science and industry along existing value chains to strengthen the commercialization and scaling of excellent basic research. Examples and best practices can be identified in the USA, Israel, Finland, France, and Japan.
10. Expanding research collaborations outside Europe with complementary institutions in the USA, Canada, Japan, and South Korea. A concerted strategic participation of German actors in these institutes and networks would have to be captured by means of a dashboard from different target variables in order to be able to moderate the exchange of knowledge.
11. Implement the already planned tax deductibility of research and development costs in the private sector, in particular for research-based small and medium-sized enterprises.

12. Promotion of more efficient innovation ecosystems. For this purpose, measures of the AI strategy should focus not only on the strengthening of startups at the national level, but on a pan-European level.
13. Promote knowledge transfer between civil servants, entrepreneurs, and employees. Conceivable programs for this purpose are programs of study between companies, authorities, and science, as provided for in the Obama administration's American AI strategy.
14. Strengthen the public sector as a user and procurer of ethically correct AI. This requires a more agile procurement process, which uses more competitive dialogues and innovation partnerships as part of EU law, as well as applying the instrument of innovation competition.

It should be noted that on the basis of all envisaged principles, the AI should be applied to serve human beings.

9.4 How Do Artificial Intelligence Applications Affect the Capitalist System?

In 2013, scientists Carl Benedikt Frey and Michael Osborne published a number that shocked many. Almost half of the jobs in the USA could be threatened by automation, they wrote in the study "The Future of Employment" (Schirmer 2019).

It should be emphasized that, as in all economic systems, capitalism is the system in which there are specific relations of production. It should not be forgotten that even in the capitalist system, the most basic element of these relations is labor (whether qualified or unqualified). If the labor force will withdraw from the production process with the spread of artificial intelligence (no one speaks of a certain limit), can one speak of a production relationship without a labor force?

The value determining factor in economic theory has been questioned by many prominent economists such as Adam Smith, David Ricardo, Jean-Baptiste Say, William Nassau Senior, William Stanley Jevons, and Carl Menger. Adam Smith put forward the idea that value was created entirely by labor in primitive societies without private property and capital accumulation. This idea was extended by David Ricardo and Karl Marx to the principle that labor was the only factor that created value at all times and called the labor-value theory. Since labor-value theory defies the profit theory of capitalism, which is based on capital in essence, it has been tried to be softened by Jean-Baptiste Say and William Nassau Senior. Labor, which is the primary source of value in labor-value theory, has become a derivative production factor shaped according to consumer preferences in marginal utility theory. Whether labor is the only production factor that creates value, one and the most important factor that creates value, or whether it is a secondary production factor in value creation is one of the most important topics of discussion in the globalized world economy and the debate has not been concluded yet. The point to consider here is whether labor is value theory or utility value theory, and labor is the source of value.

The labor factor, which determines value as an input factor in labor-value theory, is the demand element in utility value theory. What will be the source of value in a production process where labor is excluded? What will be the source of value in a production process where labor is excluded? If the source of value is not labor, but an intelligent machine (if it is artificial intelligence) then for whom will the value created be produced?

Capitalism is an economic and social system in which material goods are privately owned and the production and distribution of goods is determined by the free market. Classical economists give no place to the state in the economy and rely on the assumption that the economy will automatically provide full employment. Even if underemployment occurs according to classics, this is temporary and the economy will automatically return to full employment. Keynes, on the other hand, asserts that the economy can be caught in the underemployment balance not only in the short term but also in the long term, that the economy does not have the mechanisms to eliminate this situation and considers the state intervention inevitable. According to Keynes, one of the classics proposed by J. Baptiste Say, "each supply creates its own demand" is not correct. Keynes argues that the main cause of the 1929 Great Depression is the inadequacy of total demand, and argues that, unlike the classics, "demand creates its own supply." Behind this view, all producers will increase their investment supplies when demand rises. In case of insufficient private consumption and investment expenditures, it is stated that the state should warn the private consumption and investment expenditures by applying compensatory fiscal policies. In terms of total economy, demand is as important as supply. Supply and demand are the two pillars of the economy. Let's say, through artificial intelligence, the production side of the economy is solved. How will the demand side of the economy be solved? Because how does the labor force who does not participate in the production process spend money and buy the production? Let us assume that this problem will be solved by guaranteeing a certain income level for all households. So how?

Intelligence is a necessary fact for human beings. If the machine will replace the human brain, if the human brain is no longer needed in such a case, the question is: to whom will this benefit? To whom does a development without human beings benefit? If an economic growth does not serve people, who will it serve?

Studies show that, thanks to AI, more jobs are created in the short term than eliminated, and in the long run, it will be technically feasible to replace most jobs. Moreover, despite the fact that new jobs are being created, it is mainly employees who require a very high level of knowledge and years of education at universities. The so-called skill bias in the age of AI will bring forth the most unequal societies of all time. The main problem of the AI-driven economy is that the industry naturally tends to monopolize due to the positive feedback loop resulting from the AI's dependence on data. When a particular company using AI gains an advantage over its competitors, it is very hard to resist a self-sustaining monopolization cycle. Such a company will have advanced algorithms thanks to the already large amount of data. Advanced algorithms deliver a better user experience and more features, attracting more customers. In return, more customers generate more data, further improving the existing algorithms and making the company's products even more attractive, ultimately leading to an even larger customer base, infinitely.

This practice of unlimited artificial intelligence is also contrary to Schumpeter's theory of "creative destruction." Because the basis of this theory is the human mind and its application, not the exclusion of the human mind. Schumpeter explains the concept of innovations by introducing a different definition in terms of production function. As it is known, the production function shows the relationship between the quantities of production factors used and the amount of production. According to Schumpeter, there is innovation if a new production function is created by making a new composition different from production factors without changing the quantities of production factors. In this context, Schumpeter talks about five different types of innovations (Ünsal 2007):

1. Introducing a new product or a different type and quality of a known product to the market;
2. Use of a new production technique in production (a new technique that saves labor and capital factor). It doesn't matter that this new technique has just been discovered, but it is important that it is used for the first time in economic activities and production;
3. The finding and discovery of a new market;
4. Discovery of a new source of raw materials or semi-finished products;
5. Reorganization of industry; monopolization of a fully competitive industry, the establishment of trusts, or the reduction of the power of monopolies to a fully competitive industry.

According to Schumpeter, the successful implementation of innovation by an entrepreneur in an industry, the fact that other entrepreneurs in the industry follow the entrepreneur by imitating innovation leads to investment in the industry. Schumpeter describes this situation as a clustering of innovations, which leads to an increase in profitability and investment created by the entrepreneur who initiated innovation by affecting other entrepreneurs. Joseph Schumpeter's views on growth are explained by two concepts. The first is the concept of innovations and the second is the concept of entrepreneurs. According to Schumpeter, innovation in one industry will affect other industries as investments stimulated by innovations will also increase. In this case, the emergence of innovations in different industries and the clustering of innovations and investments in these industries will be seen (Ünsal 2007). It is important to note that innovation is not just about the production process. Innovation is a much broader concept. At the heart of innovation expressed by Schumpeter is human.

AI practices also contradict Schumpeter's concept of cluster of innovations. Because AI applications contrast with Schumpeter's concept of dynamic monopoly. In the economic growth process of Schumpeter, the concept of monopoly should not be examined separately from the concept of clustering of innovations. Because Schumpeter talks about the spread of innovations, the first entrepreneur's innovation, albeit imitation, leads to the emergence of other innovations, and thus speaks of the emergence of large increases and describes this process as a cluster of innovations.

AI practices are the result of efforts to bring economics into the framework of mathematical and natural sciences. Economics should not be forgotten that it is a social science and it is based on human behavior. Although neoclassical economics assumes that these behaviors are rational, recent studies in the economic literature are distancing from the assumption of rationality.

These developments, contrary to Max Weber's "spirit of capitalism," will bring an end to capitalism. Because, in Max Weber's "spirit of capitalism," the fundamental element is the revolution in the mind. The subject mentioned here is the human mind.

9.5 Conclusion

I think that the economic growth process cannot be achieved by reaching the best production relations or the highest level of knowledge. I consider the existence of the possibility of making mistakes as a factor in the growth process. Because such a possibility enables us to act in the direction of achieving better. More precisely, the possibility of error makes the need to move forward for the better. Here is the point to note: I'm not talking about making mistakes, I'm talking about the possibility of making mistakes. AI application eliminates the possibility of "making mistakes" in the production process over time. In other words, when the better is achieved, the steady state point specified in all growth theories will be reached. With the AI application, reaching the steady state point in the level of knowledge in the process of economic growth will be accelerated.

The ability to achieve better (high-tech) is a feature that will achieve economic growth. The opportunity to achieve better, not to achieve better, will ensure such economic growth. In fact, it is important whether such a perception exists or not, rather than whether it is getting better here. There will always be the motive of getting better in a production relationship where the workforce exists. However, this feature will disappear if the machine replaces the workforce. I think human intelligence needs to be able to control the intelligence of the machine.

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Naib Alakbarov was born in Quba, Azerbaijan, in 1974. After the collapse of the Soviet Union he took place in the first group of students who come to study in Turkey. He completed his undergraduate education in Dokuz Eylul University, Department of Economics and his Master's degree at the Institute of Social Sciences of the same university. As a scholarship student of the Konrad Adenauer Foundation, Naib Alakbarov was for doctoral studies in Germany and received his Ph.D. degree at Dokuz Eylül University in 2013. The subject of Naib Alakbarov's Master's thesis is foreign trade of Turkey and the subject of his doctoral thesis is Optimum Currency Areas theory. Naib is the author of more than 15 articles, 2 books and 3 book chapters. Naib Alakbarov worked in a project on immigrants at the University of Mannheim in Germany and in many private companies in Germany, including Daimler Chrysler. After receiving his Ph.D. degree in 2013, Naib Alakbarov started working as an academician at Usak University. He is currently working in the Department of Economics at Usak University. Naib Alakbarov's academic interests mainly consist of Macroeconomics, European Union and International Economics.

Chapter 10
Providing a Model for Promoting Industrial Productivity with an Emphasis on the Role of Intellectual Capital: A Case Study of East Azerbaijan Province

Nasser Nasiri, Ahad Lotfi, and Saeid Hajihassaniasl

Abstract Considering the increasing importance of productivity in increasing the economic growth of developing countries and also the transition to Industry 4.0, the fourth generation of the Industrial Revolution, optimizing the use of production resources and increasing the productivity of industries based on science and knowledge are among the most important goals of countries. This research has been conducted with the aim of providing a model for promoting industrial productivity with an emphasis on the role of intellectual capital in the leather and footwear industry of East Azerbaijan province of Iran in 2017. The present study is descriptive in terms of its implementation method with field approach, and is considered as an applied research in terms of its purpose. Data were collected using Bontis' (1998) Intellectual Capital Standard Questionnaire and Moghimi's (2009) Industry Productivity Questionnaire. The results of the test of research hypotheses obtained using the structural equation model showed that intellectual capital has a positive and significant effect on promoting organizational productivity in leather and footwear industries in East Azerbaijan province. Also, the test of secondary hypotheses shows that human, structural, and relational capital have a positive and significant effect on the promotion of organizational productivity in the leather and footwear industries of East Azerbaijan province. Therefore, any steps that can be taken to improve the quality and quantity of these variables can be effective in promoting the productivity of this industry.

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Keywords Organizational productivity · Intellectual capital · Human capital · Structural capital · Relational capital

10.1 Introduction

Today, the developing field of intellectual capital is an exciting subject for both researchers and business executives. Intellectual capital is conceptualized by various disciplines; Accountants are interested in measuring it in balance, and IT professionals seek to encrypt it in information systems. Human resources managers are willing to calculate the return on investment through which the education and development staff will make sure that they can put it into human resources development plans. What in the future world is the creator of economic value is not oil and gas, and things like them, but are intangible organizational assets (Asadi et al. 2013, 32). The increasing intensity of global competition, increasing uncertainty, and increasing demand for diverse products and services on the other hand, has led industries to create distinct competitive advantages over competitors, with emphasis on intellectual capital, services, and manufacturing processes. In fact, industries have well recognized the importance of the role of intellectual capital and competitiveness in better supplying customers' needs compared to their competitors in their products, thereby enhancing their productivity, profitability, and survival.

The importance of leather and footwear industries in East Azarbaijan province in terms of creating employment and creating added value and export revenues as well as the long history of this industry in East Azerbaijan province and its transformation into an industrial hub in the country and its presentation as a competitive advantage, the sensitivity of this industry has doubled. Therefore, in order to increase productivity in these industries, a model should be presented that utilizes human resources and tools and its resources as much as possible and has the necessary power to face today's market developments and competitive conditions. Adopting a suitable strategy is one of the important and effective factors in promoting productivity. In today's changing world, where competition, creativity, and innovation, as well as the productivity and job satisfaction of employees are the cause of the survival of the organization, the proper use of intellectual capital can be considered as one of the most important factors affecting this process of operation. In this regard, the present study aims to provide a model for measuring the impact of intellectual capital with three components (human, structural, and relational) on promoting the productivity of leather and footwear industries in East Azerbaijan province.

10.2 Theoretical Framework and Empirical Research Studies

Given the limited production resources in developing countries, increasing productivity in these countries is important as a basic necessity for improving the standard of living of the people. Therefore, in today's world, increasing productivity is not a choice, but a coercion and a vital and necessary thing (Sanaati et al. 2007, 106).

Higher productivity, on the one hand, improves the quality of products while therewithal decreases prices (Xu et al. 2018), and, on the other hand, increases the profits of shareholders (Mohammadi Pirasteh et al. 2012, 212). The positive role of productivity in increasing national welfare has now been definitively acknowledged. Since productivity is a factor in the growth of all living standards, productivity growth should not only focus on business goals and business profits; It should include all aspects of life as well as aspects of society (Walker 2015, 69).

Among the various factors affecting productivity, two groups of internal and external factors play a major role; Internal factors are factors that can be controlled by an individual or firm, and external factors are those that are beyond the control of individuals and firms or organizations. Hence, the first step toward increasing productivity is to identify the range of problems within the framework of these two groups of internal and external factors. According to Jones et al. (2006, 531), internal factors can be divided into two categories of hardware and software components. Similarly, external factors are also classified into three groups: structural factors, resources, and efficiency-related factors. Today, the best approach to increasing productivity is using a hybrid approach. Some effective strategies to achieve this goal are presented by Walker (2015, 71) as follows:

- Improving the effectiveness of human resources through training;
- Improving the production process through automation (replacing the machine instead of the hand);
- Improving production design through the creation of easy-to-integrate products (assembling);
- Improving production facilities.

Theoretically, productivity growth in organizations can have a very close relationship with intangible assets, especially intellectual capital and so much focus is on it. Undoubtedly, today, in organizations, in addition to tangible assets, intangible assets also play a key role in the success of them. Because these resources are part of endless resources and are important elements of the success of any organization (Wang and Chang 2014, 223). Meanwhile, intellectual capital is one of the most important intangible assets of the organization, and it is considered as a valuable tool for the development of key assets of the organization. Intellectual capital is the realm of science and knowledge and can play a very important role in the continuous success of the organization (Ardalan and Beheshti 2015, 123). By entering the knowledge-based economy, knowledge of organizations has become more prevalent in comparison with other factors of production, such as land, capital, machinery, etc., and so, in this economy, knowledge is considered as the most important factor of production and competitive advantage of organizations (Phusavat 2014, 814).

The term intellectual capital was first noticed in 1962 by Fritz Machlup. Peter Drucker (1969) used the term "knowledge workers." The first theoretical work on intangible assets in the early 1980s was published by Itami and Roehl (1991) in Japan. Kujansivu, P and Lonqvist (2007) argue that intellectual capital is very important for the competitiveness of firms regardless of the type of industry, However, it is more important for knowledge-based firms because of the fact that major resources are invisible (Abolhasani and Shariat Jafari 2012, 82). Shao-chi Cheng et al. (2008) based on a sample of US firms, found that firms with intellectual capital gain more wealth. There is also a positive and significant interaction between intellectual capital and the experience. In their article in 2002, Bontis et al. define Intellectual Capital as: Intellectual capital shows the accumulation of knowledge that exists at a particular point in time in an organization. In this definition, the relationship between intellectual capital and organizational learning has been considered (Namamian et al. 2012, 76).

Khalique et al. (2015), argue that intellectual capital is based primarily on intangible assets such as innovation capabilities, knowledge, skills, intellectual property, creativity, and education.

According to Bontis (1998), intellectual capital has three dimensions of human capital, structure, and relationship or customer. Each of these three components can be summarized as follows:

- Human capital is the basis of intellectual capital and is an essential element in the performance of its duties. Human capital refers to the capabilities, skills, and expertise of human members that lead to the creation of valuable assets for the organization (Bontis 2000, 124).
- Structural capital includes all inhuman resources and knowledge in the organization, which includes databases, organizational charts, process implementation instructions, strategies, executive programs or in general, anything that is value for the organization is higher than its material values (Martins and Lopes dos Reis, 2010, 15).
- Relational capital is defined as all the resources associated with the foreign relations of the trade unit, including the relationship with customers, suppliers, and contributors to R & D projects. In fact, the capital employed is a factor for the transformation of intellectual capital into value. The capital employed, also called as relationship capital or customer capital (Bontis 2000, 126).

These three components of intellectual capital have interdependence. Intellectual capital provides the best possible value for organizations by combining, implementing, interacting, integrating, and balancing the three components themselves, as well as managing the flow of knowledge among them (Ebrahimi 2011, 77).

10.3 Industry

Industry is an integral part of the economy. Since the evolution of industrialization, industry has undergone paradigm shifts due to technological changes and innovations. These paradigm shifts, for example, mechanization (1st industrial revolution), high electrical energy use (2nd industrial revolution), electronics and automation (3rd Industrial revolution), are known as "industrial revolutions." But in recent days of Industry 4.0, this latest automation trend, which includes processes and products from driverless cars, intelligent robots, artificial intelligence (AI), internet of things (IoT), big data analysis, cloud computing and virtual reality, simply mentions the new face of robotization. Therefore, the work done and the way of doing business will change forever and we have to keep up with this change and transformation.

Historical Development of Industry and the Concept of Industry 4.0

In the historical process, 3 major industrial revolutions took place in the development of modern industry. In the 1st Industrial Revolution, which started with the mechanization of the looms in England in the middle of the eighteenth century, production was rapidly mechanized and transported to factories as a result of increasing mobility by using coal and steam instead of wood. However, the use of iron, steam, and coal together as raw material and energy source has accelerated the development of railways. In this way, the transportation of both raw materials and products with these developing railways became easier and the Industrial Revolution spread rapidly throughout Europe.

At the beginning of the twentieth century, the world entered a second industrial revolution with the introduction of steel and the use of electricity in factories. The introduction of electricity helped manufacturers increase productivity and make factory machines more mobile. At this stage, mass production varieties such as assembly lines were introduced as a way to increase productivity. In this way, the development of industry gained momentum rapidly and the 2nd Industrial Revolution took place. Afterward, the 3rd Industrial Revolution (Industry 3.0), which includes the process from the 1970s to the present, has gone beyond the analog process of production systems and digital systems have entered our lives. Thus, the first three industrial revolutions brought mechanization, electricity, and information technology (IT) to human-centered production (Qin et al. 2016).

The industrial revolution, which was first mentioned as a concept by Louis-Guillaume Otto on July 6, 1799, was named as Industry 4.0 at the Hannover Fair in Germany in 2011. Industry 4.0 expressing the Fourth Industrial Revolution; It is a concept that deals with the developments in the fields of information and communication, automation, data collection and sharing, and new approaches in production Technologies (Banger 2018). In other words, Industry 4.0 is a new situation that occurs when ICT, communication, and internet technologies intensively affect and transform production processes. Industry 4.0 attaches importance to a whole new level and digital technology through interconnection through the Internet of Things (IoT), access to real-time data, and the introduction of cyber-physical systems and therefore, introduced a more comprehensive, interconnected, and holistic approach to production (Özsoylu 2017).

Similarly, Industry 4.0 is a holistic term that encompasses countless and innovative automation systems, including data exchange and production technology breakthroughs (Firat and Firat 2018).

The most important features that make this revolution different from others are as follows:

- *Speed:* Industrial developments in today and the last 10 years are developing in a surprising way. Every day, scientific and technological developments are experienced and this situation prepares the ground for new developments.
- *Width and Depth:* This revolution, which is based on the infrastructure of digital technologies, is progressing by creating unprecedented series of value changes in people, society, and business world and revealing its own unique equipment. In this way, the differences between generations increase more than ever.
- *System Impact:* While Industry 4.0 continues to evolve through a network that surrounds a world where everything is in a network of interaction with contemporary information and management systems, it includes the collective transformation of all existing systems in the world. With all this in mind, the Industry 4.0 revolution can be described as the digitalization of the industry. However, this should not be considered as a production line, but as a digitization of all the activities and processes of a company (Iren 2016).

Intellectual Capital and Industry 4.0

The fourth-generation Industry is causing a major change in production technology and social systems. This means that knowledge, skills, and competence are the only rules of progress with Industry 4.0. Innovation is the most important factor influencing competition in the Industry 4.0 process. It is also the most important variable in the context of sustainable competition. Digital technologies in Industry 4.0 are thought to lead to more skillfulness without sacrificing quality or cost. This will enable a company to find faster inventions and to produce more efficiently and thus to achieve higher profits. As it is known, learning and being innovative are considered as key factors in Industry 4.0. As innovation times become shorter, firms should be prepared to renew their existing investment and knowledge and skills as needed. Firms need to focus on acquiring new information and technologies. In this way, they need to transform the acquired knowledge into core competence and then develop new products based on core competence (Hermann et al. 2016).

Certainly, in the fourth generation of industries, innovation and technology, there are two segments that benefit: those with intellectual capital and those with physical capital. Intellectual capital can help firms identify and develop intangible assets that are critical to promoting the implementation of Industry 4.0. There is a common idea that intellectual capital is in one of three dimensions: employees (Human Capital), structures (Structural Capital), and customers (Relational Capital). Human capital is located in the center of Industry 4.0 and provides the most knowledge from experience. Structural capital is another factor that supports the development of human capital and finally other key factors of Industry 4.0 are Relational capital. Looking at these factors, Industry 4.0 is expected to grow gradually in terms of technological change impact. Therefore, Industry 4.0 is closely related to technical and social innovations (Cabrita et al. 2018).

Industry 4.0 and Labor Market

The fact of faster and cheaper production using the flexible labor by eastern industry has forced the West to take action recently. Germany's first movement that has echoed all over the World coincided with taking action by the West to provide more efficient and cheaper goods everywhere and to direct it from virtual power plants. Getting away from muscle strength will increase considerable production probably, and therefore firms only needs will be human capital (Zafer and Vardarlier 2020). In other words, with the fourth industrial revolution, it is aimed to increase the level of information numbering in the manufacturing industry and thus to equip production with advanced technology. In which technical staff can be found, the system will save by excluding the labor force majority and for this reason, the productivity will be increased. At the same time, the system in which faultlessness is targeted has ability to reduce the error to zero (Egilmez 2018).

The main challenge of this new revolution is to increase income inequality, especially in a way that distorts the labor market. The analysis of the mechanism of increasing inequality in the era of the Fourth Industrial Revolution is not so complex; The automation of the production process on a very broad and comprehensive scale, the substitution of machines and computers rather than the thinking and skill of the labor force has reduced the efficiency of the labor force in general and in particular more prominent against the return of capital. So, the capitalist gains more profits and the weaker middle class, whose main source of income is the wage, will be lost. Of course, it cannot be ignored that the substitution of technology rather than the labor force as a whole will create jobs that have higher safety and even higher income than previous periods. At the present moment, it cannot predict the end and the net result of these two scenarios, which have a higher probability of occurrence. But one would expect the combination of the two scenarios to be more plausible in the sense that on the one hand the efficiency of labor force against the efficiency of capital promotes inequality, and on the other hand, new jobs create higher wages that will benefit the working class. After all, in the labor market, it is an indisputable fact: skill, talent, and intelligence will become even more important than capital as a factor in production.

Industry 4.0 and Business Environment

In the fourth generation of industry, in addition to the labor market, the production side of the economy has also undergone substantial changes and shifts. Changes in production ways and mechanisms to meet the needs of the production process, along with taking advantage of the digital world and cyberspace and unlimited access to R&D resources, marketing and discovering of new markets, new ways of selling and distributing goods all cause profound shifts and vast changes in the production side. Under these changes, newcomer firms that equipped with new tools, have been able to easily and quickly capture the market and drive existing, well-managed companies. The demand side of the economy has also undergone radical changes at the same time as other sectors. Increased transparency in markets and information, deep and widespread consumer awareness of the production process and market mechanism as well as changing consumer behavior due to existence of virtual networks, all are demand side developments. These new conditions of demand have changed the advertising and marketing behavior of manufacturers and companies as well as the delivery of services and the way in which goods are sold and delivered.

Litrature Review

Among the many studies available, it can be noted that Ghiasi Nodooshan and Aminolroaya in 2016 referred to the impact of the dimensions of social capital and intellectual capital on the productivity of human resources. The results of this study show that in the conceptual model of research, human intellectual and relational capital and social and structural capital have a significant effect on human resource productivity. In another study, Nazem and Sadeghi, in 2015, investigated the structural model of productivity based on social capital and intellectual capital in education. The results show that there is a significant relationship between intellectual capital and social capital with productivity that the factor of human capital and customer capital of intellectual capital dimensions and the mass correlation factor of social capital dimensions have the most direct effect on increasing productivity. Ahmadian and Rahim Ghorbani in 2013 examined the relationship between intellectual capital and organizational performance: studied by the Ministry of Economic Affairs and Finance. The final result of this study also showed a significant relationship between intellectual capital components and organizational performance. Mohammadi Pirasteh et al. in 2012 have investigated the relationship between intellectual capital and productivity in the banking industry of Lorestan province. According to the findings of this study, there is a strong and significant relationship between intellectual capital and productivity of banking industry employees and all dimensions of intellectual capital have a positive and significant impact on productivity, and among the elements of intellectual capital, customer capital has the most impact on productivity.

> In a 2010 study, Mojtahedzadeh et al. investigated the relationship between intellectual capital and insurance industry performance from the managers' point of view, The results show that intellectual capital (human, customer and structural) has a significant relationship with performance in a separate and independent study whereas, in the simultaneous study, only the relationship between structural and human capital with performance is significant.

Vaisanen et al. in 2015 examined the impact of intellectual capital on productivity and profitability. They came to the unexpected conclusion that in the short run, investing in intellectual capital has a negative impact on productivity and profitability. Saengchan (2008) in his research in the Thai banking industry in 2015 concluded that there was a strong relationship between intellectual capital efficiency and bank productivity. Sumita in 2014 concludes that intellectual capital-based management, has a rational and close relationship with innovation and this form of management can be a suitable solution to the challenges of globalization. Bharathi in 2013 examines the relationship between intellectual capital and performance of companies in the pharmaceutical industry in India and has been concluded that among the elements of intellectual capital, human capital has the most effect on performance. Huang and Jim Wu (2010) examined the relationship between intellectual capital and knowledge productivity in the pharmaceutical industry in Taiwan and they concluded that there was a strong and positive relationship between intellectual capital and productivity of knowledge.

Research Methodology

The present study is a descriptive field research in terms of method and is an applied research in terms of purpose. In this study, library resources including books and scientific articles, online resources, and document analysis were used to formulate the theoretical foundations of the research and next, a standard questionnaire was used to examine the variables. Specific intellectual capital questions consist of 3 components (human capital, structural, and relational capital), the original version of the Intellectual Capital Questionnaire (Bontis 1998) was administered in Canada and Malaysia, that contains 21 questions. Specific questions on industrial productivity were also collected using the standard questionnaire of Moghimi (2009), with 5 components (stakeholder satisfaction, optimal resource allocation, cost reduction, service quality, and process speed) comprising 19 questions in total. All questions are scored on a Likert scale.

The statistical population of the research includes 3100 manufacturing units in East Azerbaijan province leather and footwear industries. According to the standard Krejcie and Morgan table, 341 production units were randomly selected to obtain the information. Finally, after collecting the questionnaire, and calculating the reliability and validity of the questionnaires, data analysis was performed using structural equation modeling and using SPSS and AMOS software. In this study, three hypotheses will be tested as follows:

Main Hypothesis

- Intellectual capital has a significant impact on promoting the productivity of leather and footwear industries in East Azerbaijan province.

Secondary Hypothesis

- Human capital has a significant impact on improving the productivity of leather and footwear industries in East Azerbaijan province.
- Structural capital has a significant impact on improving the productivity of leather and footwear industries in East Azerbaijan province.
- Relational capital has a significant impact on improving the productivity of leather and footwear industries in East Azerbaijan province.

Research Findings

Despite the use of standard questionnaires and no serious need to calculate the reliability and validity of the questionnaire, due to the use of intellectual capital questions (Bontis 1998), the reliability and validity of the questionnaires were calculated to be more reliable. Initially, the validity of the questionnaires was confirmed by several academic professors. The results obtained by calculating the reliability using Cronbach's alpha statistic also showed that, given the numerical value of 0.93 for this statistic, the reliability of the questions was confirmed and the possibility of using and continuing the data analysis existed.

In order to checking the normality of variables distribution, the Kolmogorov-Smirnov test was applied. The related test null hypothesis indicates normal distribution. The null hypothesis will be confirmed in the case that significance level of the test would be greater than 0.05 and therefore it is concluded that the related variable distribution is normal. According to the obtained significant levels stated in Table 10.1, all variables distribution are normal.

Next, Pearson correlation coefficient test was used to investigate the relationship between the research variables with respect to the normality of the data distribution. The null hypothesis in this test is that the correlation coefficient is zero (no relationship). If the significance level of the test is less than 0.05 the null hypothesis will be rejected. The results of Pearson correlation coefficient show that there is a significant positive relationship between intellectual capital and its dimensions with organizational productivity and its dimensions (correlation coefficient is positive and significance level is less than 0.05) (Table 10.2).

Structural Equation Modeling was used to test the research hypotheses. The calculations are done in AMOS software. First, the general fit of the model is examined

Table 10.1 Kolmogorov-Smirnoff test results for normality distribution of scores

Variables	Quantity	Kolmogorov-Smirnov Z statistic	Significance level
Productivity Improvement	285	1.008	0.261
Intellectual Capital	285	1.317	0.057
Human Capital	285	1.305	0.06
Structural Capital	285	1.291	0.068
Relational Capital	285	1.302	0.064

Source Research findings

and then the hypotheses are tested. The results of applying the general model show that the statistical significance of the chi-square test is 82.36 and its significance level is 0.01. Considering the significance level of the chi-square test that is less than 0.05, it is concluded that the collected data are matched with the theoretical model of research and this model will be reliable. Other measured indices also indicate the suitability of the theoretical model of research. The goodness-of-fit index (GFI) is 0.95, indicating that this value is acceptable for optimal model fit. The Root Mean Square Error of Approximation (RMSEA) is 0.043 which indicates that it is less than 0.05 indicating the validation of the research model. The Tucker-Lewis index (TLI) was 0.94; the Confirmatory Fit Index (CFI) was 0.96 and the Parsimony Normed Fit Index (PNFI) was 0.94, all indicating a good and acceptable fit to the research model (Table 10.3).

Results of Hypothesis Testing

Main Hypothesis

Intellectual capital has a significant effect on improving the productivity of leather and footwear industries in East Azerbaijan province.

The results of the path analysis indicate that the estimated coefficient is 0.456, the standard coefficient is 0.623, the critical ratio is 4.21 and the significance level is 0.000.

Considering the smaller level of significance of 0.05 and the critical ratio of 1.96, it is concluded that the impact of intellectual capital on promoting productivity of industries is significant. Therefore, with 95% confidence interval, we can say that intellectual capital has a positive and significant effect on productivity improvement in East Azerbaijan province leather and footwear industries Table 10.4.

Table 10.2 Pearson correlation matrix for the research variables

		Structural capital	Relational capital	Stakeholders satisfaction	Optimal allocation	Cost reduction	Quality of services	Speed of process
Structural capital	Correlation coefficient	0.697	1					
	Significance level	0						
Relational capital	Correlation coefficient	0.769	0.556	1				
	Significance level	0	0.001					
Stakeholders satisfaction	Correlation coefficient	0.49	0.351	0.542	1			
	Significance level	0.012	0.001	0				
Optimal allocation	Correlation coefficient	0.411	0.269	0.422	0.67	1		
	Significance level	0	0.013	0.001	0			
Costs reduction	Correlation coefficient	0.471	0.263	0.507	0.679	0.615		

(continued)

Table 10.2 (continued)

		Structural capital	Relational capital	Stakeholders satisfaction	Optimal allocation	Cost reduction	Quality of services	Speed of process
	Significance level	0	0.021	0	0	0.000		
Quality of services	Correlation coefficient	0.529	0.363	0.475	0.638	0.500	0.549	1
	Significance level	0	0.001	0	0	0.000	0.000	
Speed of processes	Correlation coefficient	0.311	0.139	0.254	0.588	0.416	0.438	0.419
	Significance level	0.001	0.024	0.021	0	0.000	0.000	0.000

Table 10.3 Structural model fit indicators

	Fitting index	Amount	Criterion	Interpretation
Absoulte	χ^2	82.36 with degree of freedom 19		
	p value	0.01	more than 0.05	no fit
	Goodness of Fit Index (GFI)	0.95	more than 0.90	acceptable
Comparitive	Tucker-Lewis Index (TLI)	0.94	more than 0.90	acceptable
	Confirmatory Fit Index (CFI)	0.96	less than 0.05	Optimal fit
Economical	Root Mean Square Error of Approximation (RMSEA)	0.043	more than 0.90	acceptable
	Parsimony Normed Fit Index (PNFI)	0.94	more than 0.05	Optimal fit

Table 10.4 Regression estimates and significant test for impact of intellectual capital on improving industrial productivity

Independent variable	Dependent variable	Estimated coefficient	Estimated standard error	Critical ratio	Significance level	Standard estimated coefficient
Intellectual capital	Improving the productivity of industries	0.456	0.074	4.218	0	0.623

The Secondary Hypothesis Test

Secondary Hypothesis 1:
Human capital has a significant impact on improving the productivity of leather and footwear industries in East Azerbaijan province.

The results of the path analysis of this model also show that the estimated coefficient is 0.224, the standard coefficient is 0.324, the critical ratio is 3.207 and the significance level is 0.000. Considering the smaller level of significance of 0.05 and the critical ratio of 1.96, it is concluded that the impact of human capital on promoting productivity of industries is significant. Therefore, with 95% confidence level, human capital can have a positive and significant impact on productivity improvement in the leather and footwear industries of this city Table 10.5.

Secondary Hypothesis 2:
Structural capital has a significant impact on improving the productivity of leather and footwear industries in East Azerbaijan province.

The results of path analysis of this model also show that the estimated coefficient is 0.220, the standard coefficient is 0.228, the critical ratio is 3.524, and the significant

Table 10.5 Regression Estimates of the impact of Human Capital on Improving Productivity of Industries

Independent variable	Dependent variable	Estimated coefficient	Estimated standard error	Critical ratio	Significance level	Standard estimated coefficient
Human Capital	Improving the Productivity of Industries	0.456	0.074	4.218	0	0.324

Table 10.6 Regression Estimates of the Impact of Structural Capital on Improving Productivity of Industries

Independent variable	Dependent variable	Estimated coefficient	Estimated standard error	Critical ratio	Significance level	Standard estimated coefficient
Structural Capital	Improving the Productivity of Industries	0.203	0.043	3.524	0.001	0.286

level is 0.001. Considering the significant level greater than 0.05 and the critical ratio lower than 1.96, it is concluded that the effect of structural capital on promoting productivity of industries is significant. Therefore, with 95% confidence level, it can be said that structural capital has a positive and significant effect on productivity improvement in East Azerbaijan province leather and footwear industries Table 10.6.

Secondary Hypothesis 3:

Relational capital has a significant impact on improving the productivity of leather and footwear industries in East Azerbaijan province.

The results of path analysis in this model also show that the estimated coefficient is 0.364, the standard coefficient is 0.412, the critical ratio is 3.63, and the significance level is 0.001. Considering the significant level greater than 0.05 and the critical ratio lower than 1.96, it is concluded that the impact of relational capital on promoting productivity of industries is significant. Therefore, with 95% confidence level, it can be said that relational capital has a positive and significant effect on productivity improvement in East Azerbaijan province leather and footwear industries Table 10.7.

10.4 Conclusions

In recent years, by shifting the dominant economic paradigm from an industrial to a knowledge-based economy, organizations are in a situation where mere attention to physical and financial resources cannot guarantee the survival of organizations against their competitors. So the only way is the simultaneous use of physical,

Table 10.7 Regression Estimates of the Impact of Relational Capital on Improving Productivity of Industries

Independent variable	Dependent variable	Estimated coefficient	Estimated standard error	Critical ratio	Significance level	Standard estimated coefficient
Relational Capital	Improving the Productivity of Industries	0.364	0.067	3.637	0.001	0.412

financial, intellectual, and invisible assets that can provide a sustainable competitive advantage for today's organizations and cause their survival. In sum, it can be said that intellectual capital represents a set of invisible assets that are also known as knowledge assets. This type of capital provides a new resource base through which the organization can compete. It can therefore be argued that intellectual capital is one of the vital resources for developing productivity and performance in organizations.

This paper addresses on some of the aspects of the revolution of fourth Industry 4.0 and intellectual capital approach help ability in Promoting Industrial Productivity. Representative for understanding the Industry 4.0 who makes theoretical contribution, it has also begun to debate about an expanding flow of research in the intellectual capital field. Specifically, the main objective of the fourth Industry is strengthening and expanding long-run competitiveness in the organizations through increasing the production performance by using intelligence and knowledge. In fourth-generation Industry, yet there will be classically working courses that need to be done sufficiently with the people's skills such as creativeness, intelligence, empathy, or elasticity. The background of fourth-generation Industry argued that there is an important role for these technologies while developing and transformation of the classic industry. Activation technologies refer to the application of one or a series of broad and multidisciplinary features to complete tasks. If we are to compete in the new global economy, there is a need for a sufficient supply of high quality, flexible engineering skills at all levels, developed at various levels, through apprenticeship, preparatory degrees, undergraduate degrees, and postgraduate qualifications.

The main purpose of this study was to present a suitable model to measure the impact of intellectual capital components on productivity improvement in East Azerbaijan province leather and footwear industries. In this regard, by attempting to study the theoretical foundations of the subject and extracting the theoretical framework, a conceptual model and its important components were identified and the impact of intellectual capital and its dimensions on promoting the productivity of industries in East Azerbaijan province was investigated.

The analysis of research hypotheses showed that the effect of intellectual capital on productivity improvement in East Azerbaijan province leather and footwear industries is positive and significant. Also the results of secondary hypothesis test showed that human capital, structural and relational capital have a positive and significant effect on productivity improvement in East Azerbaijan province leather and footwear industries. By comparing the results of this study with those of other researchers, it can be concluded that the results are consistent with the results of most researchers in this field.

According to the results of the analysis and the effect of independent variables on the dependent variable of research in order to enhance the human capital index, it is recommended to pay attention to staff training and development and to provide training, advice and support to the ideas presented in the organization and so on. It is also suggested to enhance the Structural Capital Index, train the work team and its related techniques at all levels of the industry, and focus on improving processes and reducing the costs of performing organizational tasks by employees. On the other hand, examining customer expectations and identifying needs, incorporating customer feedback into the design and delivery of services and products, as well as ongoing follow-up and timely response to customer expectations and complaints can be effective in enhancing the relational capital index.

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Part IV
The Impact of AI on Innovation

Chapter 11
Applications of Blockchain Technologies in Health Services: A General Framework for Policymakers

Oğuz Kara and Mehmet Nurullah Kurutkan

Abstract Developments in information and communication technologies lead to radical changes in traditional business models. This transformation process is rapidly changing the principles underpinning existing systems and governance models and makes the traditional role of centralized institutions questionable. Perhaps the newest and most important example of these changes is the "Blockchain" technology. Blockchain claims to provide a deep-rooted solution to the problem of "trust" that exists in traditional commercial relations. Blockchain technology is a technology that does not require a central structure and allows the storage and transmission of commercial or value-containing data (money, identity, valuable papers, etc.) safely and quickly. This contributes to reduced costs, increased efficiency, reduced errors as a result of continuous storage of records in the chain, and the reliability of records kept. Blockchain technology enables it to be implemented in many sectors such as finance, manufacturing, logistics, energy, health care, retail, telecommunications, media, insurance, as well as in public transactions thanks to its technological infrastructure and smart contracts. Due to the cost-cutting effect of blockchain technologies, the use of this technology is of great importance for the health sector and interest in this field is increasing. Blockchain's applications in the medical field cover a wide range of processes, including electronic health records, health insurance, biomedical research, drug supply, purchasing processes, and medical education. Blockchain networks have many promising uses in the healthcare sector, from increasing transparency in the drug supply chain to creating and sharing unchangeable medical records. In the health sector, blockchain technologies can be used at different stages, from drug and medical product development processes to diagnosis, from the e-prescription process to better preservation and use of patient records.

Keywords Blockchain technologies · Healthcare sector · Electronic health records · Electronic medical records · Electronic patient records

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11.1 Introduction

Advancements in data and communication technologies are increasingly facilitating worldwide communication and commercial system. Developments in internet technologies in particular lead to radical changes in traditional business models. This transformation process is rapidly changing the principles underpinning existing systems and governance models and makes the traditional role of centralized institutions questionable. Perhaps the newest and most important example of these changes is the "Blockchain" technology.

Blockchain technology enables individuals, firms, and communities to redesign interactions based on unreliable transactions using the impressive process of change in technology. Blockchain technology stands out as a disruptive technology with the potential to transform the foundations of social and economic systems, leading to significant policy changes for many decision-makers.

Blockchain claims to provide a deep-rooted solution to the problem of "trust" that exists in traditional commercial relations. One of the most basic conditions of commercial relations is the question of "trust" or "mistrust" (Hawlitschek et al. 2018). In order to reduce mistrust and uncertainty in the traditional commercial system, intermediary institutions providing trust-providing services between the parties are needed. Intermediaries reduce uncertainty by supervising and recording transactions between buyer and seller, making it possible for parties that have no reason to trust each other to take action. Intermediaries keep all transactions and records in their own databases. This centralized structure brings with it a number of risks. The first is the requirement that all data related to transactions be kept continuously in sync. The other is whether or not the obligations related to securing the records can be fulfilled by the intermediaries. Blockchain provides the "trust" problem with the structure of the blockchain technology itself and eliminates the need for intermediary institutions in data sharing (Akben and Çınar 2018).

Data scientists today spend 80% of their time collecting, cleaning, and preparing data for processing. On the other hand, with blockchain technology, it is possible to collect, control, save data in a common format and make it ready for access at any time (Dillenberger et al. 2019). Blockchain technology is an innovation that does not require a central structure and allows the storage and transmission of commercial or value-containing data (money, identity, valuable papers, etc.) safely and quickly. Distributed ledger structure enables instant recording, real-time monitoring, control and protection of transactions (Li et al. 2019). This contributes to reduced costs, increased efficiency, reduced errors as a result of continuous storage of records in the chain, and the reliability of records kept (Uysal and Aldemir 2018).

The Blockchain system works on the principle of systematic end-to-end addition (formation of chains) of blocks verified by participants in the distributed data structure, without the need for any third party (Mendi and Çabuk 2018). In Blockchain technology, all users registered in databases (nodes or miners) keep a copy of all the records that have been shared with them. The reliability of the records is maintained over smart contracts using cryptography (Encryption) based on private keys and digital signatures (Yıldız and İbiş 2018).

Blockchain technology enables it to be implemented in many sectors such as finance, manufacturing, logistics, energy, health care, retail, telecommunications, media, insurance, as well as in public transactions thanks to its technological infrastructure and smart contracts (Türkmen and Durbilmez 2018). Blockchain also stands out as a complementary technology. It is possible to integrate with other technologies (Li et al. 2019).

The first part of this section is the operation and application fields of blockchain technology. Later, the possibilities of the use of blockchain technologies were examined, especially in the healthcare sector. Blockchain's applications in the medical field cover a wide range of processes, including electronic health records, health insurance, biomedical research, medicate supply, purchasing processes, and medical education. The transformation process in the health system also needs to be supported by health policies.

11.2 Blockchain Concept

Blockchain technology has entered the world agenda with Bitcoin, a decentralized currency. The Blockchain concept was first used in the 2008 paper " *Bitcoin: a Peer-to-Peer Electronic Cash System*," authored by Satoshi Nakamoto. Blockchain technology was first utilized in an electronic payment system based on mathematical proof and a cryptographic method called "bitcoin" (Do˘gan2018). Later on, it was discovered that Blockchain technology is a much more comprehensive concept and it has been applied in many different fields (Biswas and Gupta 2019).

At the core of Blockchain innovation is the idea of decentralization (Kıyak et al. 2019). Its main feature is that there is no regulatory body/organization or higher authority regulating the system. From a technical point of view, a distributed database can be explained as a combination of decentralized reconciliation mechanisms and cryptographic algorithms. Transactions using Blockchain technology are stored in a sequence of cryptographically interconnected and potentially infinite blocks of data. The formation of these blocks is guaranteed by the participants (nodes) in the system through time-stamped algorithms whose accuracy and validity are not centralized (Tanrıverdi et al. 2019). The concept of blockchain has been defined in different ways due to its technological structure and wide application area. Some of these definitions can be summarized as follows:

According to Nakamoto (2008), Blockchain is a disseminated data structure in which each exchange data made is recorded and shared by members in the network. According to Beck (2018), Blockchain is a database that provides secure and consistent transactions by many nodes in the network. Chaudhary et al. (2019) defined blockchain as a ring in which all-communicating nodes are connected end-to-end (P2P) for information sharing without the need for a trusted third party. Zheng et al. (2017) defined Blockchain as a Data Book in which all approved transactions are stored in blocklists and growing as new blocks are added. Zou et al. (2019) described Blockchain as a decentralized architecture, a distributed computer paradigm that uses bitcoin and other encryption mechanisms. Reyna et al. (2018) described Blockchain as a distributed, transparent, unchangeable, and secure data structure where the reliability of transactions is verified by stakeholders in the network. Glaser (2017) described blockchain as a database that is shared among its clients and where records of important assets are recorded publicly and under pseudonyms, without the need for an intermediary or central authority. Tama et al. (2017) described Blockchain as part of a distributed software system whose purpose is to ensure data integrity (Tanrıverdi et al. 2019: 204). Vitalik Buterin (2015) portrays blockchain as the magic computer that anyone can transfer programs to and leave the programs to self-execute, where the current and all past states of each program are continuosly publicly visible, and which carries a really strong cryptoeconomically secured guarantee. Don Tapscott and Alex Tapscott (2016) describe blockchain technology as "an unhackable digital database that can be programmed to record not just financial transactions but just about anything is valuable."

11.3 How Blockchain Technology Works

Blockchain technology is a set of exchanges without centralized structure that allows reliable and fast sharing of data over the network using the internet network structure and ensures the accuracy of transactions by registered users and specific digital protocols and allows the simultaneous storage of each transaction in blocks attached. How this system works and how data sharing occurs can be explained in stages as follows:

The computers on the Blockchain network are connected over the internet as nodes, end-to-end/peer-to-Peer (P2P: Peer-to-Peer). This network is dynamic and any computer can leave or be involved in the network at any time. An account (wallet) is enough to become a member of the network. All data exchange operations performed on the network are kept in a global ledger called the distributed ledger (open ledger). The records in this ledger are completely transparent and all transactions can be tracked by nodes on the network. None of the nodes in the network need to be reliable and have no superiority to each other (Kırba¸s 2018: 76). The distributed database is maintained simultaneously by all nodes in the network, without being connected to any hub (Fig. 11.1).

The "Centralized network type" in Section (A) of the figure represents single-center networks, "Decentralized networks" in Section (B) represents multicenter networks, and "Distributed network type" in Section (C) represents distributed network structure. The locations depicted with large dots represent each node, station, and the lines represent the connection path of the nodes to each other or the center. Both single-centric and multicentric networks are essentially a subset of distributed networks (Türkmen and Durbilmez 2018).

To create a valid block (data exchange) on the network, a puzzle based on processing power is first asked to be solved by the nodes in the network. This concept is called proof of work (PoW). Participants doing this process are also called miners.

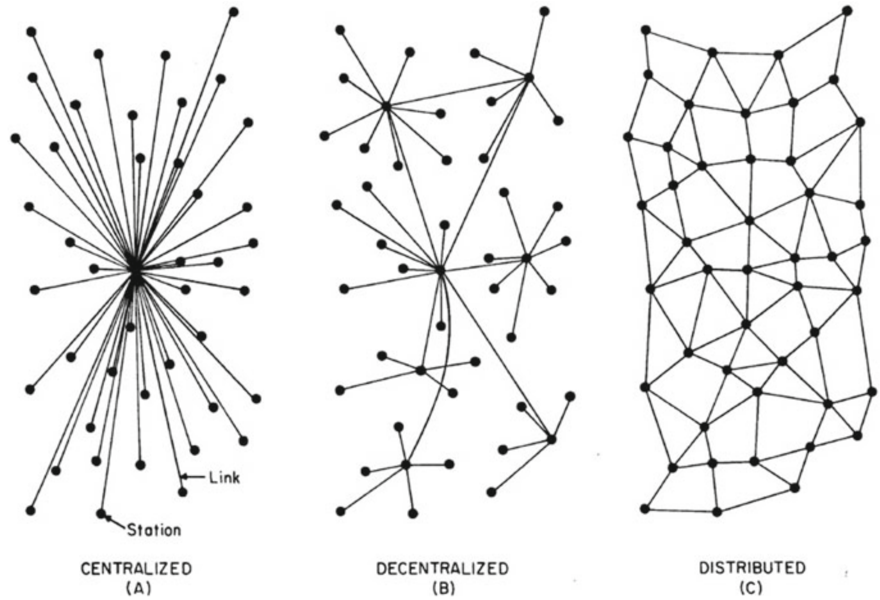

Fig. 11.1 Types of data network (*Source* Baran 1964: 1)

Miners constitute the nodes in this network structure, each miner also has a local copy of the ledger. When one of the miners involved in solving the puzzle finds this value (nonce), the block being worked on is associated with the previous valid block and propagates over the network. Then all parties on the network synchronize by adding the new block to their local databases (Kırba¸s2018). However, within the dispersed system, critical communication costs arise amid process synchronization. Increased transaction costs are due to frequent peer-to-peer (P2P) transactions and synchronization problems (Chaudhary et al. 2019).

Miners are essential for keeping a record of the Blockchain and for transferring (Kırba¸s2018: 79). Miners approve transactions over the network and allow new blocks to be added to the chain. In return, miners on the network will be rewarded with virtual money. Nodes are motivated only by a desire to gain and do not consider the well-being of their other nodes. To receive the prize, the miners compete with each other to complete the process on the peer-to-peer network (Taş and Kiani 2018).

Miners try to find a special "Hash" code from these unconfirmed transactions, called "block," which can also be found by a very large number of trials, which cannot be calculated with a standard formula, referring to the previous valid block. The miner who finds this value first publishes the hash value of the new block and another numeric value, called "Nonce," which allows him to reach that hash at the end of his trial attempts to reach that hash. The miner who completes this process first and adds the block to the chain completes the consensus process and receives the reward of the exchange (Mendi and Çabuk 2018).

The blocks are arranged in a linear sequence over time and grow by adding to the chain as each block dissolves. Each new process is continuously included to the end of the chain by the miner nodes. The ledger is formed by connecting and extending the blocks (Li et al. 2019). The process of adding blocks to the ledger is shown below with the help of a representative figure (Fig. 11.2).

Person A determines the amount of virtual money he wants to transfer and the address of the person B's digital wallet and encrypts this information with the secret key of person A's wallet. Thus, it is understood that this process was created by person A. The encrypted transaction is sent to the network for broadcast. Other network nodes analyze the digital signature to see if it belongs to person A. It is necessary to determine whether the balance in person A's wallet can meet the amount he wants to send to person B and if he does, whether person A transfers money to other people during the same time, i.e., a possible double-spending situation. Apart from these controls, any conflicts encountered need to be resolved and protection against security breaches should also be established. Since there is no central structure in the blockchain, the rules to be followed by nodes in the network are determined by contract protocols. If 51% of the nodes/users on the network verify that the processes are appropriate and valid, the processes are hashed and included to the

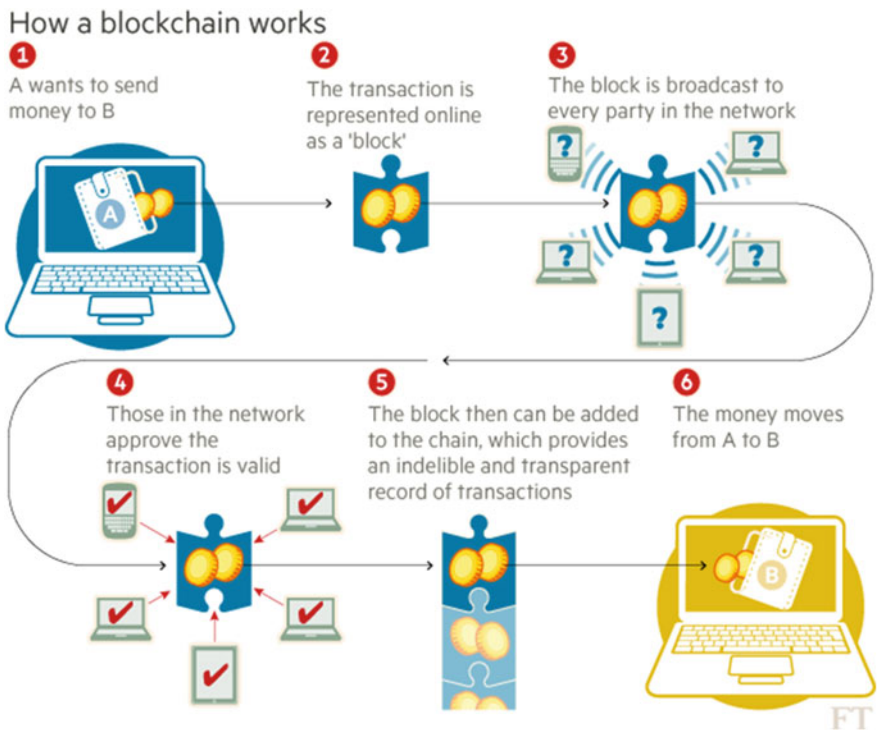

Fig. 11.2 How a blockchain works (*Source* https://www.ft.com/content/eb1f8256-7b4b-11e5-a1fe-567b37f80b64)

blockchain as a block. After the new block is added to the chain and broadcasted, the amount involved in the transaction will be added to the wallet of person B and deducted from the wallet of person A (Tanrıverdi et al. 2019). The data blocks in the system are together secured by all nodes that enable everyone to participate and make the system transparent and controllable. Because of these features, blockchain technology provides the potential to increase Big Data Security (Chen et al. 2019).

In this system, the user who wants to receive and send must have a private key and a public key connected to it. Private Key is the key we need in the digital signing process that we need to implement in order to send our assets to someone else. A sample private key is rough as follows.

$$E3843D74C6D87DC0FB3A5778739382F4453214303DA6F20BD67FC233AD33259$$

The transfer process signed with the private key is broadcast to the P2P network. The message is sent to all nodes to be announced to the entire network, not just to the recipient. The nodes that receive the message for the first time also check that the process is valid and in compliance with the rules, and then broadcast it to the nodes to which they are connected. Therefore, in a short time, the transaction spreads to the entire network, including our recipient. The nodes that receive the message use our public key and try to decrypt and control the message content. When the transaction is successfully approved, it is added to the last block of the appropriate chain (Mendi and Çabuk 2018).

In the blockchain, the first starting block is named “genesis block.” The block is consisted of a block body and block header. The block body contains a total list of transaction records. Each block has the content of the previous block passed through the hash algorithm (Azzi et al. 2019). The person who wants to change a process in the system has to calculate the extracted result of all transactions backward. This process is practically impossible because the calculated results must be the same in all miners (Fig. 11.3).

The block header is the section where important data is kept. This field basically consists of three groups of layers: the summary/hash value of the previous block header, the timestamp, the hash value of Merkle root, which is the summary of transactions in the block, and other fields (version, level of difficulty, Proof of Stake (PoS) (Kırba¸s2018). The hash value is also like a fingerprint that guarantees that the data in the block is authentic. In the event of a modification or destruction of the original data, the hash password of the modified data will be incompatible with the original fingerprint (Atalay 2018). The hash table is created using the hash function. With the support of cryptography technology, this table becomes a secure blockchain registry with a confidentiality protocol. The prerequisite for this is that the data entry into the system is realized through the hash function (Bozkuş 2019).

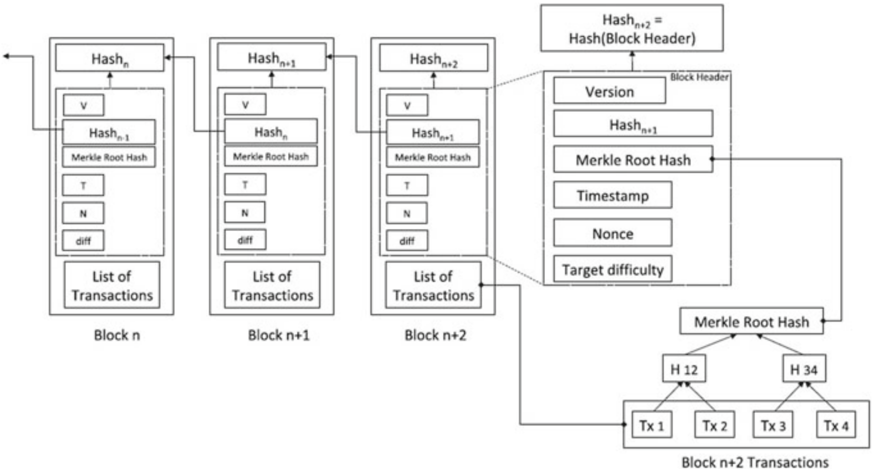

Fig. 11.3 Block structure (*Source* Raikwar et al. 2019: 148553)

11.4 Smart Contracts/Protocols

To ensure that the system is carried out transparently and correctly, nodes have to behave in an honest manner. When multiple miner nodes work to resolve the same block, predefined negotiation protocols are used to resolve conflicts and provide protection against security breaches. Negotiation protocols have been developed to ensure the consistency and safety of blockchain. Smart contracts are based on the storage of any contract conditions in blockchain by converting them into computer codes and continuing until the parties cancel or the terms of the contract are completed (Özdoğan and Karğın 2018). There are many negotiation models in the literature, and each negotiation model provides different solutions to the problems in the blockchain from different perspectives.

Smart contracts led to the creation of the second generation Blockchain smart contracts are part of a program that runs on Blockchain systems. A smart contract consists of address, functions, and specified situations. Contracts are stored on Blockchain. Smart contracts are scripts that run based on “if and then” (when one process provides the necessary rule and the other process takes place). Blockchain, therefore, checks each time the contract is allowed to proceed to the next step (Aktaş 2018). For example, a simple smart contract says, “If so much Bitcoin or Ether (Ethereum’s cryptocurrency) goes into that account, the title deed goes into that person’s name.” As soon as the money is credited to your account, the deed of the house passes to the other side, and these transactions are spread across the Ethereum network (thousands of computers spread around the world) and recorded irreversibly (Kıyak et al. 2019).

In smart contracts, all transactions are carried out electronically by computer systems. Smart Contracts are lines of code that are stored in blockchain and run automatically when predetermined conditions occur. The benefit of smart contracts is mostly seen in business agreements. Smart contracts oblige the parties to comply with the agreements agreed upon without any third party, such as a notary (Taş and Kiani 2018).

Contract/Negotiation protocols commonly use three different mediation protocols and variants (Kardaş 2019). These are proof of stake consensus protocol, proof of work consensus protocol, and byzantine fault-tolerant consensus protocol.

Proof of Work Protocol, PoW

The concept of proof of work was first used by Cynthia Dwork and Moni Naor in the fight against unsolicited emails. This protocol is used to validate operations and generate new blocks (Aggarwal et al. 2019). In this protocol, some computational transactions are requested from the requesting service and/or persons. Although it is moderately difficult for the requesting party it is possible to calculate, it is quite easy for the service provider to control the process (Kardaş 2019). In the proof of work protocol, miners must use an intense energy for proof of work. The main purpose of the proof of work POW-based protocols is to find out the "double spending" problem (Yu et al. 2019). As the number of miners competing to solve the math problem increases, energy and processing time increase (Aggarwal et al. 2019).

Proof of Stake Protocol

The proof of stake consensus protocol was introduced at bitcointalk.org in early 2011 as a coinage for use in Bitcoin. PoS-Proof of Stake has been developed to reduce energy waste (Yu et al. 2019). In this model, any user who holds money in his wallet can also be a verifier. A miner's attempt to verify a fake block reduces its stake (Aggarwal et al. 2019). In the PoS Blockchain network, it gives participants the right to mine as much as the rate they hold. To dig up the blocks, miners have to show that they have some amount of money in their hands above the set threshold. In other words, the more shares (cryptocurrency) a node has in the system (wallet) the more likely it is to gain the right to publish the next block (Kardaş 2019). The PoS protocol protects against malicious attacks, as the person holding large sums of money must risk his money to attack, and this process is costly (Taş and Kiani 2018).

Byzantine Generals Problem Protocol

The Byzantine Fault Tolerance model (BFT) is the generalized case of the two general problems. The Byzantine Generals Problem (BGP) is based on a structure that tolerates failure situations to a certain extent. In the Byzantine Generals Problem, it is assumed that few divisions of the Byzantine army camp outside the enemy city and each division is under the command of its general. Generals are only able to communicate with each other by messenger. After watching the enemy, they must choose upon a common plan of activity. A few of the generals in any case, may be backstabbers attempting to avoid faithful commanders from coming to an understanding. The generals must choose when to assault the city, but they also require a strong majority of their armies to assault it. There must be an algorithm to ensure that

(a) all loyal generals will decide upon the same plan of action, and
(b) will not allow a small number of treacherous loyal generals to draw up a bad plan. The loyal generals will do what the algorithm requires, but the traitors can do anything they want.

The algorithm must guarantee condition (a), regardless of what the traitors are doing. Loyal generals must not only reach an agreement, but they must also agree on a reasonable plan (Kardaş 2019).

The "generals" featured in the story are the members of the Blockchain. The messengers they send to each other are messages sent over the network. The common goal of "loyal generals" is to decide whether a piece of information sent to the blockchain is valid or not. Loyal generals are loyal Blockchain members who are curious about guaranteeing Blockchain integrity and only to ensure that exact data is accepted. Traitorous generals, on the other hand, are malicious extremists who want to falsify information in the blockchain (Kardaş 2019).

11.5 Application Areas of Blockchain

Blockchain is likened to the discovery of the internet due to its potential use of innovation. Many conditions may be required for Blockchain technology to be applied in any field (Türkmen and Durbilmez 2018). These conditions can be explained as follows (Durgay and Karaaslan 2018):

Multiple Parties: There must be multiple parties to share data and valuable documents. There should be many parties available for data sharing such as portfolio management companies, banks, brokerage firms. The identity of the participants must be identifiable and authoritative. *Shared Data*: There must be a flow of information, documents between the parties. The structural information that the parties use in common must exist. There must be structural information shared in common by the parties. *Low trust*: Users of the system should not fully trust each other. There needs to be a platform that is compatible with creating a contract. *The need for inspection*: Data, reports, and notifications shared between the parties should be subject to certain inspection and approval mechanisms. It must be clear who is performing this operation, records must be accessible at all times, and cannot be changed or deleted.

Many public institutions or sectors with the above-mentioned features can develop applications using blockchain technology. The potential uses of Blockchain technology can be listed as follows:

- Financial instruments, records, and models: currency, financial instruments, derivative instruments, spending and trading records, pledge-mortgage/credit records, service records, crowdfunding, Micro-Finance, and micro-charity.
- Public Records: deeds and property records, vehicle records, business licenses, business activity records, regulatory records, legislation, criminal records, passports, birth and death certificates, voter registration, voting records, health and safety audits, construction permits, gun licenses, forensic records, court records, voting proofs, non-profit records.
- Private Records: contracts, signatures, foundations, trusts, copyrights, Software Licenses, Game Licenses, music/movie book licenses, domain names, digital identities, art proofs such as authorship.
- Other semi-Public Records: titles-degrees, certificates, learning outcomes, grades, Human Resources records (Performance Outcomes, salaries, etc.), health records, accounting records, commercial records, and delivery records.
- Services: Reservations, Monitoring of city parameters (heat, humidity, pollution, traffic, etc.), photos, video, audio recordings.

11.6 Blockchain Applications in Medical Field

Blockchain technologies lead to significant changes in workflow processes in many sectors, especially finance. The health sector is expected to be one of the sectors that will be most affected by this change process.

Before the execution of Blockchain in the medical area, the development of Blockchain concept in the academic literature was examined. Scopus database was used for the literature review. Search in databases is limited to the article title only and only articles and reviews are included from document types. When the concept of Blockchain was searched in international databases (Scopus) as the title of the study, the first publications started to appear in 2015. Medical publications began to emerge one year later. The first publication was in 2016, and as of 2017, the rate of increase of publications has increased significantly. As of December 2019, 156 publications have been reached. When the publications are analyzed collectively, it is seen that the conference papers weighed 58.7% and the articles weighed 33%. It was determined that 433 of the total 4807 publications were related to the health field (Fig. 11.4).

It is seen that the majority of the authors working on Blockchain are writers of Chinese origin. In terms of studying blockchain concept in the universities, there are four Chinese universities in the top five. However, in terms of the medical field, the University of Oxford and California are in the forefront when blockchain is

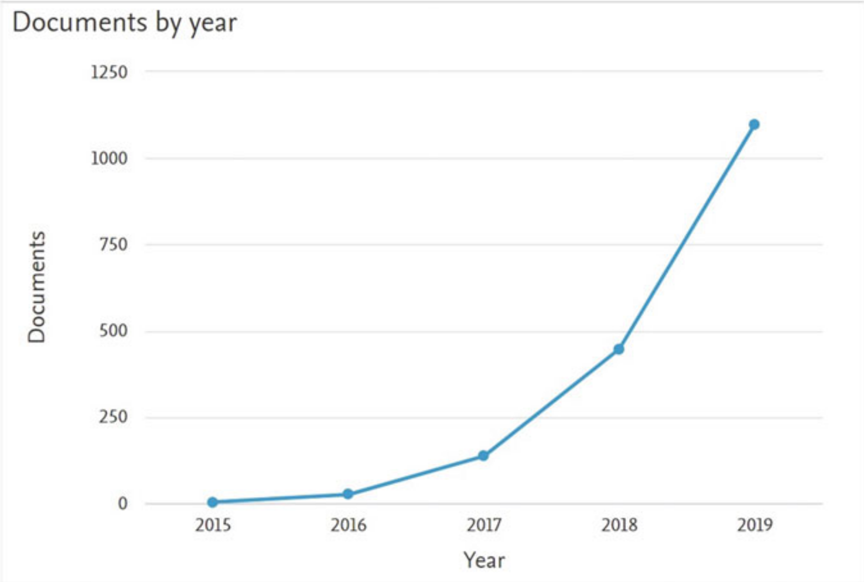

Fig. 11.4 Studies on blockchain

considered. China and South Korea are the countries that allocate the most funding to blockchain research funds (Fig. 11.5).

In terms of scientific studies on blockchain, the USA is leading with 42 publications, while China has 30 publications in the second place. Britain, India, and Brazil are the other prominent countries.

11.7 Application of Blockchain Technology in Healthcare

Blockchain stands out as a new generation of financial technology. In accordance with the financial industry, of the world, the blockchain technology market security-based is predicted to rise to approximately US $ 20 billion by 2020 (Park and Park 2017). Since September 2017, blockchain-based systems such as cryptocurrencies have reached a market value of USD 150 billion (USD) (Ray et al. 2018).

The most reason for the interest in blockchain is the cost-cutting effect that can be caused by the effective software and automation offered by this technology (Angraal et al. 2017). Billions of dollars are spent on providing dependable, timely and workable information in health care. Due to the cost-cutting effect of blockchain technologies, the use of this technology is of great importance for the health sector and interest in this field is increasing (Khurshid and Gadnis 2019). As a matter of fact, it is seen that the expenditure on blockchain technology in health has reached the US$400 million in 2019 (Radanovic and Likic 2018).

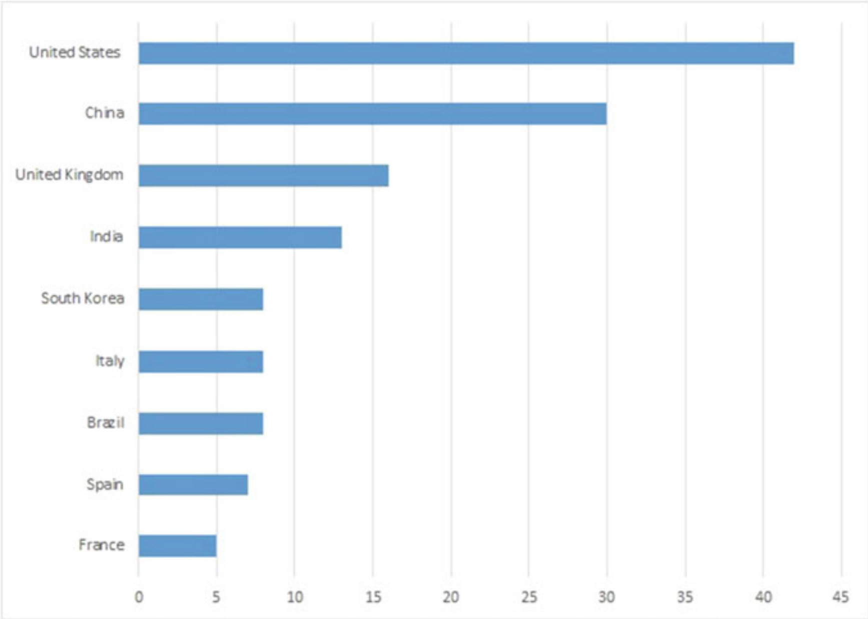

Fig. 11.5 Countries working on blockchain technology in the world

The increased blockchain use for the healthcare market and the implementation of various government initiatives contribute to the growth of the blockchain technology market in the country. Blockchain's medical practice includes electronic health records, procurement processes, biomedical research, health insurance, medical education, drug supply, and other healthcare services (Table 11.1).

Electronic Records

Many different types of electronic records are kept during the delivery of Health Services. Electronic medical records and electronic health records, are one of the most important ones. Personal health records, genomic care point records, oncological patient records, and drug/pharmaceutical networks and records are others.

Electronic Health Records (EHR) and Electronic Medical Records (EMR) are the storage of patient-related medical records on computers. These records are utilized by doctors to progress the quality of care, while for corporate administrators, the same records are basic recording parameters that show costs. EMR is generally regarded as an internal organizational system, while EHR is accepted as an interorganizational system (Heart et al. 2017). Electronic Health Records refers to systems in which patient-related information can only be seen and processed in the institution where the doctor performs his/her profession, while EHR refers to systems

Table 11.1 Blockchain companies operating in healthcare

Data	Name	Country	Website
EMR data management	PokitDoc	USA	http://pokitdoc.com
	Gem	USA	http://enterprise.gem.co/health
	YouBase	USA	http://www.youbase.io
EHR data management	Medicalchain	USA	http://www.medicalchain.com
	HealthWizz	USA	http://www.healthwizz.com
	Curisium	USA	http://www.curisium.com
	Hearthy	Spain	http://hearthy.co
	Iryo	Slovenia	http://iryo.io
	Robomed	Russia	http://www.robomed.io
PHR data management	Medcredits	USA	https://medcredits.io
	MyClinic	UK	https://myclinic.com
Point-of-care genomics	Nebula Genomics	USA	http://www.nebula.org
	Genomes.io	USA	http://www.genomes.io
	TimiCoin	USA	http://www.timicoin.io
	Shivom	Switzerland	http://shivom.io
Oncology patients network	OncoPower	USA	http://oncopower.org
Pharma and drug development	Embleema	France	http://www.embleema.com
	BlockPharma	France	http://www.blockpharma.com

(continued)

Table 11.1 (continued)

Data	Name	Country	Website
	Chronicled MediLedger	USA	http://www.mediledger.com

Note EMR: Electronic Medical Record, EHR: Electronic Health Record, PHR: Personal Health Record
Source Dimitrov (2019: 52)

in which patient-related information can be shared with other healthcare providers. EMR stores enterprise data, while EHR shares health information among health service servers. Therefore, EHR's data is more complete, as EHR provides information from other health facilities to physicians and EMR contains the patient's information in only one health facility (Heart et al. 2017).

PHR are online systems utilized by patients and are designed to guarantee transparency of data and better patient awareness (Kahn et al. 2009). PHR are a health record in which the patient's health information and other information concerning patient care are kept by the patient.

Electronic Medical Record (EMR)

Häyrinen et al. (2008) defined Electronic Medical Record (EMR) as a longitudinal electronic record of patient health information. This information could be progress notes, patient demographics, problems, medications, imperative signs, previous medical history, laboratory data, immunizations, and radiology reports. The Electronic Medical Record is outlined to mechanize and streamline the clinician's workflow. A typical Electronic Medical Record should include (Heart et al. 2017):

- Patient charts
- Order communication system or computerized physician order entry (CPOE),
- Clinical decision-making support system
- Document and image management
- Patient portal
- Management of internal and external clinical documents and notes
- Statistics and reporting.

The main purpose of medical records in hospitals is to safely store patient health records and to keep up a single version of the truth. One of the solutions developed for the safe storage of patient medical records is the use of blockchain. A platform can be created to securely store and share electronic health records using blockchain to create a distributed access and verification system that will help completely replace existing central agents (Thimmaiah et al. 2019). Once this system is installed, doctors, hospitals, laboratories, and health insurance companies may demand permission from the distributed registry database to access patient records, record transactions, and serve their purposes (Fig. 11.6).

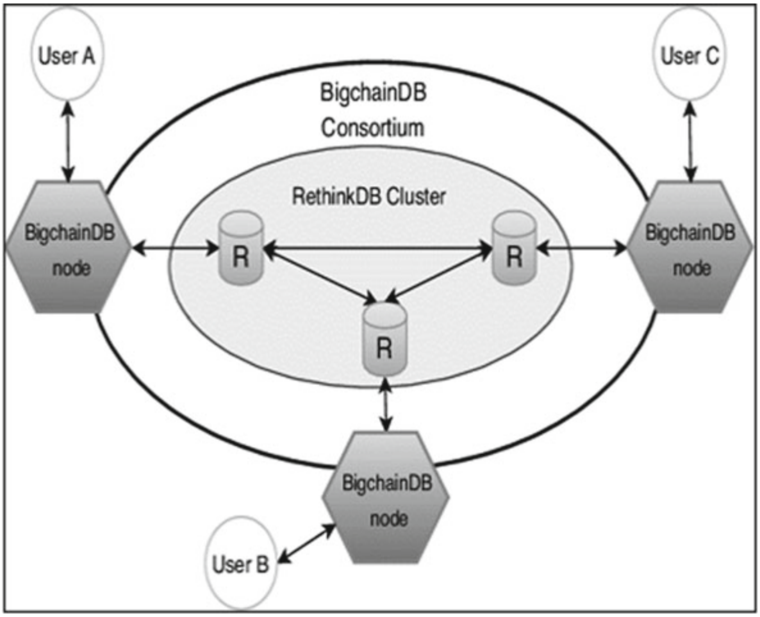

Fig. 11.6 Electronic medical record (*Source* Thimmaiah et al. 2019: 201)

One of the applications that use blockchain technology infrastructure to keep medical records is BigchainDB. It features powerful query performance, immutable data storage, high throughput, low latency, distributed control, and built-in asset support. It also permits developers and enterprises to deploy blockchain proof of concepts, platforms, and applications with a blockchain database (Thimmaiah et al. 2019).

Electronic Health Record (EHR)

In accordance with ISO/TR 14639, the Electronic Health Record is a representative record of a person's well-being, health and healthcare information in a computer-processed format according to a standard information model. The Electronic Health Record refers to a structure in the electronic path of the patient's health records collected and stored in a repository that can be shared in different digital formats. The Electronic Health Record can include various data groups such as allergies, vital signs, medical appointments, laboratory examination results, medical imaging, and diagnoses. Because the health records are not integrated among the health service providers, the transaction records realized in each hospital are called Electronic Medical Record. Electronic Medical Record can be regarded as a special type of Electronic Health Record that focuses specifically on the internal medical field of healthcare organizations (Roehrs et al. 2017). Electronic health records have ended up the standard for recording, representing, and analyzing patient's clinical information. The selection of this modern standard has brought modernly specialized (capacity, security) and moral (analysis) issues.

Blockchain technology is able to empower the forming of a patient-centered electronic health record system. Clinical data can be stored independently from other delicate data with the desired degree of detail and segmentation. It will be the patient himself who can authorize the consultation of some of the data according to his needs, preventing unauthorized access to other parts. All data is stored safely, encrypted, and time-stamped to avoid any undesirable changes. The storage system will be decentralized so there is no requirement for organizations or trusted third parties. In this way, compatibility issues between different electronic medical record systems will be avoided when the patient is treated in centers with different electronic health systems. Besides, this fragmentation will function as a safety measure against the loss of data, provided that data is present as a backup amid the different nodes of all network users (Agbo et al. 2019).

The process of patients' participation in the design of different EHR is quite limited (Gagnon et al. 2009). However, it is accepted that most of the patients desire to access their clinical data. Patients and their relatives who contribute to this process are more involved in health services and further reduce the workload of the doctor. Besides, most doctors and patients who tested this strategy express their satisfaction with the process (Delbanco et al. 2017). EHR using Blockchain technology can be adopted as a system because they are more accessible, secure, encouraging and have the potential to allow for different privacy demands (Cunningham and Ainsworth 2018).

Personal Health Record (PHR)

Personal Health Record has been explained as "online systems that include collections of patients' health care and medical data, which use health informatics standards to enable patients to share, organize and manage these data according to their views." Electronic Medical Record systems have numerous benefits (Andrikopoulou et al. 2019):

- Improve patient outcomes
- Decrease care cost
- Allow patients the ability to self-manage their health
- Increase access to care especially in remote areas
- Empower patients
- Improve medication adherence.

In accordance with ISO/TR 14639, EHR is "information relevant to the wellness, health and health care of an individual, in computer-processable form and represented according to a standardized information model." As patients are the owner of their health records, they can oversee and give authorizations for access or share their health data with third parties. PHR is arranged for the patient but can be integrated with EHR (Roehrs et al. 2017). Some healthcare suppliers have been effective in progressing communication with patients utilizing mobile technology (MPHR), which allows PHR patients to self-monitor and manage their health status (Reeder and David 2016).

The inclusion of patients in health services is recommended to improve patient management outcomes and increase patients' commitment to care plans. Personal health records (PHR) are important tools that enable patient participation. PHR, however, has many challenges that negatively affect their effectiveness and use by patients, including privacy issues and data quality issues. Some studies suggest using blockchain technology to overcome personel personal health records usage challenges and maximize patients' benefits from personal health records (Abouzahra 2019). In this way, special blockchain technology will be designed to allow caregivers to choose only the data they require for patient management while keeping up data safety and privacy for patients (Fig. 11.7).

For instance, the doctor may ask for daily blood sugar and weekly weight values for a patient with diabetes. The requests are recorded by the physician in the smart contract. After the physician publishes the contract, this contract must be affirmed by both the hospital (healthcare provider) and the patient. Once the contract is affirmed by both nodes, it is included to the blockchain and the contract becomes accessible to patients. Patients will initiate a process using the function in the contract to record their values using wearable devices. The process is then sent to a nurse or doctor as a care provider for review and confirmation. The care supplier will survey the process and decide whether to add to PHR records and whether further care is needed for the patient and whether the process is included to the blockchain. At long last, patient data will be added to the PHR by running a script to read transactions from the blockchain network and write to the fitting areas within the PHR system (Abouzahra 2019).

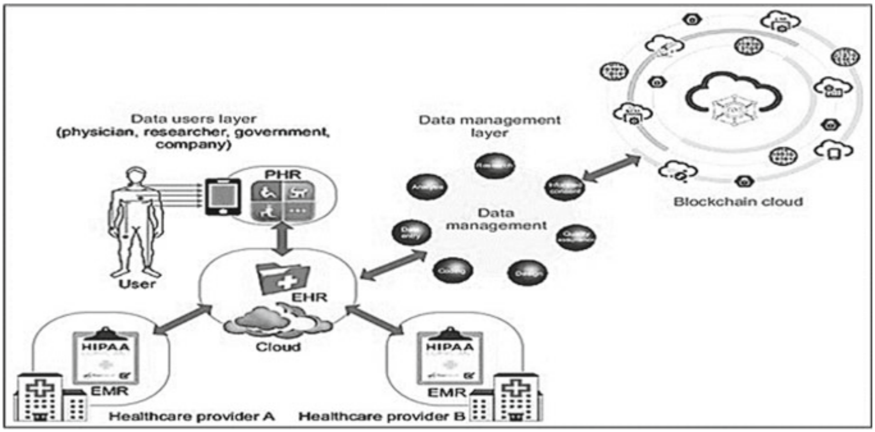

Fig. 11.7 Personal health records (*Source* Dimitrov 2019: 53)

Once patients get their medical records from medical institutions, this data can be verified by blockchain rather than by a trusted third party and sent to other medical institutions, insurance companies, and research institutions. Medical information stored on "patients" mobile phones can be used without the help of a medical institution or company. Besides, people are able to hand over their data-to-data use parties and receive compensation for the data. Recording transaction details into the blockchain are also possible with this system (Park et al. 2019).

Individual health records, a type of healthcare data recorded and managed by the patient, provide the patient with a total and precise personal medical history that can be retrieved online. Health records are important assets, and reasonable sharing of individual health records can advantage patients, research institutions, drug/pharmaceutical companies, and the entire health system (Wang et al. 2019). The Blockchain technologies that have been prominent in personal health record so far can be sorted chronologically by HDEHR 2012; m-Health 2013, uPHR 2013, CF 2014, HealthVault 2014, healthTicket 2014, DEPR 2015 my HealtheVet 2015, and SNOW 2015 (Roehrs et al. 2017).

Point-of-Care Genomics

The technology of point-of-care tests, which are carried out near the patient and where quick results are obtained, has made particular progress in recent years. As we learn more about the genomic basis of pathogen infectivity and drug resistance, point-of-care tests are an vital tool for detecting and tackling worldwide health problems (Myers et al. 2013).

In areas where access to central laboratories and trained medical personnel is difficult, it is clear that there is a great need for systems that can be used as a first step in home care applications or in outpatient patients, working with small volumes of samples, achieving results quickly and producing at low cost. It is difficult to say that home care services are useful for emergencies or underdeveloped countries for reasons such as the large and expensive laboratory instruments required for analysis, the need for trained personnel, and the need for significant quantities of samples. Point-of-Care (POC) was developed to be used in such cases. Point-of-care analyses are basically called tests performed outside the laboratory with devices such as glucometers, hemoglobinometers (Babür 2015).

It is possible that such data may be seized from unauthorized parties. To address such concerns, blockchain initiatives in health care are gaining importance. Blockchain technologies enable the transmission of data produced by the patient to the right parties and also allow the patient to sell some health data to research organizations if they wish. It also offers patients the option to make money through blockchain-backed providers. The system prevents genetic information from falling into the wrong hands and allows consumers to sell their genetic information little by little if they desire (Dimitrov 2019).

Oncology Patient Networks

A patient with a chronic illness or severe medical condition can be required to maintain records of his or her illness throughout his or her life. For those whose medical condition is more critical, such data is managed by close relatives caring for the patient. Administration of medical history, get to control, medical cost, prescriptions, insurance correspondence, and payments are unavoidably time-consuming, and these procedures are extremely difficult for most patients. For example, when new radiotherapy is planned for a cancer patient, it may be crucially necessary to know the radiation dose given for all previous cancer treatment. This data can be scattered across multiple centers. The correspondence and transfer of data on this subject are critical and prolongation of the process may delay treatment (Dubovitskaya et al. 2017) (Fig. 11.8).

A solution to overcome the above obstacles may be blockchain technology. Dubovitskaya and others developed a solution to this issue in a 2017 study. This study aims to maintain a framework for data administration that can be used by patients, specialists, and others (stakeholders) involved in the patient's healthcare processes. Once the segments that are allowed to enter the system through smart contracts process the information, the data can be transmitted securely and the data record can be stored.

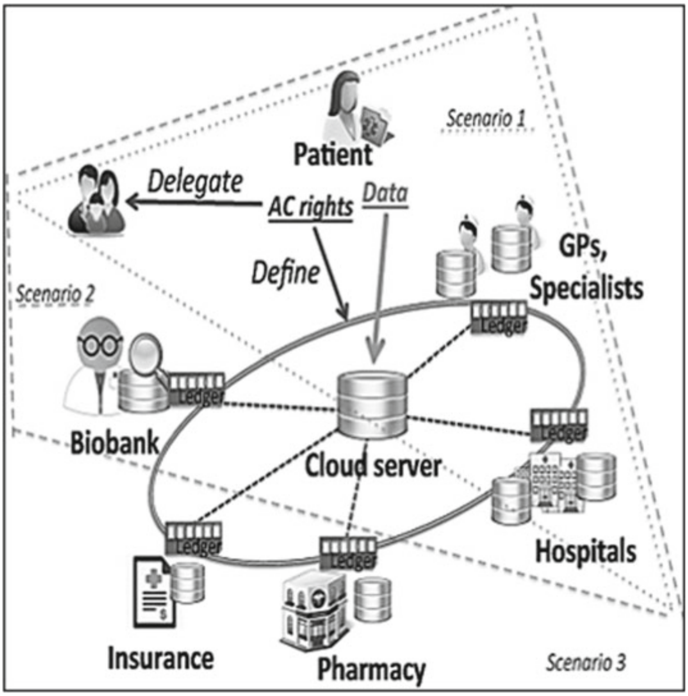

Fig. 11.8 Patient networks (*Source* Dubovitskaya et al. 2017: 5)

Drug/Pharmaceutical Supply Chain

One of the areas in which Blockchain is used in the healthcare industry is the use of the drug/pharmaceutical industry in the supply chain. Giving patients counterfeit drugs or drugs that fail to pass standard safety barriers could have critical results for patients. This is often a common issue within the pharmaceutical industry. There are indications that Blockchain technology is capable of solving this problem (Angraal et al. 2017).

Blockchain technologies implemented in the drug and pharmaceutical supply chain serve three main purposes. These include document verification, identity, and fraud detection. Blockchain initiatives serving in the field of document verification are Tierion and Factom. Blockchain initiatives that serve in the field of identification are Blockstack UniqueID, ShoCard, and SolidX. Blockchain initiatives in the field of fraud detection are Everledger, Blockverify, Verisort, Provenance, and Chronicled (Bocek et al. 2017).

The common idea is to record each process of prescribing drugs in the blockchain network to which all partners (producers, distributors, specialists, patients, and pharmacists) are affiliated. In this way, any change or noxious change in prescription can be detected by any party (Engelhardt 2017). Storage conditions and temperature information during the transport of drugs can be monitored moment by moment by blockchain technologies (Fig. 11.9).

By combining IoT sensors with blockchain technology, Modum.io AG monitors all vital data amid the transport of medical items.

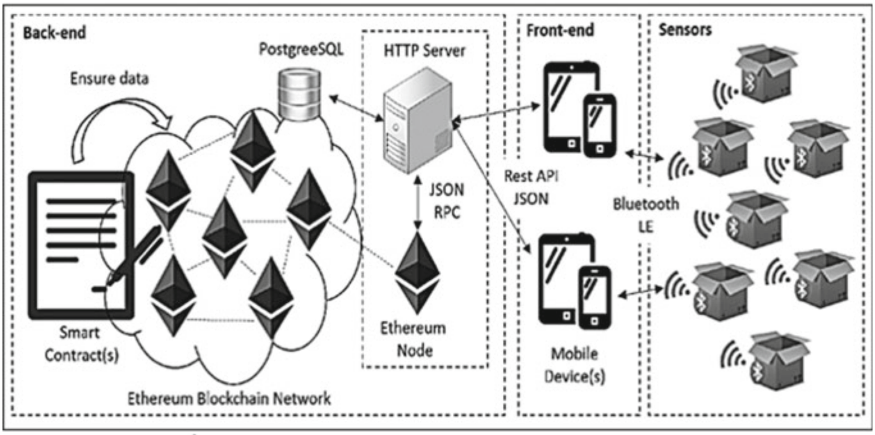

Fig. 11.9 Modum.io AG blockchain architecture (*Resource* Bocek et al. 2017)

Biomedical Research and Education

Blockchain technology has a high potential for adaptation and uses to biomedical research and education process (Agbo et al. 2019):

- In clinical trials, the blockchain can help eliminate data falsification and inadequate reporting or exclusion of unwanted clinical research results.
- Blockchain makes it easier for patients to allow their data to be used for clinical trials.
- Blockchain's invariance ensures the integrity of data collected through blockchain for a clinical study.
- The immutability property of blockchain certifies the integrity of data collected through blockchain for a clinical study.
- The transparent and public nature of blockchain also makes it easier to replicate research from blockchain-based data. (The blockchain has the potential to revolutionize biomedical research.)
- Blockchain has the potential to revolutionize the peer-review process for clinical research publications because it has decentralized, invariant, and transparent features.
- Blockchain has the potential to revolutionize the peer-review process for clinical research publications based on its decentralized, immutable, and transparent properties.
- Blockchain contributes to the training of health professionals.

According to the 2016 survey by Nugent et al. (2016), Smart contracts on the Ethereum blockchain platform could be used to enhance data transparency in clinical trials. The Ethereum platform is another proposed blockchain-based solution implementation for notarizing documents from biomedical databases (Nugent et al. 2016).

Remote Patient Monitoring

Modern disorders such as diabetes and heart disease represent a very urgent situation for the patient. The burden of these diseases on the hospitals, which can be kept under control only with close monitoring of the patient and prevent fatal cases, is increasing day by day. One solution to this problem is the remote patient monitoring system. In these systems, the patient is sent home with the necessary measuring devices. These devices are sometimes placed directly on the patient. The device continuously makes the relevant measurements through the patient. In other cases, the patient periodically makes measurements using the device. The ECG device can be used as a continuous measurement device and the blood pressure device as a device where the patient can measure manually. Most of these devices are equipped with wireless sensors. These measurements are automatically sent over the internet to the hospital-managed

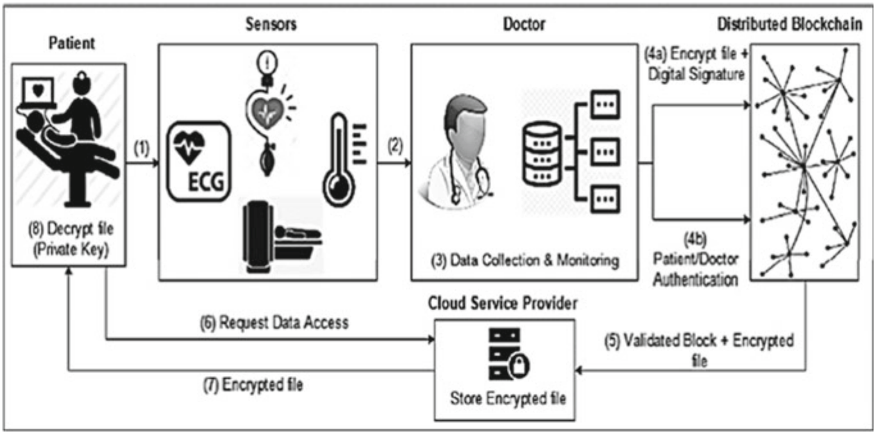

Fig. 11.10 Remote patient monitoring (*Resource* Kazmi et al. 2019: 771)

data center. The data is examined by doctors and the patient's condition is kept under monitoring. It is even possible to automatically detect critical situations such as heart attacks quickly through automated algorithms that run on computers connected to the data center IEEE 802.15.6 Protocol. The 802.15.6 standard is a communication protocol designed for wireless communication of sensors. This standard defines the media access control layer (MAC Layer) and the physical layer of communication (PHY Layer) (Özderya 2017) (Fig. 11.10).

With blockchain-based smart contracts that increase user engagement in remote patient monitoring, long-distance patients can be monitored and generate alerts in case of an emergency. A legal and secure way can be achieved through sensors that use smart contracts to authorize devices. By using Blockchain technology, people's confidence in remote monitoring can be increased by reducing fraud and privacy violations in healthcare environments (Kazmi et al. 2019).

Health Insurance Claims

One of the health sector's most troubling issues is the health insurance claims process. Claims can be inclined to extortion and expend the time and energy of the patient and healthcare supplier. The request process starts when a patient needs service from a health service provider (e.g., doctor and hospital). The number of doctors and hospitals visited may include more than one alternative. Collecting past records between different providers to determine a patient's cost to insurance requires considerable time and a serious digital infrastructure. Some major insurance companies allow servers to send claim information directly to their private systems (He et al. 2018).

In a study conducted in 2018, He and others proposed sample blockchain architecture to change the role of swap spaces during the health insurance compensation claim process and to reduce the risk of data leakage between parties in the healthcare sector. Their solution to the problems outlined above is to improve patients' privacy protection by decentralizing a Health Insurance Portability and Accountability Act compliance system using blockchain technology for the health insurance claim process. Firstly, they designed data structures for patient information, medical service registration, insurance payment and insurance contracts within the ledger. At this point, the insurance compensation process becomes automatic. Smart contracts can be specified for privacy assurance. Once patient data, medical service record, insurance payment, and insurance contracts in the ledger are checked, the claim for compensation is processed. The claims process is automated and smart contracts are developed for privacy assurance.

11.8 Health Data Analytics

Digital Health has a profound impact on healthcare systems. The growth of digital health has created challenges such as to whom the collected data belongs, who is controlled and managed, and how to protect the confidentiality and privacy of these data (Mitchell and Kan 2019).

Innovation in digital health care has brought artificial intelligence, data mining, big data, and quantum technologies to the forefront. Each title can be examined in a specific way for the health sector. Besides, examples of blockchain architectural infrastructure will be given.

Big Data

The geometric increase in computerized data capacity and processing frameworks allows Big Data (BD) analyses, a different approach in which all data is considered and processed (Reiz et al. 2019). BD is a vital discipline that gathers more useful information in decision-making and can offer possible solutions to expand wisdom. BD was first defined as volume, velocity, and Variety (3 Vs). Then two more dimensions, value and veracity, were suggested and a 5 V model was introduced. Here, volume refers to exponentially growing data; variety to the complexity of data, velocity to flow of data; and veracity to varying quality and value to the relevance of data (Dhagarra et al. 2019).

In health care, BD refers to vast and complex electronic health data sets that cannot be managed by traditional software, hardware, or data management tools (Ketal 2014). Wang et al. (2018) described the ability of five major data analytics applications in health care: analytical capabilities for unstructured data, analytical capabilities for the care model, predictive capabilities, decision support capabilities, and traceability. Big data analytics are an imaginative way to eliminate the complication of diseases (Olivera et al. 2019).

Data Mining

Data mining is most commonly used by statisticians. Statisticians look for important relationships, patterns, and connections to a particular subject of review. Data mining offers the possibility to automate this process. The extraction of significant information from vast stacks of data is defined as data mining. In other words, it can be defined as the science of uncovering valuable and interesting connections from complex data (Kalemci 2018).

Data mining methods are separated into predictive and descriptive models. Predictive models are the development of a model using data whose results are known, and the estimation of data sets whose results are unknown by using this established model. Predictive models include classification and regression methods. Descriptive models, on the other hand, guide decision-making by finding patterns in existing data. Examples of descriptive models are association rules and relationship analysis and clustering methods (Karaatlı and Altıntaş 2019).

The standard data mining process consists of (1) understanding the issue, (2) planning data samples, (3) creating the model, (4) applying it to a data set to see how the model can work within the world, and (5) generation distribution stages (Kalemci 2018).

Artificial Intelligence

The ability of computers, or computer-controlled robots, to perform defined tasks similar to humans, is called artificial intelligence (Haeberle et al. 2019). In other words, artificial intelligence is based on the learning technique of advanced machines using large amounts of data (Park et al. 2019). Artificial intelligence has many application areas (Sheikh and Fann 2019). One of the application areas is health services (Wang et al. 2019).

Robotic devices with artificial intelligence help provide services in numerous areas such as patient monitoring/evaluation, medical supplies conveyance, and helping healthcare experts (Pagliarini and Lund 2017). Using artificial intelligence applications reduces the operational cost spent on health care and creates an added value by improving quality in health (Golding and Nicola 2019). However, because the cost of acquiring artificial intelligence is too high, it poses an obstacle to reducing health problems (Inkster et al. 2018).

Worldwide revenue of global artificial intelligence applications is $36.8 billion (Kim et al. 2019). According to research by Pagliarini and Lund (2017), a $100 billion healthcare industry will be established for the production of artificial intelligence-applied robotic devices by 2020. The National Science and Technology Council's Technology Committee stated that the U.S. government spent $1.1 billion on research and development concerning artificial intelligence technology in health in 2015. The current spending is expected to increase continuously after 2015 (He et al. 2018).

The Chinese government is expected to spend 147 billion dollars on artificial intelligence technology over the next 20 years (Kong et al. 2019). A $100 billion license agreement was signed for the development of artificial intelligence applied physician technology that offers patients direct health treatment and prioritizes diseases in order of importance. Besides, by the year 2025, it is estimated that 27 billion dollars will be spent on this service market each year (Lin et al. 2019). The average cost of artificial intelligence technologies used in pharmaceutical industries is calculated as $2.6 billion (Henstock 2019; Chan et al. 2019).

Quantum Technologies

Quantum theory can be characterized as a hypothesis that defines the physics of rudimentary particles and light (Vermaas 2017), expressing phenomena and properties of atomic and subatomic systems (Schleich et al. 2016). This theory, discovered in the early twentieth century, serves as an important symbol for unknown aspects of physics (Johansson et al. 2018). This new technology also has great economic potential (Schleich et al. 2016).

Quantum applications such as quantum communication, quantum computing, quantum networks, and quantum cryptography are of great importance for understanding various diseases and developing new generation drugs and cancer treatments (Möller and Vuik 2017). Cyber-attacks have begun to cause significant damage to hospitals and state economies. The damage is reported to be 380 dollars per patient (Kalis et al. 2018). Quantum technology (QT), on the other hand, prevents unauthorized persons from accessing health data and is expected to save approximately $2 billion annually worldwide (Kalis et al. 2018; Schleich et al. 2016). With the expansion of QT, productivity gains are estimated to be $450 billion (£372 billion) annually (Kalis et al. 2018).

11.9 Conclusion and Evaluation

Advancements in data and communication technologies and big data technology improve the way of doing business and on the other hand, reveal security problems in information sharing. Recently, differential privacy algorithms and clustering algorithms have become insufficient to ensure the security of such high volume data. Users can freely access a lot of non-sensitive (confidential) information over the Internet. However, sensitive information may need to be stored securely on the network. Blockchain's innovation can develop every insecure digital system. Blockchain technology has the potential to solve the traditional database synchronization problem.

Blockchain networks have many promising uses in the healthcare sector, from increasing transparency in the drug supply chain to creating and sharing unchangeable medical records. In the health sector, blockchain technologies can be used at different stages, from drug and medical product development processes to diagnosis, from the e-prescription process to better preservation and use of patient records.

If (authorized) access to data can be achieved in electronic patient records using Blockchain technologies, savings can be achieved by reducing unnecessary imaging. Since the system can also be used for remote diagnosis and treatment, access to expert information can be provided from remote areas. Although there are some technical, logistical, and regulatory challenges, the implementation of these systems will likely play a vital role in the future of medical data storage and transfer.

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Chapter 12
Relation of Company and Innovation in National Innovation System

Zeynep Karaca, Hüseyin Daştan, and Gürkan Çalmaşur

Abstract The national innovation system is defined as a network of public and private sectors that initiate, import, modify, and distribute new technologies, activities, and interactions. These interactions constitute the structure of the system and are shaped by culture, norms, institutional arrangements, and public policies. They are the primary innovative actors in the innovation process as companies are eager to seek, accumulate, and retain innovative talents. However, firms' ability to innovate is influenced by interactions with a wide range of external organizations, government and private actors, suppliers, customers, and markets. As the state is responsible for providing infrastructure and creating an appropriate institutional platform for exchange and dissemination of information, it has an important role to stimulate the capabilities of firms. The national innovation system emerges in different fields including social sciences or engineering, and is used by policy makers. The components of innovation vary from country to country, and these differences can be explained by systemic characteristics. These differences in economic and institutional structure are reflected in the ratstructure are reflected in

tion. According to the national innovation system, the innovation ability of a firm depends on the factors including the quality of the national education system, the industrial relations, the quality of technical and scientific organizations, government policies, cultural traditions, and the interactions between them. In this paper, the most important variable affecting a national innovation system which is the firm variable will be discussed. Additionally, theoretical foundations on the interaction between firms, research and development (R&D), and innovation will be provided.

Keywords Innovation · Firm · R&D · National innovation system

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12.1 Introduction

The national innovation system is defined as a network of public and private sectors that initiate, import, modify, and distribute new technologies, activities, and interactions. These interactions constitute the structure of the system and are shaped by culture, norms, institutional arrangements, and public policies. They are the primary innovative actors in the innovation process as companies are eager to seek, accumulate, and retain innovative talents. However, firms' ability to innovate is influenced by interactions with a wide range of external organizations, government and private actors, suppliers, customers, and markets. As the state is responsible for providing infrastructure and creating an appropriate institutional platform for exchange and dissemination of information, it has an important role to stimulate the capabilities of firms. The government should lead investment in education and training, as well as leadership under its leadership (Bãzãvan 2019: 2). The national innovation system is an effective tool for understanding the competitive advantage of a country. The national innovation system focuses on the dynamic processes between universities, research centers, public, and industry. Most research focusing on the national innovation system provide mutual benefit between actors by providing strategic and technological collaborations (Liu 2019: 291). Universities are becoming increasingly important as institutional actors that play a central role in developing innovative capacities of their communities. Universities are seen as actors that contribute to innovative activities both directly and indirectly, and ultimately helping to promote regional and national economic growth (Datta et al. 2019: 27).

The national innovation system is defined in two ways; narrow and wide. The narrow definition specifically focuses on institutions that support the dissemination and use of new information while the broad definition includes not only businesses, universities, public research centers, but also other policies that support commercial policy, macroeconomic policies, and innovation capability. In other words, the narrow definition focuses only on institutions that play a direct role in scientific and technical research and innovation processes while the broad definition encompasses all economic, political, and social institutions that play a direct and indirect role in learning, research, discovery, and innovation (Sertkaya 2012). The national innovation system emerges in different fields including social sciences or engineering and is used by policy makers. The components of innovation vary from country to country, and these differences can be explained by systemic characteristics. These differences in economic and institutional structure are reflected in the rate and direction of innovation. Lundvall (1985) first examined the innovation system. Even though there are some overlaps between them, the perspectives are completely different. Freeman's analysis is based on macro-dimensional and international trade while Lundvall's analysis is micro-dimensional suggesting that innovation is shaped by the user-producer relationship (Lundvall 2015: 1).

According to the national innovation system, the innovation ability of a firm depends on the factors including the quality of the national education system, the industrial relations, the quality of technical and scientific organizations, government policies, cultural traditions, and the interactions between them. There is a wide division of labor among the actors involved in a national innovation system. It is the role of companies to transform ideas and inventions into innovation. The government plays a supporting role by formulating appropriate industrial and technological policies and funding for research. The higher education sector plays a critical role in educating people and conducting research that contributes to the generation of new ideas in the economy (Datta et al. 2019: 28). In this paper, the most important variable affecting a national innovation system which is the firm variable will be discussed. Additionally, theoretical foundations on the interaction between firms, research and development (R&D), and innovation will be provided.

12.2 Firm and Innovation

The concept of national innovation can be used as a tool to analyze the characteristics of a country in the process of innovation in a globalized economy, as well as a guide for policy-making. It emphasizes the interactions between various actors and the work of the holistic system rather than the performance of their individual components. The main component of the innovation system is firms and institutions. Important organizations in innovation systems are firms, universities, venture capital organizations, and actors in public innovation policy. There are companies, customers, suppliers, and competitors in the innovation system. While innovation is not the primary objective of firms, it is often an important condition for making a profit. Therefore, most of the innovation processes in the capitalist market economy take place within firms. This means that in addition to production, firms need to have a good overall innovation performance; that is, they must be able to innovate continuously for a long time. Innovative firms should have the habit of conducting research, change research routines when necessary, be able to use new information developed by other firms, and be open to unexpected new information (Sharif 2003: 190–191). Santarelli and Sterlacchini (1990) suggest that the systematic R & D activities of firms are more effective than the occasional R & D activities.

Although many problems are encountered during innovation, innovations are among the compulsory activities for most companies as they are the most important factor affecting the competitiveness of a company (Duran and Saraçoğlu 2009: 57). Companies wishing to work in a competitive environment must participate in creative knowledge. Each business should change its resources to gain superiority over other competing businesses by taking into account the nature of the market (Spychalska-Wojtkiewicz 2017: 53). Technological innovation has an impact on international trade, industrial structure, the formation and development of new firms and industries, and the survival and growth of existing firms and industries (Ertürk 2009: 209). Today, innovation is at the center of scientific and technological policies. It is one of the most important elements of achieving competitive advantage at a national and international level, increasing productivity and efficiency, economic growth and development, and improving welfare and quality of life for both countries and companies. According to the OECD, in the last 25 years, the contribution of innovation has been more than 50%, particularly in the economic growth of developed countries (Soyak 2008: 1). The concept of innovation was first introduced by J. Schumpeter in 1934. According to Schumpeter, innovation is the result of the entrepreneur's strong confidence in innovation as a benefit from the commercialization of the invention. In this context, everything that makes a profit for the entrepreneur and that occurs as a result of technological advances falls under innovation. Schumpeter stated that innovation can be created in five different ways that are (Schumpeter 1934: 66);

- Finding and developing new markets
- Implementation of a new production technique
- Production of a new good or service or improving the quality of the good or service produced
- Finding new raw material resources
- Realization of a new industrial organization.

There are eight important sources for the emergence of innovation in firms. These sources can be listed as unexpected sources, unexpected events, developments related to the process, changes in industry and market structure, demographic changes, changes in understanding and perspective, scientific and non-scientific new information and ideas (Thompson 1990: 302). The OECD sets four levels of innovation that can distinguish a firm regardless of its size and activity (OECD 1999: 49–51). These levels reflect various competencies of companies.

- ***Level 0***: A static firm rarely innovates or does not develop at all, but under current conditions, it may have a stable market position.
- ***Level 1***: An innovative company has the capacity to manage a continuous innovation process in a stable competition and technological environment.
- ***Level 2***: In addition to the previous level, a learning company has the ability to adapt to the changing environment.
- ***Level 3***: A company which constantly renews itself can use its basic technological features to reposition different markets and/or create new markets.

The innovation process of firms is given in Fig. 12.1.

In order to produce innovative products, companies should first make R & D expenditures. R & D activities should be supported by the state's institutional and legal infrastructure, and new inventions and ideas should be protected. Finally, these innovative products are launched.

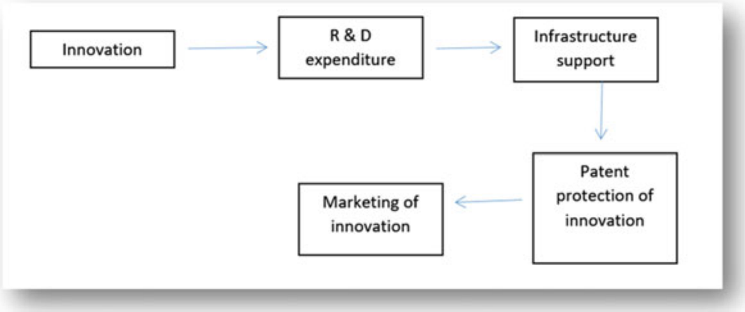

Fig. 12.1 The innovation process

R&D Expenditures and Innovation

The national innovation system is closely linked to the production of new knowledge, the combination of existing knowledge in different ways, or the transformation of knowledge into profitable goods or services. This system contributes to regional and national development by increasing its competitiveness. R & D institutions, technoparks, university-industry collaborations, innovation transfer centers, and development agencies play important roles in this process. The fact that countries have advanced innovation capabilities and the establishment of an effective national innovation system leads to a sustainable development process and increase competitiveness. In this context, investment in R & D activities is of great importance (Işık and Kılınç 2012: 170).

It is possible to define R & D in the form of activities with original, scientific, and technical content in order to develop new goods, services and processes, and meet the needs of the society by introducing them to the market. It is clear that countries aiming for sustainable economic growth, especially in the 1990s, have transferred large amounts of resources to R & D and innovation by placing a task at the center of their strategic plans, and collecting the fruits of this approach in the medium and long term. The fact that the goods or services obtained as a result of R & D activities are new, make a difference and thus, pave the way for companies to increase their consumption and export, as well as increase their profitability and employment levels (Karagöl and Karahan 2014: 9). According to Shefer and Frenkel (2005), firms should invest in R & D to innovate and hire a highly skilled workforce to cope with complex technological problems. In their study, they concluded that R & D expenditure is not related to the size of a firm. Contrary to expectations, Coad and Rao (2010) found that growth in sales and employment led to R & D expenditures, not to profit led to R & D investments. They stated that firms were willing to reduce their R & D levels after a negative growth shock and that they were willing to increase R & D after a positive shock. Baumann and Kritikos (2016) analyzed the relationship between R & D, innovation and productivity in firms with fewer than 10 employees. As small firms increase labor productivity, they benefit from innovation as much as big firms. As a result, the relationship between R & D, innovation and productivity in small firms is no different from that in large firms. Şişmanoğlu and Akçalı (2016) concluded that R & D expenditures have a positive effect on sales.

Government and Innovation

The most comprehensive benchmark in innovation is the Global Innovation Index. This report is produced annually in collaboration with the World Intellectual Property Organization (WIPO), Cornell University, and INSEAD, covering almost 130 countries. While determining the overall assessment score of the countries, the index examines two categories as in "innovation inputs" and "innovation outputs". Innovation inputs consist of institutions, human resources, infrastructure, market, and business world which are the main components of the innovation system in a national economy, while innovation outputs are represented by cognitive and technological products such as the number of articles and patents produced by these inputs. A third important performance criterion that is revealed in the report focuses on "innovation efficiency" and the ratio between the used input and the produced output. The top 3 innovative economies by region according to a recently published report, The Global Innovation Index 2019, are presented in Table 12.1.

As seen in Table 12.1, when the regions are examined, America, Switzerland, Israel, Singapore, Chile, South Africa, and India take the first place. A ranking of economies of innovation by income groups is presented in 12.2.

The top three innovation economies with the highest income by income groups are Switzerland, Sweden, and the U.S.. In other words, innovation is the basis of the economic growth of developed and high income countries. Innovation increases national or international competitiveness and improves the quality of life.

In order for companies to survive in a changing and developing competitive environment and to ensure continuity, they must present their products or services to the market by differentiating their production activities and always use the current production methods. This can only be achieved through technological progress and innovation. In the complex and interactive process of innovation involving all economic actors, governments play an important role. First of all, governments must establish an institutional and legal infrastructure in order for companies to maintain their current shares in the market in which they operate. They should then establish national innovation systems, establish appropriate conditions for all actors, and conduct the necessary audits. Governments should also introduce innovation strategies and policies in order to achieve their economic, sociological, and political goals. Thus, with innovation which is an important component of the global competitiveness, more efficient use of resources, increasing social welfare, and sustaining economic growth will be ensured (Yavuz et al. 2009: 66). Innovation plays a key role in the development of countries. Abhyankar (2014) listed the actions of the state for innovation in India that are;

Table 12.1 Top 3 innovation economies by region

	Regions						
	Northern America	Europe	Northern Africa and Western Asia	Southeast Asia, South Asia, and Oceania	Latin America and the Caribbean	Sub-Saharan Africa	Central and Southern Asia
Countries	1. The U.S.	1. Switzerland	1. Israel	1. Singapore	1. Chile	1. South Africa	1. India
	2. Canada	2. Sweden	2. Cyprus	2. Republic of Korea	2. Costa Rica	2. Kenya	2. Iran
		3. Netherlands	3. United Arab Emirates	3. Hong Kong, China[a]	3. Mexico	3. Mauritius	3. Kazakhstan

[a]In 2019, it entered the top three

Source Global Innovation Index 2019

Table 12.2 Top 3 innovation economies by income groups

High Income	Upper-Middle Income	Lower-Middle Income	Low Income
1. Switzerland	1. China	1. Viet Nam	1. Rwanda
2. Sweden	2. Malaysia	2. Ukraine	2. Senegal
3. The U.S.	3. Bulgaria	3. Georgia	3. Tanzania

Source Global Innovation Index 2019

1. to set up the National Innovation Assembly whose task is to coordinate various innovation-related activities,
2. to prepare a new Science, Technology and Innovation Policy aimed at promoting entrepreneurship and science-based solutions for sustainable and inclusive growth.

According to Mazzucato (2015), governments play a critical role in promoting innovation, spreading and finding new markets. In fact, in some of the world's most renowned innovation centers, the state has played a key "entrepreneur" role in foreseeing and financing the creation of all new fields, from information technology to biotechnology, nanotechnology, and green technology.

Intellectual Property Rights and Innovation

The inventions form the basis of innovation. An invention provides a new solution to a technical problem and must be protected by patents. Patents protect the interests of a truly groundbreaking and commercially successful inventor of a technology by enabling an inventor to control the commercial use of their invention. A patent owner or company has the right to prevent others from producing, selling, or importing this technology. This offers inventors the opportunity to sell their patented technologies to others who wish to use them. The criteria for obtaining a patent are determined by the law and vary from country to country. In general, however, in order to obtain a patent, the inventor must demonstrate that the technology is novel, useful and that no one else has previously worked in a similar field. To do this, they need to define how their technology works and what it can do. A patent can last up to 20 years, but the patent holder will usually have to pay certain fees at regular intervals during that 20-year period for the patent to be valid. In practice, this means that if the commercial value of a technology is limited, the patent holder may decide to renounce the patent where the technology falls into public domain and can be used freely. In addition to introducing and rewarding the inventors for their commercially successful technologies, the world meets new inventions thanks to patents. The inventor wishing to obtain patent protection for their invention should provide a detailed description of how their invention works. In fact, each patent grant provides the amount of technological information that is freely accessible to the public. How do patents support the inventors?

1. The patents are recognized and rewarded by the inventors. They serve as incentives to innovate. With a patent, an inventor or small business finds the time, effort, and money they spend on this technology is worth it. This means that they can earn a living from their work.
2. When a new technology arrives on the market, society benefits as a whole because what was not possible before is now possible, and new jobs and employment opportunities emerge.
3. Revenues from commercially successful patent-protected technologies make it possible to finance more technological research and development (R & D), thereby increasing the chances of better technologies in the future.
4. A patent effectively transforms the inventor's know-how into a commercially viable asset, providing opportunities for business growth and job creation through licensing and joint ventures.
5. Having a patent makes a small business more attractive to investors who play a key role in the commercialization of a technology.
6. New business ideas may arise due to patents.

Patent information is mappable and provides policy makers with useful information about where and by whom R&D is done. This information can be useful in shaping the policy and regulatory environment that promotes innovation (WIPO). Sweet and Maggio (2015) have found that strong intellectual property laws have a positive impact on a country's ability to expand its productive boundary and implement innovation. Gamba (2017) stated that innovation is sensitive to intellectual property rights, but this protection does not last long. Chu et al. (2018) state that the consolidation of intellectual property rights is positive in sectors using domestic inputs while it has both positive and negative effects in sectors using foreign inputs. Barbu and Militaru (2019) have demonstrated a positive relationship between patenting and the growth of new ventures, access to venture capital, and new information. In addition, Gangopadhyay and Mondal (2012) stated that strong intellectual property rights may discourage innovation. Woo et al. (2015) stated that intellectual property rights generally increase the industrial value added, but increasing these practices reduces the positive effects. Intellectual property rights also increase R & D spending, but there is a negative relationship between patented information and intellectual property rights.

Marketing Innovation

Innovation refers to the process as "transforming an idea into a marketable product or service, a new or improved production or distribution method, or a new social service method". The same word also describes the "marketable, new or improved product, method, or service" that is introduced at the end of this transformation process. The point that draws attention in the given definition is the emphasis on "marketability" in terms of both process and result (TÜSİAD).

There are two main problems for innovation firms. The first is the process of discovering innovation, and the second is introducing it to the market as creating a new product, a new service, or a new business process is not considered an innovation unless it is subjected to the marketing process. From this perspective, an effective innovation strategy is very important for organizations in marketing and innovation processes. Uncertainties in the innovation process for firms make the control and management of the process difficult. The most important of these uncertainties are financial, technological, and organizational uncertainties. In order to reduce these uncertainties, it is essential to have a strong operational structure and culture. The government and other organizations will help to make this process more dynamic and active by playing a supporting and regulatory role in some areas where organizations cannot overcome (Gümüş and Gümüş 2015: 263–264).

Marketing of innovation distinguishes common marketing concepts as focusing on risk reduction, uncertainty, and optimization of resources in the innovation process. In the process of successful innovation, there is a limit between the marketing before the product and the marketing after the product is released. Pre-product marketing is a “laboratory marketing” and the marketing initiated after the release of a product focuses on the consumer with visible actions (LEIA 2000: 4).

12.3 Conclusion

Innovation contributes to economic development by encouraging the development of new and existing markets. The national innovation system is defined as the aspects and all elements of economic structure and institutional formation that affect learning as well as research and discovery. The production system, the marketing system, and the financial system are the subsystems of learning. A detailed determination of which subsystems and social institutions should be included or excluded in the analysis of the national innovation system is work that includes theoretical and historical analyses. In this regard, the definition of national innovation should be left clear and flexible considering which subsystems should be included and which processes should be examined. The most critical role in a national innovation system belongs to companies. It is the responsibility of the companies to realize and introduce a new invention. Innovation is also the way to increase competitiveness, enter new markets, and increase market share.

Companies need to make R & D expenditures for innovation first. Innovation is very important for a company to compete. However, innovation is necessary not only for firms but also for a country to be classified as a “developed country”. For this reason, it is important for states to support innovation. The motivation of innovators and conservation of ideas to encourage innovation are also part of this system and the final product has to be marketed and met with the customer. Ensuring all this coordination in a good way will make the innovation process more effective.

In order to survive in a developing competitive environment, providing services and products in alignment with emerging customer needs is necessary. The importance of the concept of innovation is becoming stronger in an increasingly competitive environment. Innovation plays a key role in developing countries. Innovation is inevitable for both organizational success and strong economies. It increases productivity, productivity increases competitiveness, and competition increases the standard of living and welfare in a country. Innovation is the key to growth, quality of life, and prosperity for countries. Through innovation, society gains more returns from the same source. Therefore, innovation is not only an economic system but also a social system.

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Chapter 13
Blockchain for Financial Technology: Challenges and Opportunities for India

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Abstract The chapter explores the challenges and opportunities of Blockchain-based Financial Technology applications from the Indian perspective. Blockchain has a recent hype worldwide and India responds to it making itself open to both the challenges and opportunities. India has niche societal characteristics, which makes its Blockchain confrontation unique than the other countries exposed to this technology. This chapter contributes to the understanding of these niche characteristics to identify the unique challenges and opportunities of implementing the Blockchain technology from the Indian perspective.

Keywords Blockchain · Fintech · Challenge · Opportunity · India

13.1 Introduction

Blockchain is one of the fastest-growing trends in the last few years (Crosby et al. 2016). This technology has brought many opportunities for the globalization of finance through facilitating Financial Technology (FinTech) applications (Imansyah 2018). It has given us options to transform a plethora of traditional applications and serve our day-to-day needs in a radically more efficient and effective way (Sharma 2018). Blockchain has become a global trend, and India should embrace the opportunity it brings. India, one of the world's fastest-growing economies, considers the applicability of Blockchain seriously, along with its opportunity and relevant challenges.

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Blockchain is a digital, immutable, transparent, and distributed ledger system that chronologically records transactions in almost real-time (Coindesk 2016). The introduction and record of transactions in a ledger is subject to the approval of all the participants (called nodes) of the Blockchain network (Chepurnoy et al. 2016). Furthermore, Blockchain records are immutable and transparently viewable and accessible by all participants, which provides a persistent way of security and control of the data records by preventing their manipulation and errors (FinTech Futures 2017). As such, Blockchain is a shared network through which 'values' in the form of high-quality data and records are exchanged over the internet between participants stationed in any part of the world (Christidis and Devetsikiotis 2016) without an intermediary (Morini 2016). Because Blockchain is immutable, no changes can be made once a transaction is recorded into it, which ensures data integrity and security and reduces opportunities for fraud.

Blockchain can be defined as a digitally distributed ledger (Zheng et al. 2017), where transactions are recorded in a ledger in an automatic sequential order (Coindesk 2016). Every transaction recorded is time-stamped, i.e., against the time of transaction occurring or entry, which becomes permanent in the history and viewable and trackable by all participants (NRI 2015; Lee and Chuen 2015). As a result, Blockchain becomes an unalterable technology, which ensures its security. Blockchain can offer much more benefits than the current technology in use. The key advantages offered by Blockchain technology includes—decentralization, transparency, traceability, data security, and a high degree of data encryption (Singh 2018).

The motivation for the chapter stems from the recent confrontation among Indian regulators and the Supreme Court regarding the implementation of the Blockchain technology through the mainstream banking channel. The chapter contributes by outlining the challenges posed for implementing this technology in the Indian context and steps taken in order to mitigate these challenges. This chapter also outlines the opportunities ahead subject to a successful implementation of the technology in the financial services industry. Policymakers, regulators, and stakeholders should consider these challenges and opportunities in FinTech implementations based on this technology.

The rest of the chapter is structured as follows. The second section presents the Indian Blockchain context; the third section investigates the challenges regarding this new technology for India; the fourth section explains the mitigation steps taken against the challenges that exist. The fifth section discusses the opportunities offered for the Indian economy and other stakeholders given the Blockchain technology appropriately implemented, while the final section concludes.

13.2 Indian Blockchain Context

The relevant Indian context needs to be understood first in order to explain the challenges and opportunities of Blockchain technology in India. The latest Blockchain news is about all the severe challenges that are hidden with the adoption of the technology in the existing systems. Indeed this is a revolutionary shift in the field of operations, which has become quite efficient with the encryption-based technique (Bakshi 2018). As the world changes—so do the work culture and opportunities in the market (Akins et al. 2013). The one who changes and modifies with time survives the transformation. The same applies to the application of Blockchain technology within the Indian market, which is going through a breakthrough revolution. Even though it has been evolving since the 1990s but it came into the spotlight with the cryptocurrency craze. The entire crypto operation is based on a Blockchain-based platform. The popularity of Bitcoin has helped in spreading awareness of this technology. Blockchain news then spread like fire in the market and is now picked up by major multi-national corporations. The best feature of Blockchain is that it applies to a majority of domains, particularly in FinTech, and not just limited to cryptocurrency trade (Bakshi 2018).

India's serious inclination toward the Blockchain-based FinTech applications can be understood from the proactive stances undertaken by the Reserve Bank of India (RBI)[1]—the nation's central bank. Since 2017, RBI has conducted at least seven studies about Blockchain and its Distributed Ledger Technology's (DLT) implementation for a decentralized and cashless financial system (Priyaranjan et al. 2020). Despite the RBIs time taken to study the situation before incorporating the Blockchain trading in its banking system, the Supreme Court has allowed Indian banks to get involved in the Blockchain service and related business without any delay (Simms 2020). Several state governments have expressed their decision to embrace this updated and improved technology. For example, the Karnataka government is progressing toward Blockchain-based e-government system and the state hosts the country's Centre of Excellence (CoE) for Blockchain Technology (Choudhury 2020; THBL 2018). Besides, the Telangana government has decided to use Blockchain to digitize land records and other government data management (Sharma 2018).

Figure 13.1 shows the Blockchain use-cases in India developed into the proof of concept (PoC).[2] These include trade finance, supply chain finance, E-KYC (Electronic—Know Your Customer) document management, cross-border payments, and employee loyalty or rewards.

The usages of PoC in India can be put forward with examples as follows.

[1] RBI is the central bank of India.

[2] Here, Proof of Concept (PoC) is the evidence from a pilot study, important in order to check the feasibility of deploying a new technology.

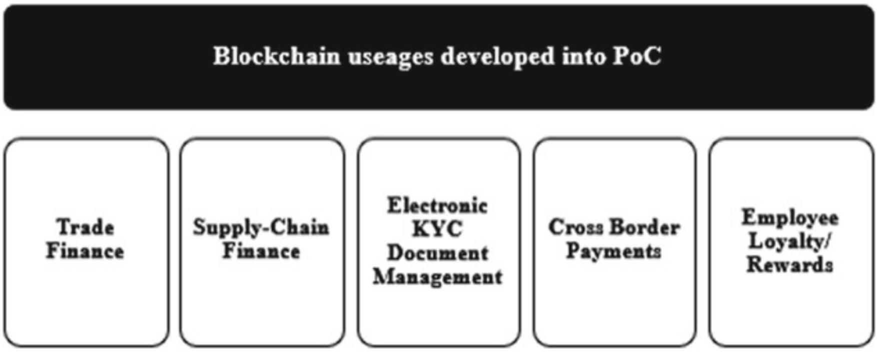

Fig. 13.1 Blockchain experiments by Indian players (*Source* Deloitte 2017)

- **Trade finance** In October 2016, ICICI Bank—a private sector bank in India—was India's first and the world's one of the few financial institutions to execute international trade finance and remittance transactions using Blockchain in partnership with Emirates NBD—a leading bank based in Dubai.
- **Supply chain finance** In 2016, Indian conglomerate Mahindra Technology in partnership with technology giant IBM initiated a cloud-based application to transform supplier-to-manufacturer trade finance transactions through a permissioned distributed ledger (Manda and Polisetty 2018). The next year, Bajaj Electricals started using Blockchain-based 'smart contracts' for facilitating 'supplier finance' in collaboration with Yes Bank, IBM, and Cateina Technologies. The adoption has helped the organization slash payment processing time close to real-time from its previous duration of 4–5 days (Manda and Polisetty 2018).
- **Electronic-KYC management**: In 2016, the National Stock Exchange—India's largest and leading stock market started using Blockchain for verification and management of KYC document in collaboration with some of the leading banks in India. Indian FinTech startup Elemential implemented the process in partnership with ICICI Bank, IDFC Bank, Kotak Mahindra Bank, IndusInd Bank, RBL Bank and HDFC Securities (Higgins 2017; IFC 2017).
- **Cross-border payments**: Stellar India Consultants[3] has collaborated with four financial institutions to enable low-cost global money transfers to the Philippines and cross-border payments to and from India, Europe, Kenya, Ghana, and Nigeria. Axis (with Dubai-based RAKBank) and Yes, Kotak and IndusInd (in collaboration with RippleNet)—five of the private sector banks in India are currently testing Blockchain transactions focused mostly on cross-border remittance & trade settlements (VK 2019).
- **Loyalty/Reward programs**: Customer loyalty and reward programs for financial and non-financial institutions are often hectic and involve large and ever-increasing data management and analytics. Blockchain technology could

[3] Stellar provide its specialized consultancy services in Electrical, Low Voltage, HVAC, and Public Health Engineering.

help minimize errors, maintain full transparency and smooth monetization of loyalty/rewards programs through e-wallets. Deloitte India has launched a Blockchain-based pilot project covering the management of customer rewards and recognition programs (Deloitte 2017).

With these unique features of Indian context, adoption and implementation of Blockchain technology pose distinct challenges as well as opportunities.

13.3 Challenges for Blockchain in India

Challenges are countless as the Blockchain is going through a very early stage of adoption. It might be risky to commit to apply and to predict its applicability for mainstream technology. Many upgradations still need to be implemented to make it safe and secure. Despite the highly promising outlook of the Blockchain technology and its applications, many unanswered questions remain that could make Blockchain a vulnerable venture to pursue. Blockchain is at the same stage where the internet was during the 1990s. The internet faced doubts and hesitation during its days of initial launching similar to what the Blockchain technology experiences today. However, with time, this technology grew, and similarly, the technology is expected to rise in the future (Noyes 2016a).

The fact that Blockchain being over-hyped than usual has created unrealistic expectations from the technology. The lack of regulation and compliance specification are few of the major challenges at the national level against the successful adoption of Blockchain technology. The existing literature identifies a number of challenges in Blockchain adoption at the firm level across the business value chain (not limited to financial technology), classified in several broad categories. For example, technological (e.g., immutability and immaturity of the technology, power consumption, the lack of appropriate platforms), social (e.g., the potential use of multiple identities, privacy concerns), political, and policy (e.g., the lack of national regulations, policies, and commitment), economic (e.g., large initial investment, maintenance cost), intra-organizational (e.g., the lack of management commitment and technology readiness, financial constraints), and inter-organizational (e.g., the lack of participation by business partners, problems and disagreements in collaboration, and information sharing) (Saberi et al. 2019; Kosmarski 2020; Pournader et al. 2019; Grover et al. 2019; Dutta et al. 2020; Sternberg et al. 2020).

To date, many people in India remain in darkness about the concepts of digitization, which could make the idea of adopting Blockchain into the mainstream somewhat unrealistic and suffer from a disconnection with reality. To master this technology, one needs to have some specific skills, for example, training in programming languages such as Java, C++, and Python, a deeper understanding about financial services and payment systems, and a detailed knowledge about big data and data analytics (Sharma 2018). This points to the fact that the readiness of the Indian society is still under question for Blockchain technology. As a result, society as a whole and the government should identify certain implementation challenges before the all embraced implementation of Blockchain technology. The steps that need to be completed to implement this technology are—onboarding end-users, enabling regulations, reshaping the roles of financial institutions and building necessary financial system infrastructure (IANS 2018).

Blockchain shows enormous potential in India's financial services industry, particularly in the banking and insurance sectors. Most of the progress happened so far have been realized through collaboration and partnership between the major FinTech enablers such as financial institutions, FinTech startups and technology companies. In addition, many large non-finance corporations are increasingly inclining to adopting Blockchain for innovating and enhancing the efficiency and effectiveness of their traditional business processes (Nair 2016).

Several Indian corporations and enterprises have already piloted Blockchain's real-life applications in the areas of international trade finance, international payments, bills discounting, supply chain finance, loyalty program management, and digital identity conversion and verification (Jaag and Bach 2016). Similarly, many Indian financial institutions such as banks and at least a stock exchange are playing a pioneering role in adopting Blockchain into their regular products, services, and processes. The main aim for most of these early adopters is to explore Blockchain's potential as an alternative to achieve a greater efficiency, effectiveness, and coverage through innovation in products, services, and processes. However, the journey of these experiments remains full of challenges, which exposes the serious difficulties lying ahead in the way of adopting Blockchain across the board. Some of the key challenges include the lack of knowledge and awareness among the stakeholders, the 'too fast to keep pace with' nature Blockchain's technological evolution and the challenges associated with operational and cultural integration across organizations and stakeholder groups.

While the use of Blockchain technology gains momentum at the industry level, the Reserve Bank of India (RBI)—main financial services regulatory authority in India closely monitors the developments (Foroglou and Tsilidou 2015). The technology research arm of RBI—the Institute for Development and Research in Banking Technology (IDRBT)[4] took the initiative to understand the applicability of Blockchain to the Indian Banking and Financial Industry in mid-2016. The Institute conducted a workshop where stakeholders from all spheres, such as the academics, bankers, regulators, and technology partners participated in contributing to an in-depth understanding of the technology, opportunities and challenges, finally the implementation impact on the society. Participants in the working group include experts from all major banks and related bodies in the country (FinTech Futures 2017). The workshop participants contributed to the development of a White Paper, which covers the fundamentals of the Blockchain technology and the critical issues surrounding it, detailed studies on its applications globally, and the potential areas for its adoption

[4] Institute for Development and Research in Banking Technology was established by the Reserve Bank of India for its technology related activities. Available at https://www.idrbt.ac.in/conferences.html.

in India's financial services industry. The document also outlines several key benefits of adopting Blockchain, such as cost and time efficiency and greater transparency. Furthermore, the IDRBT has drafted a PoC on the applicability of Blockchain in trade finance particularly through active contributions from National Payment Corporation of India, banks, FinTech start-ups, and technology firms (FinTech Futures 2017).

Deloitte—an IDRBT working group member, presented a study analysis at the IDRBT conference in Hyderabad in 2017. This study was conducted based on a questionnaire survey on and interviews of India's early adopters of Blockchain, which presents a detailed understanding about the potential challenges to the technology's adoption from the perspectives of both a customer and a technology service provider (Axon 2015). The study suggests that the journey toward Blockchain adoption can be clearly divided into three major phases as depicted in Fig. 13.2, where the challenges skew toward the pre-PoC stage. Based on the observations, the most critical challenges met by businesses at the PoC levels pertains to six major activities—building awareness, identification of business case and partners for PoC, selection of Blockchain platforms or service providers, partner onboarding, the development of a congenial environment, and security and integration-related difficulties (Biryukov et al. 2014).

Figure 13.2 presents the stages of Blockchain implementation in order to mitigate these challenges while performing the PoC.

The proposed pre-PoC stage can take three to four months approximately to intra-organization awareness about Blockchain technology byte firms intending to adopt it, identify a clear and systematic business process and the relevant stakeholders for

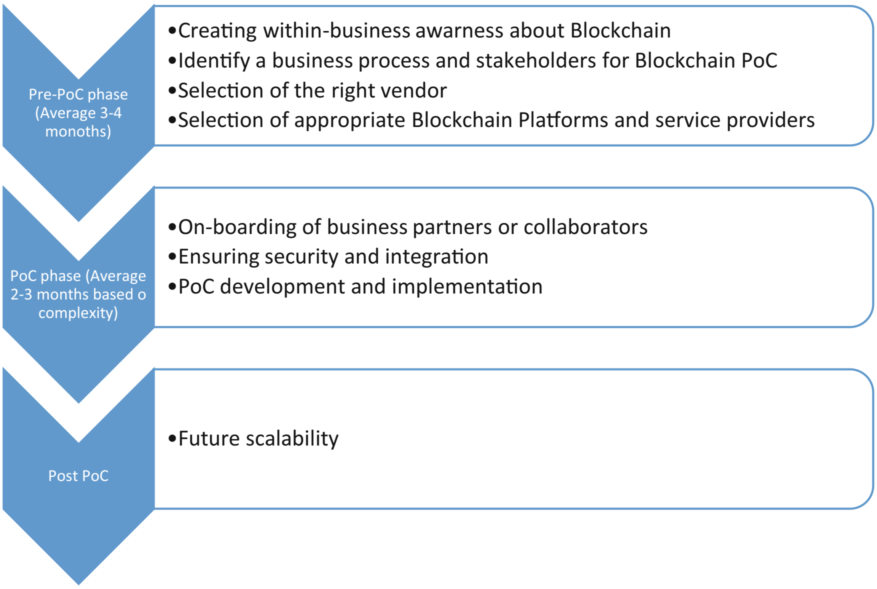

Fig. 13.2 Stages of blockchain implementation (*Source* Deloitte 2017)

the PoC, selection of both appropriate vendors and suitable platforms. The PoC stage may take a further two to three months on average based on their complexities to onboard business partners, to check security and integration, and finally the PoC development and implementation. Further, the post-PoC stage includes the future scalability according to need at times.

Each of the stages has its importance in Blockchain adoption and implementation. However, at the pre-PoC stage, the biggest challenges during the PoC development include the difficulties and complexities pertaining to the adoption and identification of the Blockchain use-cases. At the same time, the unavailability of uniform standards and complications related to the existing IT landscape works as a fundamental barrier in developing the PoC and its full-scale implementation in the later period. Nevertheless, an appropriate selection and combination of business collaborators, Blockchain platforms, and technology service providers drive the success or failure of a PoC (Deloitte 2017).

Taking all these challenges and survey findings into account RBI put a temporary ban on immediate adoption of Blockchain finance by the Indian banking industry. However, this ban was lifted by the Indian Supreme Court in early March of 2020 (Simms 2020). However, RBI warns this will expose the Indian banking industry to significant risks as they might still not be ready for the accompanying risks involved in the Blockchain transactions (Helms 2020). This might also have a spillover effect in the long run on all other sectors.

Before full stream adoption and application of the technology, the regulators, policymakers, government, and stakeholders need to be appropriately ready for the challenges it poses.

13.4 Mitigation Steps Against the Challenges

Major mitigations steps to counter the challenges in the adoption and implementation of the Blockchain technology faced by business houses are as follows.

Lack of Awareness

Since Blockchain is a relatively new technology, the lack of awareness and knowledge remains a key barrier to Blockchain adoption across the world (Noyes 2016b). For firms that want to adopt Blockchain, the ideal first step for them is to develop an internal team that will learn the technology at depth and breadth covering its technical architecture and mechanisms, impacts, and application areas in the businesses' operations. In addition to in-house training, knowledge-sharing sessions, and employee Hackathons, key employees could also be sent for attending external events such as training, conferences, and industry working groups to develop a comprehensive understanding about the technology (Gogerty and Zitoli 2011; Eyal and Sirer 2014).

Firms should consider the expenses related to Blockchain training and learning as an investment rather than just an operational expenditure.

Identifying the Right Platform, Vendor, and Partner for PoC

Once a use-case is identified and decided, the next big difficulty is to find the appropriate platform, technology service provider, and partner or collaborating firms to run a real pilot test (Meiklejohn et al. 2013). To mitigate these challenges, firms intending to implement Blockchain could develop cross-functional teams within the organization, continue consultations and focused group discussions with the prospective partner or collaborator firms, develop an inter-organizational team with the suitable partner firms, and then outline a comprehensive project charter with specific milestones and key performance metrics.

Integration and Data Security Challenges

It is important to confirm that the technology's actual integration and data security (e.g., customer data encryption) do not result in a threat or risk. During the implementation phase of PoCs, most of the early adopters came up with only a minimum number of viable products to pilot the application of the Blockchain technology. This approach allowed a smoother and carefully-monitored integration of the new technology with the existing one. As an effort to ensure data security, they also developed effective strategies for data purging or masking (i.e., a way of erasing the data blocks created so that no one can access them anymore) (Pilkington 2016). It is necessary to ensure the reliability of the technology.

While the challenges remain critical and valid, India shows an effective track so far in mitigating the challenges posed by Blockchain implementation.

13.5 Opportunities in Indian Perspective

This section unveils the opportunities and benefits offered by the Blockchain technology in the niche Indian context.

Blockchain technology has emerged as an accessible technology because of its decentralization feature (Foroglou and Tsilidou 2015), which is most likely to find applications in different aspects of mainstream society (Kosba et al. 2016). Blockchain can be a great platform that enables a range of extra facilities such as tracing the origin of a financial transaction (Sharma 2018). If appropriately implemented, Blockchain features increase the security and reliability of the technology. Blockchain has the potential to streamline land records (Dixon et al. 2012), asset registries, auto records, voting records (Dennis and Owen 2015), national identity, financial transaction records, and traceability (Peters et al. 2015). All these can eliminate corruption on a large scale and bring the large informal sector into the formal economy (Singh 2018). Blockchain, alongside other innovative technologies including artificial intelligence, machine learning, data analytics, and robotic process automation could improve the efficiency of India's current trade finance system by manifold (Assocham 2018; Omohundro 2014). Besides, according to Deloitte (2017), Blockchain's use for digital identity management and 'know your customer' (KYC) seems highly promising.

Job creation is an inevitable blessing that India might enjoy from the technology. There is an acute shortage of Blockchain developers, and it has been observed that budding engineers are now opting-out from the conventional streams. According to the latest Blockchain news, it is alleged that there will be several high paying jobs in the next decade. Giant technological companies like IBM and Tech Mahindra are conducting seminars and workshops to spread awareness on Blockchain technology (Bakshi 2018).

Neighboring countries like China have Blockchain technology and its application closer to mainstream life. Unable to deny the spill over-expectation and the obvious temptation of the advantages this technology offers, India strives forward to find the use of Blockchain in its mainstream activities. As India takes steps toward digitization; Blockchain will be the next thing the country would be aiming for. There are many sectors, which have significant value for Blockchain addition like infrastructure, education, finance and pharmaceutical (Sapirshtein et al. 2015). In addition to this, it is likely to open new career options for the upcoming generation (Eyal and Sirer 2014). Those who become proficient in it will have bright opportunities in the forthcoming years as it might replace the old conventional operational platforms (Bakshi 2018). India striving toward a sustainable democracy, voting is a potential field where the use of Blockchain Technology can potentially have a revolutionary role to ensure transparency (Ayed 2017). Although this is not very feasible right now, in the long run, the nation will find this technology to ensure accountable and secure voting (Sharma 2018).

Despite the major challenges posed by technology, Blockchain offers many benefits to Indian society and stakeholders.

13.6 Conclusion

The Indian economy is likely to be benefitted immensely from the adoption of Blockchain technology. If this new technology is proved to become successful and can be practically implemented in India, it has the potential to bring in a revolutionary change in society. Blockchain can contribute with an opportunity to create a new set of jobs to enable the nation to be independent of the unemployment problem (Sharma 2018). Indian banks and non-bank financial institutions need to prepare well for this new technology to have a more enriched understanding of its potential implications for finance (e.g., products such as trade and supplier finance) when implemented and integrated into the overall system (Assocham 2018).

However, the risk is there in implementing such an overwhelming and robust technology all out at once without proper research and pilot study. Policymakers need to consider this very carefully; dialogues among the regulatory bodies can bring an appropriate solution in deciding the right moment and extent to implement the Blockchain in the mainstream economy in India. The timely and exact address of challenges should open up the opportunities for India in Blockchain Finance.

This chapter identifies the challenges in implementing the technology that needs to be addressed before implementing such a disruptive technology that can bring us myriad opportunities as well as expose us to a lot of risks. Thus, this chapter advocates for careful consideration of the challenges before implementing Blockchain. Before implementation, the related stakeholders and industries need to be appropriately prepared for the change. A proper application of Blockchain offers radical development in the Indian economy.

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Part V
The Impact of Artificial Intelligence on Regulation and Ethics

Chapter 14
What Does Artificial Intelligence Mean for Organizations? A Systematic Review of Organization Studies Research and a Way Forward

Deniz Öztürk

Abstract Artificial intelligence (AI) is a swiftly evolving phenomenon that bears both economic and organizational significance. As organizations are increasingly benefiting from AI for both routine and highly complex tasks and decision-making, AI has developed as a key concern when contemplating the future of organizations and organizing. The ability of the AI to act autonomously distinguishes it from technologies historically used in organizations. This also entails new forms of organizing with a non-human actor and challenges existing conceptualizations of technology in organization studies. As AI is contributing to the automation of many aspects of management and impacting organizational dynamics, it has emerged as a very significant organizational phenomenon that entails both theoretical challenges and opportunities for management and organization studies scholars. Although the implications of AI for organizing has been at the centre of practitioner-oriented journals, the scholarly work has remained more nascent with regard to theory-driven research that could explicate the mechanisms between empirical cases and theoretical perspectives. This chapter aims to reveal the state of scientific knowledge on the relevance of AI in organization studies and delves into the potential implications of AI for management scholarship. The chapter first presents the historical trajectory of AI in organization studies by discussing both important antecedents for and consequences of adopting AI-based systems in organizations. It then systematically examines the extant research on the impact of AI on organizations published in the top management journals of the last two decades. The articles are delineated between theory-building and theory testing and further classified with respect to aspects of AI (such as AI as task input, task process or task output) and themes raised in them. The systematic review of these articles contributes to both identifying knowledge gaps and growing research agenda by introducing possible research questions with regard to future research directions for AI in organization studies. This review chapter ends with a brief discussion on the implications for organizational theorizing and the future of organization studies in light of AI.

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14.1 Introduction

Artificial intelligence (AI), which can be described as "a system's capability to correctly interpret external data, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaption" (Haenlein and Kaplan 2019, p. 17), has received substantial interest in terms of its potential impact on the work force. AI has become a core concern when considering the future of organizing, organizations, and society at large (Haenlein and Kaplan 2019). The advent of information technology along with the progress in artificial intelligence, machine learning and virtual reality has yielded new prospects in rethinking work, displacing the old ways of organizing and doing jobs (Özkazanç-Pan 2019). Organizations are increasingly using AI for highly complex activities, such as recruiting candidates for job positions (von Krogh 2018) and distributing expenses via blockchain-enabled contracts to partners in a complex supply chain system (Murray et al. 2020). As AI is increasingly contributing to the automation of many aspects of management and is impacting organizational dynamics, it is significant to better understand its relevance for organization studies.

AI is a very significant organizational phenomenon that bears both theoretical challenges and opportunities for management scholars (Bamberger 2018). In today's world, organizations are making use of AI across a wide range of tasks, such as recruiting employees for organizational positions, performing financial transactions, and forecasting technological developments. In a nutshell, AI is a compilation of computer-assisted systems for task performance that encompasses machine learning, automated reasoning, knowledge repositories, and natural language processing. These systems highlight the three main components of AI as "task input (data), task processes (algorithms), and task outputs (decisions, solutions)" (von Krogh 2018, p. 405).

Despite some exploratory empirical studies, theoretically grounded research that aims to understand AI and its organizational implications are relatively limited. The field is instead dominated by articles originating from practitioner-oriented journals that advise executives on the necessary guidelines for benefiting from AI without referring to the application of theory to the research. While firms have started to embrace AI, organization studies scholars have been largely silent about the recent developments, with few exceptions. This chapter aims to provide a comprehensive answer to the following research question: What role does AI play in management and organization studies? In discussing how organization studies scholars can advance the study of AI, we also seek an answer to the question of what the potential implications of AI are for management scholars in research.

The contributions of this review chapter are twofold. First, it aims to reveal the current state of the scientific knowledge on the relevance of AI in the field of organization studies. To do so, we examine the organization studies literature with regard to contributions on AI, and then we propose potential research avenues for studying the interplay of AI and organization theory. By comprehensively examining the articles published to date, we aim to reveal the emerging trends and topics that have been elaborated in the intersection of AI and organization studies. The remainder of the chapter is organized as follows: First, we map the historical trajectory of AI in the field of organization studies, and then we discuss both important antecedents for and consequences of adopting AI-based systems in organizations. We present our methodology and then the findings, and we end with a brief discussion on the potential research avenues and future of organization theory in light of AI.

14.2 AI in its Historical Trajectory: From Herbert Simon to the Current Day

This subsection aims to historically present the scientific knowledge on the role and relevance of AI in the organization studies field by addressing the repositioning of AI at the crux of management debates. Research in the 1950s revealed that AI would become important to management (Newell and Simon 1956). However, debates on AI in management were abandoned in the 1960s in favour of a contingency view in which argued that routine operational tasks carried out by machines were detached from more complex and managerial tasks. The field of AI then underwent a phase of progress and hype, subsequently followed by "AI winters". The initial winter of AI appeared in the 1970s due to the over-inflated promises made by developers, unrealistically high expectations of users, and overly extensive promotion in the media (Newquist 1994). The failure of AI in this period went hand in hand with pessimism in the AI community and cutbacks in funding, followed by the end of research in the field. During this period, research programmes had to hide the goals of their work under different names in order to receive funding. The field was then rejuvenated from the 2000s onwards, whereas its reflection upon organization studies scholarship had to wait almost two decades.

AI was first incorporated into the Dartmouth Summer Research Project on Artificial Intelligence at Dartmouth College, New Hampshire in 1956. The purpose of the project was to unite researchers across different fields to form a new research area aimed at building machines to simulate human intelligence. The subsequent decade witnessed two success stories, the first of which was a natural language processing tool named ELIZA, simulating conversation with a human, while the latter was the "General Problem Solver" program elaborated by Herbert Simon, J.C. Shaw and Allen Newell, aimed at solving certain kinds of simple problems. These systems aimed to collect rules that would presume that human intelligence could be formalized and rebuilt in a top-down method via a sequence of "if-then" statements.

However, this rising trajectory was reversed from the 1960s onwards with the liquidation of the discussion of AI in management and in the 1970s with the strong criticism of spending on AI research by the US Congress and the British government's ending support for AI research at a majority of universities (Edinburgh, Sussex, and Essex were exceptions).

With the rise and prominence of structural contingency theory in the 1960s, technology became increasingly viewed as a contingency factor for organizational structure and decision-making. Structural contingency theory suggested that different contingency factors such as environmental uncertainty, technology, and organizational size require different organizational structures, in which the fit between structure and contingencies is the key to better performance and organizational survival. From this perspective, technology had a narrower scope, such as production processes (Woodward 1965), information technology (Thompson 1967), and amount of variability (Perrow 1972). Early work focusing predominantly on manufacturing technology paved the way for research that sought to add a variety of other technologies (Perrow 1967). AI was decoupled from organization studies, where complex managerial tasks became detached from routine operational tasks that machines could handle.

The 1960s were also important with regard to Cyert and March's (1963) seminal work entitled *A Behavioral Theory of the Firm*, challenging neoclassical assumptions about firms by introducing concepts of uncertainty, conflict, satisficing behaviour and bounded rationality into explanations of firm processes, decision-making, and behaviour (Simon 1978). However, AI agents seemed to surmount these weaknesses in the economic models of firms, challenging many premises of the behavioural theory of the firm (Baum and Haveman 2020). To illustrate, in comparison to human agents, AI agents can be rational and persistently designed to maximize and not satisfy, as algorithms do as told while ignoring other considerations (Lindebaum et al. 2020). AI agents also have the capability to automate decision-making and processes within organizations by challenging bounded rationality with their abilities to process large amounts of knowledge. With AI agents becoming more advanced, there are the possibility of achieving fully automated organizations where human agents are managed by artificial agents (Curchod et al. 2020).

In this historical trajectory, AI-based solutions have been used by organizations to automate routine operations. More recently, developments in computing technology and new machine learning techniques have begun to enable organizations to benefit from AI-based solutions for managerial tasks (Raisch and Krakowski 2020). The literature on organization studies has mainly witnessed the paradigmatic change from viewing AI-based systems as replacing managers to promoting AI-enabled automation to augment tasks. The strategic value of AI-based systems depends not only on the algorithmic capability but also on the effective orchestration of organizational capabilities and managerial willingness to use them (Keding 2020).

The automation of cognitive tasks that makes substitutes of both humans and machines is referred to as the period of the "Second Machine Age" (Brynjolfsson and McAfee 2014). This age is characterized by the quick advancement of digital, computational and robotic technology or machine learning. Schwab (2017) also adopted the phrase "Fourth Industrial Revolution" to highlight the different ways in which technology is being introduced into society, while the first three revolutions were, respectively, represented by steam engines, electrification, and microprocessors. Birkinshaw (2020) conceptualized these perspectives as the exponential growth in the processing and transformation of information in the late 1960s leading to a shift in product types, internal functioning of firms, and accompanying changes in the basis of firm competitiveness.

AI has two broad applications in organizations. First, "automation" denotes that machines take over a human task, and second, "augmentation" implies that humans collaborate with machines in performing the task. In questioning the relationship between automation and augmentation, Raisch and Krakowski (2020) argued that augmentation goes hand in hand with automation in the management field. As the human–machine relationship is no longer dichotomous, both sides are perceived as having complementary strength and capabilities. That is to say, business managers need to be aware that AI bears the capacity to augment rather than replace humans in managerial tasks (Davenport and Kirby 2016). In their review of three books, Raisch and Krakowski (2020) revealed that organizations focusing on augmentation strategies would end up with superior performances and sustainable competitive advantages. However, they argued that the relationship between automation and augmentation was depicted as a trade-off in the studied books, whereas the paradox perspective replaces the traditional trade-off perspective and highlights both contradictory and interdependent elements between automation and augmentation. Throughout the entire process, they argued, these interdependencies allow management interventions in one task to have ripple effects. They suggested that raising a managerial task could allow its subsequent automation, with that automation in turn leading to augmentation managerial tasks closely related to it. As machines can only bring a certain range of options for relaxing real-life constraints, "managers need to use their intuition in matching the machine output with reality in order to arrive at a final decision" (Brynjolfsson and McAfee 2014, p. 92). Moreover, as machines are confined to a specific task, they fail to learn from their experience in one field to conduct tasks in other fields. Therefore, "managers need to ensure contextualization beyond an automated task" (Raisch and Krakowski 2020, p. 16).

14.3 Antecedents of Organizational Adoption of AI-Based Systems

In this subsection, we mainly discuss the role of decision-making and task variety as antecedents of organizational adoption of AI-based systems. The availability of relatively low-cost computing power, big data and the improvement of optimization algorithms paved the way for the new success of AI (von Krogh 2018). As argued by van Krogh (2018), the rapid adoption of AI by organizations can be attributed to four main reasons. First, the past two decades have witnessed advancements in the science and technology underlying AI methods, wherein many global companies have made these technologies available under open-source licences. Second, information technology has evolved to be very efficient in storing task-related data across organizations. Third, the decreasing cost of computer hardware has made computational power increasingly affordable. Finally, the growth of cloud-based services has also rendered AI available to organizations of different scales, from start-ups to mature firms.

The relationship of work and technology has long been studied, from the robotization of factory lines to the integration of computing technology into knowledge work. With the introduction of AI into existing practices, current organizing not only becomes computational but also algorithmic (Brynjolfsson and McAfee 2014). For many reasons, what algorithms actually do is of importance to organization studies. Algorithms influence decision-making in organizations because authority is increasingly conveyed algorithmically. As argued by Lindebaum et al. (2020), algorithms may trigger a new period of hyper-rationality that envisages people as an impediment to an efficient society. Additionally, by promising greater efficiency, algorithms are expected to entail the realization of both goals and strategies in exceptional ways. Hence, algorithms are positioned to influence both the processes and outcomes in organizations and societies. AI algorithms are more and more being utilized in organizational decision-making and, as Pasquale notes, "authority is increasingly expressed algorithmically" (2015, p. 8). Organizations have endeavoured to figure out the brains of outstanding CEOs onto algorithms for more efficient decision-making (Copeland and Hope 2016), monitor job applications via algorithms, and set up AI systems as members of boards (Libert et al. 2017).

The imperfect nature of human decision-making implies that it is also bound by cognitive biases in terms of rationality that may also pave the way to suboptimal decisions. AI transforms how businesses make decisions and interact with other stakeholders. As a multi-agent system, AI can be utilized to support individual and/or group cognition in decision-making. Furthermore, it can permit a human-agent team to better perform collective cognitive tasks than robotic agents alone. To illustrate, IBM has set up a cognitive room that aids merger and acquisition decisions. The AI system therefore forbids decision-makers to collectively interact with huge amounts of information using data visualization techniques in evaluating merger and acquisition options (Gil et al. 2019). The use of "algorithms in organizational decision-making is perpetuated by the striving for an ideal state of reality that is impacted by the ambition of reaching perfect rationality in decision-making" (Lindebaum et al. 2020, p. 7).

The current literature has mainly focused on the ways in which decision-making enabled by AI is incorporated into organization structure (Raisch and Krakowski 2020). In this regard, Shrestha et al. (2019) proposed a typology of arrangements that can be executed, going from full human–AI designation (commonly utilized for automatically detecting fraud or publicizing proposals) to crossover AI–human or human–AI consecutive decision-making (utilized for recruiting or well-being checking, for instance), and, at last, amassed human–AI decision-making (e.g., utilizing AI as a counterbalance of other board individuals' choices). Moreover, Bader and Kaiser (2019) revealed that human interaction with AI detaches the former from decision-making in terms of spatial and temporal separation, as well as facilitating the displacement of humans from decisions in cognitive terms. They challenged the prevailing notion that humans continue to be attached to decision-making because of infrastructural proximity and imposed engagement stemming from their access to contextual dynamics and their emotions. Algorithmic decision-making is, on the contrary, argued as an assemblage of algorithms and humans. They demonstrated that a user interface that introduces algorithmic decisions activates both human detachment and attachment, as they refined the classification of users as either detached from or attached to technologies.

Together with decision-making, task variety has been taken as a contingency factor influencing the adoption of AI. Organizations have benefited from AI-based solutions which automate routine operational tasks. Technological advances and machine learning enable organizations to benefit from AI-based solutions for managerial tasks (Brynjolfsson and McAfee 2017). Studies have argued that the nature of the task defines whether organizations choose automation or augmentation. AI systems learn from repetition and/or feedback from their environment to perform tasks. These tasks encompass performing analyses to grasp patterns or achieve a structured goal. This has enabled AI to do relatively better in highly structured tasks where clear rules are set (von Krogh 2018, p. 405). However, AI is constrained in understanding the context and fails to respond effectively to contextual changes. In the case of AI assisting in the carrying out of tasks, it has been suggested that a contextually sensitive practitioner is still needed to judge whether AI is relevant to a problem and, if so, to undertake reflective action (von Krogh 2018, p. 406).

It is possible to automate relatively routine and well-established tasks, while more complicated and uncertain tasks cannot, but the latter can be addressed through augmentation (Brynjolfsson and McAfee 2014; Davenport and Kirby 2016). This is because the increased learning of complex tasks is based on experts' tacit knowledge, which cannot be easily codified (Brynjolfsson and Mitchell 2017). Most managerial tasks are more complex, with a lack of rules and models, rendering automation impossible. In that case, managers could rely on the augmentation view to discover the problem and collaborate closely with machines on these tasks. In line with the augmentation thesis, AI in the workplace pinpoints the need for generating new skills that would reap the benefits of AI while retaining individuals' capacity for situational discretion both in the deployment of AI and the use of AI-generated outputs (Hadjimichael and Tsoukas 2019).

14.4 Consequences of AI at the Organizational Level: Opening the Black Box

It has been argued that AI provides benefits to organizations by enabling better organizational performance and creating competitive advantages. AI technologies are identified with benefits going from more noteworthy effectiveness and quicker and more precise outcomes to better strategic results at the organizational level (Davenport et al. 2020). In a similar vein, current scholarly work has sought to plot the brains of CEOs into algorithms to entail more competent decision-making (Copeland and Hope 2016), and instal AI systems as board members (Libert et al. 2017).

The common discourse on the positive influence of algorithms in terms of economic value and greater efficiency has recently begun to shift towards the discriminatory and exploitative nature of AI whereby algorithms may allow employers to reconstitute the employer–employee relations of production. In this regard, managers are viewed as transforming organizational control relationships in substantial ways by implementing new control mechanisms that would take full advantage of workers' labour (Kellogg et al. 2020). Among these and different uses of AI-based algorithmic dynamic are additionally various instances of "data harm", some of which might be deliberate while others are unintended. It can be argued that there is a growing concern about the "automation of society" (Helbing et al. 2017). Lindebaum et al. (2020) asserted that automation may prompt a totalitarian system enabled by technology along with oppressive guidelines mirroring the end of human decision. Birkinshaw (2020) argued that AI is forcing companies towards a more limited set of choices in terms of competition and functioning than their managers would opt for. Those restrained choices enabling incremental improvements in efficiency might curtail the ultimate strategy of gaining a competitive advantage.

The development of new technologies has been coupled with increasing concern about the ethical implications and impacts on the workforce. More specifically, there has been a lively debate about a jobless future and rising unemployment rates as humans are no longer needed for certain types of jobs, while the rise of a precarious workforce is deemed inevitable (Özkazanç-Pan 2019). While the general trend is to assume that AI is likely to eradicate jobs, others argue that the economic data do not reflect a job-killing effect of automation (Bruhn and Anderer 2019). Other studies showed a decline in available jobs coupled with a solid spill-over effect in such a way that there is an emergence of new jobs that did not exist before, which compensates for at least some of the losses (McKinsey Global Institute 2017). This trend is expected to bring about both a need to upskill workers and also high levels of unpredictability and uncertainty.

Complementing Raisch and Krakowski's (2020) argument that organizations should adopt a comprehensive perspective containing both augmentation and automation for positive organizational outcomes, others also argued that a one-sided emphasis on automation could lead to job losses and end with the deskilling of managers who hand over their tasks to machines, which could entail increasing rates of unemployment and societal inequality (Brynjolfsson and McAfee 2014). On the contrary, one-sided augmentation may also lead to another "digital divide" and "social tensions between the few who currently have the capabilities and resources for augmentation and those who do not" (Raisch and Krakowski 2020, p. 23).

As the organization studies scholarship is recently immersed into grand challenges (George et al. 2016) and more specifically inequality in organizational settings (Amis et al. 2020), the use of AI in management could also be assessed for its implications for social equality. At one extreme, it has been argued that automation takes humans "out of the loop", "reducing human biases and, in turn, promising greater equality and fairness. For example, using automation for credit approval could reduce bankers' biases that might previously have kept people from qualifying for credit due to their ethnicity, gender, or postal code" (Daugherty et al. 2019, p. 167). Correspondingly, computerized candidate assessment dependent on pre-decided rules and reliable machine processing could aid to eradicate people's hidden predispositions in recruiting choices.

In contrast to the potential equalities that AI could generate, other scholars (Brynjolfsson and Mitchell 2017) have argued that the influence of new technologies is bound by an "implementation lag". As AI implementation advances, it is foreseen that "economic growth will accelerate sharply as an ever-increasing pace of improvements cascade through the economy" (Nordhaus 2015, p. 2). In a similar vein, AI agents, defined as "actors that have the ability to imitate, and outperform human intelligence, act[ing] upon their own, distinct from and without further human intervention" (van Rijmenam and Logue 2020, p. 5), have the capacity to change their behaviour and collaborate, make decisions independently and autonomously and change the context without being subject to further human action. Authors have mentioned three areas of concern: (i) objectivity, with calls for more human oversight, as automated forms of analysis and decision may augment inequality; (ii) the ways in which artificial agency enables both governance and mass surveillance; and (iii) ordering, whereby AI agents become involved in the ordering of social life and institutional conditions.

14.5 Methodology

We conducted a comprehensive search of prominent journals in the management field. Similar to other studies (see Phan et al. 2017), we included articles from the *Academy of Management Journal (AMJ)*, *Academy of Management Review (AMR)*, *Academy of Management Annals (AMA)*, *Academy of Management Discovery (AMD)*, *Academy of Management Perspectives (AMP)*, *Administrative Science Quarterly (ASQ)*, *Journal of Management*, *Journal of Management Studies*, *Organization Science*, *Organization Studies (OS)*, *Organization*, *Human Relations* and *Strategic Management Journal*. These journals are also in the *Financial Times* list of top 50 journals (except for *Academy of Management Annals*, *Academy of Management Discovery and Academy of Management Perspectives*). We searched for papers with titles and keywords including "artificial intelligence", "robot(ics)", "automation", and "algorithm" published between 2000 and 2020. This search resulted in 15 articles; Table 14.1 provides information about these articles and their key findings.

We coded each article with regard to three dimensions: (i) whether the article is extending the theory (theoretical) or testing the theory in an empirical setting (empirical); (ii) whether the article includes task input (data), process (algorithm), and/or output (decision-making) in its design; and (iii) whether the article proposes future research avenues. We also searched for common themes in the articles. In-depth analysis of the nascent body of literature yields themes and contributes to the understanding of how this research field is evolving. This systematic review intends to contribute to the emerging debate in organization studies literature by integrating the concepts and contemplating research opportunities in the field where AI and organization studies overlap.

14.6 Findings

Stemming from the field's nascent nature, most of the articles that we examined for this review chapter commonly refer to the "possible research agenda", where the authors provide future potential questions to be studied with regard to organization studies. In this respect, while some studies raise general questions such as how technological progress in the capabilities of AI may influence organizational design, decision-making, and power issues, some others classify potential research questions at micro-, meso- and macro-levels of analyses (Raisch and Krakowski 2020). Understanding the change in the role of managers as a result of AI-based solutions represents the micro-level, whereas cooperation between humans and machines on managerial tasks pertains to meso-level analyses. Macro-level research, on the other hand, pinpoints how the automation and augmentation in management bring about institutional actions and changes that may bear wide-reaching societal implications.

Secondly, these articles mostly underline contextual factors and the contextualization of AI-related knowledge in organizations. In contrast to the discourse on the superior characteristics of AI and algorithmic decision-making, the studies merely mention the contextual actors. For instance, Fleming (2018, pp. 8–9) highlighted the various categories of jobs to be automated. This study further elaborated that AI is limited by both organizational and socio-economic forces that impact its implementation such as price of the labour, organizational power relations and the nature of the job task. From these contextual boundaries, Fleming (2018) coined the term "bounded automation", similar to bounded rationality, which allows an explication of why increasingly low-skilled (unautomated) jobs are tended to expand while "good ones" become more challenging to obtain. Instead of fetishizing smart machines and treating them in isolation, the discussion should revolve around the organizational and socio-economic conditions that embed and guide computational intelligence (Fleming 2018, p. 10). In addition, Bader and Kaiser's work (2019) indicated that

Table 14.1 Categorization of articles

Author(s) of the article	Year published	Name of the journal	Theoretical/Empirical	Key findings and arguments	Suggestions for research opportunities	AI component (task input, process, or output)
Raisch & Krakowski	2020	*AMR*	Theoretical	Augmentation cannot be separated from automation; these dual AI applications are interdependent, creating a paradoxical tension	Yes	Input Process Output
Van Krogh	2018	*AMD*	Theoretical	Functioning of AI systems entails task input, processes, and outputs. AI provides grounds for phenomenon-based theorizing	Yes	Input Process Output
Bader & Kaiser	2019	*Organization*	Empirical (case study)	"Human decision-makers' confrontations with the essence of the algorithmic decision via the user interface show that AI has a dual role in workplace decisions by creating both human attachment to and detachment from decisions" (p. 22)	No	Process Output

(continued)

Table 14.1 (continued)

Author(s) of the article	Year published	Name of the journal	Theoretical/Empirical	Key findings and arguments	Suggestions for research opportunities	AI component (task input, process, or output)
Fleming	2018	*Organization Studies*	Theoretical	"The forecast of mass joblessness is unlikely to be realized given how AI and digitalization are constrained by socio-economic and organizational forces that shape its implementation (namely labour pricing, extant power relations, and the job task in question)" (p. 2)	Yes	Input Output

(continued)

Table 14.1 (continued)

Author(s) of the article	Year published	Name of the journal	Theoretical/Empirical	Key findings and arguments	Suggestions for research opportunities	AI component (task input, process, or output)
Murray et al.	2020	*AMR*	Theoretical	"Categorizing four forms of conjoined agency between humans and technologies: conjoined agency with assisting technologies, conjoined agency with arresting technologies, conjoined agency with augmenting technologies, and conjoined agency with automating technologies" (p. 2)	No	Input Output
Lindebaum et al.	2020	*AMR*	Theoretical	Problematizing the assumptions of rationality underlying algorithmic decision-making and implications of the latter for organizations. Algorithms are theorized as supercarriers of formal rationality	Yes	Process Output

(continued)

Table 14.1 (continued)

Author(s) of the article	Year published	Name of the journal	Theoretical/Empirical	Key findings and arguments	Suggestions for research opportunities	AI component (task input, process, or output)
Phan et al.	2017	*AMP*	From the Editors	A review of prominent journals yielded no publications with regard to AI, robot(ics), and automation (except for *AMJ*, *AMR*, and *SMJ*)	Yes	N/A
Kellogg et al.	2020	*AMR*	Theoretical	"Algorithmic control in the workplace operates through six main mechanisms; employers can use algorithms to direct workers by restricting and recommending, evaluate workers through recording and rating, and discipline workers by replacing and rewarding" (p. 2)	No	Process Output

(continued)

Table 14.1 (continued)

Author(s) of the article	Year published	Name of the journal	Theoretical/Empirical	Key findings and arguments	Suggestions for research opportunities	AI component (task input, process, or output)
Glikson & Woolley	2020	*AMA*	Theoretical	Presents existing research on the determinants of human trust in AI. The form of AI representation and the level of the AI's machine intelligence are important antecedents	Yes	Input Output
Gregory et al.	2020	*AMR*	Empirical	Theorizes how a new category of network effects (data network effects) has emerged from advances in AI and the growing availability of data. A platform displays network effects if the more that the platform learns from the data it collects on users, the more valuable the platform becomes to each user	No	Input Output

(continued)

Table 14.1 (continued)

Author(s) of the article	Year published	Name of the journal	Theoretical/Empirical	Key findings and arguments	Suggestions for research opportunities	AI component (task input, process, or output)
Shrestha et al.	2020	*Organization Science*	Theoretical	Researchers are yet to recognize the value of machine learning techniques for theory building from data. Machine learning techniques are argued to be useful in theory construction during the pattern detection stage of inductive theorizing	Yes	Input Process Output
Furman & Teodoridis	2020	*Organization Science*	Empirical	Examines "how the introduction of a new technology that automates research tasks influences the rate and type of researchers' knowledge production" (p. 1)	No	Input Output

(continued)

Table 14.1 (continued)

Author(s) of the article	Year published	Name of the journal	Theoretical/Empirical	Key findings and arguments	Suggestions for research opportunities	AI component (task input, process, or output)
Curchod et al.	2019	*ASQ*	Empirical	Reveals "the power asymmetries generated by customers' evaluations in online work settings. Algorithms reproduce power asymmetries among the different categories of actors, constraining human agency" (p. 1)	No	Input Process Output
Alaimo & Kallinikos	2020	*Organization Studies*	Empirical	Unpacks the work of algorithms in the process of categorization. As "key organizational activities are rearranged by algorithms, organizations can no longer be separated from the technologies that they deploy" (p. 3)	No	Process Output

(continued)

Table 14.1 (continued)

Author(s) of the article	Year published	Name of the journal	Theoretical/Empirical	Key findings and arguments	Suggestions for research opportunities	AI component (task input, process, or output)
Newlands	2020	*Organization Studies*	Empirical	Discusses the implications of surveillance with an algorithmic observer. “Relegation of surveillance and management tasks to algorithms render platform organizations heavily reliant on the reliability of algorithms” (p. 3)	No	Input Output

relying upon the user interface, AI isolates people from their choices while simultaneously reassuring their connection. They additionally uncovered that the conflicted character of algorithms is controlled by both autonomy and reliance.

Third, these articles mostly elaborate on general broad questions deemed to provide grounds for novel research. For instance, the interaction between AI and people has been approached by most of these studies by questioning how we can bring AI into organizations and successfully integrate systems and employees to create a sustainable competitive advantage (Murray et al. 2020; Makarius et al. 2020; Fleming 2018; Haenlein and Kaplan 2019). In the context of big, fundamental and mostly ontological questions, there has been a tendency to discuss "AI actorhood". Articles highlight the need for management scholars to acknowledge that "humans are no longer the sole agents in management even though most theories focus on human agency" (Raisch and Krakowski 2020, p. 28). AI systems are thus depicted as active agents in advancing problem-solving and strategic decision-making rather than as passive recipients of human inputs.

In developing AI actorhood, AI is no longer seen as a contingency factor but rather as possessing human actors' abilities, such as collaboration, learning and adapting to employee interactions. In this context, the evolution of AI agency and actorhood is deemed to be more than just a technological development, also reflecting challenges for organizational theorizing (van Rijmenam and Logue 2020). While former technological progress "focused on altering or replacing routine manual tasks, AI involves cognitive, relational and structural complexities" (Makarius et al. 2020, p. 263). In contrast to the separation between humans and machines, recent theorizing suggests a focus on the interdependence of these two actors interacting on the same or closely related tasks. For scholars to overcome human bias and to opt for augmentation, they need to adopt a relational ontology that maintains that "human and machine agents are so closely intertwined in hybrid collectives that their relations determine their actions, and the interactions between these actors should be the unit of analysis" (Raisch and Krakowski 2020, p. 31).

14.7 The Future of Organization Theory and Future Research Avenues

In this subsection, we briefly discuss the conceptualization of the research agenda on AI and organizational theorizing with regard to the two different theoretical lenses of socio-materiality and institutional theory, the latter of which has come to dominate the organization studies field (Alvesson and Spicer 2019). The introduction of artificial agents also implicates changes in the ways that humans work across individual, group and organizational levels. This, in turn, requires a change in our understanding of these multi-level processes (von Krogh 2018). As technology is not only embedded in and shaped by socio-organizational forces but also impacts those forces (Fleming 2018), it enables socio-materiality as a theoretical lens to understand AI agency.

Information technology enables human actors to understand their world, offers a tool for the construction of their social reality, and adds to human actions by objectifying knowledge (Orlikowski and Robey 1991).

In this view, technology is deemed to be the result of interactions among human actors, actions, choices and institutional contexts; hence, materiality is both socially defined and only relevant to the people engaging with it (Orlikowski 2009). Human agency has been defined by actors of different institutional environments as temporally constructed engagement which both generates and changes these frameworks through the interplay of habit, imagination, and judgement (Emirbayer and Mische 1998). Van Rijmenam and Logue (2020) viewed these definitions as failing to fully account for understanding AI agency; rather, they argued that artificially intelligent entities can exercise agency through their performativity, by doing things that are outside the control of other agents (i.e., human or artificial), and when agents' actions materialize through their intentionality, objectives can be attained. In line with the tradition of socio-materiality, the authors defined AI agency as "coordinated artificially intelligent intentionality formed in partial response to perceptions of human agency, material agency and/or other AI agency" (p. 9).

From this perspective, it can be argued that the integration of AI into organizations raises important implications. For instance, how the entanglement of the social and material would take place if AI creates AI and how this interaction could be conceptualized when no human actions are involved in the technology creation but rather an AI agent creates technology itself are very timely questions to consider. Van Rijmenam and Logue (2020) argued that AI agency challenges the concept of entanglement. As technological artefacts are created by social action, the material influences the social and vice versa, and all organizational aspects are bounded by the material (Orlikowski 2007). According to this perspective, the social and material are entangled; however, artificially intelligent agents have the capacity to act autonomously in response to human and material agency. AI is both social and non-social; it is social because it is developed by humans, yet it is also non-social because AI artefacts are now created by other AI artefacts. Building on the extant research on socio-materiality (Leonardi and Barley 2010), a potential question could be how we can answer for the emergence of new actors or dislodgment of other actors by AI.

Rapid developments within the field of AI increasingly result in autonomous AI agents displaying reflexivity that can act with intentionality. When AI creates AI, it is increasingly further removed from human design or interaction. Van Rijmenam and Logue (2020) argued that this looming form of AI challenges our assumptions of agency, structure, materiality, actorhood, and intentionality across many perspectives of organizational, management, and innovation theorizing.

To continue with institutional theory as a theoretical lens to understand AI, recent work has established that digitally enabled institutional arrangements such as new organizational forms are creating significant changes in many industries (Hinings et al. 2018). From the institutional theory perspective, AI agency can be theorized as an actor, as a mechanism that contributes to (de-)institutionalization, as a form of institutional infrastructure, or as a diffusion mechanism.

The concept of actors has been one of the central constructs in institutional theory, but its specification and use are contested (Hwang and Colyvas 2019, p. 2). Hwang and Colyvas (2019, p. 5) theorized actors as involving three elements: (1) the level of society that claims about actors inhabit; (2) the degree of generality that claims about actors possess; and (3) the ontology, or the essential features of an actor that determine the inclusion of social entities into the construct. From this conceptualization, institutional theorists may answer the question of what theoretically relevant features of AI actors will provide cognitive adequacy and generalizability across many empirical contexts. Humans are no longer the only actors in management, although most theories focus exclusively on human agency. The emergence of novel actors and agency may also be taken as potential research by asking the following questions: How can non-human modes of agency be theorized in institutional contexts? How does the infrastructure affect the process of institutionalization? How do the actors use their dominant roles to control these infrastructures?

At the micro-level, how the advent of AI-based solutions transforms the role of managers in organizations is a potential direction of research. Management theories have already stressed the domain knowledge of managers, which has given them expert power and influence in their organizations. However, as automation and augmentation are expected to lead to institutionalized knowledge, it will become superior to individual managers' expert knowledge. At the macro-level, it is important to discuss how the advent of automation and augmentation in management contributes to institutional change. Broader networks of stakeholders (i.e., companies, governments, international organizations, public institutions) work together to build institutions, and contributions from these agents within and outside the organization have an effect on the process of automation and augmentation, which can have wide-reaching societal consequences.

AI agency bears the significant theoretical potential to be studied in institutionalization processes. These processes render practices, forms, ideas and meanings taken for granted. In this regard, the roles that AI agents may play in this process, institutionalizing certain practices and further institutionalizing bias or inequality, are potential directions of research. For instance, the questions of what role AI agents might now play in institutionalizing certain practices further institutionalizing inequality (Amis et al. 2020), how AI shapes the direction of institutional change, and what institutional conditions are at stake when AI agency is introduced may be significant research directions. Other valuable questions may regard institutionalization mechanisms, such as how new digital institutional arrangements centred on technologies such as social networking, blockchains and AI reconfigure institutionalization mechanisms and processes, or how leveraging AI affects the process of (de)-legitimation of a new venture, might be other useful concerns.

Moreover, theorizing on institutional infrastructure (Hinings et al. 2017; Zietsma et al. 2017) may also illuminate how to conceptualize AI agency. "Institutional infrastructure" refers to "cultural, structural, and relational elements that create the normative, cognitive, and regulative forces that reinforce field governance" (Hinings et al. 2017, p. 163). As these elements maintain the stability of the social environment, they also impact how organizations should interact and exchange. Possible questions may be as follows: Could AI agents provide a new form of relational infrastructure in fields? While field boundaries may be created and reinforced by the activities of AI agents, how might the same agents deinstitutionalize field boundaries and professional jurisdictions? How does AI agency change the understandings of negotiation processes within fields, if AI agents can make their own decisions independent of humans, and the interaction and mutual dependence between and across fields and subfields?

The role and impact of digitalization has also been addressed by institutional theorists where digitally enabled institutional arrangements permeate and reshape fields, challenging power structures and meaning systems (Hinings et al. 2018; Hinings and Meyer 2018). Future research can therefore delve into how actors leveraging digital technologies can change the ways in which institutions are created or destroyed. The interplay of novel digital technologies and institutional processes may provide insights into institutional emergence, change, and institutionalization and de-institutionalization. Empirically we witness platform-based organizations disrupting existing institutional processes, organizations as a part of the ongoing institutionalization process of digitalization and organizations in established fields that are changing institutional processes (Hinings et al. 2018).

14.8 Conclusion

As AI is outperforming human effort in a variety of tasks and cognitive acts, its ability to act autonomously separates it from most technologies historically used in organizations. This also results in new forms of organizing and challenging existing conceptualizations of technology in organization theory (van Rijmenam and Logue 2020). In this view, workplaces where humans once engaged in social interactions have paved the way for robots and AI assistants that will emerge as new intermediaries impacting these relationships. Organization theorists are urged to include these non-human elements into their organizational analysis with relation to cultures, norms, practices, agency and organizational policies. AI's growth can thus involve a novel period of organization theory scholarship that aims to comprehend how organizational outcomes affect different categories of employees beyond humans.

In this review chapter, we first aimed to synthesize the findings of the extant research through a systematic review of articles in top management journals about the impact of AI on organizations. We then identified knowledge gaps and provided several possible research questions regarding the future research directions for AI in organization studies. Through this systematic review, we have synthesized the knowledge from earlier research with the current scholarly work in order to structure future research avenues around the evolutionary phenomenon of AI in management. In particular, we have delineated between conceptual (theory-building) and empirical (phenomenon-based) articles, adopted a further classification with regard to aspects of AI (i.e., AI as task input, task process, or task output) addressed in the articles, and identified the common themes raised in these articles. This thematic framework ultimately served as a basis for identifying potential research streams in the emerging field of the interplay of AI and organization studies. We have aimed to contribute to the emerging scholarly discussion by systematically reviewing the research that has been conducted in the management and organization studies field.

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Chapter 15
An Overview of the Artificial Intelligence Applications in Fintech and Regtech

Gökberk Bayramoğlu

Abstract The rapid development of artificial intelligence in recent years has led to an increase in artificial intelligence-based applications in many areas. One of the important application areas of artificial intelligence has been the field of Financial Technology (Fintech) and artificial intelligence has been widely integrated into financial services. Artificial intelligence-based Fintech applications such as workflow automation, fake and fraud detection, algorithm-based asset management (robo advisors), and intelligent consultant provide significant benefits to the finance industry. Fintech applications, which means using technology to improve financial services, may cause financial risks, despite its many benefits. Especially after the 2008 Global Crisis, it is observed that there are significant deficiencies in the regulation and supervision of financial markets. In this context, regulatory technologies (Regtech) are needed in order to eliminate deficiencies and minimize financial risks. In other words, developments in Regtech make secure the improvement of Fintech. The main purpose of Regtech is to find technological solutions that help regulate Fintech without harming their positive potential. Therefore, Regtech allows both an effective financial risk management and provides significant cost saving. In order to fintech and supervision authorities to get maximum efficiency, it is very important that the application processes of Regtech are standardized and technology-oriented. The purpose of this study is to provide an overview of how artificial intelligence will transform the financial system. It is also to discuss how financial technologies (Fintech) and regulatory technologies (Regtech) will be affected by this transformation.

Keywords Artificial intelligence · Regtech · Fintech

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15.1 Introductıon

Although the first studies on the concept of artificial intelligence go back to the 1950s, the areas where artificial intelligence is used have been quite diverse in recent years. Artificial intelligence has been the driving force of changes taking place in many industries, from the manufacturing industry to the healthcare industry. One of the areas where artificial intelligence has created significant changes in the finance industry. The reasons that accelerate financial technologies (fintech) such as the development of the internet and information technologies have also made artificial intelligence an important change tool for the financial world. More and more financial institutions are using artificial intelligence in their activities every year. The global AI in the Fintech market is expected to grow from USD 6.6 billion in 2019 to USD 22.6 billion in 2025. This means an compound annual growth rate of 23.37% (Mordor Intelligence 2020).

More and more financial firms and institutions have started applying the Artificial Intelligence techniques to everything from workflow automation to fraud protection, In addition, artificial intelligence provides important services not only for businesses but also for investors. Investors use artificial intelligence and data mining for accurate estimation of their investments in financial markets.

A survey conducted by the Cambridge Centre for Alternative Finance (CCAF) and the World Economic Forum shows important results (Ryll et al. 2020):

- 77% of the participants think that artificial intelligence will turn into a very important factor in the short term (2 years).
- 64% of the participants expect that artificial intelligence will be used in many services from risk management to process automation within two years.
- 56% of the participants stated that artificial intelligence is used in risk management in their institutions. Accordingly, the most common use of artificial intelligence among the participants is risk management.
- While Incumbent firm participants state that artificial intelligence will reduce its workforce by 9% by 2030, fintech participants state that artificial intelligence will increase its workforce by 19%.
- 80% of the participants see access to data and the quality of data as the biggest obstacle to the application of artificial intelligence.

In addition to the fact that artificial intelligence has a significant impact on fintech, it also has significant benefits for regulatory authorities, as it facilitates the analysis of historical data and facilitates control with the help of algorithms. For this reason, in this study, the application areas of artificial intelligence in both fintech and regtech are examined.

15.2 What are the Fundamentals of AI

The Artificial Intelligence is the field of computer science that concern with the construction of machines that can perform human-like behavior. According to the definition made by Rich (1983), "*Artificial Intelligence is the study of how to make computers do things that people are better*." In addition to being a problem solver, artificial intelligence is a system that have capabilities of learning, analyzing, and perception. The Artificial Intelligence is not a new concept, and its theoretical bases for many researchers are based on the article "Computing Machinery and Intelligence" published by Alain Turing in 1950. In this study, also called the Turing test, it was investigated whether machines can think like humans. Turing stated that this question is too meaningless to argue. The more important question, according to Turing, is whether a digital computer will perform well in a particular game (The Imitation Game) Turing described (Oppy and Dowe 2003).

In the imitation game, computer and human are put in different rooms to be compared. The interrogator exists as a third party and communicates textually without knowing which entity is a computer. The interrogator can only understand which is a computer and which is a human based on the answers to the questions. As a result, if the interrogator can't distinguish between machine and human, machine is intelligent (Turing 1950).

Another important step regarding artificial intelligence was the "Dartmouth Conference" in 1956, in which researchers from different disciplines participated. In the conference, based on Turing's question "Can machines think", the decision-making process in the computer was examined (Mainzer 2019). The first important computer program in the field of artificial intelligence was ELIZA, which was created by Joseph Weizenbaum between 1964 and 1966. ELIZA is one of the first programs that can have a conversation with a person and try to pass the Turing Test (Weizenbaum 1966).

Another important artificial intelligence program is the General Problem Solver program created by Herbert Simon. With the success of this program, artificial intelligence programs have started to find funding. Despite all the successes, many criticisms have been made that programs such as ELIZA and General Program Solver will never be able to reason like humans and remain in the stage of imitating (Haenlein and Kaplan 2019).

In 1997, When IBM's chess program Deep Blue defeated Garry Kasparov the criticism of the inadequacy of artificial intelligence became invalid. The deep blue program was able to think 200 million moves per second and predict 20 moves later (Campbell et al. 2002). In the 2000s, there was a serious increase in demand for Artificial Intelligence applications both in the business world and in the global economy (Fig. 15.1).

Interest in artificial intelligence is not surprising given its revolutionary developments. All of this supports the view that artificial intelligence can radically change people's lives and ways of working. Nowadays, The Artificial Intelligence techniques

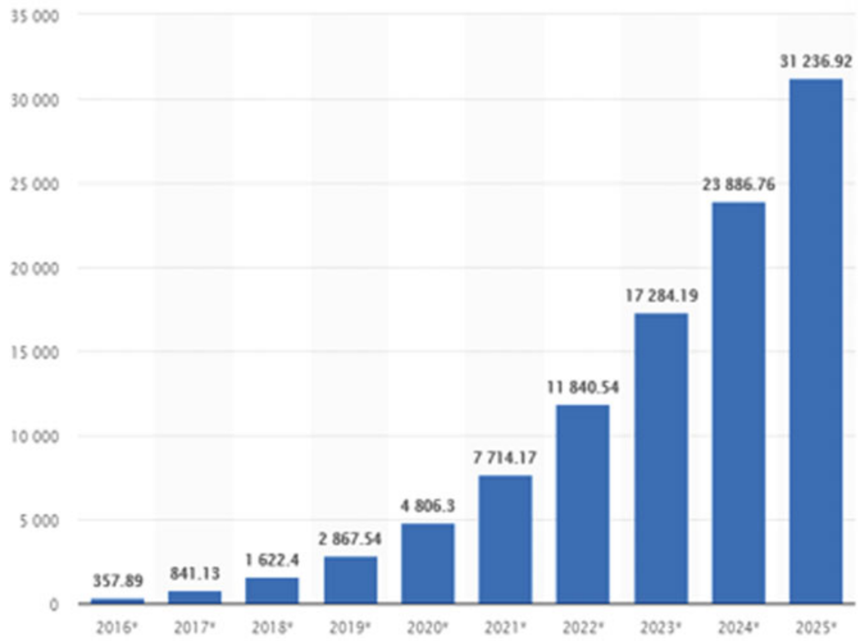

Fig. 15.1 Revenues from the artificial intelligence for enterprise applications market worldwide, from 2016 to 2025 (in million U.S. dollars) (*Source* Statista [2020])

are used in the production processes of many industries. Therefore, investing in artificial intelligence has become a necessity for companies that want to maintain their competitive capacity in the market.

Artificial intelligence has many sub-divisions such as:

- Machine Learning
- Speech Recognition
- Natural Language Processing
- Planning

Machine Learning: The term machine learning was first mentioned by Arthur Samuel in his article "Some Studies in Machine Learning Using the Game of Checkers". In the study, Machine Learning was defined as the programming of computers to learn to act in a particular manner exhibited by humans or animals (Samuel 1959). This learning process has three main sources. These resources are;

- The data uploaded to the program
- Introduction of the difference between false and correct behavior
- The measurement system created to guide the program.

Machine learning aims to create certain algorithm patterns with big data obtained from different sources and is divided into two groups. In the first group, supervised machine learning, it is desired to test the acquired data to obtain a certain result. In the second group, unsupervised machine learning, the algorithm is aimed to create certain patterns from data sets classified according to certain characteristics.

Speech Recognition: Speech recognition aims to convert the sounds that occur during speech into text. In this process, the sound to be transcribed into the text is first recorded with a microphone. Then, the cleaning process is performed to increase the quality of the sound waves. The cleared sound is converted into phonemes created equivalent to each word syllable. Phonemes are created by linguists specifically for each language. The success of speech recognition, which has successful examples such as Siri and Google Assistant, depends on the isolation of voices that will turn into text. For this reason, too much noise in the environment can make it difficult to perceive sounds and cause false text (Ashri 2020). Speech recognition is especially important in the lives of people with disabilities. In addition, speech recognition systems can only serve by adapting to the speech style of a particular person. This type of system is called speaker-dependent speech recognition (Vardhan and Charan 2014).

Natural Language Processing: Natural language processing (NLP) is an artificial intelligence sub-field that allows human language to be understood and organized with the help of computers. NLP deals with how to analyze the natural language, the way people communicate with each other.

Planning: Artificial intelligence planning is to create the most efficient algorithm to do a specific job and the ability to update to complete similar tasks.

15.3 The Basics of Fintech

Digitalization affects the financial sector considerably due to the fact that financial services are largely based on information and financial products are generally no longer a physical object. Digital transformation means not only the use of more automation in the financial sector, but also the adoption of new completely new financial technologies (Fintech). As a supreme concept, Fintech term includes financial innovations provided by information technologies, as well as newly established companies that produce innovative solutions. Fintech companies offer an efficient business model due to the fact that they are more flexible, agile, and secure than traditional financial institutions (Lee 2015).

History of Fintech

The term Fintech is not a new concept and its development consists of three periods. The first period, called fintech 1.0, was a period when technology is linked with the financial services industry. (Arner et al. 2015). This period covered the years between 1866 and 1967. At the end of the nineteenth century, the use of communication means such as the telegraph and the spread of railway networks helped to create a global financial world.

The increasing use of technology in communication processes, starting from 1968, led to the digitalization of the financial sector. The digitalization process of financial services continued until 2008 and this period was called Fintech 2.0. The emergence of the internet in the 1990s removed many physical barriers to financial services and enabled electronic banking transactions to begin (Arner et al. 2017).

Starting from 2009, the era of Fintech 3.0, which is the era of Fintech companies offering financial products and services directly to customers, has started. The most important charasteristic of Fintech 3.0 is that Fintech startups, which can adapt to rapidly changing information technology, are rivals to traditional financial institutions.

Regtech as a Complement to Fintech

Regulatory Technology (Regtech) is the use of technology to control, regulate and ensure compliance of information technology, especially financial technologies. Regtech enables companies to control their financial and non-financial risks, to report compliant with legislation and to choose compliant business systems (Butler and O'Brien 2019).

The most important factors affecting the development of regtech are the losses that emerged after the 2007 global crisis and the profits of fintech companies being very open to risk. Therefore, the development of Regtech has been provided by competent institutions that think Fintech need supervision and regulation. In other words, the reasons for Regtech's emergence are the rapid growth of Fintech and the need to be regulated (Arner et al. 2016).

15.4 How AI is Changing Fintech and Regtech

The finance industry is a field with high potential for artificial intelligence in the standardization of financial services and automation of transactions. Thanks to artificial intelligence, the cost of financial services decreases while the quality of service increases. Irrational behavior is also prevented by removing barriers such as information asymmetry and access to the financial market. This part of the study will focus on the most important service areas of artificial intelligence technology in the financial industry.

Robo-Advisors: Robo-advisors are used to provide portfolio management services to customers. Behavioral data are taken into account to determine each client's investment objectives, risk tolerance, and purchasing style. The main purpose of Robo-advisors is to create the most optimal portfolio in the shortest time and at the lowest cost in line with the preferences of the customers.

Risk Management: The ability of artificial intelligence to process large amounts of data allows it to create credit systems. Therefore, financial risk management can be achieved in a more reliable and low-cost way compared to traditional risk management. Today, financial institutions generally provide public transportation to their customers and a personalized risk management cannot be provided. However, with the help of IOT (Internet of Things) technology, it can provide information to customers about financial risk situations even during shopping (Dineshreddy and Gangadharan 2016).

Fraud Detection: Fraud detection, which is an important area of artificial intelligence technologies used in financial services, is the prediction or prediction of fraudulent behavior. It focuses on the early detection of fraud and alerting managers (Kreutzer and Sirrenberg 2020).

15.5 Conclusion

With the driving force of artificial intelligence technologies, the finance industry is in an important digital transformation process. This digital transformation has two basic dynamics, namely, minimizing costs and risks. Therefore, artificial intelligence applications make financial services customer-oriented and personalized. As a result of the 2007 global financial crisis, regulations regarding financial technologies were insufficient and financial markets were negatively affected. This situation led policy makers to search for different and Regtech emerged. The fact that the use of artificial intelligence in financial technologies will become more widespread in the future will increase the need for regulatory technologies. In other words, Fintech and Regtech will show a parallel development, otherwise the compliance of financial technologies with legal regulations will become increasingly difficult.

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Chapter 16
Ethico-Juridical Dimension of Artificial Intelligence Application in the Combat to Covid-19 Pandemics

Muharrem Kiliç

Abstract With the dramatic development of information technology, the Covid-19 pandemic period has created the opportunity to access a new phase in terms of the age that is becoming more and more digitized every day. Covid-19 pandemic has emerged as a driving force in changing certain things in the global world order. In order to minimize the effects of the current crisis, countries have entered into a digital transformation process in many different areas, from the education sector to the health sector, judicial practices to monitoring social distance rules. Artificial intelligence (AI), which already existed in our lives, started to be used in certain application areas, especially in this period. Pandemic period once again demonstrated that artificial intelligence and digital technologies have become a big part of our lives. The global world has witnessed a digital transformation with the applications developed within the scope of the Covid-19 fight. However, while using AI-based apps provides many benefits to manage the pandemic process, it also brings with several ethical and legal concerns regarding human rights and fundamental freedoms. Ethics provides several frameworks in the name of the promotion of human values and dignity. Among human rights and ethics, there is a clear and strong connection. The rights and freedom demands that arise based on human rights are ethically based. The legitimacy of human rights-based demands is originally based on ethics. For that reason, using artificial intelligence is directly linked to "human safety, health and safety, liberty, confidentiality, integrity, dignity, autonomy, and non-discrimination," and these also include ethical concerns. Therefore, artificial intelligence practices related to human rights and freedoms that cause some human rights violations during the pandemic period also reveal an ethical violation. Another risk factor is the use of "surveillance technology" in the "new normal" lifestyle, which was effectively used by national governments during the pandemic period. In this extraordinary period, there is concern that artificial intelligence-based practices developed to protect public health will be permanently used as usual in the post-pandemic period. AI has tremendous potency to advance the lives of many people and procure human rights for all. It

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is necessary to evaluate these potentials and minimize the risks associated with artificial intelligence. Likewise, artificial intelligence also poses deep risks to security, democracy, and human dignity.

Keywords Ethics · Values · Covid-19 · Ethical-juridical basis of artificial intelligence · Failure transparency · Judicial transparency · Liberty and privacy · Digital technologies

16.1 Introduction

The "*modern world*," has separated from the "*ancient world*" with a radical break from the initial industrial revolution, which has forced all countries to have a mandatory internal-dependency relationship with the world in the process of globalization, where it evolved with its immanent dynamics. Especially with the dramatic development of information technology, the Covid-19 pandemic period has created the opportunity to access a new phase in terms of the age that is becoming more and more digitized every day.

Artificial Intelligence (AI), thought to have emerged in the mid-twentieth century with a historical timing equivalent to the historical background of modern computer technology, shows the reach horizon of the technical move of the industrial revolution toward mechanization. This horizon predicts the establishment of autonomous artificial intelligence or operating systems with human-specific existential qualities, such as thinking, speaking, learning, sensing, communicating, conceptualizing, and even sensing. This prediction is based on the substitution of a robotic existence that will replace people with all her/his cognitive and affective functions. Especially, the development of artificial intelligence technology with techniques of "machine learning" and "deep learning" can be considered as important steps of progress toward this era. All these developments are compatible with the "*technological progress*" motto idealized in terms of modern human history, this situation has the potential yet to lead humanity into a deep crisis, especially based on ethical values.

The efficient use of the opportunities of the digital world to meet basic human needs in quarantine periods have brought new momentum to the digitalization movement of the world after the pandemic. At this point, the speed of going to a world where the health and many public services, particularly the justice service, can be offered in the digital universe, has grown exponentially. In this context, artificial intelligence-based applications implemented during the pandemic period have been used within the scope of government measures to ensure public health during the devastating pandemic period, which is still ongoing.

This study aims to discuss the impact of artificial intelligence on governance, economics, finance and various thematic areas from financial services to investor preferences, risk management to derivatives markets, economic integration to international trade, future labor markets to accounting and auditing, central banking to sustainability, governance and ethics to understanding algorithmic decision-making processes. As a contribution to such an extensive study, our chapter will focus on the positive and negative effect of artificial intelligence on “management processes and ethics.”

For this purpose, this study will specifically focus on the problems that have the potential to highlight the ethical-juridical basis of artificial intelligence applications which have developed during the pandemic period in order to protect public health. Our contribution to this study on a departmental basis includes an *ethico-juridical* critical assessment of the use of artificial intelligence-based applications in the process of combating the Covid-19 pandemic, which is currently having destructive effects on public health on a global scale. The problem that the department is going to review is that artificial intelligence-based programs are produced as administrative mechanisms based on “surveillance and control.” At this point, our study will focus on the reconstruction of artificial intelligence as an instrument of a “*body politics*” in a more sophisticated way. Although artificial intelligence-based practices create an effective managerial capacity, especially in crisis management such as the current pandemic, this possibility can lead to a violation of human rights and freedoms, of which onto-political legitimacy is based on ethics. We will try to explain our concerns regarding the ethical area that has been addressed, especially in regard to the right to privacy and protection of personal data, and of surveillance-based management technology during the ongoing pandemic process.

16.2 Conceptual Framework of Artificial Intelligence: Benefits and Challenges

Artificial Intelligence (AI) can be described as using Machine Learning (ML), Natural Language Processing (NLP), and Computer Vision applications to use computers based on big data models for pattern recognizing, explaining, and prognosis (Naudé 2020a). In addition, artificial intelligence with transformative and global effects can be defined as the “*Fourth Industrial Revolution*.” AI can be qualified as “a field of study that integrates computer science, engineering and relevant disciplines to constitute machines capable of behavior that would be said to require intelligence were it to be observed in humans” (Murphy et al. 2020).

Another definition of artificial intelligence has been put forward by McCarthy, Minsky, Rochester, and Shannon in the “Proposal for the Dartmouth Summer Research Project on Artificial Intelligence.” According to this, “AI as a computational artifact made by human intervention that thinks or acts like humans, or how we expect humans to think or act.” According to the “founding document” that established the field of AI in 1956: “*For the present goal, the artificial intelligence problem is taken to be that of making a machine act in ways that would be named intelligent if a human were so acting*” (Dignum 2019).

When we trace the history of artificial intelligence, we can say that it was first used in the Dartmouth Summer Research in 1956. In this period, it should be said that artificial intelligence did not function as much as today and did not act with ethical concerns. In addition, there were some technical difficulties such as data scarcity and severe hardware limitations on memory capacity. During the 1970s, artificial intelligence was beginning to prove itself, but it still had a number of technical difficulties. By the 1980s, when Japan launched the "*Fifth Generation Computer Systems Project*," artificial intelligence had once again found the opportunity to prove itself. It was a project that planned to transcend technology by developing a parallel computer architecture that would serve as a platform for artificial intelligence. With this project, which started in Japan, it began to increase artificial intelligence investments in other countries. Nevertheless, this project did not reach the desired level and failed like other expert systems. The fight against the technical difficulties encountered in artificial intelligence continued and in the 1990s, with the introduction of new techniques, artificial intelligence continued to take an important place on the agenda of countries (Bostrom 2014).

Today, we see that artificial intelligence is used in many different areas, from earing aids with algorithms that filter out ambient noise; to route-finding programs that offer navigation advice, to medical decision support systems to surgical robots (Bostrom 2014). The other area of artificial intelligence systems have been used in the judiciary[1] in countries such as Germany, England, and USA. For example, it was determined that four out of every five decisions made by artificial intelligence in England coincided with the court decision. On the other hand, in USA, some courts use artificial intelligence software to determine the duration of the sentence and the possibility of the perpetrator to commit a crime again. In Germany and England, police use artificial intelligence software to predict and prevent crime. In Turkey, an artificial intelligence-supported e-trial application has been implemented in the judiciary. In this context, it is also aimed to develop artificial intelligence applications in the legal qualification of dispute issues and in determining the legislation to be applied to the dispute.[2]

Also, AI and the other technologies have started to formalize significant parts of the digital economy and impress essence fields of our day by day networked communities. Whether it be transportation, manufacturing, or social justice, AI has the potency to intensely affect our lives and change our futures. From productivity gains to incredible improvements in quality of life, AI-based technologies have enormous benefits. The fact remains that, AI has benefits as well as challenges. The difficulties brought by the use of artificial intelligence have been described as generating vagueness surrounding the future of labor and the change of power to new structures beyond the control of existing governance and accountability limits. Also, unequal access and affect of artificial intelligence-based technologies on marginalized populations pose a worrying threat of increasing global digital inequalities.[3]

[1] For detailed information about using AI technologies in legal process and judiciary, see; Ashley, Kevin D., *Artificial Intelligence and Legal Analytics: New Tools for Law Practice in the Digital Age*, Cambridge University Press, 2017.

[2] https://basin.adalet.gov.tr/adalet-yapay-zekaya-emanet.

[3] Artificial Intelligence & Inclusion, https://aiandinclusion.org/.

AI has a significant potency to reform the lives of many and it provides for each of us human rights. It is necessary to evaluate these potentials and minimize the risks associated with artificial intelligence. Because artificial intelligence also poses deep risks to security, democracy, and human dignity. Since the artificial intelligence systems developed deeply affect people's decision-making mechanisms and carry the risk of taking their place, we face the risk of being dependent on artificial intelligence systems (Dignum 2019).

Artificial intelligence affects our lives in a broad framework, from identifying the information we receive to the programs we follow or voting for specific candidates. So, how autonomous we are in terms of decision-making is a big problem when the information we get is determined by a system and pushes us to track certain things and vote for certain candidates. It is difficult to say that we are autonomous in terms of decision-making, as we are made dependent on acting within the framework of the information and events that the system offers us (Dignum 2019).

16.3 Normative Framework of Artificial Intelligence

Artificial intelligence has begun to shape important parts of our world. There is a growing usage of AI-based technologies. As the area of use increases, there have been deep concerns about the ethics, legal and social effect of artificial intelligence. For that reason, transnational and national governance bodies and countries, inclusiving the European Union, OECD, United Kingdom, France, Canada, and others, have launched initiatives. "The IEEE initiative on Ethics of Autonomous and Intelligent Systems the High Level Expert Group on AI of the European Commission, the Partnership on AI, the French AI for Humanity strategy, the Select Committee on AI of the British House of Lords" can be mentioned as the most familiar initiatives (Dignum 2019).

The goal of these very initiatives are ensuring some practical suggestions, general standards, and policy recommendations to stand the progress, prevalence, and usage of AI technologies. The other initiatives which are Asilomar principles, Barcelona declaration, Montreal declaration, Japanese Artificial Intelligence Association's ethical rules have set sight on analyzing the main principles and values of AI technologies and developing progress they must abide by (Dignum 2019).

Also, on May 16, 2018, Amnesty International and the non-profit organization which is defending and extending the digital rights of people globally named Access Now, led the drafting of "The Toronto Declaration: Protecting the Rights to Equality and Non-Discrimination in Machine Learning Systems." This declaration focuses on the regulating framework of AI bias in binding international legal principles. Toronto Declaration regulates the liabilities of both states and private organizations related to the usage of machine learning systems. These regulations include lighting discriminatory impact, transparency, and provision of influential solution to whom damaged by AI technologies (Latonero 2018).

In the legal framework, The GDPR (*General Data Protection Regulation*)[4] includes a set of general security tools that can be customized and adapted for using AI in specific regulations. In this scope of regulation, there are principles just as data protection by design (Article 25), procedural rules for instance the data protection impact assessment (Article 35) and the designation of data protection officers (Articles 37–39), self-regulatory mechanisms such the progress of codes of conduct confirmed by data processing companies (Articles 40–41) (Marsch 2020).

In addition, CEPEJ European Ethical Charter regarding the use of artificial intelligence (AI) in judicial systems has determined five principles. First principle is respect of fundamental rights; this requires designing and implementing artificial intelligence tools and services are comply with fundamental rights. Second principle is non-discrimination; it means that avoiding the improvement or reinforcement of any discrimination among individuals or groups of individuals. The third principle is quality and safety; this means using official resources and intangible data in a secure technological environment with models designed in a multidisciplinary way, regarding the processing of judicial decisions and data. The fourth principle is transparency, impartiality, and fairness making data processing methods reachable and comprehensible, empowering external governance. The last principle is that AI systems are under user control, which allows users to become informed actors and retain control of their choices.[5]

16.4 Ethical Framework of Artificial Intelligence

Artificial intelligence has ensured useful vehicles that are used anytime and anywhere by people across the world. The continuous development of artificial intelligence will provide incredible opportunities to aid and fortify people. These opportunities will bring with them a number of ethical concerns.[6] So, there is a need develop to AI principles. In this scope, there are principles about AI which is called Asilomar AI Principle one of the AI principles. This principle contains three parts which are *Research Issues, Ethics and Values, Longer-term Issues.* According to these principles, Ethics and values include *Safety* this means AI systems must be trustworthy, secure, and verifiable along with their operational life.

The other principle is *Failure Transparency* this mean when an AI damages the system, it should be possible to determine the cause of that damage. *Judicial Transparency* is the involvement of a self-governing program in the judicial decision-making process for that reason it should provide a satisfying explanation that can be

[4] For more information, see; https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0679.

[5] CEPEJ European Ethical Charter, https://www.coe.int/en/web/cepej/cepej-european-ethical-charter-on-the-use-of-artificial-intelligence-ai-in-judicial-systems-and-their-environment.

[6] For the historical and intellectual discussions about Ethics see; Ashby, W. (1997). *A Comprehensive History of Ethics*, New York. Mabbott, J. D. (1996). *An Introduction to Ethics*, London.

overseen by a constituent human authority. Responsibility means that the designers and founders of enhanced artificial intelligence technology systems have the responsibility and opportunity, they are stakeholders in the moral consequences of their usage, abuse, and act. The principle of *Value Alignment* in AI systems must be conceived to ensure that their aims and attitudes are aligned with human values along their operations. AI systems should be devised and used in line with ideals of human dignity, freedoms, rights, and cultural diversity which serve to preserve human values. Perhaps one of the most important principles is human value, because an artificial intelligence system that does not serve human rights and freedoms is unthinkable.[7]

Privacy means that AI systems have the power to analyze and use, which requires people to have the right to conduct, reach and control the data they constitute. The other principle is freedom and privacy, which requires not implausible restricting people's real or perceived freedom. Another principle is shared benefit. According to this principle, artificial intelligence technologies should have the aim of reaching as many people as possible. Artificial intelligence technologies should adopt the principle of providing maximum benefit.[8]

According to "*shared prosperity*" principle, AI has created economic prosperity for the people and this economic prosperity should be share benefit all of humanity. Undoubtedly, artificial intelligence technologies have the potency to direct and control the person other than their own behavior. Therefore, there should be a human control principle in artificial intelligence systems, which means that people can choose which of their decisions will be transferred to artificial intelligence systems. The other principle is *Non-subversion.* According to this principle AI systems should develop and respect, instead of destroy, the civic and social processes on which the health of society is based. AI technologies have been used very different areas, arms are one of the using area of AI. According to the AI Arms Race principle, AI should not be used in as a deadly autonomic weapons.[9]

AI systems have an effect on our lives, so AI systems need accountability to be properly deployed and adequate solutions provided. In addition, artificial intelligence systems should be transparency and explainability in order to determine where, how and for what purpose they are used. According to *Fairness and Non-discrimination* principle; one of the concerns about artificial intelligence is the tendency of these technologies to be discriminatory and against equality. Because of this, artificial intelligence applications developed need to be used in a fair and non-discriminatory way to cover all humanity. AI technologies should contain professional responsibility. Undoubtedly, artificial intelligence applications developed have the potential to have a great impact on our lives. Therefore, people who develop and implement this technology should have a responsibility from planning long-term results to sharing them with relevant people (Fjeld et al. 2020).

[7] https://futureoflife.org/ai-principles/.

[8] https://futureoflife.org/ai-principles/.

[9] https://futureoflife.org/ai-principles/.

The other principle which is to regulate AI is EU guidelines. According to EU guidelines, human centric approach should be one of the core principle developing AI technologies. Also, AI technologies should be respectful of European values and principles (Madiega 2019).

According to EU ethical rules, respect for human autonomy and fundamental rights is main principle. To procure that this basic principle is reflected in practice, the EU guidelines propose three steps. The first step is impact assessment which is mean that before the artificial intelligence system is developed, an assessment should be made that this product does not have any negative impact on fundamental rights. After that, mechanisms should be established to provide feedback to determine whether there is any fundamental violation of rights (Madiega 2019).

The second step is to provide human agency, meaning that users must be able to interact and understand satisfactorily with artificial intelligence systems. The third step; should always be human surveillance, as the machines cannot be fully controlled. People must always have the skill to handle a decision made by a system. Therefore, while developing artificial intelligence systems, measures should be developed to ensure this (Madiega 2019).

According to EU perspectives there are some key ethical requirements; these are *technical robustness and safety, privacy and data protection*. In this context, citizens should have complete check over their own data, and their data should not be used to damage or discriminate versus them. In practice, this means that AI systems should be designed to guarantee data protection and privacy. *Transparency* means that all AI technologies should be documentable and traceable. Providing transparency is important in terms of ensuring that AI is not biased. Creating mechanisms to provide accountability and responsibility for artificial intelligence systems and their results is crucial. Because artificial intelligence systems have started to be used in almost all areas and have the potential to cause some violations. Therefore, in case of any violation of rights that may occur, it is necessary to ensure that artificial intelligence developers are responsible and accountable (Madiega 2019).

In conclusion, although there are many ethical regulations about artificial intelligence, AI ethics fail in many situations. Because *ethics lacks a reinforcement mechanism.* There are no consequences of not following ethical rules. Ethics is seen as a marketing strategy in most cases. Also in practice, AI ethics is considered "add-on" as the non-binding framework imposed from institutions "outside" of the technical community. Economic incentives, in particular, easily override adherence to ethical principles[10] and values. This means that the purposes for which artificial intelligence systems are developed and implemented are not in accordance with social values or fundamental rights such as "benefcence, non-maleficence, justice and explicability" (Hagendorf 2020).

[10] For more information about the ethical dimension of AI see; Don B.; Matteo V. A. (ed.) (2019). *Ethical, and Scientic Dimensions of Artificial Intelligence* , Philosophical Studies Series, Springer Nature, Switzerland.

16.5 Using Artificial Intelligence in Pandemic Period: Country Examples

The Covid-19 pandemic has spread rapidly worldwide, leading to a global outbreak. Countries and scientific research institutions are struggling to prevent the spread of the pandemic. For that reason, there is potency to use big data and machine learning combating this pandemic. In this pandemic period, countries have used widely AI from "early detection and diagnosis of the detection to early warning and alerts, tracking and prediction to diagnosis and prognosis and social distance" (Naudé 2020a). In addition, in parallel with the conditions caused by the pandemic, artificial intelligence was used both in the applications developed within the scope of the fight against the virus and as an effective means of combating fake news which is called *infodemia.*

In the early detection and diagnosis of detection, Artificial Intelligence is used to promptly analyze irregular symptoms and other "red flags" thereby alerting patients and health officials. It provides faster decision-making, which is cost-effective. Also, using AI for detection and diagnosis of the detection help to improve a new diagnosis and management system for the Covid-19 cases, by way of practical algorithms. AI provides to diagnosis of the infected cases with the help of medical imaging technologies like Magnetic Resonance Imaging (MRI), Computed Tomography (CT) scan of human body parts (Vaishya et al. 2020).

The final generation systems of AI-based diagnostic, that leverage artificial intelligence, are very likely to affect positive impact the right each of us access to the highest attainable standard of health. It is substantial that in recognizing the right that each of us possesses "*to a standard of living adequate for the health and well-being of himself and of his family*," Article 25 of the Universal Declaration of Human Rights) relates access to medical care to the basic fundamental of life, such as food, clothing, and housing. Given this link between good health, access to healthcare, and all the economic, social, and cultural rights each of us have, the using artificial intelligence in medical diagnosis will have a positive effect on each of us right to work, and providing ourselves an existence worthy of human dignity (Raso et al. 2018).

Also, AI can be used to predict and track how the Covid-19 disease will expand over time and space. To predict diseases, an artificial intelligence-based "HealthMap" model has been developed at the Boston Children's Hospital (USA), which alarms several times before Covid-19 (Huang et al. 2020). *HealthMap*—a website—uses artificial intelligence (AI) to analyse social media, reports of news, queries of internet search, and other information for disease outbreaks. The data mining program detected the news of a new kind of pneumonia in Wuhan, China. The one-line email newsletter stated seven was serious and rated the urgency three on a five scale.[11]

[11] https://www.sciencemag.org/news/2020/05/artificial-intelligence-systems-aim-sniff-out-signs-covid-19-outbreaks.

The other usage of Artificial Intelligence has been for early warning and alerts for the fight against Covid-19. In this content; we can give an example of an artificial intelligence system developed in Canada. Artificial intelligence-based application called BlueDot helps find unpredictable people in detecting infectious disease outbreaks (Naudé 2020a). Also, AI has been used to conduct the pandemic by using thermal imaging to scan public spaces for infected people and by implementing social distance and lockdown measures. For instance; The Chinese have deployed and developed AI-based contactless temperature detection software. In this context; "*Smart AI Epidemic Prevention Solution*" which controls fever and determines the person not wearing a face mask by integrating artificial intelligence algorithms with infrared thermal technology, can be cited as an example (Huang et al. 2020).

The use of mass surveillance to enforce lockdown and isolation measures including infrared cameras to detect potentially infected persons in community is not just China, but are embraced by some countries, just like Australia, Germany, South Korea, Spain, United Kingdom, and USA. Not too much community infrared cameras used here, but contact tracking apps that use personal mobile phone data. According to OneZero's data, there are at least 25 countries that have used surveillance technologies to monitor compatibility and implement social distancing precaution by mid-April 2020. Almost all countries violate data privacy norms. These contain developing countries such as Argentina, Brazil, Ecuador, India, Indonesia, Iran, Kenya, Pakistan, Peru, Russia, South Africa, and Thailand (Naudé 2020b).[12]

In Singapore, citizens are used *TraceTogethe*r,[13] which swaps Bluetooth signals through mobile phones in close distance. This is modern reaction to the traditional and time-consuming contact-tracing process, which relies on fallible human memory. An example of another contact tracking method is the corona 100 m application used in South Korea. This artificial intelligence-based app gathers data from public government data that warn users about any Covid-19 patient within a 100-meter radius, along with the patient's diagnosis date, age, gender, and nationality (Huang et al. 2020).

Taiwan developed individualized risk assessment for blanket travel restrictions. Travelers use their smartphones to scan the QR code to send them to an online travel declaration form requesting travel history and flight information, fever or respiratory infection symptoms, and contact information in Taiwan. According to health and travel information, passengers are sent a pass card with a message, asked to quarantine at home for 14 days, or isolate themselves at home for 14 days (Mello and Wan 2020).

In Italy, a smartphone application has been developed that can be used to track the route of an infected person and alert people who come into contact with it. According to the designer, privacy will be protected, as the application will not unveil phone numbers or personal data.[14]

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[12] Also see; https://www.gov.sg/article/help-speed-up-contact-tracing-with-tracetogether.

[13] See, https://www.gov.sg/article/help-speed-up-contact-tracing-with-tracetogether.

[14] Council of Europe, "AI and Control of Covid-19 Coronavirus", https://www.coe.int/en/web/artificial-intelligence/ai-and-control-of-covid-19-coronavirus.

The great platforms of social media such as Google and Facebook have begun to use AI more densely to theme moderation, included controlling fake news (Naudé 2020a). Also, The International Research Centre for Artificial Intelligence (IRCAI) in Slovenia has launched a "*smart*" media watch on the Covid-19 which is named *Corona Virus Media Watch* and provided updating on national and global news based on a selection of media with open online information. In addition, developed with the support of the OECD and event registry information extraction technology, it is considered a useful source of information for policy makers, the media and the public to observe new trends relevant to Covid-19 in their countries and around the world.[15]

During the ongoing pandemic period, countries have tried to combat Covid-19 by developing artificial intelligence-based applications we have given above. Countries have implemented measures to facilitate surveillance and the collection of personal data[16] to monitor the spread of Covid-19. While technology is an important tool in managing "public health" crises, digital surveillance and increased gathering of personal data can have a negative impact on privacy, freedom of expression, and freedom of association. At this point, it is important that the measures to be taken to combat the pandemic are "transparent, legal, necessary and proportional." Any surveillance and data collection measures implemented in the process of combating Covid-19 should be specified in the law and should be necessary and proportionate to legitimate public health goals.[17] However, in this period, there were some negative scenes regarding human rights stemming from artificial intelligence-based applications. As a matter of fact, the study conducted by Amnesty International on the practices developed during the current pandemic period revealed these risks.

According to Amnesty International's research there is tend three categories Covid-19 apps which doing "digital contact tracing" contrary permit users to voluntarily record and control their symptoms just like Vietnam and Lebanon. The other category is which apps that use a much less violating, decentralized Bluetooth contact tracking model, such as those improved by Apple and Google. In this model, data is stocked on people's phones but rather in a central database. This contains countries are such Austria, Germany, Ireland, and Switzerland. The third category is the applications that upload the phone to a central government database provided with Bluetooth or GPS. According to Amnesty International last category has an enormous human rights violation risks because of data centralized government database.[18]

[15] Council of Europe, "AI and Control of Covid-19 Coronavirus", https://www.coe.int/en/web/artificial-intelligence/ai-and-control-of-covid-19-coronavirus.

[16] For more information about the responsibility of using AI Technologies see; Lenca, M.; Vayena, E. (2020). "On the Responsible Use of Digital Data to Tackle the COVID-19 Pandemic", *Nature Medicine*, vol. 26.

[17] Rights and Security International, "Covid 19: Toolkit for Civil Society Partners", p. 14. Also see; Kılıç, Muharrem, "Human Rights Politics in the Pandemic Period: The Fragile Nature of the Rights and Freedoms", *Journal of Justice*, 64, 2020/1.

[18] https://www.amnesty.org/en/latest/news/2020/06/bahrain-kuwait-norway-contact-tracing-apps-danger-for-privacy/.

We examined the practices developed in the fight against pandemic on the basis of country examples. Although these practices are seen as an effective tool in combating pandemic, they also bring some legal and ethical risks. Therefore, it is necessary to question these applications in terms of ethics.

16.6 Ethico-Juridical Questioning of Artificial Intelligence Applications in Pandemic Era

The risks of the current pandemic have led the world states to seek a new solution. Within the scope of Covid-19 measures, schools were closed and distance education has started, and remote work has started in business life. Covid-19 has emerged as a driving force in changing certain things in the world order. In order to minimize the effects of the current crisis, countries have entered into a digital transformation process in many different areas, from the education sector to the health sector, judicial practices to monitoring social distance rules. Artificial intelligence, which already existed in our lives, started to be used in certain application areas, especially in this period. The pandemic period once again demonstrated that artificial intelligence and digital technologies have become a big part of our lives. The world has witnessed a digital transformation with the applications developed within the scope of the Covid-19 fight.

The pandemic has created an exception on a global scale with all these devastating effects. Agamben resolved this concern through his original conceptual framework, which he described as a "*state of exception*."[19] This exceptional case, which found itself by justifying with the individual and social extraordinary situations experienced with the pandemic, poses a serious risk of breaking in the post-pandemic period in terms of human rights policy. In terms of the pandemic period, which is characterized as an exception, artificial intelligence-based applications have a constructive effect, especially for the health care sector, but also have a devastating impact on human rights.

One of the devastating effects is that, long after the outbreak, governments have the opportunity to maintain extraordinary oversight of their citizens. There is a risk that the personal data obtained through to the applications developed during the pandemic period, even after the pandemic is over, the governments can have surveillance over the populations of their countries or the obtained data can be used for other purposes other than the fight against Covid-19 (Naudé 2020a).

Another risk factor is the use of "*surveillance technology*" in the "new normal" lifestyle, which was effectively used by national governments during the pandemic period. In this extraordinary period, there is concern that artificial intelligence-based practices developed to protect public health will be permanently used as usual in

[19] Agamben, Giorgio, "The Invention of an Epidemic", https://www.journal-psychoanalysis.eu/coronavirus-and-philosophers.

the post-pandemic period. In one aspect, artificial intelligence provides a very effective infrastructure mechanics for the protection of public health, while also raising concerns about the right to privacy.

Using AI-based apps brings many benefits to manage the pandemic process, they also highlight several ethical and legal concerns linked to the risks facing fundamental freedoms and human rights. Based on human dignity, human rights and freedoms have an ethical appearance. Based on this idea, the techniques and technologies developed to meet the vital needs of human beings are expected to respect this ethical value. Unstructured technical possibilities or practices will ultimately damage human dignity. "Human dignity" is the focus of the normative arrangement of the fundamental contractual texts of the international canon of human rights. In terms of human rights "human dignity" is a fundamental place in terms of being the existential basis for the realization of an individual's personality. The value that is intended to be protected based on human rights is the value or dignity of the person.

Ethics provides several frameworks in the name of the promotion of human values and dignity. Among human rights and ethics, there is a clear and strong connection. The rights and freedom demands that arise based on human rights are ethically based. The legitimacy of human rights-based demands is based on ethics. Using artificial intelligence is linked to worries about, confidentiality, health and security, human security, liberty, integrity, dignity, autonomy, and non-discrimination, and these also include ethical concerns (Kritikos 2019). Therefore, artificial intelligence practices related to human rights and freedoms that cause some human rights violations during the pandemic period also reveal an ethical violation. For this reason; unethical human rights norms and practices are unthinkable.

Artificial Intelligence has many ethical considerations. Using artificial intelligence to monitor and even predict human behavior risks stigma, cultural and social discrimination and exclusion, undermining individual preferences and equal opportunities. "AI's potency for reinforcement, the risks linked to playing a part "filter bubbles" or with using social scoring methodologies by means of the use of AI and the affordability and reachability of AI technologies are linked to worries about human security, health and safety, liberty, confidentiality, integrity, dignity, autonomy and non-discrimination" (Kritikos 2019).

In particular, Artificial Intelligence, in addition to the protection of personal data and the right to privacy, also poses a risk of discrimination when algorithms are used for purposes such as profiling individuals or solving situations in criminal justice (Madiega 2019). Bias and discrimination are one of the main topics for concerned with the governance and social impact of AI systems. A number of studies have shown that some AI systems are inherently discriminatory, as in the case of skin color detection. There is some report which have detailed how discriminatory algorithms are already applied in the justice system, here the judges use these tools for punishment to estimate the likelihood of a defendant re-offending (Latonero 2018).

A key issue to address is how to balance the risks and benefits of AI technology. Integration of AI technology into the healthcare system is beneficial as it provides the opportunity to improve the efficiency of healthcare and the quality of patient care. However, it is necessary to decrease the ethical risks of AI practice, which may contain privacy and confidentiality, informed consent, and patient autonomy, and to consider how to integrate AI into clinical practice. Another theme covered in this issue clarifies the health and legal policy conflicts that arise with the use of AI in health care (Michael 2019).

It is essential that privacy policies and regulations extend their scope beyond individual privacy to the protection of individuals' identities, including the definition of categories of individuals (group privacy) in order to protect rights and ensure fair treatment of these groups. Therefore, regulation should be made to ensure that data collected by any digital monitoring and monitoring system during the pandemic will be erased after overcoming the crisis and that access to relevant anonymized and aggregated data is strictly regulated and allowed for scientific purposes only (Taddeo 2020).

"*Contact tracing*" is a key constituent of influential pandemic response, and contact-tracing applications have the potency to promote this goal. But, to meet the requirements of human rights, contact-tracing applications, privacy, and data protection by design should develop, and this means that they must be to have the minimum amount of data collected and safely stored. All data collection should be limited to checking the spread of Covid-19 and not used for any other goal, inclusiving law enforcement, national security or immigration control. In addition, it should not be made available to any third party or commercial use. Downloading and using contact tracking apps, it should be optional, not required to download. The data collected must remain anonymous, when combined with other datasets.[20]

Actually, the ethical affect of big data analysis stems from two main concerns. Big data leaning to be comprehensive and exact. "Big data isn't about samples, it's about populations." The other main concern linked to big data is stems from its ability to be *reused, repurposed, recombined, or reanalyzed* which is called the 4R challenge of big data. Given the connection of big data, its elements can be simply imagined as lego parts ready to be rearranged and connected to other parts or collections of parts to gain new insights. New insights can generate new information, not just unpredictable threats to person or populations under observation. Because individuals publish their data for a specific use and purpose, any other analyze that uncovers new processes in that population can provide insights that are not anticipated or desirable by individuals contributing to the data (Steinmann et al. 2016).

"*Reuse* means to taking data gathered for a specific scientific aim and reusing them again for contrastable aims in contrastable areas. *Repurposing* means taking data originally gathered for a specific aim in a specific area and reviewing them for disconnected aims in an area other than their area of origin." Together with questions about data reuse, the reuse of big data raises questions about the legality of analysing data obtained in a single privacy bunch and using it in other privacy bunch (Steinmann et al. 2016).

Besides questions raised by reusing the data and making it suitable for other purposes, the recombination of the data raises questions about the probability

[20] https://www.amnesty.org/en/latest/news/2020/06/bahrain-kuwait-norway-contact-tracing-apps-danger-for-privacy/.

of improving new information that the researcher cannot access only from the constituent datasets. In terms of privacy perspective, data recombining potentially allows individuals to be redefined from data that does not contain specific identifiers or is deliberately free of identifiers (Steinmann et al. 2016).

Big Data archives have been collected with relative or longitudinal purposes in mind, especially in public health and health care. Although researchers can determine some specific goals at the time archives creation, they hope and wait for new uses as scientific information increases, research lines evolve, and technical for obtaining new information from collected data sources become more complex (Steinmann et al. 2016).

In conclusion, community has an ethical attention in human control and AI surveillance for a variety of reasons. The first is due to the general ethical principle that people are morally liable for the act we choose. Because artificial intelligence-enabled systems to emerge as a result of deliberate human design, humans are deeply, always morally responsible for the impacts of such agents on the world. Therefore, it would seem obviously unaccountable to humans to permit an artificial agent to provide meaningful control or oversight so that their actions drift out of our grasp (Vallor and Bekey 2017).

The other reason why we have ethical interest because of human control and surveillance of AI is its promptly expanding scope of action. AI-powered technologies long since work in real-world contexts such as medicine and driving, which include issues related to death and life, as well as other fundamental dimensions of human development. So, in a world where people are responsible—positive and negative—the effects of artificial intelligence increase moral gravity. This movement will be strengthened as artificial systems increasingly indicate competence and trustworthiness in contexts with moral risks (Vallor and Bekey 2017).

16.7 Conclusion

With the desire of man to rule over the world of nature and objects, the techno-cognitive mind, which is activated and developed, has led to the birth of modern technology. Modern technology, which has the ideal of facilitating and enriching human life with all its technical equipment and facilities in practical terms, has displayed a development dynamic that forces all predictions. This technological development dynamic, which produces visible and vital practical benefits, has led to a rapid change in all sectors and human life. This change can be described as a radical socio-cultural and socio-economic paradigm shift. As a matter of fact, this change has manifested itself in a wide range of social, economic, cultural, and educational fields. Each developmental and initiative step of the human mind, which claims to be sovereign, creates an effect that records human life in an existential sense. This situation arises in the effort to create the substitution of the mind-thinking abilities that define human, especially in the existential sense, with the techno-entity design.

This is a search for artificial intelligence that will replace the capabilities of the human mind.

Undoubtedly, this search comes across as an inevitable situation in the flow dynamics of human history in modern times. What needs to be done at this point is to determine the humanitarian boundaries of this development dynamic, especially at the ethical as well as normative level. It is necessary to draw the normative boundaries of this development, which creates a digital world order, based on basic ethical values. Otherwise, the hegemonic mind of the global political order will allow for evil ambitions that can bring about the end of humanity. It is vital to develop an ethical mind that takes into account all these problems.

Artificial intelligence-based digital world order, which continues to develop rapidly with each passing day, exists in all areas of human life or in the sector. However, many countries of the world do not have access to this digital universe, as they lack adequate infrastructure. There are 3.9 million internet users in the world and almost half of the world does not have internet access, and the evolution of our world into a digital world will deepen digital inequalities. In this sense, it is not possible to talk about an equality of opportunity among the world nations in accessing digital resources.[21]

For this reason, artificial intelligence-based technical facilities and equipment must be developed in a manner that will serve all people in an inclusive manner. Especially in the pandemic period we are in, this deprivation has manifested itself much more clearly. In this context, it is seen that artificial intelligence-based applications, especially in the education sector, eliminate the equality of opportunity for the citizens of the country and the nations of the world. This inequality in accessing digital tools in terms of human rights deepens the victimization of particularly vulnerable segments of society.

In this unprecedented combat to Covid-19, digital technologies present the only chance for governments, individuals, and businesses to handle with social distancing, provide business continuousness, and avoid service interfere. Our high addiction on digital infrastructure and increased confidence in safe online services have never been greater.[22]

But the using digital technologies to combat the pandemic also risks producing surveillance technology on humans. With the end of the pandemic, there is a risk of using the data obtained for other purposes and controlling and monitoring the populations of the countries. These policies based on big data have great risks because all data from health decisions to traffic decisions can be based on a black box and our lives are conducted by Big Data system. Byung-Chul Han says that "*the transparency society is similar to a surveillance society, because there is a control instead of trust. There is a Big Brother Instead of Big Brother, where our entire life is centered. Digital*

[21] COVID-19 Crisis Response: Digital Development Joint Action Plan and Call for Action, http://pubdocs.worldbank.org/en/788991588006445890/Speedboat-Partners-COVID-19-Digital-Development-Joint-Action-Plan.pdf.

[22] COVID-19 Crisis Response: Digital Development Joint Action Plan and Call for Action, http://pubdocs.worldbank.org/en/788991588006445890/Speedboat-Partners-COVID-19-Digital-Development-Joint-Action-Plan.pdf.

panopticon citizens perceive that they are free but it is just an illusion" (Numerico 2019). For these reasons, necessary arrangements should be made so as to minimize the risks of the artificial intelligence base and the use of the obtained data should be guaranteed.

As a result, the world will move toward a digital evolution after the pandemic, and artificial intelligence will expand its use in almost every aspect of our lives, from the business sector to the education sector, the health sector to the legal sector. While all these developments are happening, a digital development is essential in the world order after the pandemic. Action plans should be developed for digital development and inequalities should be prevented in cooperation. We need digital regulation. "Beyond the immediate and short-term intervention to the crisis, recognition of the power of digital technologies to facilitate and advance primary services and social cohesion remotely and effectually must bring a new need to the digital inclusion agenda of governments all around the world."[23]

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Muharrem Kiliç Completed his initial law education at Marmara University Faculty of Law. Prof. Kılıç then completed his doctorate in 1999 and received the title of associate professor in 2006 and was appointed as a professor in 2011. Dr. Kılıç worked as the Dean of Akdeniz University Faculty of Law and vice Rector of the University. He also has held academic positions such as the Head of Public Law Department, Head of Legal Philosophy and Sociology Department and Legal Research Center. Dr. Kılıç also held several administrative positions such as Council of Higher Education (YÖK) and advisor to the President of Student Selection and Placement Center (ÖSYM), Vocational Qualification Authority Representative of Justice and Security Sector Committee. Dr. Kılıç's disciplinary academic field constitutes of the 'Legal Philosophy and Sociology' discipline. Kılıç's academic interests also include 'Comparative Law Theory,' 'Law and Literature,' 'Methodology of Law,' and 'Human Rights Law' and 'Ethics.' In line with his academic interests, Kılıç has written scientific publications consisting of many books, articles and reports. In addition, the author has published many academic papers and conferences presented at national and international congresses.

Dr. Kılıç has worked as either an expert or project manager in multiple national and international projects. One of these projects, which was carried out on behalf of the Justice Academy of Turkey, is titled as 'Needs Analysis Report on the Training Curriculum of Judges and Prosecutors' report which was completed and published in January 2020. He is currently working as a Project expert in the 'Technical Assistance for Increasing Ethical Awareness among Elected and Non-Elected Local Government Officials' ongoing from 2019 to 2021. This project is an international project supported by the Republic of Turkey and the European Union, of which the Ethical Committee of Public Officials is the main beneficiary. He is also a Project expert of the 'Project on Supporting the Implementation and Reporting on the 'Action Plan on Prevention of European Convention of Human Rights Violations in Turkey' (2019–2021), which is carried out in partnership with the Republic of Turkey and the Council of Europe and whose main beneficiary is the Human Rights Department of the Ministry of Justice.

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Chapter 17
Concluding Remarks

Sezer Bozkuş Kahyaoğlu

The form of competition varies in the business world. Now, a competition starts over the value offered to the customer instead of just a competition on quality and/or price. The prerequisite for realizing these goals is to update the "business model" of companies and make them compatible with AI applications.

Financial markets are among the sectors where artificial intelligence is used most effectively and widely. In this context, high-frequency time series data is analyzed instantaneously. In addition, financial institutions and investors change their major trading policies and strategic portfolio management approaches to products. One of the most important developments in this process is digitalization. In other words, start of digital banking, the spread of digital money, and the adoption of block chain technologies as the key infrastructure in this field. Artificial intelligence applications developed especially for the financial sector require that financial institutions upgrade their current management processes, audit and risk management methods, and organizational infrastructure.

Over time, it is a fact that the infrastructure has been developed that will enable fast and easy integration of each AI application with each other. This situation requires businesses to make certain decisions from the beginning. For example, is it more appropriate to produce the relevant parts of a product within the company or to supply it from outside? In this case, there are two basic options. The first is to buy the most affordable and fast parts from the outside. The second is to make production within the company by doing research and development. This decision carries a contradiction in itself for digital products. Wodecki (2019) proposes that research and development activities for the solution of this problem be carried out in different formats. The author offers an approach that plans to collaborate with

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outside service providers and R&D teams within the company. This working style is called "Development and External Provider Team -Dev-ExP".

The usage of digital products and parts, such as sensors, communication infrastructure means, operating systems, data storage systems, analytical tools, etc., are increasing in the global economy. Thus, companies have significant competitive advantages by using smart systems via AI implementations. Their highlights are: the opportunity to produce more, lower costs and savings, the opportunity to sell more, and in summary, the opportunity to make more profit. Business models are changing to make things faster, cheaper, and easier. In order to adapt to this, it is critical to harmonize the organizational structure and employee competencies. Therefore, although artificial intelligence has its benefits, it also has risks and threats arising from uncertainty about the product ownership model, internal control weaknesses, and lack of regulatory environment (McKinsey Global Institute 2017).

Artificial intelligence applications have important effects on the functioning of the global markets. Especially, institutions that provide brokerage and / or intermediation services may not be needed in the future. Instead, platforms are created. This transformation is accelerating with the effect of developments in the communication sector and technological innovations. An example of this is the impact of financial markets and digitized products and services. Therefore, the way the world trade and economic units do business begins to change in every aspects. Even companies competing in this renewed market structure have to cooperate among themselves. With the renewal of the business model, the emergence of new business ideas and the changing areas of expertise of employees, the position of artificial intelligence in strategic business management is strengthening to achieve more intelligent ecosystem in the future than today.

In this book, the impacts of artificial intelligence on governance, finance, and economy in general are investigated and major findings are discussed within the framework of the expertise areas of the contributing authors. In conclusion, the major impacts of AI to achieve high business outlook can be summarized as follows:

- "**Economics of Predictive Learning**" leads to better analysis based on AI algorithms (McKinsey Global Institute 2017).
- "**Change in Amortization**" leads to an increase in the value of products and services. It should be noted that this is just the opposite case of traditional systems (Porter and Heppelmann 2015).
- "**Increase in Quality of Assessment and Evaluation**" leads to experienced-based learning system ensure strength of business model and decision making process (Ransbotham et al. 2017).
- "**Increase in Synergy Effects**" by integrating human soft skills with the AI practices to achieve better end-user experiences (Ross 2017).
- "**Ethical Decision Making**" is needed more because of conflicting needs and expectations arising from AI-based smart systems to identify the complete understanding of the meaning of being "fair" (Wilson et al. 2017).

It is important to use artificial intelligence applications for the well-being and happiness of humanity in very accurate and expert hands. In this context, instead of a future guided by machines developed based on artificial intelligence practices, we should be in the expectation of a life that increases effectiveness and efficiency caused by them. In this way, there will be some more time to achieve sustainability by acting more humanely.

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