

FINTECH DEVELOPMENT IN THE EUROPEAN UNION: ESTABLISHING SUPPORTIVE FACTORS

Nikolaj AMBRUSEVIČ^{ID*}

Vilnius University Business School, Sauletekio av. 22, Vilnius, Lithuania

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Abstract. The author of the presented article aims at discovering main supporting factors, essential for developing fintech in the context of social, economic and technological progress; to develop and suggest methodology necessary to assess the process of the development according to the processes of internationalisation. The theoretical and systematic analysis of related concepts dedicated for the fintech development is analysed here. Theoretical assumption to use financial freedom index for the measurement of country's readiness for fintech development in the context of the European Union is discussed and examined here, too. The author's suggestion to investigate the processes of fintech development on industrial, business, national and international levels is raised. As a result, the author determines main factors supporting the fintech development on every level of the process. Empirical verification of the suggestion, based on cluster analysis, correlation analysis and dispersion calculations, justifies the application of the methodology in an example of the EU countries.

Keywords: fintech, internationalisation, financial freedom index, cluster analysis, determination coefficient.

JEL Classification: F37, C10, O10, O32, O52.

1. Introduction

In recent years, the finance technology (fintech) industry has become one of the fastest growing high-tech areas. Nowadays, many companies are developing technologies that cover a range of economic business-to-business (B2B) and business-to-customer (B2C) activity, including payments, money transfers, credit card charges, check scanning, ecommerce and digital consulting, customer relations management, and app trading services (Novak, 2015).

In Lithuania, the fintech has become one of the most expanding sectors in national economy, and its performance is noticeable even outside the country. According to Lithuania's business services report (2023), prepared by Invest Lithuania, the country's investment promotion agency, in 2020 Lithuania already became the leader in area of export of information technologies and financial services in the Baltic countries, surpassing Estonia and Latvia. In the beginning of 2022, there were 265 fintech companies operating in Lithuania, employing 5,900 people, making the country 10th in Global Fintech Ranking (Findexable, 2023).

Despite the importance of the sector, which stands out for its modernity and uniqueness and offers innovative solutions to consumers, little attention has been paid to main assumptions for its development. In short, the relevance of the article can be supported with a need of creating a new type of economy with a clear focus on modern society development including ensuring technological development, social security and long-term prospects.

The goal of the article is to analyse and evaluate the trends and prospects for the fintech development in order to provide guidelines for a complex evaluation of various supportive factors related to the fintech sector.

In order to achieve the aim following *tasks* are presented in the article:

- to provide literature review in order to establish main theoretical background regarding main fintech-related concepts;
- to present empirical research methodology, suitable for verifying main supporting factors required for the fintech development;
- to provide findings based on empirical research results analysis stressing importance of main estab-

* Corresponding author. E-mail: n.ambrusevic@vvf.viko.lt

lished factors for the fintech development in the context of the European Union.

Methodology of research includes the analysis of scientific literature, the systematic review of scientific statements and empirical research results, comparison and synthesis. The main method applied in the article is based on the systematic analysis of the background for the fintech development supported with empirical methodology evaluating the process. Empirical studies are conducted on the basis of cluster analysis, correlation analysis and dispersion calculations of the established supporting factors.

2. Literature review

2.1. Meaning of fintech

According to Leong and Sung (2018), fintech is an international compound term used to describe an interdisciplinary subject that combines finance, innovation and technology management. As stated by Campanella et al. (2022), the development of financial technologies has changed the entire structure of the financial market, adding services for better convenience of customers, and, therefore, huge change in banking sector appeared. Similarly, Micu and Micu (2016) define the development of financial technologies as a new sector in the financial industry, which is used to facilitate the implementation of financial processes. Finally, Goldstein et al. (2019) describe the term *fintech* as the merger of finance and technology. The authors highlight, that technology has always influenced the financial system, but its impact and rapid development on the financial sector nowadays is greater than ever. Importantly, many changes are facilitated by establishing new companies that are replacing well-known financial products and services with new ones (Goldstein et al., 2019).

Puschmann (2017), when analysing the sector, defines this term fintech in many ways:

- advanced financial solutions enabled by information technologies;
- business startups that provide these solutions;
- current providers of financial services such as insurance companies.

Fintech phenomenon refers to startups that use the latest technologies to offer innovative financial services (Irimia-Dieguez et al., 2023). Jünger and Mietzner (2020) investigate digitized business models and processes and innovative products and services.

Nowadays, fintech considers to be an integral aspect of the banking industry (Hassan et al., 2023). FinTech is a widely used platform by banks to improve bank efficiency and consumer experience (Hu et al., 2019). According to Giglio (2021), fintech describes the interaction between technology such as cloud computing and mobile internet and financial service businesses, including payments, money transfers, and other banking services.

The order of the Ministry of Finance of the Republic of Lithuania “Regarding the development of the financial

technology industry in Lithuania” (The Ministry of Finance of the Republic of Lithuania, 2017) indicates following important areas:

- favourable public policy and legal environment;
- capital supply at each stage of development;
- demand for financial technology products and services;
- supply of professional workforce.

According to Invest Lithuania (2023), there are many competent specialists in Lithuania, who are supported by flexible legal system and an attractive business environment.

2.2. Methodology for evaluating fintech sector development

Scientific literature provides a number of different methods evaluating the fintech development.

There is an important group of authors focused on quantitative research measuring fintech variables (Pham et al., 2024). For example, Phan et al. (2020) estimates the number of fintech companies as the fintech variable; Asmarani and Wijaya (2020) suggest to use fintech’s funding frequency and fintech’s funding value; Dranev et al. (2019) believes that the number merger and acquisition of related firms in the fintech sector should be in use as the fintech variable.

Another group of scientists evaluates information about fintech available in cyberspace. According to Xie et al. (2021); Li et al. (2017), and Gupta et al. (2020), the text mining approach might be appropriate to get the unstructured data from the Internet. Therefore, it should be considered to be a new method to measure fintech’s development through mining unstructured data about fintech in cyberspace.

According to Liu et al. (2024), fintech industry is categorized as a macro dimension that includes various fintech firms and encompasses the entire supply chain of fintech services for commercial and retail customers. However, some authors argue that fintech is not yet recognized as an independent industry Wójcik (2020) but rather a branch of the general financial industry (KPMG International, 2017; Pollari, 2016).

Liu et al. (2024) state, that the classification of fintech can be challenging due to the large volume of material and proposed a vertical classification scheme based on the most commonly appearing dimensions. In authors’ scheme, fintech is categorized into following five dimensions:

- fintech industry;
- fintech firms;
- fintech systems, platforms, and apps;
- fintech as tools and fintech services;
- fintech technologies.

The authors established, that fintech services and the fintech industry are popular research topics. According to KPMG International (2017), fintech should always aim to be a financial solution and innovation initiator that integrates financial services, enhances customer

experience, adapts to regulatory change, and fosters cooperation between different industries driven by technology.

Zhao et al. (2022) highlighted the importance of patents and bank performance, Wijaya et al. (2024) analysed results of empirical research of other authors (Diemers et al., 2015; Lee & Yong, 2018; Vovchenko et al., 2019) and suggested a set of factors, that can be divided into industrial, business, national and international levels.

Table 1. Systematic classification of fintech sector development supporting factors

Levels	Supporting factors
Industrial	Patents Demand Technology
Business	Access to the right talents Human capital Access to capital Literate consumers Financial institutions
National	A startup supporting community Government support A progressive regulator
International	Technology development Entrepreneurship

Thus, the revealed supporting factors of fintech sector development (see Table 1) are based on comprehensive approach combining qualitative and quantitative assessment, that can be included into further empirical research.

3. Research methodology

The theoretical analysis of the background for the fintech development shows that the contribution of know-how, highly qualified labour force, a startup supporting business sector and the policy of governmental institutions the key factors for the process. The contribution of each supporting factor at every level can be evaluated by using correlation analysis, however, the unified factor for verifying dispersion calculations need to be selected. The financial freedom index (Global Economy, 2024), an annual index and ranking created in 1995 by *The Heritage Foundation* and *The Wall Street Journal* to measure the degree of economic freedom in the world's nations, was chosen for the cluster analysis, as its methodology, consisting of rule of law, government size, regulatory efficiency, market openness, corresponds to the previously selected fintech development supporting factors.

Moreover, the methodology seeks to evaluate the impact of each supporting factor on the fintech development and strives to be applicable in the context of internationalisation, and, as the result, assimilation in terms of changing environment.

3.1. The measurement and assessment

The measurement and assessment of the supporting factors of the fintech development consist of two parts.

The first part is dedicated to the analysis of the financial freedom index, reflecting the level of countries' performance in the financial area. The cluster analysis helps distinguishing main groups of countries here.

The second part is dedicated to reveal main factors supporting the process of the fintech development. The process of the fintech development splits into four stages: 1) *industrial level*, characterised by the number of patents per mln. inhabitants; 2) *business level*, characterised by the employment in high- and medium-high technology manufacturing sectors and knowledge-intensive service sectors; 3) *national level*, characterised by the share of innovation active enterprises; and 4) *international level*, focusing on the gross domestic expenditure on R&D. The methodology of variation of economic phenomena is based of correlation analysis and dispersion calculation.

3.2. Detailisation of methodology of empirical research

Cluster analysis focuses on the analysis of particular types of indicators Pryor (2006), which can be grouped according to countries' overall performance characterised by a unified criterion or index.

More specific mathematical basis for the classification is focused on calculations using the function depending on the pair of operational taxonomic units (Schloss & Handelsman, 2006):

$$d_r(\tilde{j}, \tilde{k}) = \left(\frac{1}{n} \sum_{i=1}^n |X_{ij} - X_{ik}|^r \right)^{1/r}, \quad (1)$$

where: $d_r(\tilde{j}, \tilde{k})$ – coefficient of space for operational taxonomic units j and k , n – number of attributes; X_{ij} – attribute i for operational taxonomic unit j ; X_{ik} – attribute i for operational taxonomic unit k ; r – integer number.

In order to establish the strength of relationship between the fintech development supporting factors and the results of the cluster analysis, it is necessary to determine the *determination coefficient* and the *empirical correlation ratio*.

Determination coefficient represents the relation of the intergroup and general dispersion (Bartosevičienė & Stukaitė, 2009). In order to find the intergroup dispersion, the set of averages of the analysed aspects in every cluster should be calculated:

$$\bar{x} = \frac{\sum \bar{x}_j f_j}{\sum f_j}, \quad (2)$$

where: \bar{x} – average of the analysed aspect of all clusters; $\sum \bar{x}_j f_j$ – total of averages of the analysed aspects of the countries f_j of the clusters j ; $\sum f_j$ – total of the countries f_j of all clusters.

Intergroup dispersion is calculated according to the following formula:

$$\delta^2 = \frac{\sum (\bar{x}_j - \bar{x})^2 f_j}{\sum f_j}, \quad (3)$$

where: δ^2 – intergroup dispersion; \bar{x} – average of the analysed aspect; \bar{x}_j – average of the analysed aspect in the cluster; f_j – number of the countries of the cluster j ; $\sum f_j$ – total of the countries of all clusters.

The average intergroup dispersion is calculated as the average of all intergroup dispersions:

$$\overline{\sigma^2} = \frac{\sum \sigma_j^2 \times f_j}{\sum f_j}, \quad (4)$$

where: $\overline{\sigma^2}$ – average intergroup dispersion; σ_j^2 – average intergroup dispersion of cluster j ; f_j – number of the countries of the cluster j .

The general dispersion is calculated regarding the composition rule:

$$\sigma^2 = \overline{\sigma^2} + \delta^2, \quad (5)$$

where: σ^2 – general dispersion; $\overline{\sigma^2}$ – average intergroup dispersion; δ^2 – intergroup dispersion.

Determination coefficient represents relation of intergroup dispersion and general dispersion:

$$\eta^2 = \frac{\delta^2}{\sigma^2}. \quad (6)$$

Empirical correlation ratio represents the square root of determination coefficient:

$$\eta = \sqrt{\eta^2}. \quad (7)$$

4. Results of empirical research

Performed analysis of scientific sources, dedicated to the fintech development has justified the inclusion of the financial freedom index into suggested methodology of evaluation. Cluster analysis based on scores of the financial freedom index has identified four groups of countries. Each group of countries can be summarised by the results of main tendencies related to the process of the fintech sector development in each cluster.

Table 2. Comparison of EU countries fintech development supporting factors (sources: Eurostat, 2022; Eurostat, Eurostat, 2023; 2024a; Eurostat, 2024b)

Countries	Financial Freedom Index	Cluster	Number of patents per mln. inhabitants	Employment in high- and medium-high technology manufacturing sectors and knowledge-intensive service sectors, %	Share of innovation active enterprises, %	Gross Domestic expenditure on R&D, % of GDP
Belgium	70	2	221.54	4.2	71.3	3.43
Bulgaria	60	3	6.98	4.5	36.2	0.77
Czechia	80	1	20.23	11.0	56.9	1.96
Denmark	80	1	448.7	5.0	57.7	2.89
Germany	70	2	292.61	9.4	68.8	3.13
Estonia	70	2	48.32	4.2	64.2	1.78
Ireland	70	2	219.47	4.2	57.6	0.96
Greece	50	4	17.8	1.7	72.6	1.48
Spain	70	2	40.05	4.0	33.4	1.44
France	70	2	160.13	3.8	54.8	2.18
Italy	50	4	82.65	6.2	55.7	1.33
Croatia	60	3	8.31	3.7	54.9	1.43
Cyprus	60	3	45.62	1.0	65.8	0.77
Latvia	60	3	11.68	2.1	32.0	0.75
Lithuania	70	2	27.3	2.8	53.0	1.02
Luxembourg	80	1	519.06	0.6	53.6	0.98
Hungary	70	2	10.63	9.2	32.7	1.39
Malta	50	4	132.83	2.5	41.1	0.65
Netherlands	80	1	382.12	2.9	55.8	2.30
Austria	70	2	262.28	6.4	60.0	3.20
Poland	70	2	16.73	5.2	34.9	1.46
Portugal	60	3	29.81	3.8	51.1	1.71
Romania	50	4	2.41	6.8	10.7	0.46
Slovenia	50	4	58.11	8.8	55.2	2.11
Slovakia	70	2	9.03	11.3	36.6	0.98
Finland	80	1	384.62	4.6	68.6	2.95
Sweden	80	1	359.55	4.5	65.2	3.40

Table 3. Evaluation of dependence of fintech development factors on clustering features

Cluster	Number of countries	Average number of patents per mln. inhabitants	Intergroup dispersions	Average employment in high- and medium-high technology manufacturing sectors and knowledge-intensive service sectors, %	Intergroup dispersions	Average share of innovation active enterprises, %	Intergroup dispersions	Average gross domestic expenditure on R&D, % of GDP	Intergroup dispersions
1	6	352.38	24893.11	4.77	9.98	59.63	28.95	2.41	0.63
2	11	121.42	11543.02	4.94	8.09	49.27	201.09	2.00	0.81
3	5	20.48	225.37	3.02	1.64	48.00	153.86	1.09	0.16
4	5	58.76	2182.11	5.20	7.21	47.06	430.15	1.21	0.35
General dispersion		667061.33		193.12		5907.74		15.26	
Determination coefficient		0.56770		0.07530		0.10194		0.31201	
Empirical correlation ratio		0.75346		0.27411		0.31928		0.55858	

Comparative analysis of the fintech development supporting factors in the context of the European Union has confirmed the idea of four levels of assessment: 1) *industrial level*, characterised by the number of patents per mln. inhabitants; 2) *business level*, characterised by the employment in high- and medium-high technology manufacturing sectors and knowledge-intensive service sectors; 3) *national level*, characterised by the share of innovation active enterprises; and 4) *international level*, focused on the gross domestic expenditure on R&D.

Calculation of determination coefficient is in use in order to discover the dependence between grouping factors (Table 4) and the established factors, characterising fintech development, in the context of the European Union. The results of the calculations are given in Tables 2–3.

Table 4. Results of the cluster analysis (source: Global Economy, 2024)

Cluster	Financial Freedom Index	Countries
1	80	Czechia, Finland, Denmark, Luxembourg, Netherlands, Sweden,
2	70	Austria, Belgium, Estonia, France, Germany, Hungary, Ireland, Lithuania, Poland, Slovakia, Spain
3	60	Bulgaria, Croatia, Cyprus, Latvia, Portugal
4	50	Greece, Italy, Malta, Romania, Slovenia

The determination coefficient shows the importance of the relations between the cluster class and the size of the fintech development supporting factors, and the correlation ratio reflects the strength of relation between the chosen aspects (Table 3). The calculation has shown that the strongest correlation ratio is established on the industrial level, as the determination coefficient for the

average number of patents per mln. inhabitants is the greatest (0.56770). Moreover, a significant relationship is established on the international level, as well, with its determination coefficient for the average gross domestic expenditure on R&D (0.31201).

Therefore, the research revealed that the variation of the financial freedom index is appropriate for predictions regarding two parameters characterizing the fintech sector development in the context of the European Union: the average number of patents per mln. inhabitants (empirical correlation ratio 0.75346) and the average gross domestic expenditure on R&D (empirical correlation ratio 0.55858). This leads to the conclusion that the results of the cluster analysis is appropriate to use in a process of assessment of the fintech development on industrial and international levels.

Performed empirical evaluation of theoretical guidelines of the method assessing factors supporting the fintech development in the context of the European Union has shown that suggested methodology can be implemented in practice for comprehensive evaluation.

5. Conclusions

Performed comparative analysis of the fintech development in the European Union countries has justified the inclusion of the financial freedom index into suggested theoretical model.

Evaluation of strength of connections between grouping factors and investigated supporting factors discovered that cluster analysis may be implemented by making predictions based on the average number of patents per mln. inhabitants and the average gross domestic expenditure on R&D.

Results of evaluation of the set of supporting factors in the example of the European Union have revealed, that established financial freedom scores meet tendencies of the fintech development on industrial and international levels, characterised by established supporting factors.

Performed empirical evaluation of theoretical guidelines of the method assessing the process of the fintech development in the example of the European Union has shown, that suggested methodology can be implemented practically assessing the fintech development in different countries and regions.

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