Digitalization of financial services in European countries: Evaluation and comparative analysis

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Abstract. Constant innovations in finance and technology and different levels of their development worldwide necessitate investigating universal integrated indexes. It will enable a general assessment of the digitization of financial services and allow carrying out a comparative inter-nation analysis. The authors proposed to evaluate the level of digitalization of financial services (DFSI) based on three components: digital inclusion, financial inclusion, and digital financial services. The suggested approach includes several steps: 1) forming an array of input data by eight indicators; 2) establishing the priority of indicators and calculating their weights by using the Fishburne formula; 3) calculating the integral index of digitization of financial services by using the weighted sum method. According to the obtained DFSI values, the European countries were divided into four groups: with a high, medium, low, and critically low level of digitalization of financial services. Countries with a high level of DFSI are considered to be Denmark, the Netherlands, the UK, Finland, Sweden, and Norway. Most countries experience low (Greece, Hungary, Italy, Croatia, Portugal, Poland, Slovenia, Slovakia, Malta, Lithuania) or medium (Estonia, Ireland, Belgium, Latvia, Luxembourg, Germany, the Czech Republic, France, Austria, Spain) levels of DFSI. Critically low level of digitization of financial services is observed in Bulgaria, and Romania.

Keywords: financial services, digitalization, FinTech, Internet banking, mobile banking, electronic payments.

JEL Classification: G20, O33, C43

1. INTRODUCTION

Many scientific studies prove that innovative development is the basis for the country's economic growth and long-term welfare (Balzer et al., 2020; Kirikkaleli & Ozun, 2019). Innovation is often seen as one of the fundamental components in ensuring the efficiency of enterprises (Bilan et al., 2020; Chigrin & Pimonenko, 2014; Podhorska et al., 2020; Pukala et al., 2018; Zygmunt, 2019), promoting economic security and sustainable economic development of the country (Sineviciene et al., 2018). Particularly relevant is the choice of an innovative development path for transition economies, for which production, environmental and financial innovations can become a lever of competitive advantage in the international market (Bilan et al., 2019; Brychko et al., 2019; Lyulyov et al., 2021). At the same time, the nature of innovation is currently becoming quite specialized. The level of ICT adoption is increasingly crucial for the success and competitiveness of the market, as innovation is technologically driven. It is linked to the increased automation of production and general management, cloud technologies, management of large databases, etc. (Karaoulanis, 2018). Thus, there is a gradual transition to a new technological way - Industry 4.0. That is why the trend of modern scientific research is to discuss topics related to Industry 4.0 and its accompanying transformations that occur in all areas of human life (Postelnicu & Câlea, 2019).

Modern innovation is, first and foremost, the use of technologies (Kohnová et al., 2019). Their distribution has become widespread in product manufacturing and service delivery and has comprised all stages, from consumer research, production, promotion, and marketing to feedback obtaining (Ahmed et al., 2020). It is not a strange fact that e-commerce is being developed – the attention of companies has shifted to this distribution channel of goods and services, the possibility to form a competitive position

and to meet consumer demand through electronic means has been explored (Hu et al., 2019). Moreover, digitalization has touched public administration (Balaraman, 2018), public governance (Androniceanu et al., 2020; Zarutska et al., 2018), community activities (Petrushenko et al., 2017; Petrushenko et al., 2020), capital market instruments and returns (Kozmenko & Vasyl'yeva, 2008), financial security (Kuzmenko et al., 2020; Petroye et al., 2020; Vasylieva et al., 2020), and even social and cultural aspects of electronic communication (Beyi, 2018; Vasilyeva et al., 2020).

Indeed, such trends influence the financial system as well. In one way or another, any operation related to finance can be "upgraded" and transformed with the aim to increase its adaptability. New technologies have been emerged and appreciably changed the existing financial services (Petrushenko et al., 2018). They have created opportunities for new marketing approaches (e-banking, mobile-banking), new types of financial services (online financing through crowdfunding and peer-to-peer platforms), and also caused such a phenomenon of the digital age as cryptocurrencies (Civelek et al., 2020; Knezevic, 2018; Kohardinata et al., 2020; Kukurba & Waszkiewicz, 2018).

The increase of financial and technological innovation has led to a growing scientific interest in this field. On the one hand, such innovations can be considered as a source of efficient improvement for the economy and the financial sector (Folwarski, 2018). They can help to align economic and business cycles, and to raise financial inclusion (Didenko et al., 2020; Gatsi, 2020; Lyeonov & Liuta, 2016), to avoid the devastating impact of financial crises and imbalances (Brychko et al., 2021). On the other hand, unregulated use of technology in the financial sphere can have negative consequences and create additional risks, such as money laundering, data breaches, and other cyber frauds (Brychko et al., 2021; Lebid et al., 2018; Leonov et al., 2019; Lyeonov et al., 2020; Yarovenko et al., 2021). It should be noted that financial and technological innovations are often explicitly studied with respect to the segments of the financial market (Tvaronavičienė, 2019), types of financial services (Kapidani & Luci, 2019), individual financial transactions (Adeyinka et al., 2019) or financial decision- making processes (Njegovanović, 2018; Kuzmenko & Kyrkach, 2014).

It is defined that the level of implementation and willingness to innovate varies depending on the country and region (Carrillo, 2019; Wierzbicka, 2018), it is relevant to carry out an inter-nation comparative analysis of the financial and technological innovation development features. Existing studies demonstrate attempts to conduct international research, but most of them are based on a set of disparate indicators (Afonasova, 2019; Buriak et al., 2015; Vasilyeva et al., 2019; Kozmenko et al., 2009; Kozmenko & Roienko, 2013). It complicates the qualitative interpretation of the obtained results, generalized assessment, and ranking countries by using the proper criterion. At the same time, the use of an index method or an integral estimation method avoids these shortcomings and makes a comparative assessment of the degree of particular economic phenomena development in different countries worldwide (Kiseľáková et al., 2018; Alikariev & Poliakh, 2018). There are virtually no specialized studies on the financial sector among existing techniques to calculate integrated indexes of innovation and technological development (Roszko-Wójtowicz & Białek, 2019). The most relevant studies are the FinTech Adoption Index by EY and FinTech Index by ING Economics Department. The advantages and disadvantages of using these indexes are detailed in the next section of the article.

Thereby, the scientific task to create a universal indicator that would allow evaluating and comparing the digitalization of financial services in different countries has not been solved yet. Therefore, this study aims to develop a methodology for calculating an integrated index aimed to evaluate the digitalization of financial services in the European countries and to carry out a comparative inter-nation analysis. The structure of the article includes following sections. The "Literature review" section analyzes the existing methods to calculate indexes, which can reflect the digitalization degree and FinTech innovations influence on the financial services market. The "Methodology" section provides a detailed description of

the integrated digitalization index of financial services according to the three components (financial inclusion, digital inclusion, and digital financial services), as well as its calculation stages. The "Empirical results and discussion" section contains the calculation of the index for 28 European countries. In this section, the authors also define the range of index values, distribute them in 4 levels for qualitative results interpretation (high, medium, low, and critically low level) and compare the obtained results with the EY FinTech Adoption Index.

2. LITERATURE REVIEW

Existing studies propose separate indicators for analyzing digital innovation development and penetration in countries worldwide. For example, in 2015, Ernst & Young, one of the world leaders in insurance, taxation, and financial advisory services, implemented the EY FinTech Adoption Index to analyze Internet activity to use FinTech companies' services (Ernst & Young, 2019). The company calculates the index every two years, expanding an amount of countries and types of FinTech services each time.

In another study, presented by ING Bank N.V. ("ING") in 2016, it was proposed to calculate the FinTech Index assessing the potential of low- and middle-income countries regarding the implementation of FinTech innovations (ING Economics Department, 2016).

These studies have applied different approaches to form an integrated index with the aim to estimate FinTech development. The calculation of the FinTech Adoption Index by Ernst & Young is based on a survey of digital service users. In contrast, ING considers a person is a FinTech adopter if he or she uses two or more FinTech services.

The FinTech Adoption Index calculation was started in 2015 with a study of 6 markets (6 countries) and ten types of FinTech services within five categories: money transfers and payments; budgeting and financial planning; savings and investments; loan; insurance. The classification of services into five categories was retained in further surveys in 2017 and 2019, and the geographical scope of the study and the list of FinTech services were constantly expanding. In 2019, Ernst & Young surveyed over 27.000 people in 27 countries worldwide using 19 types of FinTech services.

ING Bank N.V. calculates the FinTech Index as an integrated index of 3 subindexes, namely:

- urgency for financial inclusion: characterizes the relevance or need for FinTech to reach the financial services of the entire population and small and medium-sized enterprises (SMEs); it is calculated based on indicators regarding the share of population that does not have a bank account; shares of SMEs not covered by financial services; shares of poor and rural population;

- FinTech infrastructure (technology development assessment that enables to implement of FinTech services): the share of the population using mobile communications; share of Internet users; the proportion of the population connected to the electricity grid; the number of electrical outages per month;

- FinTech ecosystem: an assessment of the country's business environment for FinTech companies by the time spent on setting up a new enterprise and the Global Innovation Index.

The study also analyzes the political and regulatory environment index, which is a general feature of the country's investment climate. The country may be highly prepared to implement FinTech, has adequate infrastructure and ecosystem from the one side, but has a limited investment in FinTech caused by the unstable investment climate – from the other side (ING Economics Department, 2016).

The features of the considered approaches to assessing the digitalization level of financial services are presented in Table 1.

Table 1

Comparative description of existing approaches to assessing the digitalization level of financial services

Criteria for comparison	Approaches	
	FinTech Adoption Index (EY)	FinTech Index (ING)
The calculation method	Survey method. The index is calculated by determining the proportion of respondents who use two or more FinTech services in the total number of respondents.	Composite index. Based on three subindexes. All indicators used for the calculations are normalized and adjusted to values from 0 to 10.
Aspects of FinTech development considered in the study	- the category of consumers - individuals; small and medium business; - 5 categories and 19 types of FinTech services (2019 survey).	- supply, demand, and risks for the FinTech development; - 3 sub-indexes are calculated, each of which describes a separate group of FinTech development factors: the need for FinTech, FinTech infrastructure, and FinTech ecosystem.
Advantages	- simplicity and comprehensibility of the method; - the most total possible consideration of the financial services related to technological innovation.	- use of official statistical sources for calculation; - various aspects of the analysis: supply, demand, and risks for the FinTech development; - calculation of subindexces allows to carry out a detailed analysis of each component of FinTech development.
Disadvantages	- the survey is conducted among internet users, not the entire population; - the sample survey can give a significant margin of error; - only one aspect of financial and technological innovation introduction is considered – demand among consumers for FinTech start-up services.	- the analysis is only for low- and middle-income countries; - FinTech is seen as a substitution by the traditional banking services - for the sub-index that determines the need for FinTech, the share of the population without a bank account, SME credit gaps, etc. are considered to be stimulants for the FinTech development, contrary to the results obtained in other studies.

Source: own compilation.

3. METHODOLOGY

Taking into account the advantages and disadvantages of the considered approaches to the formation of integrated indexces of FinTech and digital financial services development, the authors propose to assess the digitalization level of financial services with the Digital Financial Services Index (DFSI), which summarizes three components:

1) digital inclusion – the indicator of digitization level in society in general, refers to the penetration of digital technologies without attachment to the financial sector;

2) financial inclusion – refers to the financial services market development, indicates the general usage level of financial services;

3) digital financial services – refers to the implementation of digital technologies in providing different financial services.

Since the third group of indicators directly reflects the digitization of a particular financial service, it should be the largest. The indicators appurtenant to this group should be assigned the highest ranks in determining the weighting coefficients for the DFSI indicators. The list of indicators included in the Digital Financial Services Index is presented in Fig. 1.
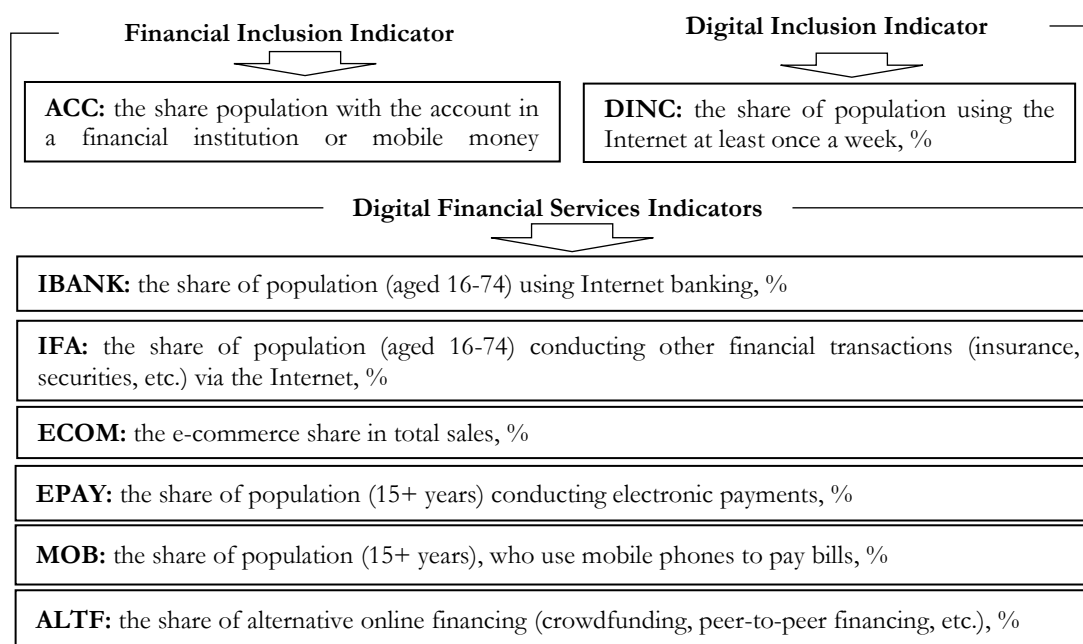
Financial Inclusion Indicator	**Digital Inclusion Indicator**
ACC: the share population with the account in a financial institution or mobile money	**DINC:** the share of population using the Internet at least once a week, %

Digital Financial Services Indicators

IBANK: the share of population (aged 16-74) using Internet banking, %

IFA: the share of population (aged 16-74) conducting other financial transactions (insurance, securities, etc.) via the Internet, %

ECOM: the e-commerce share in total sales, %

EPAY: the share of population (15+ years) conducting electronic payments, %

MOB: the share of population (15+ years), who use mobile phones to pay bills, %

ALTF: the share of alternative online financing (crowdfunding, peer-to-peer financing, etc.), %

Figure 1. The structure of the Digital Financial Services Index (DFSI)

Source: own compilation.

The values of most indicators selected to calculate an integrated index of digitization of financial services are published in official statistical databases regularly, particularly in the World Bank and Eurostat databases (Table 2).

Table 2

Data sources for DFSI indicators

DFSI indicators	Data sources
ACC	Global Financial Inclusion Database, the World Bank
DINC, IBANK, IFA, ECOM	Eurostat
EPAY, MOB	Global Financial Development Database, the World Bank
ALTF	Cambridge Centre for Alternative Finance; the World bank

Source: own compilation.

For raising the digitalization of financial services, both financial and digital inclusion of consumers are essential. We've chosen the most general indicators for this criteria. The financial inclusion component is taken into account by indicating the share of respondents who has an account (individual or shared) in the bank or another type of financial institution or uses the mobile money service for the last 12 months.

The digital inclusion component reflects the share of the population who uses the Internet regularly, i.e., at least once a week, during the last three months before the survey. The criterion of using the Internet to calculate this indicator includes all access methods (computer, mobile phone, personal digital assistant, gaming machine, digital television, etc.) and any purpose (private or related to work/business).

The IBANK indicator characterizes the share of the population using Internet banking. It considers all the respondents' transactions with the bank, which are carried out in electronic form (for example, payment of bills), and receiving information about the account status.

The next indicator of the DFSI is the share of the population who conducts other financial transactions via the Internet (IFA). It takes into account at least one of the following financial transactions via the Internet during the reporting period:

- sale or purchase of shares, bonds, other investment assets and obtaining other investment services via the Internet;

- the purchase or renewal of existing insurance policies, including those offered as part of bundled services (e.g., travel insurance provided with a plane ticket) via the Internet;

- obtaining a loan or making a loan at a banking or other financial institutions via the Internet.

The e-commerce indicator (ECOM) characterizes the share of enterprises' cash revenues from the sale of products through electronic networks in the total volume of sales over the last 12 months.

The share of the population making electronic payments (EPAY) reflects the percentage of respondents who used electronic means to pay bills or purchase goods (including payments made personally by respondents through using the money on accounts and automatic payments) over the last 12 months. Another indicator representing digital financial services is the percentage respondents who used a mobile phone to pay their bills in the previous 12 months.

The last indicator to evaluate the level of digitalization of financial services is the share of traditional loan replacement with alternative online financing (ALTF). This indicator is proposed to be calculated as a share of alternative online financing in the total private sector lending. The total amount of alternative financing includes the sum of all loans attracted by individuals and legal entities through online platforms in the form of peer-to-peer loans, crowdfunding, balance loans, and more. Private-sector lending includes all financial resources provided to the private sector (households, private enterprises, and in some countries also public enterprises) by financial corporations (banks, financial and leasing companies, credit unions, insurance companies, pension funds, etc.) through loans, commercial credits, debt securities purchase, financing of receivables, etc.

The digitalization level of financial services is proposed to calculate using the linear mathematical model of the integrated indicator (weighted sum method) according to the formula (1):

$$DFSI = w_{acc} \cdot ACC + w_{dinc} \cdot DINC + w_{ibank} \cdot IBANK + w_{ifa} \cdot IFA + w_{ecom} \cdot ECOM \qquad (1)$$
$$+ w_{epay} \cdot EPAY + w_{mob} \cdot MOB + w_{altf} \cdot ALTF$$

where w_i is a weighting coefficient of i-indicator of the DFSI.

In order to establish the weighting coefficients for the variables selected as indicators of the Digital Financial Services Index, we apply the Fishburn formula (formula (2)):

$$w_i = \frac{2 \cdot (n - i + 1)}{n \cdot (n + 1)} \qquad (2)$$

where
n – the total number of indicators for evaluating the digitalization of financial services;
i – the rank of an indicator in assessing the digitalization level of financial services.

The Fishburn formula in calculating weighting coefficients allows to determine the indicators' significance based on their ranking. It is used in cases where it is sufficient to know only the degree of

preference for one indicator compared to others, which is fully consistent with the objectives of this study.

Thus, the calculation of the DFSI includes the following steps:

1) to form an array of input data by eight indicators;

2) to define the weighting coefficients of the indicators according to the Fishburn formula;

3) to calculate the integrated index of digitalization of financial services by weighted sum method.

Let us note that due to the use of only relative indicators as indicators expressed in percentages or fractions of a unit, there is no need to normalize the indicators.

4. EMPIRICAL RESULTS AND DISCUSSION

Starting the practical implementation of the proposed approach to assessing the digitalization of financial services, we form an array of input data from eight indicators. Given the constraints of the availability of statistics for individual countries and periods of study, a group of countries to calculate an integrated index of digitalization of financial services includes 28 countries in the European region. The selected indicators, defined as components of the integrated index, are relative values, which can be expressed in fractions (with values from 0 to 1) and in percentages (range of possible values from 0% to 100%). We've chosen the percentage view of the analyzed indicators. An array of input data was generated for 2016-2019 to ensure comparability of the used indicators (Table 3).

The next step is aimed to calculate the weighting coefficients for the indicators regarding the integrated index of digitalization of financial services. To achieve this, we need to determine the priority of each indicator.

The highest priority is given to the share of the population who uses Internet banking (IBANK). Banking services are in high demand among the general public and business entities. Usually, banking services sales volume is more significant relatively to other types of financial services. Financial and technological innovations are spread in the fastest way in the banking sector and make the first indicator of digitalization of financial services.

In its turn, the share of the population who conducts other financial transactions (transactions with securities, insurance services) over the Internet (IFA) is the second priority in the integrated index. The digitalization of these financial services is also one of the most critical components of digital financial services in general. Still, unlike banking services, the demand for insurance services and securities brokerage services is not so massive, and, as a rule, there is a less frequent need for these services.

The third priority is given to payment transactions. This component includes all types of payments made over the Internet using a personal computer or mobile application, either through a financial institution or with the participation of traditional intermediaries. In calculating the integrated index, payment transactions are represented by two indicators - the proportion population making electronic payments (automatic and online) (EPAY) and the proportion of the population using a mobile phone to pay bills (MOB). An equal priority is set for both indicators.

The next highest priority is the indicator of the traditional loans replaced with alternative online financing (ALTF). It describes the next digitalization level of financial services where information technologies are not used only to change the way of distribution of financial services and their improvement but also to transform financial intermediation by replacing traditional financial institutions with online platforms. As this level of transformation of the financial sector is not typical for all world countries, the relevant indicator can only be considered an additional factor with lower priority.

Table 3

Input data to calculate the integrated index of digitalization of financial service (fragment for 2019)

Country	Indicators, %							
	ACC	DINC	IBANK	IFA	ECOM	EPAY	MOB	ALTF
Austria	98.2	86.0	63.0	9.0	14.0	93.5	8.5	0.0040
Belgium	98.6	89.0	71.0	12.0	33.0	96.3	22.7	0.0143
Bulgaria	72.2	67.0	9.0	4.0	4.0	41.2	2.3	0.0000
Croatia	86.1	77.0	46.0	5.0	12.0	75.1	13.5	0.0000
The Czech Republic	81.0	85.0	68.0	16.0	32.0	76.4	10.4	0.0107
Denmark	99.9	95.0	91.0	25.0	25.0	98.5	18.5	0.0051
Estonia	98.0	88.0	81.0	50.0	14.0	94.4	11.1	0.2218
Finland	99.8	93.0	91.0	39.0	23.0	98.1	25.1	0.0316
France	94.0	87.0	66.0	12.0	22.0	89.5	6.1	0.0150
Germany	99.1	91.0	61.0	21.0	15.0	96.5	5.7	0.0103
Greece	85.5	74.0	31.0	5.0	4.0	56.6	3.6	0.0000
Hungary	74.9	80.0	47.0	11.0	24.0	61.7	2.7	0.0000
Ireland	95.3	88.0	67.0	40.0	34.0	91.2	13.1	0.0000
Italy	93.8	74.0	36.0	8.0	12.0	86.2	4.7	0.0022
Latvia	93.2	84.0	72.0	30.0	7.0	83.1	9.1	0.1216
Lithuania	82.9	81.0	65.0	20.0	13.0	67.0	5.0	0.0000
Luxembourg	98.8	93.0	71.0	13.0	14.0	96.8	9.2	0.0000
Malta	97.4	85.0	54.0	14.0	13.0	79.3	6.3	0.0000
Netherlands	99.6	95.0	91.0	43.0	15.0	96.9	17.9	0.0142
Norway	99.7	98.0	95.0	46.0	26.0	98.9	29.9	0.0003
Poland	86.7	78.0	47.0	7.0	18.0	79.0	8.9	0.0043
Portugal	92.3	73.0	42.0	10.0	19.0	81.2	5.4	0.0000
Romania	57.8	72.0	8.0	2.0	7.0	32.7	3.3	0.0000
Slovakia	84.2	82.0	55.0	10.0	21.0	75.9	5.2	0.0064
Slovenia	97.5	81.0	47.0	8.0	17.0	89.9	6.1	0.0000
Spain	93.8	88.0	55.0	11.0	17.0	88.2	7.2	0.0038
Sweden	99.7	95.0	84.0	50.0	25.0	97.5	30.5	0.0022
The UK	96.4	95.0	78.0	56.0	31.0	94.2	18.2	0.1252

Source: own calculation.

The share of e-commerce in total sales is the indicator that has the most indirect impact on the digitalization level of financial services. The demand for financial assistance in e-commerce usually arises when handling accounts and financial transactions. The share of e-commerce shows the level of digitalization of the economy as a whole. Still, in the case of financial services, this indicator is indirect and, therefore, it will have the least priority among the indicators of digital financial services determining the weighting coefficient.

Indicators representing the financial and digital inclusion (ACC and DINC) reflect only a single aspect of digitalization of financial services, i.e., either digital or financial service extension criteria. Consequently, they will have the lowest priority among all analyzed indicators. As for the priority between

the two components, it must be equal since the level of technological and information development and the demand for financial services are equally important for the digitalization of financial services.

According to the above considerations, it is possible to establish the following system of inequalities between the indicators of assessing the digitalization of financial services by their priority (formula (3)):

$$w_{ibank} > w_{ifa} > w_{epay} = w_{mob} > w_{altf} > w_{ecom} > w_{acc} = w_{dinc} \tag{3}$$

Based on the given system of inequalities between the weighting coefficient, we can determine their ranks and calculate their values by the formula (2). The results are presented in table 4.

Table 4

Ranks and values of the weighting coefficients of DFSI indicators

Indicator	Priority	Rank	Weight of indicator, fraction	Weight of indicator, %
ACC	6	7.5	0.04167	4.167
DINC	6	7.5	0.04167	4.167
IBANK	1	1	0.22222	22.222
IFA	2	2	0.19444	19.444
ECOM	5	6	0.08333	8.333
EPAY	3	3.5	0.15278	15.278
MOB	3	3.5	0.15278	15.278
ALTF	4	5	0.11111	11.111

Source: own calculation.

Depending on the priority of each of the eight indicators, they are assigned a proper rank from 1 to 8. It is necessary to take into account the equality of priorities of some indicators. The figures of the population who conducts electronic payments (automatic and online) and the population who uses mobile phones for paying bills occupy the 3ᵈ and 4ᵗʰ positions with equal priority, so they are assigned an equal rank – 3.5. Similarly, indicators regarding the account in a financial institution or mobile money provider and the share of the population using the Internet receive equal rank – 7.5. Thus, substituting the defined ranks of indicators in the Fishburn formula, we obtain the weighting coefficients in the percentages and fractions.

Taking into account the obtained weighting coefficients, we calculate the integrated index of the digitalization of financial services for European countries by the formula (1). The results for 2016 and 2019 are presented in Fig. 2.

Most European countries increased the level of digitization of financial services during the period 2016-2019. The Netherlands and Scandinavian countries (Denmark, Finland, Sweden, and Norway) have the highest digitalization level of financial services (53-60%) both in 2016 and 2019. The United Kingdom and Ireland achieved the highest increase of the DFSI for the period (from 48.3% to 56.0%, and from 40.8% to 49.1%, respectively).
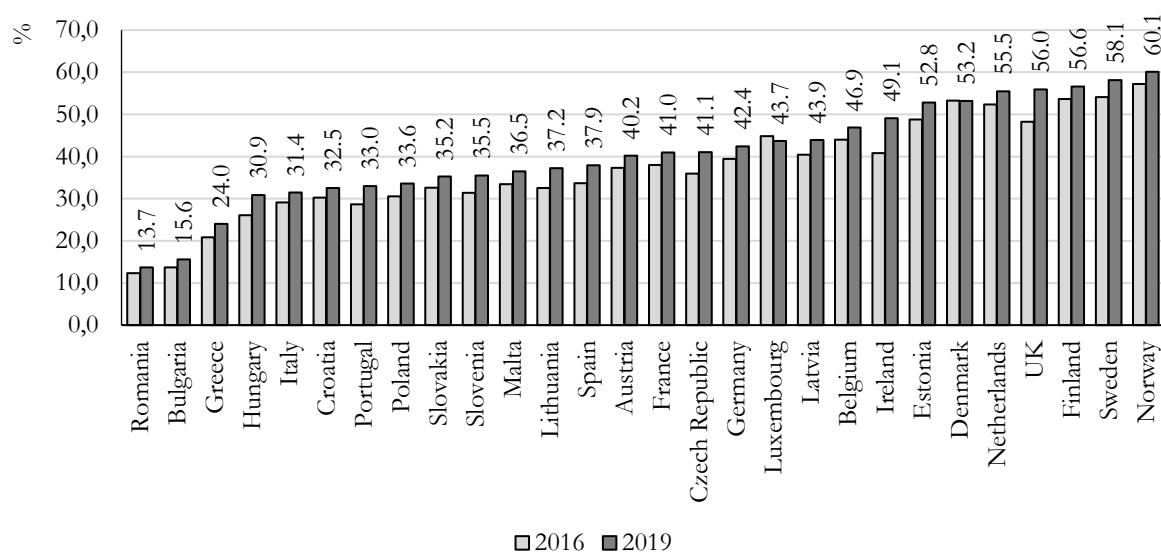
Figure 2. Results for calculation of DFSI in European countries, %
Source: own compilation.

The lowest digitalization level of financial services (13-15%) is in Romania and Bulgaria. Despite the positive dynamics, they lag far behind other European countries in the digitalization level of financial services.

Mathematically, the interval of possible values of the calculated integrated index of digitalization of financial services, expressed in fractions, is [0; 1] (or [0; 100] when expressed as a percentage). However, to establish scientifically sound limiting values for the index and qualitatively interpret the obtained results, it is necessary to define the minimum and maximum values of each component of the integrated index for the studied sample of countries and to adjust it by the magnitude of the average linear deviation towards the decrease or increase respectively for the minimum and maximum value (Table 5).

Table 5

Limiting values of the integrated index of digitalization of financial services

Indicators	ACC	DINC	IBANK	IFA	ECOM	EPAY	MOB	ALTF	DFSI
Minimum value of the sample ()	57.8	56.0	4.0	2.0	4.0	32.7	2.3	0.00	X
Maximum value of the sample ()	99.9	98.0	95.0	56.0	35.0	98.9	30.5	0.22	X
Average linear deviation ()	7.9	8.8	18.6	10.6	5.4	13.1	6.4	0.03	X
The lower limit)	49.9	47.8	0.0	0.0	0.0	19.6	0.0	0.00	7.06
The higher limit ()	100.0	100.0	100.0	68.3	41.2	100.0	36.9	0.25	68.23

Source: own calculation.

Thus, the values of the integrated index of digitalization of financial services are in the range of 7% to 68%. In order to give a qualitative interpretation of the results, we divide the obtained range [7, 68] into 4 equal intervals ([7; 22); [22; 37,5]; [37,5; 53]; [53; 68]). Extending the boundaries of extreme intervals to mathematically possible values (0% and 100%), we obtain the following gradation of financial services digitalization levels (Table 6).

Table 6

Qualitative interpretation of the DFSI values

	The range of values of the DFSI, %			
	[0; 22)	[22; 37.5)	[37.5; 53)	[53; 100]
Qualitative interpretation of digitalization of financial services	Critically low	Low	Medium	High

Source: own compilation.

Therefore, countries with a high digitalization level of financial services include six countries: all analyzed Scandinavian countries (Norway, Denmark, Finland, Sweden), the United Kingdom, and the Netherlands. The UK moved to the top countries with the highest digitalization level of financial services in 2019. One of the favorable factors for this is that the state policy is aimed to actively support FinTech innovation and digitalization. The smallest group is countries with a critically low digitalization level of financial services: Bulgaria and Romania. The sample of countries for analysis was made of European countries, most of which are highly economically developed and have a high digitalization level. Most countries have a medium digitalization level of financial services: Estonia, Ireland, Belgium, Latvia, Luxembourg, Germany, the Czech Republic, France, Austria, and Spain. The rest of the studied countries are described by low digitalization level of financial services.

We compared the obtained results from the Digital Financial Services Index calculation with other similar indexes, particularly the FinTech Adoption Index by Ernst & Young (Ernst & Young, 2019). The sample of countries is determined by the availability of data on the FinTech Adoption Index. The results are presented in Fig. 3.
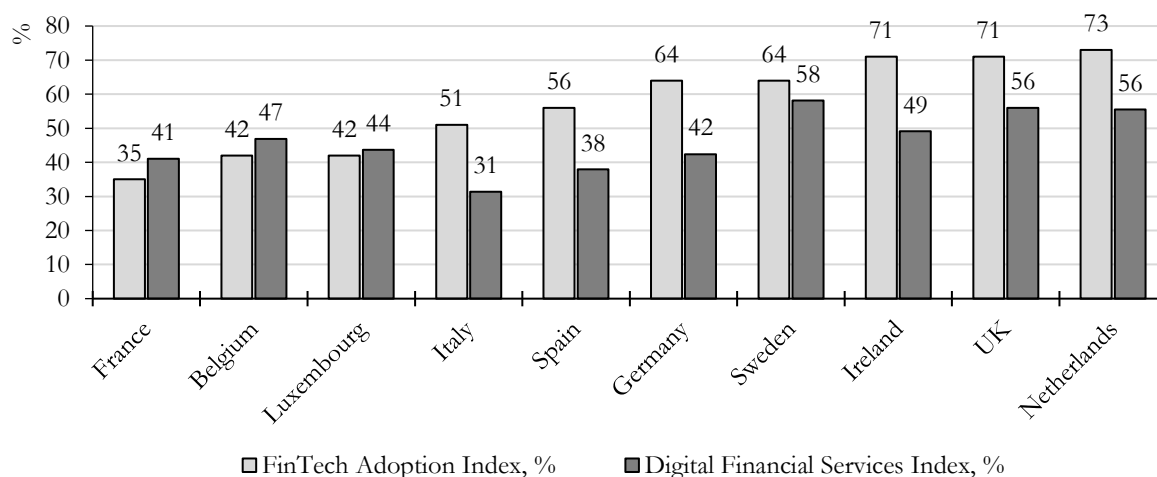

Figure 3. Digital Financial Services Index and FinTech Adoption Index in 2019
Source: own compilation.

According to Fig. 3, there are significant differences in the Digital Financial Services Index and FinTech Adoption Index results for European countries in 2019. In most of the analyzed countries, the FinTech Adoption Index is much higher than the digitalization level of financial services, except for France, Belgium, and Luxembourg. The high values of the FinTech Adoption Index indicate the growing

popularity of FinTech services in recent years and their use by a significant proportion of Internet users (according to the methodology of the index). At the same time, the digitalization level of various types of financial services and financial transactions has significant differences. It varies from a high level of electronic payments and online banking to relatively low values of e-commerce and digitalization of other types of financial services.

5. CONCLUSION

The paper proposes a method for calculating the integrated index of digitalization of financial services (DFSI) using the weighted sum method for eight indicators based on three components (financial inclusion, digital inclusion, and digital financial services). To give the qualitative interpretation of the integrated index, four ranges of its values are set with critically low, low, medium, or high digitalization level of financial services. During 2016-2019, the digitalization level of financial services had increased in most European countries. In 2019 the high digitalization level of financial services had been reached by six countries, including Norway, Denmark, Finland, Sweden, the UK, and the Netherlands. The countries where the digitalization of financial services is critically low are Bulgaria and Romania. The largest groups are countries with low and medium digitalization level of financial services. In particular, countries with a medium level of financial service technologization include ten countries: Estonia, Ireland, Belgium, Latvia, Luxembourg, Germany, the Czech Republic, France, Austria, and Spain. Countries with low digitalization levels of financial services also include ten countries: Greece, Hungary, Italy, Croatia, Portugal, Poland, Slovenia, Slovakia, Malta, and Lithuania. Financial market participants and national regulatory authorities can use the obtained results to develop measures to stimulate and oversee innovative technology implementation in financial activities.

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