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Cluster analysis of development of alternative finance models depending on the regional affiliation of countries

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Abstract: The article examines the hypothesis about the existence of regional peculiarities in the development of alternative financing models (such as p2p consumer lending, p2p business lending, p2p real estate lending, balance sheet business lending, balance sheet consumer lending, equity-based crowdfunding, reward-based crowdfunding, real estate crowdfunding, profit sharing crowdfunding, donation-based crowdfunding, invoice trading, debt-based securities). According to an alternative hypothesis, due to the high integration of international financial markets, there are no regional peculiarities of the development of alternative financing models. The cluster analysis tools allow verifying these hypotheses. The cluster analysis methods used, such as tree clustering, k-means clustering, and two-way joining, demonstrate the lack of links between the country's regional affiliation and the degree of development of certain types of alternative financing in it. The key factors affecting the formation of clusters are volumes of peer-to-peer consumer lending and business lending, as well as the volume of invoice trading. According to the results of the research, the authors conclude that it is necessary to find other factors, apart from the regional features, which influence the ratio in the development of certain types of alternative financing in different countries.

JEL Classifications: C38, G15, G23, O16

Keywords: Alternative finance, peer-to-peer lending, crowdfunding, cluster analysis, regional analysis

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1. Introduction

The modern development of the market is inextricably linked with the use of information technology. The emergence of new financial and technological startups forms the new quality of both financial institutions and the market as a whole. Reducing the sales of financial services through traditional sales channels (official representative offices, branches of financial institutions, the networks of agencies, etc.) gradually leads the entire market space to new conditions and approaches to promotion and marketing, and new financial product requirements (Beyi, 2018, Kirichenko et al., 2017).

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Therefore, a detailed study of the prevalence and consequences of using different models of alternative online financing in different countries and regions of the world is essential for the formation of an efficient financial system. Identifying global trends in the market of online alternative finance allows us to take into account the most widespread experience for forming the priority directions of the development of this market and, consequently, stimulating balanced economic development.

Alternative finance can not be ignored as a trend in the development of the financial system that emerged in the IT era. According to some researchers, alternative financing can become the central technology of the future for attracting financial resources both by households and by business (Njegovanović, 2018; Hulme & Wright, 2006; Alshubiri, 2015). For example, Barnes (2015) gives strong arguments that platforms with online financing can become a strong competitor to traditional financial intermediaries. Leonov et al. (2014) discuss the non-bank financial intermediaries while studying the alternative sources of financing. We suggest considering the online platform as an alternative to traditional banking and non-bank financial intermediaries.

Loans which are carried out directly between individuals without involvement of financial intermediaries are not a new phenomenon. However, due to the transition of this mechanism to the online space, this type of financing has become massive, affordable and inexpensive (Morgan Stanley, 2015). With the advent of the first online financing platform Zopa, this phenomenon has attracted the interest of many researchers. Berger (2009), Dhand (2008), Everett (2010), Greiner (2010), Klafft (2008) are among the first researchers of alternative online funding. Currently, the alternative financing includes not only loans between individuals, but also actively uses as a source of replenishment of financial resources by small and medium-sized businesses (Bruton et al., 2015). The main types of alternative funding include peer-to-peer consumer lending, peer-to-peer business lending, balance sheet business lending, equity-based crowdfunding, reward-based crowdfunding, real estate crowdfunding, profit sharing crowdfunding, donation-based crowdfunding, invoice trading, and debt-based securities. Most of the listed kinds of alternative finance are one of the two main funding models - peer-to-peer lending or crowdfunding.

Peer to peer lending is most similar to bank lending and uses the principles of compulsory reimbursement (return) and payment (charging) (Mateescu, 2015; Belás et al., 2016). On the other hand, the specificity of peer-to-peer lending is the lack of collateral for loans and the independent choice of borrowers by lender based on his/her own priorities, values, preferences (Lin et al., 2013) or under the influence of another factors (Lee & Lee, 2012).

The second funding model - crowdfunding - involves the pooling of financial or other resources of a large number of investors through an online platform to support efforts, ideas and projects of other people, organizations or individual communities (Greenberg et al., 2013). In crowdfunding it is possible to attract financial resources both under normal conditions (refunding and payment), and on a non-refundable basis (donation-based) or with a non-financial reward (reward-based) in the form of obtaining the first sample of a product, meeting the author, obtaining a discount, etc. (Gerber et al., 2012). Therefore, crowdfunding is popular in the EU to attract investment in "green" technologies and projects (Pimonenko et al., 2017; Cebula et al., 2015).

This article has the following structure: Section 2 presents a review of the literature and justifies the hypotheses of this study; Section 3 describes the research models used;

Section 4 gives details of the input data analysis, as well as the results obtained; Section 5 describes study limitations; Section 6 summarizes the main findings and implications of this study.

2. Literature review

All types of alternative financing have various dynamics of development in different countries and regions of the world. This is due to a number of factors, including national peculiarities of functioning and availability of traditional financing channels for business and individuals, legislative restrictions or incentives for the development of certain types of alternative financing (Logan & Esmanov, 2017).

The trends of the markets of the three countries (China, the US, and the UK) determine the dynamics of the global market of online alternative financing. 99% of the world market of alternative online financing falls on these countries. The rest of the market (about 1% in the structure of the worldwide market) is the result of the influence of 20-30 countries of the world, including Japan, Australia, France, New Zealand, Canada, and others. Given the geographic location of the leading countries, there is a reason and necessity to analyze the development of alternative financing market from the point of view of the Americas, the European and the Asia-Pacific regions. The alternative funding in other regions (Africa, Middle East) is relatively small. Leading countries of the world market of alternative financing actually determine the specifics of the development of this market in the corresponding region. All other countries may have their own specific organization and operation of alternative financing models and related online platforms. Even if these models differ from the leading country in the region, their small share in the structure of the world market does not have a significant impact on the overall market dynamics.

The existence of clearly identified three macro-regional centers of alternative financing is the basis of the hypothesis of the existence of differences in the structure of regional markets of alternative finance. There is a reason to test a hypothesis about the possible existence of regional specifics of the development of online alternative financing models in these three macro-regions.

However, the investigation of the presence of a real relationship between the country's regional affiliation and the development of alternative funding models requires the use of specific economic and mathematical methods. It is worth noting that in modern economic research a wide range of economic and mathematical tools are used to identify the interstate patterns of the development of financial processes.

For example, in Djalilov et al. (2015) suggest economic-mathematical modeling of financial indicators of transition economies based on the construction of correlation matrices and regression dependencies. Regression analysis is also used in Vasilyeva et al. (2016) and Karaev et al. (2017) to formalize the influence of selected factors on the stability of the banking system. Melnyk et al. (2018) use the OLS method for studying the role and impact of fiscal decentralization on the macroeconomic stability of the country. Christopoulos and Tsionas (2004) investigate the relationship between financial system performance and economic growth using panel unit root and cointegration tests. In addition to standard methods of economics and mathematical analysis, it is possible to use author's methods of comparing countries or their modifications (Lyeonov et al., 2018).

Aware of the advantages and disadvantages of the above methods, in the opinion of the authors, cluster analysis is best for the purposes of this study. The works of Liu et al. (2017), Raykov et al. (2016), Vasylieva & Chmutova (2015), Reiff & Tokar (2016), Chow & Fung (2013), Myšková & Hájek (2017) mention its advantages and expediencies of use in economic researches, in which the goal is to divide countries or financial intermediaries into groups according to specific indicators.

3. Research model

For exploring the presence of a real relationship between the regional belonging of countries and the development of alternative funding in them, that is, ensure sufficient validity and reliability of such a study (Bhandari, 2018), the authors suggest to use cluster analysis. Cluster analysis allows us to distribute the objects under study into homogeneous groups or clusters, given the multiple parameters. In this case, such parameters are alternative amounts of funding in terms of their types. The clustering algorithm determines the similarity of objects of research based on the calculation of the distance between points, assuming that each clustering object corresponds to a point in n -dimensional space (where n is the number of characteristics (parameters) of the object). Accordingly, the smaller the estimated distance between points, the more similar (homogeneous) are the objects of the study (Everitt et al., 2011). The results of cluster analysis essentially depend on the chosen method of calculating the distance between the points (Zarutka, 2018). The main functions for determining the distances (metrics) between objects are: the Euclidean distance, the square of the Euclidean distance, the distance of urban neighborhoods (Manhattan distance), Minkowski distance, the percentage of inconsistencies, the metric "Pearson correlation coefficient" (Tan et al., 2006).

The most common among these functions is the distance between objects, which is the function of the Euclidean distance, the calculation of which is carried out by the formula (1):

$$p(x_i, x_j) = \sqrt{\sum_{i=1}^k (x_{in} - x_{jn})^2}, \quad (1)$$

Where, x_{in} - standardized value of i object by n indicator; x_{jn} - standardized value of j object by n indicator; k - number of objects.

Cluster analysis methods can be classified into hierarchical and non-hierarchical, clear and illegible. The result of applying hierarchical methods is the construction of a clusters tree, that is, the distribution of the sample of objects into cluster occurs several times with the formation of the system of tested clusters. Separation of objects into clusters is performed by one of the non-hierarchical methods of cluster analysis. According to the simple clustering algorithm, each object belongs to only one cluster (k-means clustering method). The probability of assigning an object to each cluster determines by the fuzzy clustering algorithm (clustering by the c-means method).

Hierarchical (tree-like) algorithms, in turn, are divided into agglomerative and divisive clustering. The principle of realization of hierarchical agglomerative methods consists in the consecutive combination of objects from the nearest (homogeneous) to the most distant from each other. Hierarchical divisive methods have the reverse algorithm of the applying, which consists in the sequential separating a group of objects, with the division them on clusters. The process starts with all objects grouped in a single cluster and then transfers to the objects with a shorter distance between them (that is the algorithm moves to more similar elements) (King, 2015).

Thus, the hierarchical methods of cluster analysis better correspond to the purpose of this research. Among them, we suggest using the following methods: tree clustering, k-means clustering, two-way joining.

We also note that the grouping of countries into cluster performed using standardized tools of the Statistica 10 software.

Taking into account the preliminary analysis of the data, the hypothesis about the existence of regional patterns of alternative finances development is put forward in the research. To test this hypothesis, hierarchical divisive methods of the cluster analysis are used: tree clustering, k-means clustering and two-way joining. The formation of clusters of countries predominantly from one region will be a confirmation of this hypothesis; and the representation in clusters of countries from different regions without domination of one of them will be its refutation.

At the preparatory stage of the cluster analysis, the bringing of an array of input data into a single comparative form has been made by normalizing the values of the indicators of the amount of alternative financing by their types. It was implemented using the "Data/Standardize" tool of the Statistica 10 software package.

The next stage of the cluster analysis was a consistent application of cluster analysis methods to the formed array of normalized data and an interpretation of the results.

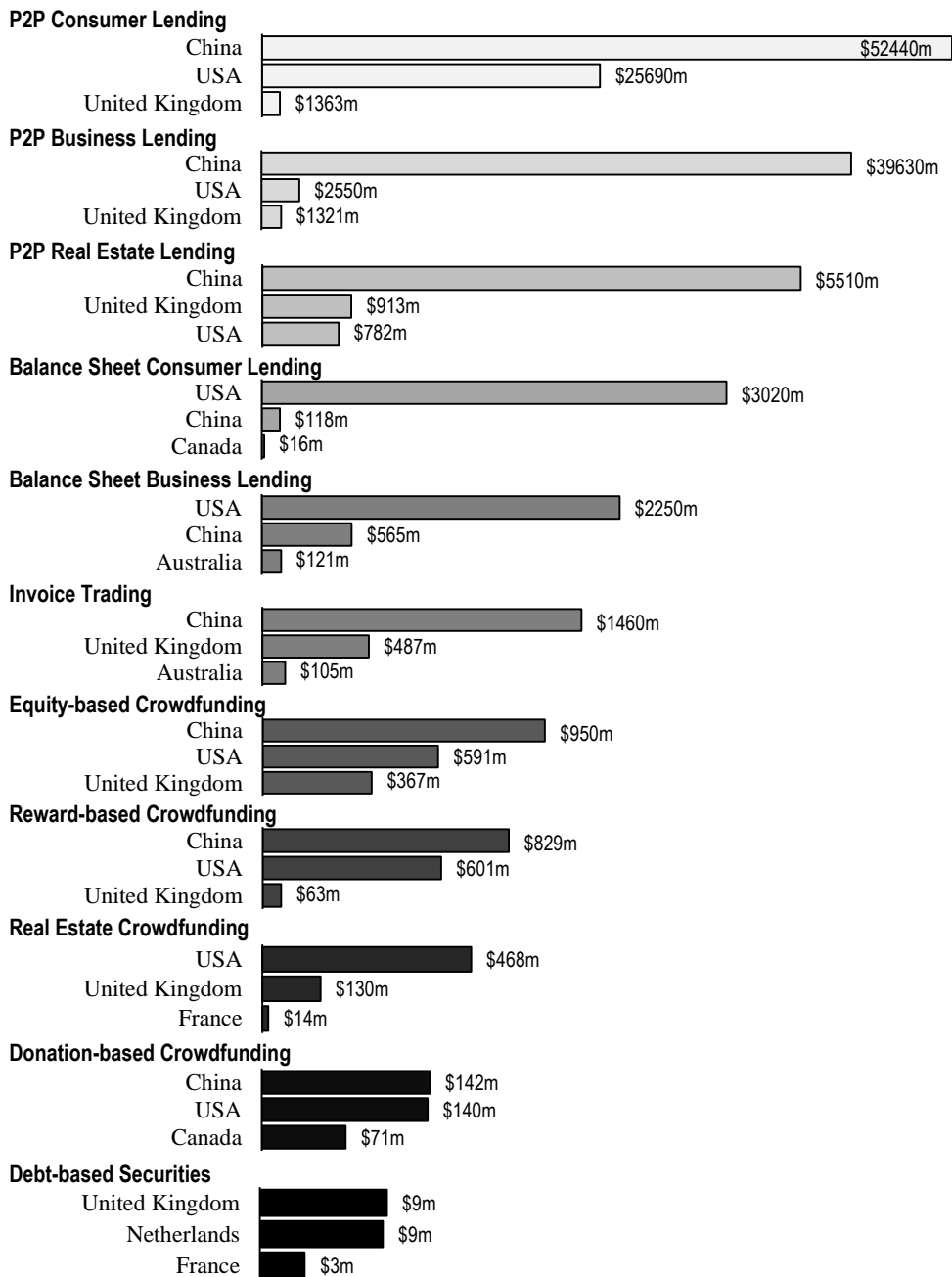
For the metric of distances between the objects under study, we use the calculation of the Euclidean distances as one of the most common and universal approaches.

4. Results and discussions

4.1. Data analysis

The using an array of input data, which includes indicators of alternative financing on its main types, allows studying the regional aspects of the online alternative finance development. The analysis considers such types of financing models as peer-to-peer consumer lending, peer-to-peer business lending, peer-to-peer real estate lending, balance sheet consumer lending, balance sheet business lending, invoice trading, equity-based crowdfunding, reward-based crowdfunding, real estate crowdfunding, donation-based crowdfunding, debt-based securities (Zhang et al., 2014). The input data for the reporting period takes into account information on the 31 countries with the largest total amount of alternative financing (Zhang et al., 2015; Zhang, Deer et al., 2016; Zhang, Baeck et al., 2016; Wardrop et al., 2016).

FIGURE 1. LEADING COUNTRIES IN TERMS OF ALTERNATIVE FINANCING IN 2015



Source: Own elaboration based on the data from Zhang, Deer et al. (2016), Zhang, Baeck et al. (2016), Wardrop et al. (2016).

To ensure the comparability of data and given the limited statistical information, the chosen study period is 2015.

The sample is representative, because it includes data for countries from different regions of the world:

- the Americas (6 countries - USA, Canada, Chile, Brazil, Mexico, Argentina);
- the European region (16 countries - UK, France, Germany, Netherlands, Finland, Spain, Belgium, Italy, Estonia, Denmark, Switzerland, Latvia, Sweden, Austria, Poland, Czech Republic);
- Asia-Pacific region (9 countries - China, Japan, Australia, New Zealand, South Korea, India, Singapore, Taiwan, Hong Kong).

The countries represented provide 99.9% of the world's alternative financing.

The initial analysis of the input data made it possible to identify certain regularities and regional features of the development of alternative financing. China is one of the top three countries in terms of almost all types of alternative financing volumes, except real estate crowdfunding and debt-based securities (Figure 1). But the countries of the European region are not the leaders on balance sheet lending, and this applies both consumer and business loans of such type. Most leaders in the balance sheet consumer lending are the countries of the Americas region (the USA and Canada); as well as countries of the Asia-Pacific region (China and Australia) are leaders on business lending. The European region is inferior to other countries in terms of crowdfunding.

The exception is only real estate crowdfunding, high rates of which are typical for Great Britain, France, Germany, Sweden and other countries.

Among the types of alternative financing, the highest development of which took place only in the countries of the European region, it is possible to name debt-based securities. The leaders of this financing type are the United Kingdom, the Netherlands, and France.

As Figure 1 shows, world leaders differ in alternative financing types. The dominance of various alternative financing types in three macro-regions of the world is different. However, we should admit that three countries namely China, the United States and Britain remain the leaders.

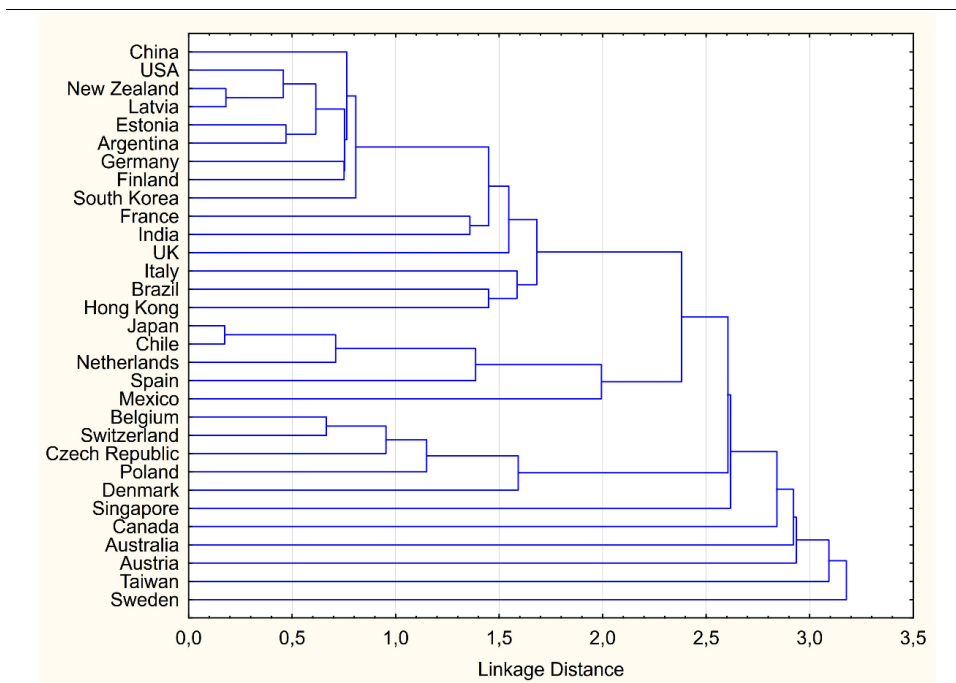
4.2. Building a hierarchical cluster tree

The first cluster analysis method (tree clustering) consists in using the calculated values of Euclidean distances for each analyzed country to build a hierarchical cluster tree (Figure 2).

The cluster tree (dendrogram) allows us to demonstrate the stages of consolidation and integration of clusters. In the presented horizontal dendrogram the ordinate axis shows a list of 31 analyzed countries. The abscissa axis reflects the distance between the objects of research starting from the minimum distance (approximately equal to 0.2). This distance corresponds to the closest connection and means greater similarity in the development of alternative finance in the respective countries. The longest linkage distance (approximately equal to 3.2) characterizes the weakest criterion for the similarity of the countries and

means their association in the single cluster. The weakening of the criterion for the uniqueness of objects (lowering the threshold conditions for combining two or more objects into one cluster) leads to the aggregation (unification) of an increasing number of objects and clusters with increasingly large differences between them. At the end of the process (at the last step) all objects are combined into a single cluster.

FIGURE 2. TREE DIAGRAM FOR 31 COUNTRIES (SINGLE LINKAGE, EUCLIDEAN DISTANCES)



Source: Own elaboration.

The cluster tree analysis shows that the majority of the formed clusters with the least differing elements (with the shortest connection distances (less than 0.5)) unite countries from different regions (New Zealand - Latvia - USA, Japan - Chile, Estonia - Argentina). Thus, the use of the first cluster analysis method does not allow to confirm the hypothesis about the dependence of the development of alternative types of financing on the regional affiliation of the country.

4.3. Formation of 2 clusters by the k-means method

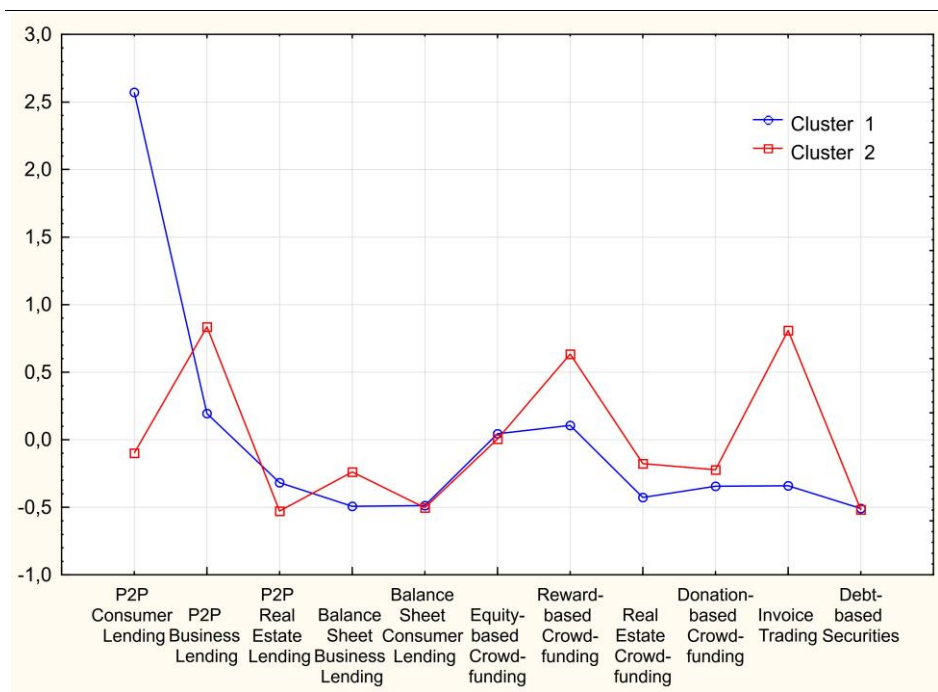
Grouping the countries by the next cluster analysis method, namely the k-means clustering, enables a clear partition of the countries into the clusters, as well as allows analyzing of the statistical significance of the implemented distribution. Table 1 shows a visual representation of the composition of the formed clusters with the definition of the correspondence of the countries included in them to a specific region.

TABLE 1. THE RESULTS OF THE CLUSTER ANALYSIS BY THE K-MEANS METHOD

CLUSTER 1			CLUSTER 2		
Countries	Distance	Region	Countries	Distance	Region
China	0,501060	Asia-Pacific	Japan	0,787211	Asia-Pacific
USA	0,299539	Americas	Australia	0,919716	Asia-Pacific
UK	0,718958	European	Canada	1,043159	Americas
France	0,376964	European	Netherlands	0,787855	European
Germany	0,189247	European	Spain	0,602287	European
New Zealand	0,267430	Asia-Pacific	Chile	0,801334	Americas
Finland	0,352621	European	Belgium	0,717539	European
South Korea	0,326160	Asia-Pacific	Singapore	0,748812	Asia-Pacific
India	0,648121	Asia-Pacific	Denmark	0,607888	European
Italy	0,632604	European	Switzerland	0,664427	European
Estonia	0,247867	European	Taiwan	0,878984	Asia-Pacific
Brazil	0,509583	Americas	Sweden	1,017863	European
Latvia	0,275047	European	Mexico	0,745314	Americas
Argentina	0,188572	Americas	Austria	1,037620	European
Hong Kong	0,496558	Asia-Pacific	Poland	0,737104	European
			Czech Republic	0,752549	European

Source: Own elaboration.

FIGURE 3. PLOT OF MEANS FOR TWO CLUSTERS



Source: Own elaboration.

The division of countries into 2 clusters is uniform in both the total number of countries and their number on a regional basis. The first cluster includes 15 countries. Three countries belong to the Americas, 5 of them relate to the Asia-Pacific and 7 - to the European region. The peculiarity of the first cluster is the involvement of all three alternative financing market leaders (China, UK, and the USA). The second cluster consists of 16 countries, three of which belong to the Americas region, four ones belong to the Asia-Pacific region and nine - to the European macro-region. Thus, according to the results of clustering by the k-means method with the division into 2 clusters, there are no signs of developing alternative financing in the world, depending on countries regional affiliation.

In addition to dividing countries into clusters using the k-means clustering algorithm, a constructed graph of mean values provides the supplementary information. This graph summarizes the mean values of distances according to each cluster and parameter (the type of alternative financing). From the Figure 3 we can conclude that the main parameter, depending on the value of which was the distribution of countries between clusters, is the volume of the p2p consumer lending. Besides, the following indicators as the invoice trading, the p2p business lending and the reward-based crowdfunding significantly affected the distribution of countries by clusters.

The analysis of the data in Figure 3 allows us to confirm the adequacy of the results of the cluster analysis by this method. The figure clearly shows the deviations between the average Euclidean distances for both clusters according to most indicators (i.e., on the types of alternative financing models). As for the first clustering option (with the division into two clusters), the volume of the p2p consumer lending is the key characteristic of the unification of countries in the first cluster. By the other indicators, the deviation of distances between different clusters is insignificant, especially between the mean values for the first and second clusters.

4.4. Formation of 3 clusters by the k-means method

The feature of the analysis by the k-means clustering method is the opportunity of grouping the countries by selection the number of clusters. According to the number of studied geographic regions, we set the number of clusters equal to 3. The results of clustering by this option show an uneven grouping of countries, namely there are 15 countries in cluster 1, whereas cluster 2 and cluster 3 consist of 5 and 11 countries accordingly (Table 2).

The data in Table 1 and Table 2 are the results of grouping countries in two clusters and three ones, respectively. Comparing these data allows us to make some conclusions. In both cases, the composition of cluster 1 remains unchanged and includes 15 countries. Among these countries, there are three leading countries and two countries with the least amount of alternative finance from the analyzed selection.

The regrouping of the remaining countries allows the formation of two new clusters. At the same time, the countries from different regions retain their representation in all clusters. In the second cluster, there are two countries of the European region, 2 - from the Americas region and 1 - from the Asia-Pacific region. In the third cluster, there are seven countries of the European region, 3 - of the Asia-Pacific region and 1 - from the

Americas region. Also, it is worth noting the marked predominance of the countries of the European region in the third cluster.

TABLE 2. THE RESULTS OF THE DIVISION OF COUNTRIES INTO THREE CLUSTERS BY THE K-MEANS METHOD

COUNTRIES	DISTANCE	REGION	COUNTRIES	DISTANCE	REGION
CLUSTER 1			CLUSTER 2		
China	0,501060	Asia-Pacific	Japan	0,175892	Asia-Pacific
USA	0,299539	Americas	Netherlands	0,214102	European
UK	0,718958	European	Spain	0,320390	European
France	0,376964	European	Chile	0,220353	Americas
Germany	0,189247	European	Mexico	0,465291	Americas
CLUSTER 3			CLUSTER 3		
New Zealand	0,267430	Asia-Pacific	Australia	0,781835	Asia-Pacific
Finland	0,352621	European	Canada	1,060973	Americas
South Korea	0,326160	Asia-Pacific	Belgium	0,532050	European
India	0,648121	Asia-Pacific	Singapore	0,804933	Asia-Pacific
Italy	0,632604	European	Denmark	0,668514	European
Estonia	0,247867	European	Switzerland	0,545711	European
Brazil	0,509583	Americas	Taiwan	0,860862	Asia-Pacific
Latvia	0,275047	European	Sweden	0,991249	European
Argentina	0,188572	Americas	Austria	1,022806	European
Hong Kong	0,496558	Asia-Pacific	Poland	0,515962	European
			Czech Republic	0,543966	European

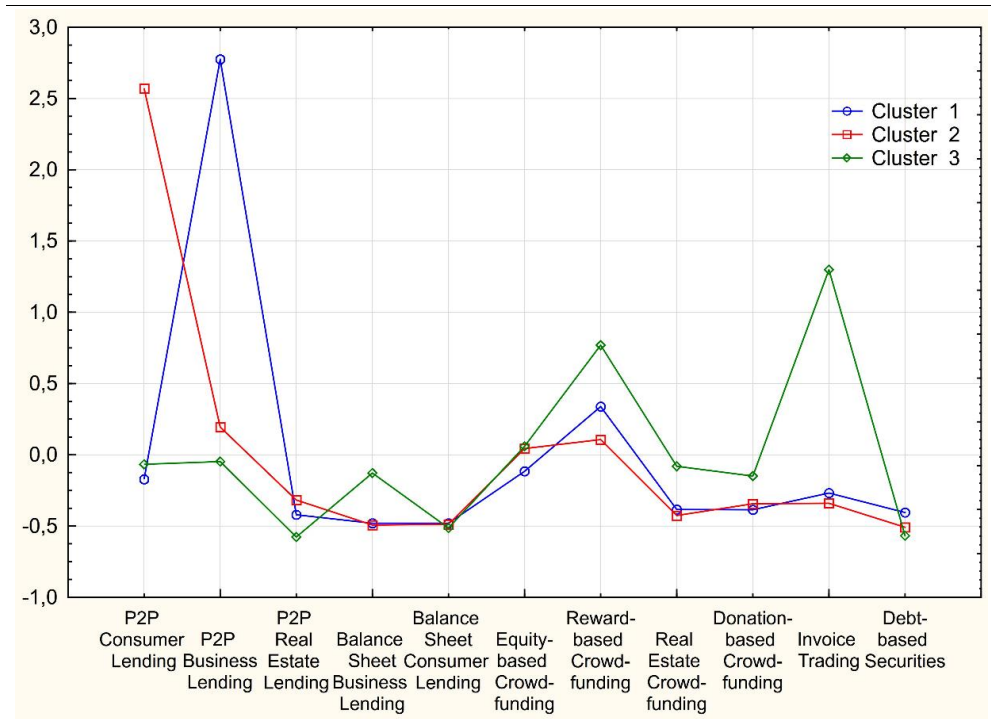
Source: Own elaboration.

The analysis of the means graph for the three clusters shows significant deviations of the Euclidean distances by the p2p business lending volume indicator for the cluster 2 and by the invoice trading indicator for the cluster 3 from the corresponding values of other clusters (Figure 4). Therefore, the separation of the second cluster was mainly due to the development of the p2p business lending, and the third cluster - due to the development of the invoice trading.

Thus, using the k-means clustering method with the allocation of 3 clusters shows that the regional component appears in the formation of the third cluster. This cluster includes the countries of the European region, mainly. This is due to the higher development level of alternative financing based on the invoice trading in the European region compared to other macro-regions.

However, in the framework of the alternative financing, the invoice trading is in a small proportion (about 1.5% in 2015). Therefore, it does not significantly affect the overall dynamics of the global market of alternative financing, as well as on its regionalization.

FIGURE 4. PLOT OF MEANS FOR THREE CLUSTERS



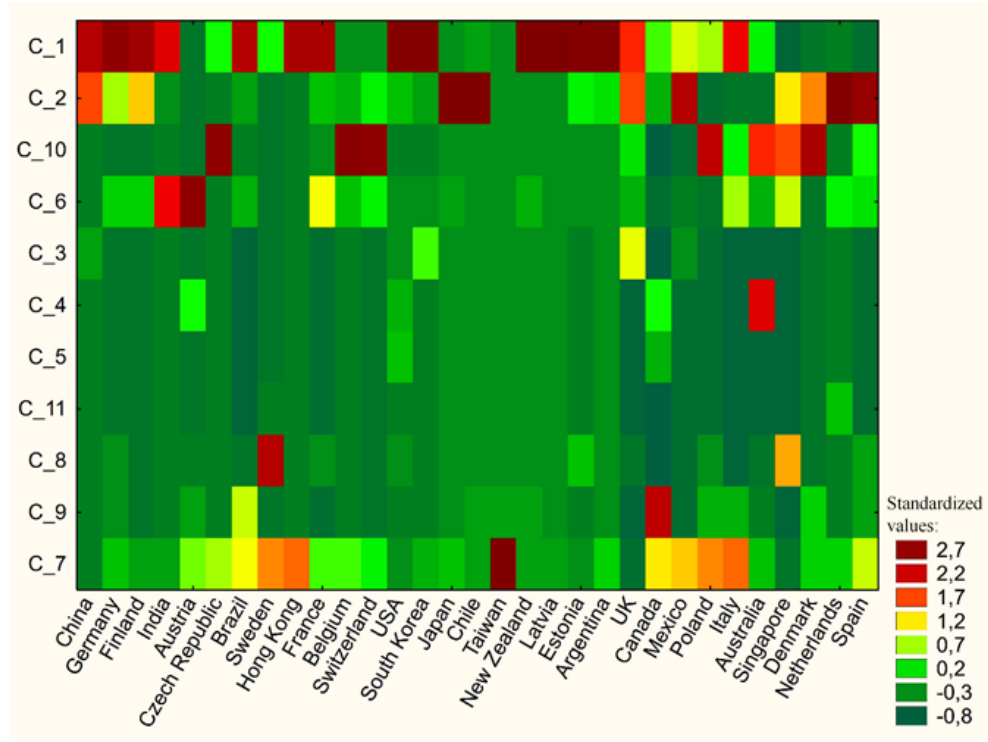
Source: Own elaboration.

4.5. Clustering by two-way joining algorithm

The third method of clustering, namely two-way joining, allows to get a graphical interpretation of the results of grouping in the form of a matrix of comparability, which simultaneously displays clustering both in terms of indicators (types of the alternative financing) and of research objects (countries). The graphical representation of the calculated Euclidean distances between the indicators is achieved due to their different color in the matrix (Figure 5).

A wider variety of colors in the matrix is characteristic for the indicators C_1 - p2p consumer lending, C_2 - p2p business lending and C_10 - invoice trading. This is fully consistent with the results of previous clustering methods, which showed clustering of countries on the basis of deviations of the Euclidean distances precisely according to the given indicators. The remaining indicators show the dominance of one or several close colors, which indicates the possibility of assigning countries to one cluster in accordance with the development indicators of these types of alternative financing.

FIGURE 5. TWO-WAY JOINING RESULTS



Source: Own elaboration.

Note: C_1 - p2p consumer lending; C_2 - p2p business lending; C_3 - p2p real estate lending; C_4 - balance sheet business lending; C_5 - balance sheet consumer lending; C_6 - equity-based crowdfunding; C_7 - reward-based crowdfunding; C_8 - real estate crowdfunding; C_9 - donation-based crowdfunding; C_10 - invoice trading; C_11 - debt-based securities.

5. Study limitations

In general, most cluster analysis methods are heuristic methods, that is, supported only by the experience of researchers (Aldenderfer & Blashfield, 1984). In fact, clustering methods are plausible algorithms that allows us to create clusters of objects. The limitation of cluster analysis is due to the fact that it only provides the most likely solution. Also, different clustering algorithms can produce various results for the same input data.

It is advisable to use cluster analysis methods when there are no a priori hypotheses at the descriptive stage of research regarding the structure of the data and their division into groups. These methods allow to process a large amount of information in order to distribute it into groups for further analysis.

The advantage of the K-means clustering algorithm is that it is quite fast, because it has a linear complexity. But the K-means algorithm has some limitations. This method requires prior establishment of the number of clusters in order to divide the entire set of objects

into this specified number. Therefore, the process of initially specifying the number of clusters introduces uncertainty and requires a preliminary analysis of the data and their correct understanding by the researcher.

Additionally, uncertainty with the final result of the analysis may also appear due to the fact that clustering by this method begins with a random selection of cluster centers. This may lead to different results when re-clustering the same objects. Other clustering methods are slower and simultaneously more consistent.

6. Conclusions

Based on the results of the cluster analysis, we can draw the following conclusions. The key factor in dividing countries into clusters is the volume of the p2p consumer lending. This type of the alternative financing has the largest share of the world's alternative finance market (about 55% in 2015) and affects its dynamics the most. The volume of the p2p consumer lending forms the first major cluster of countries. It included three world leaders in this area, namely China, the USA, and Great Britain. Similarly, such indicators as the p2p business lending and the invoice trading have a significant impact on the order of clustering the countries.

Thus, the applied methods of the cluster analysis demonstrate the absence of the link between the regional affiliation of the country and the degree of development of certain types of alternative financing. Therefore, the hypothesis about the existence of regional peculiarities of the development of alternative financing models can be considered to be refuted.

Taking into account the results obtained, we can conclude that in a global society the spread of financial innovation at the world level has no pronounced regional features. The factors that may influence the development degree of alternative financing in particular countries are the state of the development of the financial services market, the state policy in the field of the alternative finance, the availability of traditional sources of funds for individuals and business, the level of society informatization. The influence of these factors on the development of alternative finance may be the subject of further research in this direction.

References

- Aldenderfer, M. S., & Blashfield, R. K. (1984). *Cluster analysis*. Beverly Hills: SAGE Publications.
- Alshubiri, F. (2015). The impact of financial position on risk asset ratios: Empirical study of banking sector listed in Muscat Security Market. *Economics and Sociology*, 8(2), 95-107.
- Barnes, S. (2015). Peer-to-peer lending - Disruption for the banking sector? *International Banker*. Retrieved September 21, 2018, from <https://internationalbanker.com/>
- Belas, J., Vojtovich, S., & Kljuchnikov, A. (2016). Microenterprises and significant risk factors in loan process. *Economics and Sociology*, 9(1), 43-59.
- Berger, S. C., & Gleisner, F. (2009). Emergence of financial intermediaries in electronic markets: The case of online P2P lending. *BuR - Business Research*, 2(1), 39-65.

- Bruton, G., Khavul, S., Siegel, D., & Wright, M. (2015). New financial alternatives in seeding entrepreneurship: Microfinance, crowdfunding, and peer-to-peer innovations. *Entrepreneurship Theory and Practice*, 39(1), 9-26.
- Cebula, J., & Pimonenko, T. (2015). Comparison financing conditions of the development biogas sector in Poland and Ukraine. *International Journal of Ecology and Development*, 30(2), 20-30.
- Chow, W. W., & Fung, M. K. (2013). Financial development and growth: A clustering and causality analysis. *The Journal of International Trade and Economic Development*, 22(3), 430-453.
- Christopoulos, D. K., & Tsionas, E. G. (2004). Financial development and economic growth: Evidence from panel unit root and cointegration tests. *Journal of Development Economics*, 73, 55-74.
- Dhand, H. Mehn, G., Dickens, D., Patel, A., Lakra, D., & McGrath, A. (2008). Internet based social lending. *Communications of the IBIMA*, 2, 109-114.
- Djalilov, K., Lyeonov, S., & Buriak, A. (2015). Comparative studies of risk, concentration and efficiency in transition economies. *Risk Governance and Control: Financial Markets and Institutions*, 5, 179-198.
- Duran, B. S., & Odell, P. L. (1974). *Cluster analysis: A survey*. Berlin: Springer-Verlag.
- Everett, C. R. (2010). Group membership, relationship banking and loan default risk: The case of online social lending. *Banking and Finance Review*, 7(2). Retrieved September 21, 2018, from SSRN website: <https://ssrn.com/abstract=1114428>
- Everitt, B., Landau, S., Leese, M., & Stahl, D. (2011). *Cluster analysis* (5th ed.) Chichester: Wiley.
- Greiner, M., & Wang, H. (2010). Building consumer-to-consumer trust in e-finance marketplaces: An empirical analysis. *International Journal of Electronic Commerce*, 15(2), 105-136.
- Gerber, E. M., Hui, J. S., & Kuo, P. Y. (2012). *Crowdfunding: Why people are motivated to post and fund projects on crowdfunding platforms*. Proceedings of the International Workshop on Design, influence, and social technologies: Techniques, impacts and ethics (Vol. 2, No. 11). New York, NY: ACM.
- Greenberg, M. D., Hui, J., & Gerber, E. (2013). Crowdfunding: a resource exchange perspective. In *CHI'13 Extended Abstracts on Human Factors in Computing Systems*. Conference proceedings of the ACM SIGCHI (pp.883-888). April 27-May 02, 2013. Paris, France.
- Hulme, M. K., & Wright, C. (2006). Internet based social lending: past, present and future. *Social Futures Observatory*. Retrieved September 21, 2018, from <http://citeseerx.ist.psu.edu/>
- Karaev, A., Melnichuk, M., Guev, T., & Mentel, G. (2017). Stability analysis of the banking system: A complex systems approach. *Journal of International Studies*, 10(3), 273-284.
- King, R. S. (2015). *Cluster analysis and data mining: An introduction*. Herndon, VA: Mercury Learning and Information.
- Kirichenko, L., Radivilova, T., & Carlsson, A. (2017). Detecting cyber threats through social network analysis: Short survey. *SocioEconomic Challenges*, 1(1), 20-34.
- Klafft, M. (2008). *Online peer-to-peer lending: A lenders' perspective*. Paper presented at the International conference on E-Learning, E-Business, Enterprise Information Systems, and E-Government, Las Vegas, USA. Retrieved September 21, 2018, from <https://ssrn.com/abstract=1352352>

- Lee, E., & Lee, B. (2012). Herding behavior in online p2p lending: An empirical investigation. *Electronic Commerce Research and Applications*, 11(5), 495-503.
- Leonov, S., Frolov, S., & Plastun, V. (2014). Potential of institutional investors and stock market development as an alternative to households' savings allocation in banks. *Economic Annals-XXI*(11-12), 65-68.
- Lin, M., Prabhala, N. R., & Viswanathan, S. (2013). Judging borrowers by the company they keep: Friendship networks and information asymmetry in online peer-to-peer lending. *Management Science*, 59(1), 17-35.
- Liu, Y., Nagahata, H., Uchiyama, H., & Taniguchi, M. (2017). Discriminant and cluster analysis of possibly high-dimensional time series data by a class of disparities. *Communications in Statistics: Simulation and Computation*, 46(10)8014-8027.
- Logan, W., & Esmanov, O. (2017). Public financial services transparency. *Business Ethics and Leadership*, 1(2), 62-67.
- Lyeonov, S. V., Vasylieva, T. A., & Lyulyov, O. V. (2018). Macroeconomic stability evaluation in countries of lower-middle income economies. *Naukovi Visnyk Natsionalnoho Hirnychoho Universytetu*, 1, 138-146.
- Mateescu, A. (2015). Peer-to-peer lending. *Data and Society Research Institute*. Retrieved September 21, 2018, from <https://www.datasociety.net/pubs/dcr/PeertoPeerLending.pdf>
- Bhandari, M. P. (2018). Journal article critique: The validity and reliability of cross-national surveys analysis. *Business Ethics and Leadership*, 2(1), 116-120.
- Morgan Stanley. (2015). Global marketplace lending: Disruptive innovation in financials. *Morgan Stanley Blue Paper*. Retrieved September 21, 2018, from <https://bebeez.it/>
- Mysková, R., & Hájek, P. (2017). Comprehensive assessment of firm financial performance using financial ratios and linguistic analysis of annual reports. *Journal of International Studies*, 10(4), 96-108.
- Njegovanović, A. (2018). Artificial intelligence: Financial trading and neurology of decision. *Financial Markets, Institutions and Risks*, 2(2), 58-68. doi:10.21272/fmir.2(2).58-68.2018
- Pimonenko, T., Prokopenko, O., & Dado, J. (2017). Net zero house: EU experience in Ukrainian conditions. *International Journal of Ecological Economics and Statistics*, 38(4), 46-57.
- Raykov, Y. P., Boukouvalas, A., Baig, F., & Little, M. A. (2016). What to do when k-means clustering fails: A simple yet principled alternative algorithm. *PLoS ONE*, 11(9).
- Reiff, M., & Tokar, V. (2016). Post-communist financial and economic development: Cluster analysis of selected countries. *Economic Annals-XXI*, 161, 12-17.
- Tan, P.-N., Steinbach, M., & Kumar, V. (2006). *Introduction to data mining*. Boston: Pearson Addison-Wesley.
- Vasylieva, T. A., & Chmutova, I. M. (2015). Empirical model of a bank life cycle. *Actual Problems of Economics*, 172(10), 352-361.
- Vasilyeva, T., Sysoyeva, L. & Vysochyna, A. (2016). Formalization of factors that are affecting stability of Ukraine banking system. *Risk Governance and Control: Financial Markets and Institutions*, 6(4), 7-11.

- Wardrop, R., Rosenberg, R., Zhang, B., Ziegler, T., Squire, R. et al. (2016). *Breaking new ground: The Americas alternative finance benchmarking report*. University of Cambridge. Retrieved September 21, 2018, from <https://www.jbs.cam.ac.uk/>
- Beyi, W. A. (2018). The trilogy of a digital communication between the real man, his digital individual and the market of the digital economy. *SocioEconomic Challenges*, 2(2), 66-74. doi:10.21272/sec.2(2).66-74.2018
- Zarutska, E. (2018). Structural-functional analysis of the Ukraine banking system. *Financial Markets, Institutions and Risks*, 2(1), 79-96.
- Zhang, B., Colins, L., & Baeck, P. (2014). *Understanding alternative finance*. University of Cambridge and Nesta. Retrieved September 21, 2018, from <https://www.jbs.cam.ac.uk/>
- Zhang, B., Wardrop, B., Rau, R., & Gray, M. (2015). *Moving mainstream: The European alternative finance benchmarking report*. University of Cambridge and EY. Retrieved September 21, 2018, from <http://www.jbs.cam.ac.uk/>
- Zhang, B., Baeck, P., et al. (2016). *Pushing boundaries: The UK alternative finance benchmarking report, 2015*. University of Cambridge and Nesta. Retrieved September 21, 2018, from CAM website: <https://www.jbs.cam.ac.uk/>
- Zhang, B., Deer, L. et al. (2016). *Harnessing potential: The Asia Pacific alternative finance benchmarking report, 2016*. University of Cambridge. Retrieved September 21, 2018, from CAM website: <https://www.jbs.cam.ac.uk/>