A Knowledge Discovery in Databases Approach to Analyse Digital Financial Activities in the European Union Countries

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Abstract

The digital transformation of the financial sector is reshaping how residents of European Union countries use financial services. This paper examines online financial activities using knowledge discovery in databases methods, with particular emphasis on Internet banking and online financial services. The analysis is based on Eurostat data and employs cluster analysis and regression analysis to identify behavioural patterns and cross-country differences among European states. The findings reveal substantial disparities across European Union countries. More digitally advanced countries record higher levels of use of online financial services, whereas others continue to progress at a slower pace. The analysis confirms the pivotal role of modern information and communication technologies in developing innovative digital financial solutions. The conclusions highlight digital literacy, user trust and the regulatory framework as key determinants of the continued development of financial services in the European Union.

Keywords: digital financial services; Internet banking; knowledge discovery in databases; information and communication technologies

Type of paper: Research article

Received: 30 Jan, 2026
Accepted: 26 Mar, 2026

DOI: 10.2478/crdj-2026-0002

Introduction

The accelerated digital transformation of the financial sector is significantly changing the way financial activities are conducted via the Internet. The development of Internet banking, digital investment platforms, and other online financial services is affecting user behaviour, the business models of financial institutions, and regulatory frameworks. Despite the relatively high level of digital literacy in the European Union, substantial differences remain among Member States in the adoption and use of online financial services, indicating the need for a systematic and empirically grounded analysis of these patterns.

Previous studies have largely focused either on specific aspects of financial sector digitalisation or on limited datasets, whereas comprehensive analyses of online financial activities at the European Union level remain relatively rare. In particular, the application of knowledge discovery in databases methods to identify patterns of digital financial behaviour and cross-country differences in the use of online financial services has been insufficiently explored. Accordingly, this study aims to analyse the online financial activities of residents of European Union countries through the application of knowledge discovery in databases methods. The analysis is based on official Eurostat data and employs cluster analysis and regression analysis to segment countries according to the intensity and type of use of online financial services and to determine the relationship between different forms of online financial activity and the use of Internet banking. The study covers the period from 2020 to 2024 to identify trends in the digital transformation of financial activities.

The dataset consists of the following variables:

- [I_BFIN_IN1] Online purchases (in the last 3 months): purchase of insurance policies, including travel insurance, as well as purchases bundled with other services, such as airline tickets;
- [I_BFIN_CR1] Online purchases (in the last 3 months): arranging loans, mortgage loans or other forms of borrowing through banks or other financial institutions;
- [I_BFIN_SH1] Online purchases (in the last 3 months): purchase or sale of shares, bonds, units in investment funds, or other financial assets;
- [I_BFIN2] Online purchases (in the last 3 months): carrying out at least one of the financial activities (I_BFIN_SH1, I_BFIN_IN1, I_BFIN_CR1).

This paper provides empirically grounded insights into patterns of digital financial behaviour within the European Union and contributes to the literature by linking financial digitalisation with knowledge discovery in databases methods. The findings may serve as a basis for understanding the challenges and opportunities associated with the further development of online financial services and for shaping policies aimed at balanced digital development within the financial sector.

The paper is organised into five sections. Following the Introduction, the next section outlines the research area. The third section describes the data and the applied knowledge discovery in databases methods. The fourth section presents the empirical

results. The final section offers the conclusion, highlighting the principal findings, the limitations of the study and recommendations for future research.

Field of Research

The digital age is characterised by the rapid development of Internet technologies, which have significantly improved the accessibility and efficiency of business transactions and communication. The process of digitalisation, present for almost two decades, intensified further during the Covid-19 pandemic, when online platforms became a key channel for accessing financial services. In this transformation, the banking sector benefited from a comparative advantage owing to its earlier investment in digital technologies (Gang Peng, Peng, Zhu, 2024). Banks increasingly use Internet banking to reduce operating costs, rationalise branch networks and attract new clients (Claessens et al., 2002). The development of intuitive websites and mobile applications has enabled simple and direct access to banking services, thereby further encouraging users' financial activity (Samar, Yasin, Alnaser, 2017; Brun et al., 2017). Nwoke (2024) defines the digital transformation of financial services as the integration of information and communication technologies, such as artificial intelligence, machine learning, and blockchain, aimed at increasing operational efficiency, service accessibility, financial literacy, and financial inclusion.

Growing demand for Internet and mobile banking is associated with time savings, lower transaction costs, and the convenience of making financial decisions from home (Michelangeli & Viviano, 2024). Digital channels have improved the accessibility of banking services, increased flexibility for users and reduced pressure on bank staff. The introduction of these forms of banking, which depart from traditional business models, has triggered disruptive processes and structural changes in the banking sector (Vyas, 2012).

Internet and mobile banking constitute the foundation of digital banking, which continues to evolve through the application of advanced information and communication technologies such as cloud computing and big data analytics (Vyas, 2012; Bhat, AlQahtani, Nekovee, 2023). Cloud computing has enabled banks to manage data more efficiently, improve operational flexibility, and reduce IT infrastructure costs through cooperation with external service providers (Cheng et al., 2022). The banking sector also makes extensive use of artificial intelligence, machine learning, and chatbots to automate processes, enhance data analysis, and strengthen operational security. Artificial intelligence, defined as the capacity of a system to learn and adapt to new circumstances (Haenlein & Kaplan, 2019), has become a key investment priority for banks (Lazo, Ebardo, 2023). Artificial intelligence and machine learning facilitate service personalisation, advanced analysis of user behaviour, and more precise assessment of credit and fraud risk, thereby simultaneously increasing security and strengthening user trust (Nwoke, 2024). In addition, blockchain technology enables decentralised, transparent, and secure transaction recording, reducing dependence on centralised systems and increasing resilience to fraud (Budisteanu, 2025). It also

supports the development of innovative solutions in payments, asset management, and smart contracts.

The development of advanced information and communication technologies has created the conditions for the emergence of neobanks—financial institutions operating exclusively in the digital environment. Their business model is based on the absence of physical branches, lower operating costs, and a strong focus on customer experience, which makes them particularly attractive to younger generations (Janamolla, 2024; Sharma, 2024). Nevertheless, traditional banks continue to maintain a dominant market position owing to regulatory stability, long-established client trust, and economies of scale (Citterio et al., 2025). The most plausible future trajectory of banking is the establishment of a hybrid model combining the advantages of digital and traditional banks (Sharma, 2024).

The adoption of Internet banking depends on a range of factors. Santouridis and Kyritsi (2014) identify perceived usefulness, ease of use, trust in the system, user innovativeness, and satisfaction with ATMs as key determinants of adoption. The availability and quality of digital channels further increase user engagement and bank profitability (Thuranire et al., 2024), while education and customer support play an important role in the transition from traditional to digital channels (Kaur et al., 2021). Within the European Union, readiness to adopt digital financial services is strongly associated with perceptions of security, data protection, and the regulatory framework, with younger age groups demonstrating higher levels of adoption (Polasik & Kotkowski, 2022).

Digital transformation has increased the efficiency of financial services, but it has also heightened exposure to cyber threats. The most common risks in online banking include social engineering, malicious software, and security vulnerabilities in systems, which makes an integrated approach to security essential, encompassing technical, organisational, and educational solutions (Oyewole et al., 2024). The expansion of digital channels further increases the risk of incidents such as data breaches, thereby necessitating continuous monitoring and standardised incident-response plans (Shehab et al., 2024).

Digitally oriented business models respond more effectively to the needs of contemporary users, and digital transformation generates measurable financial effects (Nwoke, 2024). At the same time, the expansion of online financial services also has a broader social impact through the enhancement of financial literacy and financial inclusion, particularly in countries with limited access to traditional banking services. The development of Internet-based financial services results from a dynamic interaction between technology, the market, and regulation (Nourallah, Ohman, Hamati, 2024). Both theoretical and empirical findings confirm that digital transformation, driven by technologies such as artificial intelligence and blockchain, represents a long-term and fundamental driver of change in the financial sector (Nwoke, 2024).

Research Framework

The research framework of this paper consists of two parts. The first part presents the collected data for 34 European countries relating to financial activities carried out via the Internet. The data collection period spans from 2020 to 2024. The second part comprises the statistical analysis, including cluster analysis and regression analysis.

Data

The analysis is based on data obtained from the statistical database of the European Union, Eurostat, specifically the section entitled "Financial activities over the Internet (2020 onwards)". The study examines citizens' online financial activities in the period from 2020 to 2024 for selected European countries. The data are structured by country, thereby enabling comparative cross-country analysis.
The original dataset includes 27 European Union Member States and 11 European countries outside the EU. The following countries were included in the broader dataset: Belgium, Bulgaria, Czechia, Denmark, Germany, Estonia, Ireland, Greece, Spain, France, Croatia, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, the Netherlands, Austria, Poland, Portugal, Romania, Slovenia, Slovakia, Finland and Sweden, as well as Iceland, Norway, Switzerland, the United Kingdom, Bosnia and Herzegovina, Montenegro, North Macedonia, Albania, Serbia, Turkey and Kosovo. Owing to missing data for some observed periods, the following countries were excluded from the analysis: Iceland, Switzerland, the United Kingdom and Kosovo. The final sample, therefore, comprises 34 countries. Data for France are unavailable for 2020 and are therefore excluded from the cluster analysis for the 2020–2024 change period.

The analysis considers four financial activities carried out over the Internet:

- [I_BFIN_IN1] Online purchases (in the last 3 months): purchase of insurance policies, including travel insurance, as well as purchases bundled with other services, such as airline tickets;
- [I_BFIN_CR1] Online purchases (in the last 3 months): arranging loans, mortgage loans or other forms of borrowing through banks or other financial institutions;
- [I_BFIN_SH1] Online purchases (in the last 3 months): purchase or sale of shares, bonds, units in investment funds, or other financial assets;
- [I_BFIN2] Online purchases (in the last 3 months): carrying out at least one of the financial activities (I_BFIN_SH1, I_BFIN_IN1, I_BFIN_CR1).

The data were collected from Eurostat and subsequently subjected to cleaning, formatting, and transformation procedures in order to make them suitable for input and processing in the Weka software environment. In the final dataset, 34 unique values representing individual countries were defined, with all analysed attributes associated with them.

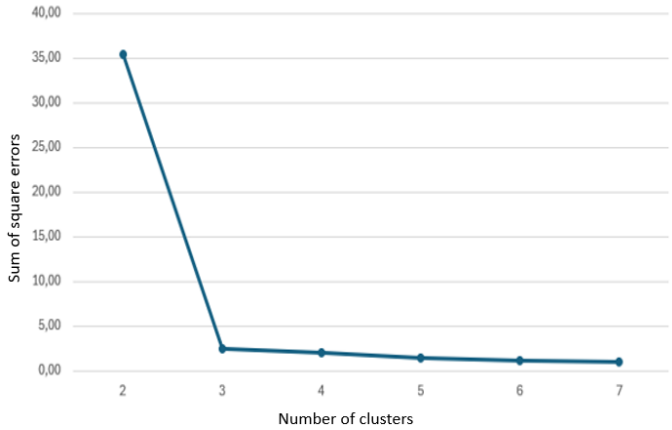
Research Methodology

Two data-mining methods were applied in this study: k-means clustering and regression analysis. The k-means method was used to group the data into mutually similar, homogeneous clusters on the basis of Euclidean distance as a measure of similarity. The purpose of clustering was to uncover hidden patterns and the underlying structure of the data without predefined classes or categories.

Regression analysis was applied to examine the relationship between the dependent variable and multiple independent variables and to develop a predictive model. This made it possible to assess the effect of individual factors on the observed phenomenon and to evaluate their statistical significance.

Cluster analysis was conducted using data for 2020 and 2024 in order to determine differences among the selected countries and identify trends in the use of online financial services. A non-hierarchical statistical cluster analysis was applied to classify the selected European countries, using the least-squares method.

Figure 1
Determination of the number of clusters



Source: Authors' work using Eurostat data set-Financial activities over the Internet (2020/2024) (24.11.2025)

In addition to the graphical determination of the number of clusters shown in Figure 1, the rule-of-thumb heuristic may also be used to estimate the optimal number of clusters. According to the formula $k \approx \sqrt{\frac{n}{2}}$, n represents the number of objects in the dataset, and the method provides an approximate number of clusters appropriate for the data (Lakshmi, 2018). In this study, the number of instances is 34, and the calculation according to the formula yields k = 4.123. In view of this result, four clusters were used in the analysis. For the implementation of cluster analysis in the WEKA software package, the least-squares method was applied through the k-means algorithm with the Euclidean distance measure, with the objective of minimising the sum of squared distances between data points and their corresponding centroids. The centroids were initialised by randomly selecting k observations from the dataset, while

cluster stabilisation was achieved through iterative execution of the algorithm. This method serves to segment the data and enables the identification of groups of instances that are mutually similar according to the selected attributes. In this study, the attributes refer to the online financial activities of the populations of the selected European countries. On the basis of data for 2020 and 2024, changes expressed in percentage points were calculated to identify trends in online financial services. Regression analysis was carried out in order to determine the relationship between Internet banking use and variables describing online financial activities. Through the application of regression analysis, patterns of change in the use of specific types of online financial services in the period from 2020 to 2024 were identified.

Results

The empirical results comprise the findings of both the cluster analysis and the regression analysis. The cluster analysis was conducted on the change in online financial activity rates in 2024 relative to 2020. A non-hierarchical statistical cluster analysis was employed to classify the selected European countries and to identify both progress and cross-country differences. The purpose of the regression analysis was to determine the relationship between Internet banking usage and variables measuring online financial activities.

Cluster analysis

Analysing changes in the observed variables over the period 2020–2024 provides a more detailed insight into the dynamics of digital financial behaviour among the populations of European countries. Using data for 2020 and 2024, changes in the observed indicators were calculated (Table 1).

Table 1
Cluster analysis of changes in the use of online financial services between 2020 and 2024

Variables (2020–2024)	Sample n = 33	Cluster 0 n = 7	Cluster 1 n = 8	Cluster 2 n = 6	Cluster 3 n = 12
Arranging loans, mortgage loans or other forms of borrowing	1,3003	-0,7612	3,0775	1,7367	1,2691
Purchase or sale of shares, bonds, units in investment funds	3,6427	-1,7038	11,0125	3,0067	2,5182
Purchase of insurance policies	5,6252	1,5437	6,075	12,8733	4,3127
Carrying out at least one of the financial activities	7,0266	0,7599	9,7375	14,1083	5,75

Source: Authors' work using Eurostat data set-Financial activities over the Internet (2020/2024) (24.11.2025)

For the variables included in the study for 33 European countries, the change in the level of use of online financial services between 2020 and 2024 was calculated by subtracting the 2020 value from the corresponding 2024 value. The resulting figures, therefore, express increases or decreases in percentage points over the observed four-year period. These data were then used to conduct cluster analysis in the Weka software environment in order to group the selected European countries according to trends of growth or decline in the use of online financial services. The optimal number of clusters was four. According to the data presented in Table 2, Cluster 0 contains seven countries, Cluster 1 contains eight countries, Cluster 2 contains six countries, and Cluster 3 contains 12 countries.

Table 2
Number of countries in each cluster

Number of clusters	Number of countries in clusters
0	**7**
1	**8**
2	**6**
3	**12**

Source: Authors' work using Eurostat data set-Financial activities over the Internet (2020/2024) (24.11.2025)

Table 3 presents changes in the variables in 2024 relative to 2020, expressed in percentage points. The largest changes were recorded in Clusters 1 and 2, whereas the smallest changes were recorded in Cluster 0.

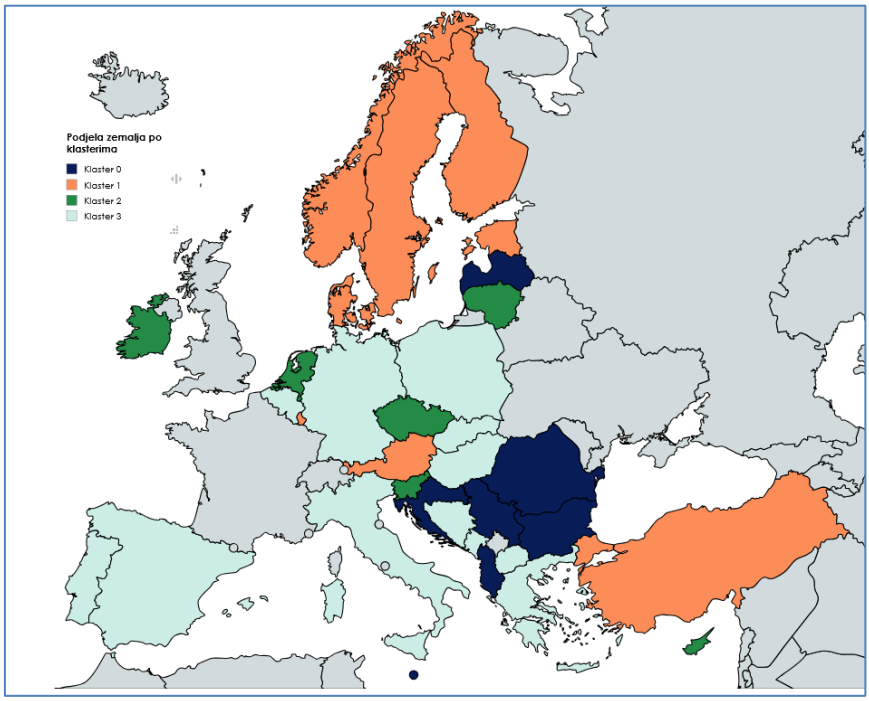
Table 3
Changes in variables in 2024 relative to 2020 in percentage points

Cluster	Purchase of insurance policies	Arranging loans, mortgage loans or other forms of borrowing	Purchase or sale of shares, bonds, units in investment funds	Carrying out at least one of the financial activities
0	1,54	-0,76	-1,7	**0,76**
1	6,08	3,08	11,01	**9,74**
2	12,87	1,74	3,01	**14,11**
3	4,31	1,27	2,52	**5,75**
Average of the data set	**5,63**	**1,3**	**3,6**	**7,03**

Source: Authors' work using Eurostat data set-Financial activities over the Internet (2020/2024) (24.11.2025)

Figure 2 presents the cluster membership of the analysed countries. Cluster 0 includes Latvia, Croatia, Serbia, Romania, Bulgaria, Albania and Malta. Cluster 1 includes the Scandinavian countries (Norway, Sweden, Finland and Denmark), together with Luxembourg, Austria, Estonia and Turkey. Cluster 2 comprises Ireland, the Netherlands, Lithuania, Czechia, Slovenia and Cyprus. Cluster 3 contains Portugal, Spain, Belgium, Italy, Germany, Poland, Slovakia, Hungary, Bosnia and Herzegovina, Montenegro, North Macedonia and Greece.

Figure 2
Classification of the selected countries based on cluster analysis



Source: Authors' work using Eurostat data set-Financial activities over the Internet (2020/2024) (24.11.2025)

Cluster 1 comprises countries that recorded the most pronounced growth in the use of online financial services. Most countries within this cluster are at the forefront of financial sector digitalisation, which can be associated with a high level of digital infrastructure, well-developed financial markets, and technologically oriented user behaviour. An exception is Turkey, which is included in this cluster primarily due to its low initial levels of online financial service usage. A relatively small absolute increase in users was sufficient for Turkey to be classified among the countries with the most dynamic growth during the observed period.

Cluster 2 consists of countries that also exhibit a high level of online financial service usage, although at somewhat lower levels compared to Cluster 1. Despite lagging behind the leading countries, they still demonstrate a significant degree of digital inclusion. Within this cluster, higher values are observed for variables related to insurance contracting and the execution of at least one of the observed financial activities via the Internet, whereas variables related to borrowing and the trading of financial instruments are more pronounced in Cluster 1.

Cluster 0 predominantly includes Balkan countries, along with Malta and Lithuania, which exhibit very modest or statistically insignificant changes in the use of online financial services. A particularly notable trend is the decline in variables related to borrowing and the trading of financial instruments, which is unexpected given the continuous increase in Internet usage in these countries. A possible explanation may lie in the lower wealth levels of the population, the orientation of financial institutions

toward more developed markets, or an insufficiently developed IT infrastructure, which represents an interesting avenue for future research.

Cluster 3 includes countries of Southern Europe, parts of Central Europe, and several smaller Balkan states that have achieved moderate but positive growth, approximately at the level of the European average. In these countries, the use of online financial services is around the average level. This pattern may be associated with a satisfactory level of financial literacy, technological development, and user trust in digital banking systems. Nevertheless, further investment in the advancement and use of information and communication technologies in the financial sector is necessary to prevent these countries from falling further behind other European nations.

The results of the cluster analysis confirm that changes in the use of online financial services are closely associated with the level of economic development and the quality of existing infrastructure. The highest growth rates were achieved by countries that had already been leaders in digitalisation, whereas countries with lower initial levels of use generally recorded slower progress. Accordingly, public policy should further encourage investment in digital development and in the financial education of the population.

Regression Analysis

This section presents the results of the regression analysis. The study uses 2024 data from two datasets: “Online financial activities (2020 onwards)” and “Individuals using the Internet for Internet banking”. The analysis covers individuals who had used Internet banking during the previous three months. This variable was defined as the dependent variable, while the remaining variables were treated as independent variables. The purpose of the regression analysis was to determine the effect of three variables describing the use of online financial services on the rate of Internet banking use. Since the attribute “[I_BFIN2] Online purchases (in the last 3 months): carrying out at least one of the financial activities (I_BFIN_SH1, I_BFIN_IN1, I_BFIN_CR1)” exhibited high collinearity with the other independent variables, it was excluded from further analysis.

The results of the regression analysis indicate that the observed variables have different effects on Internet banking use. The variable [I_BFIN_CR1], referring to arranging loans, mortgage loans or other forms of borrowing through banks or other financial institutions, shows a negative and statistically significant coefficient of –0.7456, implying that an increase in this activity is associated with lower use of Internet banking. More specifically, a one-percentage-point increase in the share of users of online credit products is associated with a decrease in Internet banking use of approximately 0.75%. This finding may be explained by the fact that credit products are often associated with greater regulatory complexity and a stronger preference for personal interaction with banking institutions, thereby reducing reliance on digital channels.

Table 4
Regression analysis results

Variable	Impact of variable on Internet banking usage
Arranging loans, mortgage loans or other forms of borrowing through banks or other financial institutions	-0,7456
Purchase or sale of shares, bonds, units in investment funds, or other financial assets	1,8285
Purchase of insurance policies, including travel insurance, as well as purchases bundled with other services, such as airline tickets	1,3274
Constant	38.7792

Source: Authors' work using Eurostat data set-Financial activities over the Internet (2020/2024) (24.11.2025)

The variable [I_BFIN_SH1], referring to the purchase or sale of shares, bonds, investment fund units or other financial assets, records the strongest positive effect in the model, with a coefficient of 1.8285. The results indicate that active participation in securities trading is strongly associated with more intensive use of Internet banking, with an increase in this activity by one unit resulting in an almost 1.83% increase in Internet banking use. This finding is unsurprising, given that securities trading is predominantly conducted through digital platforms. Moreover, users of such services tend to be more digitally literate and more willing to use advanced online financial services.

A positive and statistically significant effect was also observed for the variable [I_BFIN_IN1], referring to the purchase of insurance policies, including travel insurance and policies bundled with other services such as airline tickets. Its coefficient is 1.3274, indicating that an increase in the number of users arranging insurance online contributes to an increase in Internet banking use of approximately 1.33%. Individuals who use digital channels to take out insurance demonstrate a higher level of trust in online financial services.

The constant in the estimated regression model is 38.7792, indicating a stable level of Internet banking use even where the observed online financial activities are absent. According to the model estimates, approximately 39% of respondents would use Internet banking even in the absence of online credit products, securities trading or online insurance purchases. This result may be explained by structural changes in the financial sector, particularly the ongoing process of digitalisation and the increasing availability and institutional standardisation of Internet banking.

The robustness and reliability of the model are supported by a high correlation coefficient (0.7933), indicating a strong relationship between the dependent and independent variables, as well as by relatively low estimation error values (Mean Absolute Error = 11.6226; Root Mean Squared Error = 14.1547). These indicators suggest that the model explains the relationships present in the observed data to a satisfactory extent.

Overall, the regression results indicate that digitally intensive activities, such as securities trading and online insurance purchases, exert a strong positive effect on Internet banking use, whereas more traditional credit products are associated with a negative effect. Despite these differences, the model confirms the existence of a stable baseline of Internet banking use of approximately 38%, reflecting broader processes of digitalisation in the financial sector. The relatively high correlation coefficient (≈ 0.79) further confirms that online financial activities constitute a reliable predictor of Internet banking use. The findings also underscore the important role of online financial services in promoting digital inclusion and in supporting the further development and adoption of Internet banking as the dominant form of interaction between financial institutions and users.

Conclusion

The past decade has been marked by the accelerated development of Internet-based financial services, driven by the application of digital technologies and the adaptation of the business models of banks and other financial institutions. In this context, digital transformation is no longer a matter of choice but a strategic imperative for maintaining competitiveness in the banking sector. It also affects the structure of the financial services market itself. Traditional banks face pressure to adapt their business models, while FinTech firms, owing to their agility and user orientation, are entering segments that were previously dominated by conventional banking. Digitalisation therefore supports the development of open banking and open finance, thereby increasing market competition and innovation.

The aim of this paper was to examine patterns in the use of Internet banking and online financial services across European countries and to identify the key factors shaping digital financial behaviour among the population. The empirical analysis, conducted using cluster and regression methods, showed that the use of online financial services differs significantly across countries and is strongly associated with the level of economic development, digital infrastructure, financial literacy and user trust in digital channels. The results confirm that the digital transformation of the financial sector does not progress uniformly, but instead reflects specific national and individual behavioural patterns.

The cluster analysis for 2024 identified four groups of countries with differing levels and trajectories of digital inclusion. The Nordic countries, the Netherlands and Ireland belong to the more advanced groups in terms of Internet banking use and online financial activity, which is associated with high digital literacy and strong user trust in financial institutions. By contrast, several Balkan countries and some Central and Southern European economies remain less dynamic, pointing to infrastructural constraints, lower levels of financial inclusion and greater user caution towards digital services. The corrected cluster structure presented in this paper resolves the earlier inconsistency in cluster numbering and aligns the interpretation with the empirical distribution reported in the cluster analysis.

The analysis of developments during the period 2020–2024 further highlights the heterogeneity of digital transformation. The greatest growth in the use of online financial services was recorded in countries that already had relatively high initial levels of digitalisation, but also in certain countries with lower starting values, such as Turkey, where a more pronounced inclusion of new users occurred. By contrast, growth was slower in some countries of South-Eastern Europe, indicating the presence of structural barriers to the adoption of online financial services.

Regression analysis, with Internet banking use as the dependent variable, confirmed that individual financial activities strongly influence users' digital financial behaviour. The strongest positive effects were observed for the purchase and sale of securities and for online insurance purchases, which is characteristic of users who are more digitally literate and financially active. By contrast, arranging loans and mortgages online showed a negative effect, suggesting that users still prefer personal interaction with banks when making more complex financial decisions. The model also indicated the existence of a stable baseline level of Internet banking use of approximately 39%, suggesting that digital banking has already become a standard channel for a substantial share of the population, irrespective of the type of financial products used.

The findings of this study are consistent with previous research emphasising the importance of trust, perceptions of security and digital literacy in the adoption of online financial services. They also confirm that younger users and those with higher levels of financial activity make greater use of digital channels, whereas older users and those with lower levels of digital competence retain a preference for more traditional forms of financial interaction. The results are therefore consistent with prior studies highlighting the selective nature of digital transformation in banking, particularly in relation to more complex financial products.

The identified clusters also indicate different levels of countries' digital financial integration and confirm the relationship between the use of online financial services and broader economic indicators. Countries with high levels of digital financial activity generally have more developed financial sectors, higher GDP per capita and more advanced digital infrastructure. Geographical position also appears to matter, as more developed European regions are more strongly integrated into global financial and technological flows. By contrast, countries with lower levels of digital financial activity often face infrastructural and developmental constraints. In addition to economic factors, cultural affiliation and trust in institutions also significantly influence the adoption of online financial services.

The implications of this research may encourage fintech firms to undertake more detailed and strategically oriented market analyses in order to identify emerging technological opportunities in individual countries. By identifying such opportunities, firms may position digital financial services more effectively and adapt them to the specific characteristics of local environments. In this way, fintech firms may better capitalise on the growing digital readiness of the population, attract substantial numbers of new users and strengthen their market position.

The findings also carry important implications for banks, regulators and society as a whole. Banks should adapt their digital channels to the specific needs of users, especially those with lower levels of digital literacy, and should continue to invest in security and user education. For policymakers, the findings point to the need to reduce the digital divide both across countries and within populations. Greater use of online financial services contributes to stronger financial inclusion, more efficient capital market functioning and the long-term stability of the financial system.

This study has several limitations. First, it relies on aggregated macro-level data, which means that individual motivations and perceptions cannot be fully explained. Secondly, the temporal scope of the analysis does not capture the most recent technological innovations and regulatory changes. Future research should therefore incorporate individual-level microdata, such as age, income, education and digital competences, as well as psychological factors such as trust and perceived risk. Particular attention should also be devoted to the analysis of emerging digital business models, including open banking and beyond banking services, in order to assess their long-term effects on user behaviour and on the competitiveness of the financial sector.

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