

Financial Services Digitainability: Financial Inclusion and Efficiency in EU Countries

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Abstract: - Digitalization of financial services is one of the biggest challenges of the last decade, both in the EU and globally. The rapid development of digital technologies undoubtedly creates a favourable environment for significant progress in the financial sector, moreover, the Global Financial Crisis (GFC) and the pandemic have served as additional catalysts. However, several aspects on the way to financial services digitainability are still insufficiently explored. Considering the latest trends in the financial sector and advances in digital transformation, this study aims to identify the key drivers for the implementation of digital financial services and initiatives that managers should pursue to effectively transform business processes. The methodological base of the research consists of an extensive analysis of current publications in such areas as digital transformation, sustainable development, digital financial services, etc. The article investigates two aspects of financial sustainability: financial inclusion and operational efficiency of financial institutions, based on Eurostat data on financial services provided in the EU during 2011 - 2021, the Digital Economy and Society Index variables, and European Central Bank data on operational expenses. Correlation and regression analysis methods are used to study the relationships between variables under investigation, as well as statistical tests to acquire necessary evidence for statistical inferences about the proposed hypotheses.

The results of the study provide the possibility to judge current trends in the use of digital financial services in the EU countries, determine the main drivers of sustainable digital financial services, as well as to observe the benefits of digital transformation in the financial sector.

Key-Words: - digital financial services, digital transformation, financial services digitainability, financial inclusion, operational efficiency, EU countries

Received: February 12, 2023. Revised: June 10, 2023. Accepted: June 20, 2023. Published: June 30, 2023.

1 Introduction

Digital technologies have rapidly entered our lives and significantly influenced the way information is acquired, processed, and used, [1], [2], [3], [4], and [5]. This also applies to financial services, which have experienced drastic changes as the result of technological development, [6], [7], [8]. Digital technologies develop and transform products and services, change business processes, and cause the need not only to adapt but also to change the business model to successfully use the opportunities created by them. Financial transactions, without which the economic development of society is unthinkable, are of course no exception.

Increasing access to mobile money accounts and the use of digital payments can facilitate the path to a digital economy, which in turn opens additional opportunities for economic development. In this context, income-generating activities, access

to new markets, joining platforms, or simply obtaining important information such as market price trends, fluctuations, etc. for business decision-making should be noted.

Digitalization of financial services provides an opportunity to significantly increase the financial autonomy of citizens and organizations while improving the operational efficiency of these service providers. However, despite obvious progress, for example, individuals in the EU aged 16-74 who have used online banking increased during the last 10 years 61%, there are significant opportunities for growth, because in 2021 only 58.3% used such a financial service, [9]. Moreover, significant differences in the achieved development levels are evident between the EU countries and it is, therefore, necessary to assess the reasons.

Although the intensity of research in the field of digital transformation has significantly increased in recent years, however, as shown by publications,

[10], [11], [12], [13], [14], [15], financial sustainability activities are still insufficient to ensure the UN Sustainable Development Goal agenda, [16].

Considering the latest trends in the financial sector and advances in digital transformation, this study aims to identify the key drivers of digital financial services and initiatives that managers should pursue to effectively transform their operations for sustainability. This article investigates two aspects of financial sustainability: financial inclusion and operational efficiency of financial institutions, using the Digital Economy and Society Index (DESI) variables, [17].

2 Literature Review and Hypotheses Development

2.1 Defining Digital Transformation

The beginnings of digitization can be traced back to the 20th century, in the second half of the last decade, and it has shown particularly rapid reversals during the last decade, as evidenced by studies, [10], [18]. Researchers use different definitions to characterize activities related to digitalization and these are largely determined by the object and/or subject of the study.

Verhoef et al. identifies three stages of development in this area: digitization, digitalization, and digital transformation, [2]. Researchers define digitization as the transition from analog to digital form of information storage, [1], [18], and the additional channel of delivery, [19]. Digitalization is the next stage when digital technologies are applied to optimize business processes leading to improved process management, [18], creating value for the customer, and building customer loyalty by using data generated by the customers themselves, [20], [21], [22]. Digital transformation (DT) can be defined as a fundamental change process that affects the whole organization, its ways of doing business, [1], [18], [23] and the value creation process, [1].

The whole DT is a comprehensive process driven mainly by digital technologies and plays an important role in achieving the goals of organizations, institutions, or companies, as well as having an impact on a country's economy, society, and environment.

[5], defined DT as the continuously increasing interaction between technologies, business, and society, which results in transformational effects and changes in process velocity, scope, and impact,

[5]. They regarded DT as a vector, referring to a dynamic activity and direction itself as digital transformation.

DT in the financial sector is manifested by the broad and deep use of information and communication technologies (ICT) that significantly changes the way customers are attracted and retained, [20], [24], financial services are provided, [25], [26], [27], [28], [29], [30], [31], and customer value created, [32]. DT leads to fundamental changes in business processes, routines, and capabilities, and allows financial services providers to enter new markets, [8], [31], [33], [34]. At the same time, the risk structure of the financial services providers is also changing, [35], [36], [37], [38], [39]. A successful digital transformation allows one to gain competitive advantages and therefore can lead to successful performance in a hyper-competitive financial services environment, [40].

2.2 Digitainability in the Financial Sector

DT is considered one of the essential enablers of sustainable development, [10], [41], it contributes to the comprehensive progress of society by improving information and services, incl. access to education, [42], financial access, [43], [44]. DT is changing the business case for both investors and consumers, [45], the rapid digitization of the economy and the approach of digital business are driving the transition of traditional business models to networked and integrated digital platform business models, [12]. DT allows companies to foster innovation and entrepreneurship, [46], increase their market share, reduce energy waste, recover, and reuse material, [47].

DT plays an important role in achieving the United Nations Sustainable Development Goals (SDGs), [16]. In [48], authors investigated the relationship between digitalisation and SDGs, [48]. Research results show a positive impact of DT on five SDGs, focused on business. [49], indicated, that increasing access to digital technologies could help countries reduce their poverty rates, [49]. Without the DT of business and social processes, it is not possible to sustainably solve both economic and environmental problems in the future, [50], [51]. [52], propose a conceptual solution for how digital readiness, digital technologies, and digital business models could be sustainably linked to innovation governed by the DT process, [52].

The term 'digitainability' was introduced to highlight the interplay between digitalisation and sustainability, [46]. Digitalization and sustainability are two different dimensions, which are not always

completely independent. Only if both are perceived as priorities in management decisions, digitainability opportunities can be effectively realized.

Digitainability offers the opportunity to move beyond optimization and cost savings due to digitalization and sustainability initiatives, [46].

[53], explored the perspective on the development of sustainable banking publications over time and across academic categories, [53]. The researchers point to the gradual convergence of instrumental and ethical approaches to sustainable banking and emphasize the importance of both the public debate on the role of banks on the path to sustainability and the business rationale for banks choosing sustainable strategies.

[10], categorized the main gaps in SDGs research and indicates growing expectations of the added value that digitization brings to the achievement of the SDSs, [10]. The findings suggest that further multidisciplinary research, dialogue, and concerted transformational efforts are needed.

[29], investigated the linkage between financial literacy, digital literacy, and digital financial literacy and concluded that financial practitioners need to design online and offline educational resources to teach their clients how to access and use digital financial services, [29].

[54], analysed the interfaces between digital aspects and broader sustainability challenges for humanity, in the context of the UN's 2030 Sustainable Development Goals, [54]. The authors show how digital technologies have changed the way people communicate, learn, work, and interact and conclude that the sustainability of the use of digital technologies must be based on the value of equality, universal harmonious cooperation, and self-determination.

2.3 Financial Inclusion

Although financial inclusion is not directly included among the 17 goals proposed in the UN Agenda 2030 for Sustainable Development, [16], it is an essential basis for achieving several Sustainable Development Goals, [15], [16], [44], [48], [55].

Sha'ban et al. constructed a multidimensional financial inclusion index for a global sample of 95 countries and revealed overall progress over the period 2004-2015, [56]. Research results show a positive relationship between financial inclusion with GDP per capita, employment, bank competition, human development, government integrity, and internet usage.

[57], studied the relationship between the understanding of the use of Fintech innovations and financial inclusion. Research findings show that performance and effort expectancy has a significant relationship with the intention to use mobile money services.

[36], investigated the importance of digital financial inclusion, utilizing ICT techniques to promote sustainable growth via economic stability, [36]. Researchers argue that digital technology is currently being used to deliver financial services with reduced cost, thereby enhancing financial inclusion.

[58], researched the rationale for the development of digital payments in passenger transport, [58]. Using the multiple linear regression method, researchers determine the factors influencing digital payments in passenger transport and show that the level of digital payments depends on the degree of mobile device usage for accessing the internet on the move, as well as the level of financial inclusion provided.

[43], studied the impact of financial inclusion on the economic development of 27 EU countries in the period from 1995 to 2015 and obtained evidence that access to finance has a significant positive impact on economic growth, and the impact on economic output is more significant in low-income countries and new EU member states, [43].

[56], studied differences in financial inclusion across age groups and countries, [56]. The authors of the study identified challenges during the pandemic that increased the need for online access to financial services. The results of the study indicate the problems and the need for solutions to promote convergence and ensure the possibility of considering financial inclusion as a public good and an active tool for improving the quality of life.

Khan et al. investigated the impact of financial inclusion on financial sustainability and economic development in the G-20 countries, [59]. The study shows that in the long term, financial inclusion has a significant impact on financial efficiency, sustainability, and economic growth.

[60], investigated the relationship between financial inclusion and sustainable development. Research findings support calls for greater financial inclusion and faster achievement of Sustainable Development Goals, [60].

[61], analysed the effect of financial inclusion on economic growth, and banks' financial efficiency in high-, low-, and middle-income countries and conclude that financial inclusion has a positive impact on sustainable development in

each level of income group in the case of most the models, [61].

[44], point out that digital financial inclusion is essential to ensure everyone can access digital financial services and thus promote sustainable economic growth, [44].

[62], examined the determinants of financial inclusion and the impact of financial inclusion on poverty reduction and income inequality, based on a composite financial inclusion index, [62]. Research results support the role of financial inclusion in reducing income inequality in European countries.

2.4 DT and Operational Efficiency of Financial Institutions

[63], investigated the effect of ICT on the profits and risks of the EU banking industry. Research results reveal that ICT exerts a positive role in improving performance measures and that overall financial stability in the banking industry is enhanced by the intensive adoption of both ICT and FinTech, [63].

[64], tested how the rapid advancement of DT has impacted the price of financial services in Korea and got evidence that the long-term effect of the DT trend is negative - cost-saving for labour input, capital expenditure, and the total unit cost of financial intermediation. Researchers conclude that DT contributed to enhancing consumer benefit, mainly by achieving the operational efficiency of labour and capital, [64].

[65], studied DT of the Chinese banking industry, evaluated digital maturity and DT experience, and discovered that investments in digitalization have contributed to substantial production efficiency improvement for commercial banks, [65].

[66], analysed the effects that digitization has had on the financial performance of banks in Central and Eastern European Union countries during the 2010–2021 period. The obtained results show that an increase in the use of internet banking generated positive effects on the performance of banks, [66].

[67], investigated how innovation affects the relationship between the digitalisation of the company and its economic and financial performance. Research results allow us to conclude that it is not only important to digitalise the business processes to improve its performance, but that DT should also be aligned with a clear innovation strategy that allows for improving the company's performance, [67].

[68], analysed a sample of 122 Japanese banks from 2004 to 2018 and the investigations show that financial inclusion is a driver of profitability even in a developed economy, [68].

[69], constructed the dimensions of a DT capability that contains three hub factors - sensing, organizing, and restructuring. Study results demonstrate that strategic orientation has a positive impact on a DT capability and that DT capability has a positive impact on companies' operational performance, [69].

2.5 Drivers of Digital Transformation

[70], propose the methodology for the determination of the key drivers of digitalisation, which can provide the most dynamic GDP growth in the EU. Results of the research show that six aspects are significant for socioeconomic growth, e.g., broadband connectivity, digital skills, and e-business environment, [70].

[71], analysed the adoption of digital financial services by German households and got evidence that a household's level of trust and comfort with new technologies, financial literacy, and overall transparency impact its propensity to switch to a FinTech, [71].

[72], proposed five recommendations on how institutions can develop the strategies needed for DT and showed that DT should be a top management priority and a defining trait of corporate business strategy, [72].

[41], investigated the relationship between digitalization and sustainable development using the Digital Economy and Society Index (DESI). Researchers draw conclusions about the increase of convergence between the EU-28 countries in terms of the level of development of the digital economy and society, [41].

[73], indicated that the use of financial technology influences financial behaviour, and financial literacy, and the use of financial technology influences satisfaction in finance. Researchers also found that financial literacy and the use of financial technology were mediated by financial behaviour, [73].

[74], analysed the impact of human capital and digitization on the well-being of the general population, in eleven CEECs of the European Union. Researchers used Human Development Index as a proxy and showed that the digitization of the economy and the developed human capital will ultimately lead to an increase in the population's welfare, [74].

[75], examined the influence of DT in Europe using DESI and four socioeconomic indexes:

Social Progress Index, Corruption Perception Index, Global Innovation Index, and Doing Business. The study results show correlations and intensity between the variable considered, [75].

[76], investigated the digital competencies needed to develop a sustainable society. Research results highlight the importance of digital literacy and challenges related to DT which should be addressed to fight the digital divide and foster the widest possible social inclusion for the promotion of a sustainable society, [76].

[2], identify three external drivers of digital transformation: digital technology, digital competition, and digital customer behaviour. Researchers posit that DT requires specific organizational structures and metrics used to calibrate performance, [2].

[69], explored the relationship between a strategic orientation and organizational performance through digital competence at the organizational level. Researchers point out the importance of digital competence for successful DT and that digital competence can ultimately achieve value delivery through the improvement of enterprise organizational performance, [69].

[77], investigated the impact of DESI dimensions on SGDI by using panel regression modelling and exhibit that DESI sub-dimensions influence SGDI differently - connectivity, human capital, and the use of internet services have a larger impact on SGDI compared to the integration of digital technology and digital public services, [77].

[78], examined the factors that influence the adoption of digital financial transactions (DFTs) and identify fifteen factors that motivate the adoption of DFTs as well as five inhibitors to adoption. Researchers conclude that cost of use, perceived danger, complexity, unwillingness to change, and privacy concerns are major challenges to DFT adoption, [78].

[79], examined factors that affected the adoption of mobile finance and discovered that performance expectancy, effort expectancy, social influence, facilitating conditions, trust, and perceived risk affect the intention to use mobile finance, [79].

[80], investigated whether methodological changes to the structure of DESI improve its ability to capture the DT of EU economies. Results show that connectivity is the dimension with the largest impact on DT in the EU countries, [80].

[81], revealed that the use of digital payment tools and platforms is associated with higher digital literacy, at all levels of financial literacy, and more

informed personal finance choices, instead, are associated with higher financial literacy, at all levels of digital literacy. Researcher suggests that digital and financial literacy should be considered together when assessing the implication of digitalization for individual investors, [81].

[5], believe that the drivers of DT should be classified into 23 'DT interactions' across six categories and can help to better understand how the changes unfold and how influence each other, [5].

Based on the literature review the following hypothesis was developed:

- H1. There is significant progress in online banking intensity in EU countries during the last ten years.
- H2: There is a relationship between online banking intensity and the use of other financial services.
- H3. There is a positive relationship between online banking intensity and human capital development in EU countries.
- H4. There is a positive relationship between online banking intensity and connectivity in EU countries.
- H5. There is a positive relationship between online banking intensity and the integration of digital technologies in EU countries.
- H6. There is a positive relationship between online banking intensity and digital public services development in EU countries.
- H7. There is a positive relationship between online banking intensity and the operational efficiency of financial institutions in EU countries.

3 Data and Methods

3.1 Online Banking Intensity Dynamic

To answer the questions that arose during the research and justify the conclusions about the proposed hypotheses, the author collected data from four main sources: the Eurostat data, [82], for online banking intensity, the World Bank [83], for financial services intensity, DESI Database, [9], for DESI indicators and the European Central Bank Consolidated Banking Database, [84], for the financial institutions' expenses:

- individuals 15+ have used online banking (OBI),
- account owners 15+ intensity (ACC),
- made digital payments 15+ intensity (MDP),

- received digital payments 15+ intensity (RDP),
- savings at financial institutions 15+ intensity (SAF),
- borrowed any money 15+ intensity (BOR),
- human capital development index (HCD),
- connectivity index (CON),
- digital public services development index (DPS),
- integration of digital technologies index (IDT),
- total costs, % of assets, in the EU banking sector (TOC),
- staff costs, % of assets, in the EU banking sector (STC).

The data were collected for 27 European Union countries for the years 2011, 2016, 2019, and 2021. The online banking intensity dynamic 2011 – 2021 is presented in Figure 1.

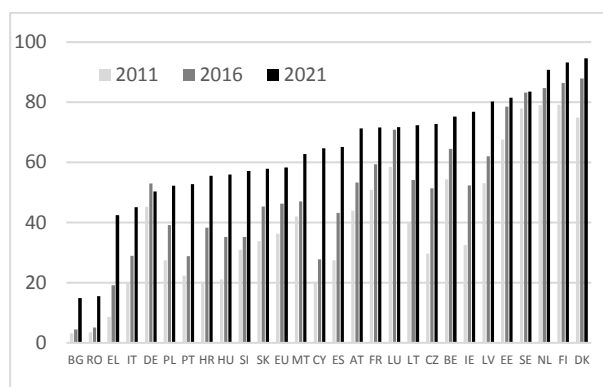


Fig. 1: Online banking intensity dynamic 2011 - 2021

Source: Calculated by the author based on Eurostat data

To assess the dynamics of online banking intensity the author uses a chi-squared test and the test statistic is calculated as follows:

$$\chi^2 = \sum_{i=1}^k \frac{(O_i - E_i)^2}{E_i} \quad (1)$$

were O_i – observed (2021) online banking intensity in i -th country,

E_i – expected (2011, 2016, or 2019 accordingly) online banking intensity in i -th country.

3.2 Online Banking Intensity Relationship with other Financial Services Intensities in EU Countries

To evaluate the relationship between the intensity of online banking and other financial services intensities in the EU countries, we used Pearson's correlation analysis and the results obtained with the RStudio function `cor.test`, [85].

In addition, we use regression analysis to estimate the quantitative impact of changes in online

banking intensity on other financial services intensity, as follows:

$$ACC = \beta_{0.1} + \beta_{1.1}OBI + \varepsilon_1 \quad (2)$$

$$MDP = \beta_{0.2} + \beta_{1.2}OBI + \varepsilon_2 \quad (3)$$

$$RDP = \beta_{0.3} + \beta_{1.3}OBI + \varepsilon_3 \quad (4)$$

$$SAF = \beta_{0.4} + \beta_{1.4}OBI + \varepsilon_4 \quad (5)$$

3.3 Online Banking Intensity Relationship with key DESI Indicators

To evaluate the relationship between the intensity of online and the DESI key indicators in EU countries, we use regression analysis and equations as follows:

$$OBI = f(x_{HCD}, x_{CON}, x_{DPS}, x_{IDT}) + \varepsilon_i \quad (6)$$

were OBI – online banking usage intensity by individuals in the EU countries,

x_{HCD} – human capital development level in the EU countries,

x_{CON} – Internet connectivity in the EU countries,

x_{DPS} – digital public services development in the EU countries,

x_{HCD} – integration of digital technologies in the EU countries.

3.4 Online Banking Intensity Relationships with the Operational Efficiency of Financial Institutions

To evaluate the relationship between the intensity of digital payments and the operational efficiency of financial institutions in the EU countries, regression analysis was used. To test the proposed hypothesis, four regression equations were drawn up:

$$TOC(OBI) = \beta_{0.5} + \beta_{1.5}OBI + \varepsilon_5 \quad (7)$$

$$STC(OBI) = \beta_{0.6} + \beta_{1.6}OBI + \varepsilon_6 \quad (8)$$

were $TOC(OBI)$ – total costs (% of assets) depending on online banking intensity,

$STC(OBI)$ – staff costs (% of assets) depending on online banking intensity,

$\beta_{0.5}, \beta_{0.6}$ – intercepts of the respective regression model,

$\beta_{1.5}, \beta_{1.6}$ – regression coefficients of the respective regression model,

$\varepsilon_5, \varepsilon_6$ – error terms of the respective regression model.

The regression model's calibration and evaluation results were obtained with the RStudio, [85].

4 Research Results and Discussion

4.1 Online Banking Intensity Dynamic

In the EU in 2021, the intensity of online banking usage was the highest in Denmark - 95% of the population aged 15+ have used online banking -, followed by Finland (93%), the Netherlands (91%), Sweden (84%) and Estonia (82%). The indicators of other Baltic countries Latvia (80%) and Lithuania (72%) are also above average in European Union (58%).

The fastest growth in usage of online banking over the last ten years has been in Bulgaria, Greece, Romania, Cyprus, and Croatia, which is largely explained by the low intensity of digital payments in 2011. Among the Baltic States, the fastest growth in 2021 compared to 2011 was in Lithuania, followed by Latvia and Estonia (see Table 1).

Table 2 summarizes the results of the chi-squared test about online banking intensity differences in the research period.

Table 1. Online banking intensity and growth (+%) in EU countries

Country	2021	2021 vs 2011	2021 vs 2016	2021 vs 2019
Austria	71	61	34	13
Belgium	75	39	17	6
Bulgaria	15	400	275	67
Croatia	56	180	47	22
Cyprus	65	225	132	59
Czechia	73	143	43	7
Denmark	95	27	8	4
Estonia	82	21	4	1
EU	58	61	26	5
Finland	93	18	8	2
France	72	41	22	9
Germany	50	11	-6	-18
Greece	42	367	121	35
Hungary	56	167	60	19
Ireland	77	133	48	15
Italy	45	125	55	25
Latvia	80	51	29	11
Lithuania	72	80	33	11
Luxemburg	72	22	1	1
Malta	63	50	34	17
Netherlands	91	15	7	0
Poland	52	93	33	11
Portugal	53	141	83	26
Romania	15	275	200	88
Slovakia	58	71	29	5
Slovenia	57	84	63	21
Spain	65	141	51	18
Sweden	84	8	1	0

Source: Calculated by the author based on Eurostat data

Table 2. Chi-squared test statistics for online banking intensity dynamic

Years	Chi-square stat	p-value
2021 vs 2011	847.3245	<0.001
2021 vs 2016	246.0149	<0.001
2021 vs 2019	50.9297	0.0035

Source: Calculated by the author based on Eurostat data

As can be seen from the data in Table 2, for online banking intensity dynamic chi-squared statistics are larger than chi-squared critical values (38.89) for all three comparable periods and therefore we can conclude that the increase in online banking intensity comparing 2021 with 2011, 2016 and 2019 was statistically significant at a confidence level higher than 95%. This conclusion is confirmed by the p-values, which are summarized in Table 2.

Chi-squared test results provide evidence for confirming the first hypothesis.

4.2 Online Banking Intensity Relationships with other Financial Services Intensities in the EU Countries

The following Table 3 summarizes the results of the correlation analysis between online banking intensity and other financial services intensities in the EU.

Table 3. Pearson correlations test statistics

Indicator	r	t-stat	p-value	LCI95%	UCI95%
Account owners	0.7336	9.411	<0.001	0.6108	0.8220
Digital paym. made	0.8206	12.520	<0.001	0.7317	0.8821
Digital paym. received	0.7802	10.873	<0.001	0.6748	0.8544
Savings at FI	0.7967	11.491	<0.001	0.6979	0.8657
Borrowings	0.3031	2.7726	0.0070	0.0864	0.4924

Source: Calculated by the author based on Eurostat and World Bank data

Since the tests of correlation coefficients substantiate the statistical significance of the relationship between the intensity of online banking and other financial services intensity identifiers, the author draws the conclusion that with increased opportunities to use online banking, the proportion of account owners in the population group 15+, the intensity of made and received digital payments and savings at financial institutions increases. On the other hand, the relationships between the intensity of online banking and borrowings are weak.

The following Table 4. summarizes the results of regression analysis between online banking

intensity and other financial services intensities in the EU.

Table 4. Online banking regression with other financial services model's statistics

Variable	R ²	AdjR ²	Std.Err	F-stat	p-value
Account owners	0.5382	0.5321	6.7996	88.57	<0.001
Digital paym. made	0.6735	0.6692	10.580	156.75	<0.001
Digital paym. received	0.6087	0.6035	8.1749	118.21	<0.001
Savings at FI	0.6347	0.6299	10.2020	132.05	<0.001
Borrowings	0.0919	0.0799	9.8387	7.687	0.007

Source: Calculated by the author based on Eurostat and World Bank data

Calculated regression models' statistics justify the conclusions that with changes in online banking intensity, one can explain 53.2% of changes in proportions of account owners, 66.9% of changes in made digital payments intensity, 60.4% of changes in received digital payments intensity, 63.0% of changes in savings at financial institutions intensity and only 9.2% of changes in borrowings.

From calculated regression coefficients estimates, see Table 5, one can conclude that when online banking intensity increases by one percent, account owners' intensity increases on average by 0.31% (95% confidence interval 0.24 – 0.37%), made digital payments intensity increases on average by 0.64% (0.53 – 0.74%), received digital payments intensity increases on average by 0.43% (0.35 – 0.50%), savings at financial institutions intensity increases on average by 0.56% (0.47 – 0.66%), and borrowings intensity increases on average by 0.13% (0.04 – 0.23%).

Table 5. Online banking regression with financial services coefficients statistics

Variable	Estimate	Std.Err	t-stat	p-value
Account owners	0.3071	0.0326	9.4112	<0.001
Digital payments made	0.6357	0.0508	12.5198	<0.001
Digital payments received	0.4266	0.0392	10.8726	<0.001
Savings at FI	0.5627	0.0490	11.4912	<0.001
Borrowings	0.1309	0.0472	2.7726	0.007

Source: Calculated by the author based on Eurostat and World Bank data

Regression analysis results provide some evidence for confirming the second hypothesis with one exception - relationships between online banking intensity and borrowings intensity are weak.

4.3 Online Banking Intensity Relationship with DESI Key Indicators

The following Table 6 summarizes the results of regression analysis between DESI key indicators and online banking intensity in the EU.

Table 6. DESI key indicators regression with online banking models statistics

Variable	R ²	AdjR ²	Std.Err	F-stat	p-value
HCD	0.7243	0.7217	11.2203	278.481	<0.001
CON	0.2184	0.2110	18.8921	29.620	<0.001
DPS	0.6340	0.6305	12.9281	183.609	<0.001
IDT	0.5438	0.5395	14.4327	126.376	<0.001

Source: Calculated by the author based on Eurostat and World Bank data

Calculated regression models' statistics justify the conclusions that with changes in the human capital development index, one can explain 72.2% of changes in online banking intensity, with changes in the connectivity index one can explain 21.1% of changes in online banking intensity, with changes in digital public services development index one can explain 63.1% of changes in online banking intensity, and with changes in the integration of digital technologies index, one can explain 54.0% of changes in online banking intensity.

The following table summarizes the results of regression coefficients statistics between DESI key indicators and online banking intensity in the EU.

Table 7. DESI key indicators regression with online banking coefficients statistics

Model	Variable	Estimate	Std.Err	t-stat	p-value
OBI (HCD)	Intercept	-32.4116	5.5968	-5.7911	<0.001
	HCD	1.9328	0.1158	16.6878	<0.001
OBI (CON)	Intercept	14.5669	8.4056	1.7330	0.0860
	CON	1.0567	0.1942	5.4425	<0.001
OBI (DPS)	Intercept	-5.1155	4.9090	-1.0421	0.2998
	DPS	1.0456	0.0772	13.5502	<0.001
OBI (IDT)	Intercept	4.5491	5.0586	0.8993	0.3705
	IDT	1.5834	0.1408	11.2417	<0.001

Source: Calculated by the author based on Eurostat and World Bank data

From calculated regression coefficients estimates, see Table 7, one can conclude that when the human capital development index increases by one unit, online banking intensity increase on average by 1.93% (95 & confidence interval 1.70 – 2.16%), when the connectivity index increases by one-unit, online banking intensity increases on average by 1.06% (0.67 – 1.44%), when digital public services development index increases by one-unit, online banking intensity increases on average by 1.05% (0.89 – 1.20%), and when integration of digital technologies index increases by one-unit, online

banking intensity increases on average by 1.58% (1.30 – 1.86%).

Regression analysis results provide evidence for confirming the third, fourth, fifth, and sixth hypotheses.

Figure 2 shows the regression between the human capital development index and online banking intensity in the EU.

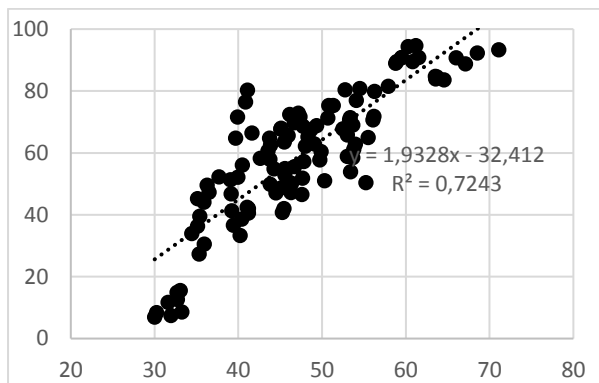


Fig. 2: Human capital development index regression with online banking intensity in the EU
 Source: Calculated by the author based on Eurostat data

Figure 3 shows the regression between the connectivity index and online banking intensity in the EU.

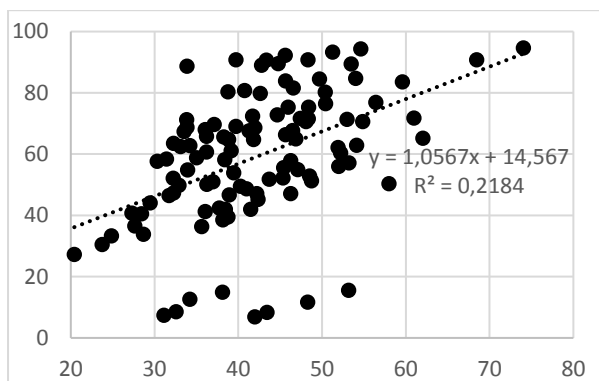


Fig. 3: Connectivity index regression with online banking intensity in the EU
 Source: Calculated by the author based on Eurostat data

Figure 4 shows the regression between the digital public services index and online banking intensity in the EU.

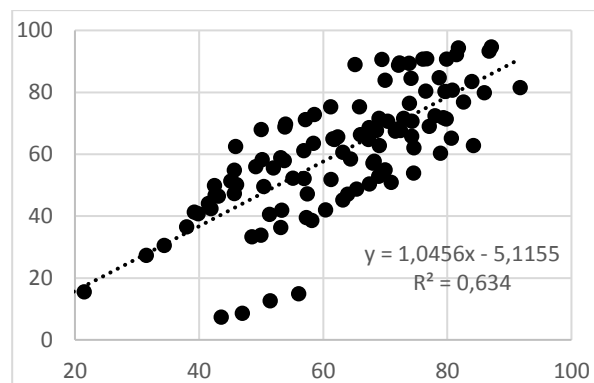


Fig. 4: Digital public services index regression with online banking intensity in the EU
 Source: Calculated by the author based on Eurostat data

Figure 5 shows the regression between the digital technologies index and online banking intensity in the EU.

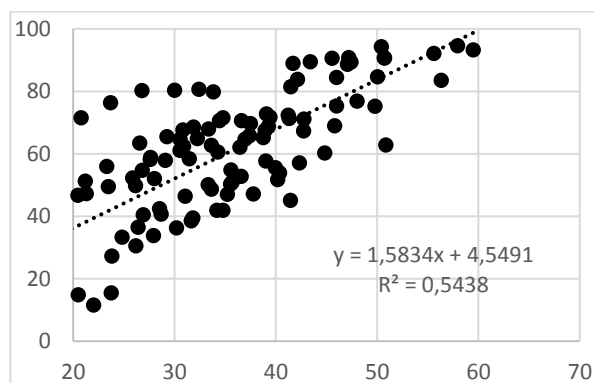


Fig. 5: Digital technologies index regression with online banking intensity in the EU
 Source: Calculated by the author based on Eurostat data

4.4 Online Banking Intensity Relationships with Banking Sector Expenses in the EU Countries

The following Table 8 summarizes the results of regression analysis between banks' expenses and online banking intensity in the EU.

Table 8. Online banking regression with banks' expenses models statistics

Model	R ²	AdjR ²	Std.Err	F-stat	p-value
TOC(OBI)	0.4989	0.4892	0.3214	51.7666	<0.001
STC(OBI)	0.4996	0.4900	0.1465	51.9204	<0.001

Source: Calculated by the author based on Eurostat and ECB data

Calculated regression models' statistics justify the conclusion that both models are statistically significant at a confidence level <0.01.

Table 9. Online banking regression with banks' expenses coefficients statistics

Model	Variable	Estimate	Std.Err	t-stat	p-value
TOC (OBI)	Intercept	2.2753	0.1224	18.5942	<0.001
	OBI	-0.0142	0.0020	-7.1949	<0.001
STC (OBI)	Intercept	1.1147	0.0558	19.9911	<0.001
	OBI	-0.0065	0.0009	-7.2056	<0.001

Source: Calculated by the author based on Eurostat and ECB data

All estimated regression coefficients are statistically significant at level <1%, see Table 9. The results obtained allow us to conclude that there is a negative relationship between online banking intensity and the operational efficiency of financial institutions – when the intensity of online banking increases, both banks' total costs to assets and staff costs to assets decrease. With changes in online banking intensity regression models can explain ca. 49% of both changes in banks' total costs to assets and in banks staff to assets in the EU countries. More, when online banking intensity increases by one percent, banks' total costs to assets on average decrease by 0.0142% to assets (95% confidence interval from -0.0181% to -0.0101%), and banks' staff costs to assets on average decreases by 0.0065% to assets (from -0.0083% to -0.0047% respectively).

Regression analysis results provide evidence for confirming the seventh hypothesis.

The Figure 6 shows a regression between banks' total expenses and online banking intensity in the EU.

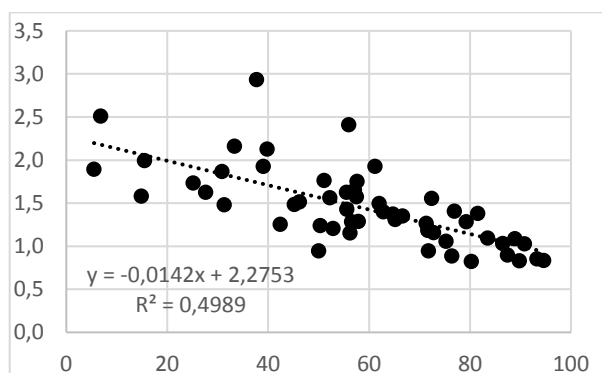


Fig. 6: Banks' total expenses regression with online banking intensity in the EU.

Source: Calculated by the author based on Eurostat and ECB data

Figure 7 shows the regression between banks' staff expenses and online banking intensity in the EU.

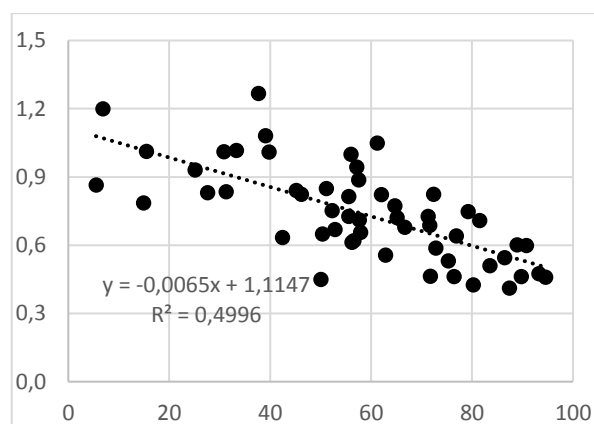


Fig. 7: Banks' staff expenses regression with online banking intensity in the EU.

Source: Calculated by the author based on Eurostat and ECB data

5 Discussions

Providing sustainable financial services to individuals, companies and organizations, and society, in general, is one of the great challenges of the first quarter of the 21st century, [15], [53]. As research shows, the development and successful implementation of digital technologies is one of the essential factors for ensuring sustainability, [2], [5], [6], [8], [13], [18], [24], [31], [48], which creates an opportunity to provide customers with more friendly access to financial services, [26], [28], to reduce service costs, [69], and to create additional added value for customers, [22], [32]. Therefore, the digitalization of financial services promotes financial inclusion, [34], [49], [57], [58], [62]. On the other hand, as research shows, financial inclusion is a factor contributing to the profitability of financial service providers, [68], and one of the driving forces of economic development, [43], [61], thus contributing to the sustainable development of society, [44], [60].

However, it should be remembered that digital transformation is always a complex set of measures, so it is important to be aware of possible obstacles and barriers, [7], [72] as well as risks on the way to sustainable digital financial services, [36], [38].

Sustainability and digitization are two related, yet different concepts, so their in-depth understanding and awareness of each of their advantages and their interaction, as well as successful integration, can create additional benefits in the way of implementation of sustainable digital financial services, [10], [15], [46], [50], [52], [76].

6 Conclusions

Technological development creates opportunities to radically change both financial services and delivery channels, as well as business models and processes in the classic financial sector, opportunities for new business directions and companies. However, the effective use of these opportunities is associated with many limitations, including economic and financial ones, public sector and industry readiness levels, individuals' digital financial literacy, society's attitude, etc.

Global shocks, such as the GFC and the pandemic, as experience shows, can create additional incentives for the faster development and implementation of advanced technologies and thus contribute to the achievement of UN Sustainability goals.

To make use of limited resources as effectively as possible, it is necessary to evaluate and prioritize the factors affecting the process and prepare and implement appropriate programs. In this context, it is important to be aware of the widest possible range of studies and their main conclusions, because one study will never provide exhaustive answers to all important questions:

- digitization and sustainability are two important aspects, both in the context of the individual, companies, and organizations and the entire society, whose adequate perception and inclusion in development programs can ensure a maximum effect in the long term.
- a wide range of solutions and positive experience stories are available, which can help to successfully continue progress in the development and implementation of digital financial services.
- as a result of technology development, opportunities have opened for new promising business directions, incl. FinTech, and thus the increased competition, has contributed to the sustainable transformation of the financial sector.
- digital solutions make it possible to successfully solve financial inclusion issues both in developed countries and especially in countries with a low level of economic development and thus to develop the national economy relatively faster.
- studies have also highlighted several risks associated with digital transformation, thus providing an opportunity to learn from mistakes and avoid potential losses.

The main conclusions of this study are:

- during the last decade, significant progress has been achieved in the development and implementation of digital financial services in most EU countries.
- financial services are largely interconnected and in a developed society there is a demand for a wide range of them, which opens the opportunity for service providers to benefit from cross-sales and volume.
- it is important to be aware of the needs and habits of customer groups and individuals so that the offer of financial services and delivery channels meet customer needs and preferences.
- at the current stage of development, the most important factor affecting the intensity of digital financial services in the EU is human capital development, followed by the integration of digital technologies. Consequently, responsible institutions should prioritize the relevant measures to more effectively deal with the implementation of sustainable digital services more.
- digitization is associated with significant investments, but by successfully and far-sighted solving the challenges of DT, financial services companies could reduce their relative operational costs, both total and staff expenses.

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Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

The author contributed to the present research, at all stages from the formulation of the problem to the final findings and solution.

Conflict of Interest

The author warrants that this study is his original work and has not been submitted to any other journal for publication purposes.

Sources of Funding for Research Presented in a Scientific Article or Scientific Article Itself

The study did not get financial support from any agency or organization.

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