DYNAMICS OF BANK LENDING IN UKRAINE: INFLUENCE OF THE DEVELOPMENT OF DIGITAL INNOVATIONS AND TECHNOLOGIES

Andrii Semenog [1]
[1] Department of Financial Technologies and Entrepreneurship, Sumy State University, Ukraine
*Corresponding author: Andrii Semenog, a.semenog@biem.sumdu.edu.ua

The article examines the relevance of the development digital innovations and technologies and their impact on the growth of the fintech direction of digital lending, which is represented by the landscape of fintech companies that use the disruptive power of digital technologies and the advantages of innovations of service institutions to offer consumers a wide range of digital credit products and services. The purpose of the article is to define the essence of digital lending and identify the role of digital technologies and innovations in the development of fintech, using the example of calculating the dynamics of bank lending in Ukraine. The article characterises the essence, types and significance of digital technologies in the context of the general development of the financial sphere and the credit market. The role and types of financial innovations are highlighted as the ability of fintech companies to combine digital technologies through product and service transformations. The unique role in terms of scale and impact on other areas of financial innovation of digital lending as a direction of fintech focused on digital forms of providing and administering loans through digital channels using a range of digital technologies to collect and process digital customer data is emphasised. A description of the directions of digital lending and the critical component of its development is presented. The bank is proposed to be characterised as the primary mediator in the credit market using digital innovations and technologies. A set of more than 30 indicators has been formed within three groups of components for evaluating the effectiveness of digital lending by banks, characterising the state and dynamics of non-cash transactions, the use of payment cards, payment and credit banking infrastructure, and credit and deposit activities of banks. A methodology for calculating the Harrington desirability function is proposed to calculate a comprehensive assessment of the "quality" of the functioning of the electronic payment segment of the banking sector of Ukraine in the context of the potential for developing digital banking lending.

Keywords: bank, digital bank, digital lending, credit market, digital innovations, digital technologies, fintech, household.

ДИНАМІКА БАНКІВСЬКОГО КРЕДИТУВАННЯ В УКРАЇНІ ПІД ВПЛИВОМ РОЗВИТКУ СФЕРИ ЦИФРОВИХ ІННОВАЦІЙ ТА ТЕХНОЛОГІЙ

Андрій Семеног[1]
[1]кафедра фінансових технологій і підприємництва, Сумський державний університет, Україна
*автор-кореспондент: Андрій Семеног, a.semenog@biem.sumdu.edu.ua

У статті досліджено актуальність розвитку сфери цифрових інновацій і технологій та їх вплив на зростання фінтех-напрямку цифрового кредитування, що представлений ландшафтом фінтех-компаній, які використовують підривну силу цифрових технологій та переваги інновацій сервісних установ для пропозиції споживачам широкого спектру цифрових кредитних продуктів і послуг. Метою статті є визначення сутності цифрового кредитування, виявлення ролі цифрових технологій та інновацій у розвитку цієї сфери фінтеху на прикладі розрахунку динаміки банківського кредитування в Україні. У статті схарактеризовано сутність, види та значення цифрових технологій у контексті розвитку фінансової сфери загалом та кредитного ринку зокрема. Виокремлено роль та види фінансових інновацій як здатності фінтех-компаній комбінувати цифрові технології через продуктові та сервісні трансформації. Наголошено на особливій ролі за масштабом та впливом на інші напрямки фінансових інновацій сфери цифрового кредитування як напрямку фінтеху, що зосереджений на цифрових формах надання й адміністрування кредитів через цифрові канали з використанням спектру цифрових технологій для збору й обробки цифрових даних клієнтів. Представлено характеристику напрямків цифрового кредитування та ключових компонентів його розвитку. Запропоновано характеризувати банк як основного медіатора на кредитному ринку з використанням цифрових інновацій та технологій. Сформовано набір з понад 30 індикаторів у межах трьох груп складових оцінки ефективності цифрового кредитування банками, що характеризують стан і динаміку здійснення безготівкових операцій, використання платіжних карток, платіжно-кредитної банківської інфраструктури, кредитно-депозитної діяльності банків. Запропоновано методику розрахунку функції бажаності Харрінгтона для проведення розрахунку комплексної оцінки «якості» функціонування електронно-платіжного сегменту банківського сектора України у контексті потенціалу розвитку цифрового банківського кредитування.

Ключові слова: банк, цифровий банк, цифрове кредитування, кредитний ринок, цифрові інновації, цифрові технології, фінтех, домогосподарство.

Cite as: Semenog, A. (2024). Dynamics of bank lending in Ukraine: influence of the development of digital innovations and technologies. Visnyk of Sumy State University. Economy Series, 1, 39-51. https://doi.org/10.21272/1817-9215.2024.1-04

INTRODUCTION

The analysis and generalisation of scientific sources, analytical materials, and reports of auditing, consulting, technological, and financial companies confirm that the dynamic development of the field of financial technologies and innovations has contributed to the awareness of radical changes in the forms of financial business, the essence and role of financial intermediaries, methods of interaction with clients and state institutions, creating additional value for partners and the economy as a whole. Changing the traditional approaches to making money transfers, savings, lending and investing, fintech companies have used the power of digital technologies and the advantages of innovation of service institutions, offering consumers a wide range of digital financial products and services, the disruptive characteristics of which serve as the main factor in the transformation of the modern market of credit services.

Despite the widespread use of the categories financial and digital technologies, as well as the obviousness of their importance in financial relations in terms of lending to subjects of economic activity, the theoretical essence of both the field of digital lending and the role of digital innovations and technologies remains insufficiently disclosed and proven, which leads to the relevance of the conducted study of the dynamics of bank lending in Ukraine in the conditions of the growth of the field of digital innovations and technologies.

ANALYSIS OF RECENT RESEARCH AND PUBLICATIONS

As evidenced by the analysis [1-3; 6; 8; 12; 14; 17], the development of the digital economy, stimulated by the emergence of the Internet, is interconnected with progress in several disruptive digital technologies (disruptive technologies), the most important of which, according to the scientific community and international organisations, are such software-oriented technologies as Blockchain, Analytics of Big Data, Artificial Intelligence (AI), Cloud Computing, as well as specialised machine-oriented equipment: 3D printers, devices of the Internet of Things (IoT), automation and robotics. Significant progress in the use of such technologies contributes to the growth of production capabilities, labour productivity and return on capital of both digital companies and enterprises of the non-digital economy with the simultaneous transformation of their established business models and principles of the formation of income and expenses of companies.

According to studies [4; 5; 7; 11; 13; 16; 19], the most transformative digital technologies in terms of their impact on the business model of financial institutions, which are at the stage of implementation and are simultaneously actively used in other areas of the economy, are 5G communication (data exchange speed, the possibility of configuring Internet of Things devices), Big Data analysis (analysis of customer behaviour and formation of personalised pricing), Artificial Intelligence (assessment of creditworthiness, risk management; better efficiency and lower operating costs), Embedded finance (technology of combination of financial services and e-commerce, e-transport, e-real estate, etc.). Cloud technologies and computing (processing large flows of data and transactions; processing transactions in real-time to ensure fast and uninterrupted service) and the Internet of Things (automation of data collection and processing processes, measurement of customer behaviour) also have a high degree of influence.

It should be noted that QR payments, NFC payments, chatbots, and embedded payment systems are also at the stage of active implementation and use in the process of providing digital financial services. However, their influence on the development of business models of financial companies is quite limited. Instead, blockchain, API management financial platforms, robo-advisors, and virtual assistants (new customer access channels, gamification of financial services) are in the evaluation or beta testing stages of commercial use while potentially having a high or transformative impact on the formation of future business models for the provision of digital financial services.

Regardless of the experience of using digital technologies, the success of their application in the financial sphere is closely related to the ability of financial companies to combine them and create financial innovations [5; 9; 12; 13] in the following forms:

– Product or service innovation (implies offering new financial products and services. Examples include embedded finance, BNPL, API, etc. A vivid example of a combination of product and service innovation is the Square company, which offers fintech solutions for the organisation of financial activities of companies representing SMEs (settlement and cash service, accepting credit cards, crediting working capital, tracking and analysing sales and inventory, etc.) In addition, Square offers its own equipment, payment products and devices for the development of the payment ecosystem of its SME representatives);

– Process innovation (implies the transformation of internal processes to increase productivity or reduce the cost of providing financial services. For example, ZestFinance offers an automated service for assessing the creditworthiness of the population from "risk groups" using Artificial Intelligence and Big Data;

– Organisational innovation (presupposes a change in the organisational structure of a financial institution to provide an innovative product. For example, fintech startups, unlike classic financial institutions, pay more attention to IT development, design and quality of applications websites, which forms a management system and hierarchy in the organisation that is more characteristic of the IT sector rather than the financial sector (for example, the services of neobanks such as Revolut, Monzo, Monobank, which in their essence resemble IT companies rather than financial institutions, given the lack of branches and offline contact with the client);

– Business model innovation (presupposes adopting an innovative approach to creating and monetising value for customers, which is created when providing a financial service or selling a financial product. For example, the use of telemetry sensors in car insurance adjusts the cost of a driver's insurance policy depending on his driving style.

As evidenced by our analysis of the diversity of fintech digital innovations, based on which digital technologies form the fintech landscape as a joint and interdependent space in which fintech companies operate, providing digital financial services within various areas of fintech (digital payment services, digital banking, digital lending, crowdfunding, digital insurance, digital capital management), as well as fintech representatives who form the fintech infrastructure, combining digital technologies to improve the quality and trust of digital financial services.

According to its scope and impact on other areas of financial innovation, the most potential area of fintech innovation is digital lending [16]. In general, digital lending is a fintech direction focused on digital forms of providing and administering loans, primarily to individuals and representatives of SMEs, through digital channels with a wide range of digital technologies for collecting and processing digital customer data.

The direction of digital lending includes [16]:

– Online banking or mobile lending – digital products of traditional financial institutions and neobanks that offer card credit products, various instalments, and partial payments (Monobank, PrivatBank);

– Online lending platforms that provide end-to-end fully automated and contactless digital customer lending products via a website or mobile application (Capital Float, Konfio, Lidya, Lulalend, Branch, Tala);

– P2P lending platforms that allow individuals to provide credit to other individuals or representatives of SMEs without the mediation of banks (CreditEase, KwikCash);

– Partner credit programs of e-commerce platforms – hybrid credit products of online stores and financial institutions based on the power of the online store brand, its digital distribution channel and customer database (Amazon, Flipkart, Alipay, WeChat);

– Credit marketplaces – online services that host a wide range of credit products from many financial institutions on their web platforms enabling borrowers to choose the most convenient and affordable of them (Loan Frame, Creditas);

– Partner lending in the field of mobile payments – joint credit products between providers of mobile money circulation services and mobile network operators for mobile users (Kopo Kopo, Safaricom, Airtel, Jumo).

The critical components of digital lending are [16]:

– Availability and accessibility of essential information and digital infrastructure for customers. It refers to the spread of the Internet, especially mobile broadband in the country, and its wide availability for households and businesses. Also critical is the level of smartphone penetration and the involvement of households in their everyday use of smartphones.

– Readiness of households and businesses to use digital lending. By their very nature, credit services are quite complex from the point of view of both households' understanding of their possibilities in obtaining them, as well as mechanisms of creditor assessment of the borrower's ability to service loans. It has historically required direct, live communication between lender and borrower and often several rounds of meetings. That is why the digital method of obtaining a loan requires both the presence of a certain level of digital financial literacy on the part of the client and the development of a complex digital infrastructure on the part of the credit organisation to ensure the entire stack of the loan product offer (from the attraction of the client to the issuance of the loan and its constant support).

– The primary focus is on digital channels for finding new customers, communicating with them, disseminating information about credit products, and directly providing and administering them. The leading digital channel today is mobile applications for smartphones. Online sites and USSD commands are less often used. Digital channels are a convenient remote way for a customer to interact with a financial company and, simultaneously, a source of customer data for a financial company or digital lending platform.

– Automated collection, processing, and use of digital customer data: bank statements, the history of paid bills, transactions made by the client on e-commerce platforms, and data from social networks and other financial and credit institutions are used by algorithmic analysis systems to predict the client's readiness and ability to pay for the loan. Digital data is also the basis for forming a strategy to improve interaction with existing customers and attract new ones by offering personalised financial products, promotions or discounts.

– Focus on the digital client experience, which involves a convenient format for informing the client about the credit possibilities of a financial institution, access to obtaining a loan, quick approval of a loan application, personalised communication, and reasonable credit service prices.

RESEARCH RESULTS

The analysis of the essence of digital lending and the types and forms of its implementation proves the undeniable role of the bank as the central mediator in the credit market using digital innovations and technologies. Considering the current trends in the development of the concept of open banking, a modern, open, modular banking infrastructure is of particular importance as a key element in the development of the field of digital lending. In this context, the issue of the presence and effectiveness of the functioning of the electronic payment component of the infrastructure of traditional banks, which, taking into account the synergistic effect of cooperation and partnership with third-party organisations, provides the necessary prerequisites for further digitalisation of the lending sector and the country's economy as a whole, is gaining significant relevance.

The analysis of statistical materials of the National Bank of Ukraine [10], the State Statistics Service of Ukraine [15], and the World Bank [18] made it possible to form a set of more than 30 indicators within three groups of components for evaluating the effectiveness of digital lending.

For the first group, we included *indicators characterising the state and dynamics of non-cash operations and the use of payment cards.* In particular, the number and amount of non-cash transactions using payment cards; the number and amount of payments using contactless cards and NFC gadgets; the number of active contactless, digital (tokenized), virtual cards and cards with the function of electronic money.

The second group of components for evaluating the effectiveness of digital bank lending includes *indicators characterising the state and dynamics of the payment and credit banking infrastructure:* the number of self-service devices (ATMs, deposit ATMs, PTKS); the number of payment terminals

ISSN 1817-9215 (print)
1817-9290 (on-line)

(in banks and the trade and service network); the number of business entities that accept electronic means of payment; the number of bank branches and the number of people employed in the financial sector.

The third group of indicators covers *the results of credit and deposit activities of banks:* volumes of loans granted to individuals and legal entities, funds raised from individuals and legal entities; net interest income from transactions with individuals and legal entities.

To understand the general situation regarding the level of electronic payment activity in the banking sector of Ukraine as an integral component of the credit market, we briefly analysed the dynamics of the above indicators.

During 2002-2022, we observed a significant growth in non-cash card transactions in terms of number and amount. Thus, the number of transactions using payment cards increased 966 times (from 6 to 5,796 million transactions), while the number of cash withdrawal transactions increased only seven times (from 68 to 463 million). During the analysis period, the share of non-cash card payments in quantitative terms increased from 8 to 93% (Fig. 1).

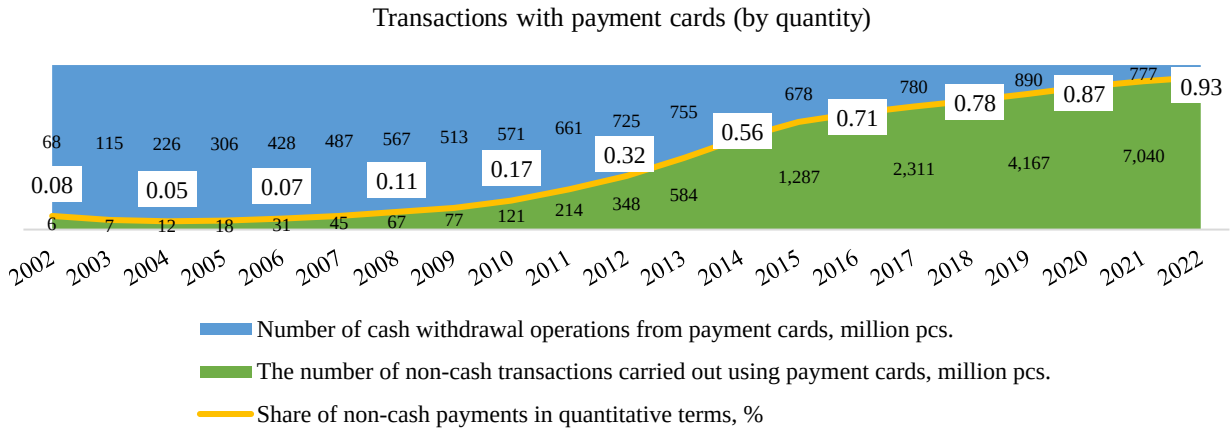

Figure 1. Dynamics of operations using payment cards for the period 2002-2022
Source: compiled by the author based on data [10]

Similarly, in monetary terms, non-cash transactions using payment cards grew at significantly higher rates. During the analysis period, the annual volume of such transactions increased 3,200 times (from UAH 1.16 billion in 2002 to UAH 3.72 trillion in 2022), while the annual amount of transactions for receiving cash from payment cards increased by 94 times (from UAH 18.8 billion to UAH 1.77 trillion). Thus, the share of non-cash card payments in monetary terms increased from 6% to 68%.

An analysis of indicators of the state and dynamics of the payment card market showed an increase in the number of active bank payment cards by 43% from 32 million. 2006 it reached 46 million pcs in 2022 (Fig. 2).

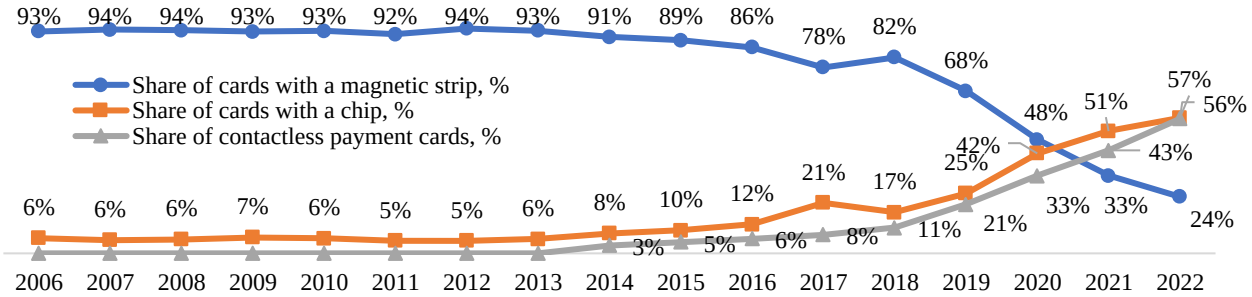

Figure 2. Market dynamics of payment cards issued by banks (with magnetic strip, chip and contactless payment) for 2006-2022
Source: compiled by the author based on data [10; 18]

ISSN 1817-9215 (print)
1817-9290 (on-line)

If in 2006, on average, only seven out of ten residents of Ukraine had an active payment card, then in 2022, the average citizen would have 1.1 active payment cards. In addition, during the analysis period, we witnessed a decline in the popularity of payment cards with a magnetic strip among customers, their transition to cards with a chip, and the possibility of making contactless payments.

The share of active cards with a magnetic strip decreased from 93% to 24%, or from 30 to 11 million pieces. Instead, the share of cards with a chip increased from 6% in 2006 to 57% in 2022, reaching 26 million pieces. Contactless cards also quickly gained popularity. Thus, in 2014, their number barely exceeded 1 million, which was 3.3% of the number of active cards, and in 2022, the share of contactless cards exceeded 56%, reaching 26.1 million.

The analysis shows that the most significant card market changes occurred in 2018-2020. This, in our opinion, is primarily related to the spread of 3G and 4G communication in Ukraine, which stimulated the development of mobile banking applications and the spread of NFC technologies (both in payment cards and smartphones with support for NFC payments through the Apple Pay and Google Pay applications). Confirmation of the spread of payments using contactless cards and NFC gadgets is the positive dynamics of growth in their number and volume (amount) of transactions (Fig. 3).

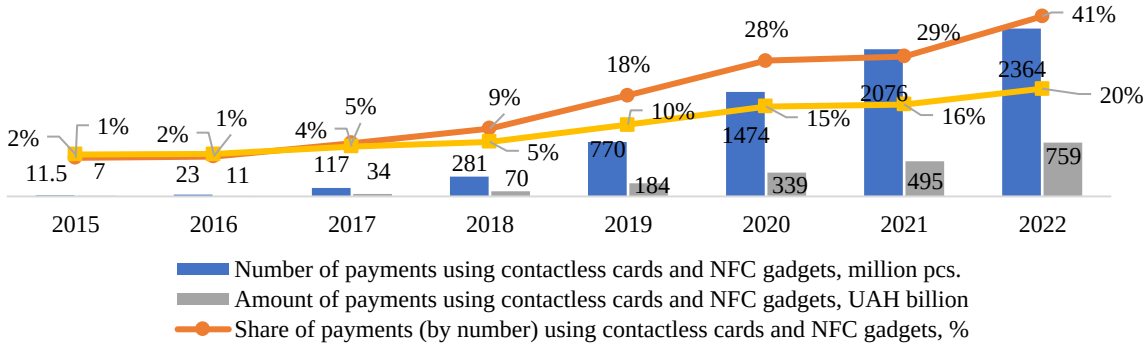

Figure 3. Dynamics of payments using contactless cards and NFC gadgets for 2015-2022
Source: compiled by the author based on data [10; 18]

Thus, according to the number of calculations, the share of use of NFC technologies increased from 1% in 2015 to 41% in 2022, or from 11.5 to 2.4 billion units. In monetary terms, payments using contactless cards and NFC gadgets increased more than 108 times from UAH 7 billion to UAH 759 billion. Thus, as of the end of 2022, one-fifth of payments (20%) were made using contactless technology.

The growth of digitisation in the payment card market was also reflected in the dynamics of the use of virtual cards, the number in circulation, despite still having a relatively small share of the payment card market (2.2% in 2022), increased from 248,000 units up to 1.04 million pcs. (Fig. 4).

Concerning cards with the function of electronic money, we note rather low indicators of emission and use of these means of payment. The largest number of cards of this type in circulation was observed in 2016 (54,000).

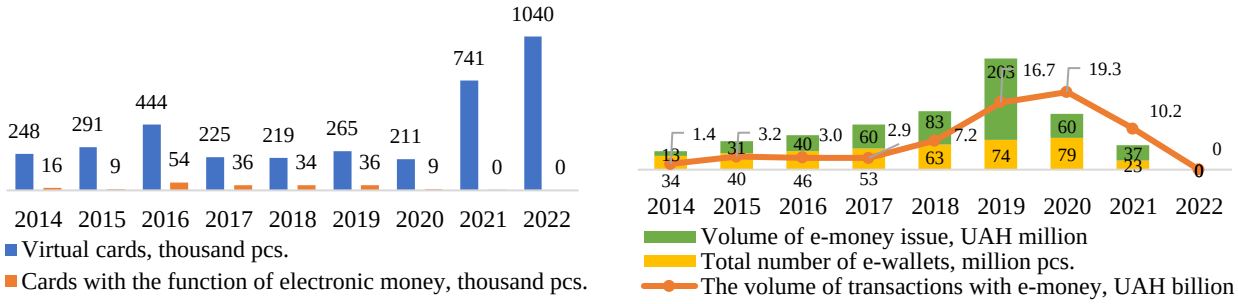

Figure 4. Dynamics of the number of virtual cards and the electronic money market for 2014-2022
Source: compiled by the author based on data [10; 18]

ISSN 1817-9215 (print)
1817-9290 (on-line)

As shown in Fig. 4, in 2021, their number decreased almost to zero (253 units). In 2022, the issuance of cards was suspended following the Resolution of the NBU Board No. 18 of February 24, 2022, "On the operation of the banking system during the introduction of martial law". In addition to suspending the issuance of electronic money, the Resolution also includes a ban on the "replenishment of electronic wallets with electronic money and distribution of electronic money" [**Error! Reference source not found.**]. However, negative dynamics were previously observed for this indicator. An enormous amount of e-money issuance was observed in 2019 (203 million UAH), and the volume of transactions with e-money - in 2020 (over 19.3 billion UAH).

In 2020, the peak of the use of e-wallets was observed, the number of which reached 79 million units. The analysis confirms a decrease in indicators from 2020 to 2021. It is due to changes in the regulation of the e-money market, which required the identification of e-money users (both payers and recipients), the establishment of new limits for transactions with electronic money, strengthening requirements for electronic money issuing banks regarding control over the activities of commercial agents.

In contrast to the field of payment cards, the market of self-service banking devices has negative development dynamics, which corresponds to the growing demand for mobile banking and cashless transactions (Fig. 5).

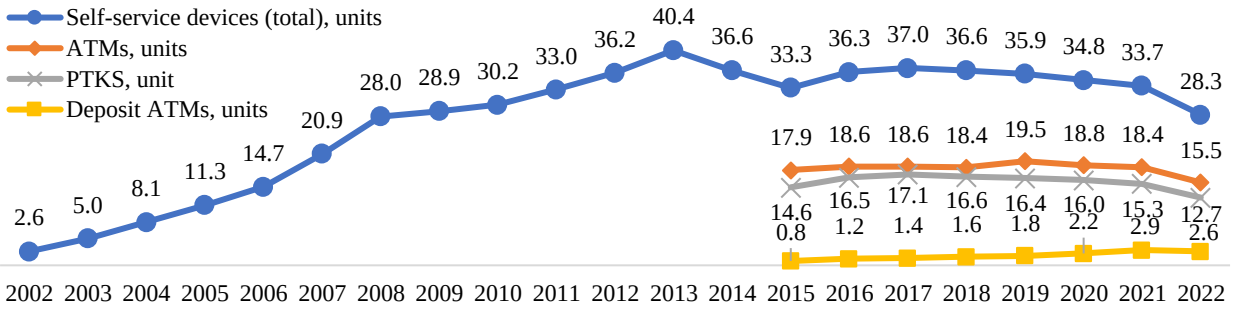

Figure 5. Dynamics of the number of self-service bank devices for 2002-2022
Source: compiled by the author based on data [10]

According to the data in Fig. 5, by the end of 2022, the network of self-service devices numbered 28.3 thousand units, 43% less than the peak level in 2012. Among the devices, ATMs make up more than half of the network. 41% are PTKS (self-service software and technical complex), and 8% are deposit ATMs (with the possibility of cash replenishment by the client). In addition, deposit ATMs are the only group of devices that increased from 811 to 2,574 units between 2015 and 2022.

The analysis of Fig. 5 shows that in the development of self-service devices, it is advisable to distinguish several stages: 2002-2008 - dynamic growth of the network of devices from 2.6 to 28 thousand units. (average annual growth of 150%), which was interrupted by the onset of the global economic crisis of 2008-2009 and 2009-2013 – significant growth rates of devices from 28 to 40.4 thousand units. (average annual growth of 109%); 2014-2015 – a drop in the number of devices by 18% (from 40.4 to 33.3 thousand units), caused by the economic crisis and the loss of part of the network by banks in the Crimea, Donetsk and Luhansk regions as a result of the occupation of part of the territory of Ukraine; 2016-2017 – growth of the network of devices by 11% (from 33.3 to 37 thousand units) mainly due to more active growth of the network of PTKS and deposit ATMs; 2018-2021 – gradual reduction of the network of self-service devices from 36.6 to 33.7 thousand units. (by 9%) against the background of the restoration of the efficiency of the banking system and the growth of the economy; 2022 – a significant decrease in the network of devices (by 16% per year) due to the occupation of a large part of the territory of Ukraine and the loss of operational control over the network of devices on the part of banks.

Similar negative dynamics regarding causes and consequences are observed in the analysis of the number of bank branches and employment in the financial sector (Fig. 6).

ISSN 1817-9215 (print)
1817-9290 (on-line)

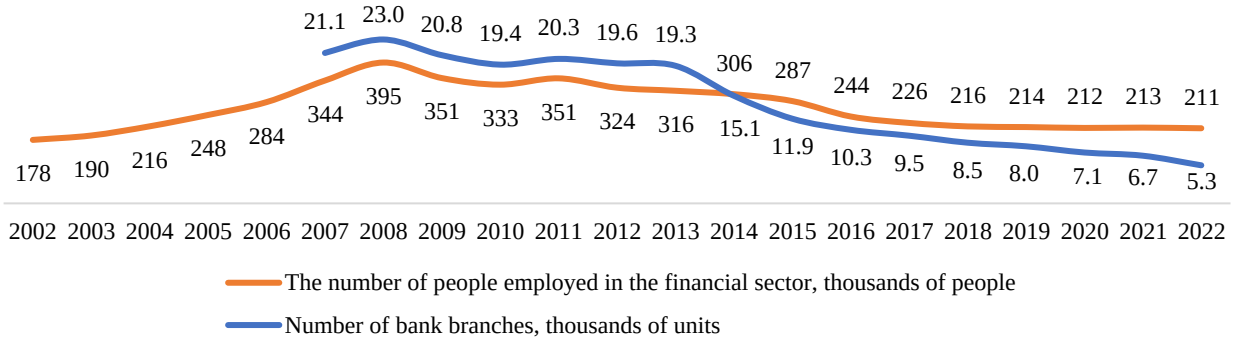

Figure 6. Dynamics of the number of bank branches and employment in the financial sector for 2002-2022

Source: compiled by the author based on data [15]

As evidenced by the analysis of Fig. 6, 2008 was the most successful year according to these indicators. In the specified period, the network of bank branches comprised 23,000 units, and in general, more than 395,000 people worked in the financial sector. In the future, we will observe three stages of reduction in the market: 2009-2013 – a slow reduction in the number of branches by 9% and a noticeable reduction in the number of employees by 20%; 2014-2017 – a significant reduction in the number of branches by 51% and the number of employees by 19%; 2018-2022 – continuation of the trend to reduce the number of bank branches by an additional 18% and stabilisation of the number of people employed in the financial sector (current reduction by 2%).

Stabilisation of the number of employees with a constant reduction of bank branches indicates the reorientation of banks to "back-office" work to support remote work through mobile applications and Internet banking sites. During the analysis period, the network of bank branches decreased by 4.3 times, and the number of employed persons decreased by 47%.

Instead, the market of payment terminals in Ukraine developed quite actively (see Fig. 7).

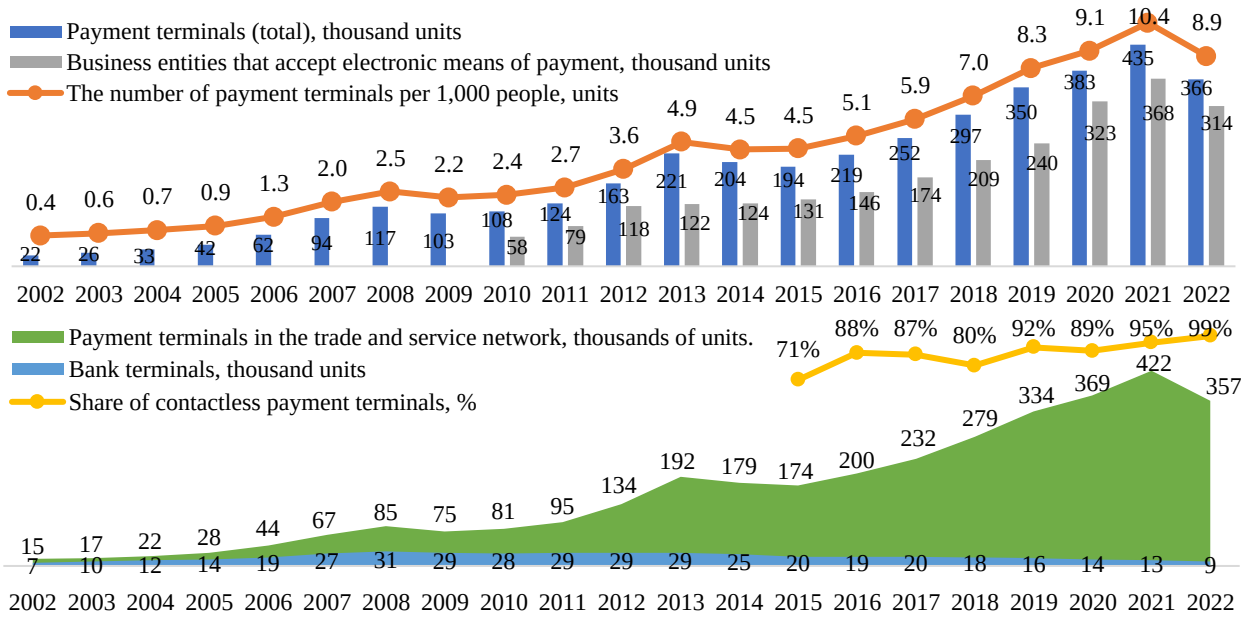

Figure 7. Dynamics of the payment terminal market for the period 2002-2022

Source: compiled by the author based on data [10]

The number of payment terminals in Ukraine from 2002 to 2022 increased more than 16 times (from 21.7 to 365.8 thousand units). In the calculation for 1,000 people in the population, the increase is more significant - almost 20 times. In 2002, there was one payment terminal for every 2.5 thousand people in Ukraine; in 2022, there were almost nine payment terminals. Likewise, the number of

business entities that can accept electronic means of payment increased by 540%. As of the end of 2022, their number has reached 314,000. According to the structure of the payment terminal market, throughout the period, we observe a dynamic increase in the number of payment terminals in the trade and service network, the share of which has increased from 64% in 2002 to 97% by the end of 2022. Instead, the number of bank terminals reached a peak of 28,900 units. In 2013, it steadily decreased to the level of 9.3 thousand units by the end of 2022. This is due primarily to the reduction in the number of bank branches and the growing demand for remote operations by bank clients.

On the technological side, we note the absolute superiority of contactless payment terminals, the share of which increased from 71 to 99% during 2015-2022. It indicates the readiness of market agents to accept non-cash payments using contactless cards and NFC devices. In general, the dynamics of the development of the payment terminal market show the best levels of growth in the group of indicators of the state and dynamics of the payment banking infrastructure, taking into account the slightest periods of decline caused by the economic crises of 2008-2009 and 2013-2015, as well as the consequences of military actions in 2022.

Thus, the analysis of the electronic payment activity of the banking sector of Ukraine proved the existence of a trend towards the growth of a cashless economy with a growing demand for contactless payments, which is supported by the increase in the offer of payment terminals by banks and the growing interest of business entities in accepting electronic payments. Under the conditions of a reduction in the network of branches and employment in the financial sphere, this is evidence of both customer demand and the corresponding response of banks to the change of the concept of priority use of information technologies as auxiliary in the processes of providing financial services to the idea of digital banking as the predominant form of remote customer service and the provision of personalised digital financial services.

At the same time, the development of electronic payment activities in the banking sector and indicators of banks' credit activities can be evidence of the development of digital banking in Ukraine. We believe that in the specified period, bank lending indicators depend to a much greater extent on the level of digitalisation than on the development of electronic payment activities. To test this hypothesis, we conducted a comprehensive assessment of the "quality" of the functioning of the electronic payment segment of the banking sector before the development of digital bank lending. Such a comprehensive approach serves as a basis for understanding the level of information and technological development of the banking sector as a whole, considering the dynamics of banks' financial indicators.

To check the "quality" of the functioning of the electronic payment segment of the banking sector in the context of the potential for the development of digital bank lending, the calculation of the Harrington desirability function was used. This method considers the components' quantitative characteristics and the properties of indicators such as adequacy, efficiency, and statistical sensitivity. We reduced all the investigated indicators to a dimensionless form to apply the Harrington scale and calculated partial Harrington functions using formulas (4.5; 4.6).

$$G_i = \sqrt[n]{\prod_{k=1}^{n} d_k}; \tag{4.5}$$

$$d_k = exp(-exp(-\overline{x_k})), \tag{4.6}$$

where G_i *is* the desirability coefficient of the Harrington function;
k - the number of indicators used in desirability assessment;
d_k is a partial function defined according to the Harrington scale;
$\overline{x_k}$– indicator in dimensionless form;
n *is* the number of studied objects.

The construction of the desirability function involves plotting the ordinate value of the desirability indicator d_k, which varies from 0 to 1 (0 is the worst value of the indicator, and 1 is the best). The graphic representation of the function is shown in Figure H.1. Distribution of "desirability scale" intervals: [0.80-1.00] – acceptable level with an "excellent" rating; [0.63-0.80) – an acceptable level with a rating of "good"; [0.37-0.63) – an acceptable level with a rating of "satisfactory"; [0.20-0.37) – the limit level with the rating "unsatisfactory"; [0.00-0.20) is an unacceptable level of system development that requires a significant update of elements.

Data in the banking sector section, collected as of January 1, 2023, are presented in Table 1.

Table 1. Indicators for calculating a comprehensive assessment of the "quality" of the functioning of the electronic payment segment of the banking sector in the context of the potential for the development of digital bank lending

Indexes	2015	2016	2017	2018	2019	2020	2021	2022
Non-cash operations and payment cards								
1	2	3	4	5	6	7	8	9
The number of non-cash transactions carried out using payment cards, million pcs.	1287	1775	2311	3073	4167	5211	7040	5796
The amount of non-cash transactions carried out using payment cards, million hryvnias	384795	571275	834957	1297429	1798276	2208721	3099118	3720118
Active contactless payment cards, million pcs.	1451	1993	2746	3961	8644	13181	20014	26149
Active digital (tokenised) payment cards, million pcs.	0.00	0.00	0.00	1158.1	2521.0	3945.1	6693.2	7936.4
The number of payments using contactless cards and NFC gadgets, million pcs.	11.5	23.1	116.5	281.3	769.9	1474.3	2076.3	2363.9
Amount of payments using contactless cards and NFC-gadgets, UAH billion	7	11	34	70	184	339	495	759
Active virtual cards, thousand pcs.	291.1	444.5	225.4	219.4	265.5	210.7	741.3	1040.2
Active cards with the function of electronic money, thousand pcs.	9.5	54.5	36.4	33.6	36.1	8,9	0.3	0.3
Banking payment and credit infrastructure								
ATMs, units	17896	18558	18586	18381	19538	18783	18434	15549
Deposit ATMs, unit	811	1193	1363	1589	1809	2234	2873	2574
PTKS, unit	14627	16511	17054	16615	16392	16006	15292	12719
Payment terminals in the trade and service network, unit	174293	199796	232063	278993	333840	368642	421623	356527
Bank terminals, unit	20185	19445	19618	18273	16373	13965	12898	9310
Business entities that accept electronic means of payment	131264	145938	173756	208661	240228	322736	368112	314139
Bank branch, unit	11871	10316	9489	8509	8002	7134	6685	5336
Employed in the financial sphere, thousands of people.	287	244	226	216	214	212	213	211
Results of credit and deposit activities of banks								
Loans granted to legal entities, thousand UAH	616421	479393	469265	480000	419577	447262	566642	330882

ISSN 1817-9215 (print)
1817-9290 (on-line)

Continuation of the table. 1

1	2	3	4	5	6	7	8	9
Loans granted to individuals, thousand UAH	97553	87118	92063	114004	142584	148619	200197	132915
Funds raised from legal entities, thousand UAH	360454	424213	427479	430779	525042	681195	799845	942713
Funds raised from individuals, thousand UAH	399842	435826	480001	509853	552115	681892	726898	933240
Net interest income from operations with legal entities, thousand UAH	59114	66114	61287	67869	67881	22947	26290	26171
Net interest income from transactions with individuals, thousand UAH	-15244	-17781	-4583	6610	12228	18481	35735	37802

Source: compiled by the author based on [10; 15; 18]

A graphical interpretation of the "quality" of the functioning of the electronic payment segment of the banking sector in the context of the potential for the development of digital bank lending according to Harrington's scale of desirability for the period 2015-2022 is presented in Figure 8.

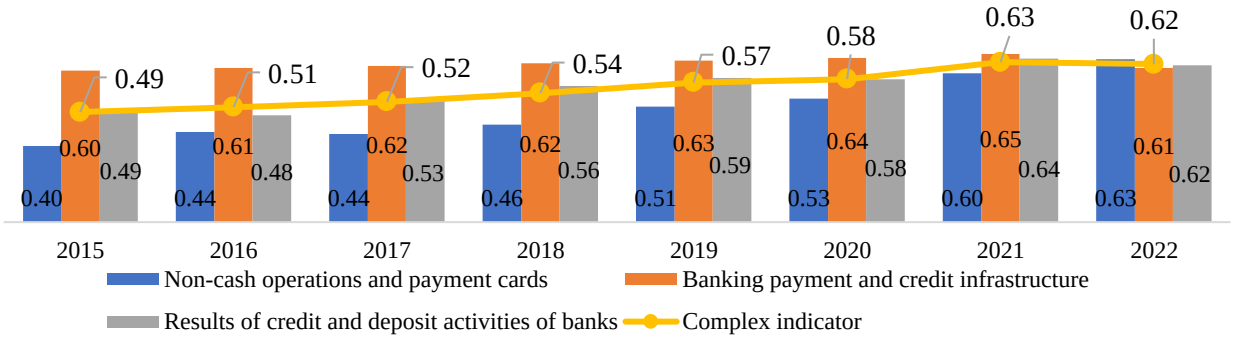

Figure 8. Harrington's desirability function is used to assess the "quality" of the functioning of the electronic payment segment of the banking sector in the context of the potential for the development of digital bank lending for 2015-2022

Source: compiled by the author

Thus, the calculations showed an increase in the "quality" of the functioning of the electronic payment segment of the banking sector for the period 2015-2022. However, during the analysis period, its assessment level was equally satisfactory, approaching the limit of the "good" assessment in 2021-2022. (0.62 points). In general, all components of the electronic payment segment as a system (cashless operations, payment cards and infrastructure, financial results) had similar results as of the end of 2022. However, in the context of the analysis of the components, we note that the growth of the cashless operations and payment card indicators was the most observed (+23 points). The growth of the group of credit and deposit activity indicators of banks was significant (+13 points). At the same time, the level of bank payment and credit infrastructure group almost did not change (+1 point). A more detailed analysis of partial desirability coefficients testified to the strong positive influence of indicators characterising the overall activity of banking sector entities in the field of non-cash transactions, issuance and distribution of payment cards and payments using NFC gadgets, distribution of payment terminals and deposit ATMs. A negative factors in the growth of the quality of a system correspond to the electronic money, employment in the financial sphere and a network of branches, PTKS and ATMs.

CONCLUSIONS

The results of the study proved the development of the modern economy is carried out thanks to the development of digital technologies, which stimulate the growth of production capabilities, labour productivity and return on capital of both digital and non-digital companies, accompanying the transformation of their business models and contributing to the country's economy. In the context of the development of the financial sphere in general and the credit market in particular, technologies that are at the stage of active implementation, such as 5G communication, Big Data Analytics, Artificial Intelligence, and NFC payments, have a remarkable impact on the business models of financial institutions and chatbots. These technologies enable the optimisation of risk management processes, analysing customer behaviour, and creating personalised services.

The successful use of digital technologies in finance is driven by their combination and the ability of companies to create financial innovations through product and service changes such as embedded finance and APIs, process improvements such as automated credit scoring, and organisational transformations that allow fintech startups to focus on quality and product design rather than traditional banking processes. Business model innovation, which includes new approaches to monetisation and customer value creation, is also a vital element of this process. Regarding its scale and impact on financial innovation, the area with the most potential is digital lending, which encompasses many forms of lending through various digital channels and digital tools. Digital technologies, such as automated credit scoring services and credit marketplaces, are turning the credit process into a convenient, secure, and efficient way to interact with customers. Key components, such as infrastructure availability, customer readiness to use digital services, and automated data collection and analysis, determine the success and availability of these services in the financial services market.

The analysis of the essence of digital lending and the types and forms of its implementation proved the undisputed role of the bank as the central mediator in the credit market using digital innovations and technologies. As the calculation shows, the development of electronic payment activity in the banking sector in combination with indicators of credit activity of banks is evidence of the development of digital banking in Ukraine, as well as the presence of a positive effect of the introduction of digital technologies and innovations in the financial and credit sphere of the economy.

REFERENCES

1. *Big Data*. (2019). Statista. Retrieved from: https://bit.ly/3TLblGQ.
2. Curry, E. (2016). The Big Data Value Chain: Definitions, Concepts, and Theoretical Approaches. *New Horizons for a Data-Driven Economy: A Roadmap for Usage and Exploitation of Big Data in Europe.* Springer Nature, 29-37.
3. *Digital Economy Report. Value Creation and Capture: Implications for Developing Countries*. (2019). United Nations Conference on Trade and Development (UNCTAD). Geneva. Retrieved from: https://bit.ly/3vjLmMq.
4. *Fintech lending: 2021 market map and 5 trends shaping the landscape*. (2021). Ocrolus. Retrieved from: https://bit.ly/48FbPCt.
5. Kumar, M., Agrawal, S., Aliza, F. (2020). Emergent role of fintech in financial landscape: A perspective on banking industry. *International Journal of Scientific and Technology Research*, 9(3), 4055–4058.
6. Madakam, S., Ramaswamy, R., Tripathi, S. (2015). Internet of Things (IoT): A Literature Review. *Journal of Computer and Communications*, 3, 164–173. https://doi.org/10.4236/jcc.2015.35021.
7. Maier, E. (2016). Supply and demand on crowdlending platforms: connecting small and medium-sized enterprise borrowers and consumer investors. *Journal of Retailing and Consumer Services*, 33, 143–153. https://doi.org/10.1016/j.jretconser.2016.08.004.
8. Panetta, K. (2019). 5 Trends Appear on the Gartner Hype Cycle for Emerging Technologies. *Gartner*. Retrieved from: https://bit.ly/47llP2S.

9. Parker, G., Van Alstyne, M. (2017). Innovation, Openness, and Platform Control. *Management Science*, 64(7), 3015–3032. https://doi.org/10.1287/mnsc.2017.2757.
10. *Payments and settlements*. (2023). National Bank of Ukraine. Retrieved from: https://bank.gov.ua/ua/payments.
11. *RBS to become biggest player in the peer-to-peer lending referral market*. (2022). NatWest Group. Retrieved from: https://bit.ly/3RNV7dv.
12. Schwab, K. (2019). The fourth industrial revolution. Shaping the fourth industrial revolution. Kharkiv: Family Leisure Club.
13. Shkarlet, S. M., Dubina, M. V., Zhuk, O. S. (2019). Theoretical aspects of defining the essence of the "Fintech" category. *Polissya scientific bulletin,* 1 (17), 148–157. https://doi.org/10.25140/2410-9576-2019-1(17)-148-157.
14. Stamford, C. (2017). Gartner Says Worldwide Public Cloud Services Market to Grow 18 Percent in 2017. *Gartner*. Retrieved from: https://bit.ly/3RHQcKZ.
15. *Statistical information*. (2023). State Statistics Service. Retrieved from: http://www.ukrstat.gov.ua/.
16. Stewart, A., Yaworsky, K., Lamont, P. (2018). Demystifying Digital Lending. Cambridge. MA: Accion Insights.
17. Tapscott, D., & Tapscott, A. (2019). Blockchain revolution. How the technology underlying Bitcoin and other cryptocurrencies is changing the world (M. Demkiv & K. Shcheglova, Eds.; Yu. Grigorenko & G. Leliv, Trans.). Chronicle.
18. *World development indicators*. (2023). The World Bank. Retrieved from: https://bit.ly/41MLWhH.
19. Yeh, K.-H., Deng, R. H., Kikuchi, H. (2020). Special Issue on FinTech Security and Privacy. *Future Generation Computer Systems*, 112, 1172–1173. https://doi.org/10.1016/j.future.2020.07.057.