

Diversification of the financial education needs of the entrepreneurial ecosystem: a multidimensional scaling analysis applied to data from a financial intelligence platform

Diversificación de las necesidades de educación financiera del ecosistema emprendedor: un análisis de escalamiento multidimensional aplicado a los datos de una plataforma de inteligencia financiera

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Abstract:

The objective of this research is to analyze the financial education needs of the central region of the country through Non-Parametric Multidimensional Scaling (NMDS), Shannon's diversity index and Simpson's dominance index, applied to a database from of a financial intelligence technological platform to identify the similarity of financial needs among users and their financial preferences. The results obtained show similarity between the data, which indicates that there is a lack of financial knowledge in the entrepreneurial ecosystem and, therefore, a high death rate of SMEs and uninformed financial decisions based on errors of interpretation of the information.

Keywords:

Financial education needs, nonparametric multidimensional scaling, diversity index, dominance index, center region

Resumen:

La presente investigación tiene el objetivo de analizar las necesidades de educación financiera de la región centro del país mediante el Escalamiento Multidimensional No Paramétrico (NMDS), el índice de diversidad de Shannon y el índice de dominancia de Simpson, aplicados a una base de datos proveniente de una Plataforma tecnológica de inteligencia financiera para identificar la similitud de necesidades financieras entre los usuarios y sus preferencias financieras. Los resultados obtenidos muestran similitud entre los datos, lo que indica que existe carencia de conocimientos financieros en el ecosistema emprendedor y por ende, una alta tasa de mortandad de PYMES y decisiones financieras desinformadas basadas en errores de interpretación de la información.

Palabras Clave:

Necesidades de educación financiera, escalamiento multidimensional no paramétrico, índice de diversidad, índice de dominancia, región centro

Introduction

Financial education contributes to various aspects of life, in healthy personal finances, in the culture of savings and investment, but also in the management of business

finances. In a macroeconomic context, it is one of the most important elements for the economic growth of a country and strengthens the financial capacities of the population in all its segments, which is why financial education is one of the priorities of the Mexican Government and in

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Collaboration with the World Bank established objectives oriented to the empirical understanding of financial knowledge and to design public policies focused on the knowledge of financial services [1] for the entire population. Currently, there are a variety of initiatives to promote financial education, however, there is still a long lag and lack of inclusion, which leads to an increasing importance regarding the knowledge of financial needs for individual and society well-being, with the purpose of achieving financial stability for the population [2].

The National Policy for Financial Inclusion through the CEF Financial Education Committee) aims to coordinate efforts, actions and programs on financial education issues. It aims to "strengthen the financial health of the Mexican population, through increased access and efficient use of the financial system, the development of economic-financial skills, and the empowerment of the user" [3] in terms of development economic and financial competence refers to financial education, the proper use of information and its interpretation for proper decision-making.

According to Calzada, Pérez and Escamilla (2015), there is a relationship between financial education and the poverty of a population, in this regard there are studies that show that this relationship and that to a large extent, there is a contribution to the economic growth of a country . [4]

The present study aims to identify whether there is similarity between the financial education needs among users in the central region of the country and is structured by the theoretical framework that supports the applied techniques, the previous studies where the contexts and the usefulness of the analyzes in other disciplines are addressed, the research methods applied with a clear explanation of each analysis, the results obtained, as well as a final section of conclusions.

Theoretical framework

According to López & Hidalgo (2010), non-parametric multidimensional scaling (NMDS) is defined as the analysis or technique applicable to distances defined in a non-metric way and establishes as requirements [5]:

1. A minimum number of dimensions to find the relation of the proximities.
2. A set of coordinates to display the points in that graphic space.
3. A diagram to represent the relationship of proximities and distances.

Among its precursors are Shepard (1962), Kruskal (1964), Meuser (1962) and Guttman (1968), who contributed to the development of this multivariate, metric and non-metric technique.

According to Causio (2013), this technique establishes an relationship in terms of order of proximity, not of sums or products, which is why it is non-linear [6] and it is considered a versatile multivariate method for ordering data that can even be metric [7]. Therefore, it is also necessary to make a clarification about the type of distance applied for a correct analysis, for this investigation the Bray-Curtis distance is considered because there is no linear relationship but rather, an increasing monotonic relationship [8] and is based on the measures of similarity or proximity to analyze the information [9].

The proximity shows the similarity of two individuals, if it is small, in the graph they will be seen as separate points, otherwise, if the similarity is large, then the points will be concentrated near one of the axes. The diversity of the data implies a dissimilarity or difference [10] between them, in fact, this type of multivariate techniques are used when it is not possible to make comparisons with any other multivariate method. [11].

This research is also supported by the Simpson and Shannon indices, since they are the most common to measure diversity, the first is used to measure the probability in a group that two individuals belong to it and have the same characteristics [12] and the second is used to relate the individuals of a group with respect to the richness of the data, that is, with similar characteristics. [13].

Previous studies

It is important to clarify that non-parametric multidimensional scaling (NMDS) is a multivariate technique that is applied to non-normal data to measure the dissimilarities between objects or individuals of a group or different groups. But there is also multidimensional scaling analysis (MDS) applied for normal data where there is clarity of the similarities or preferences of a data set. [8].

In the international context, the United States continues to be a country with more efforts aimed at financial training at all levels of education [2]. In Mexico, since 2008, the National Financial Education Week (SNEF) has been carried out coordinated by Condusef, to provide society with the fundamental basic concepts of financial education

and thus create awareness [3], however, the reality is that not all the population has access to this information, either due to lack of knowledge or interest on the subject, on the other hand, it is necessary to identify the financial education needs of the different regions of the country, for this research in particular, the central region, as it is considered one of the main entrepreneurship ecosystems in Mexico.

This research considers the places that make up the central region of the country and for its analysis it is divided into the central-western region (RCO) and the central-southern region (RCS). It is worth mentioning, that the central region is the second most important economic zone in the country and where there is a greater concentration of jobs and individuals who want to start or are already entrepreneurs with micro and small businesses, therefore, with financial education needs.

The importance of this study and according to the bibliography consulted, to date there are no studies in the area of economics and administration that apply non-parametric multidimensional scaling analysis (NMDS) to understand the behavior of data or individuals located in different places but with similar characteristics, therefore, this research considers the applied techniques as an opportunity to represent the similarities or dissimilarities between individuals from different places regarding the issue of financial education needs.

Research Methods

This research applies diversity indices to identify equity and dominance among the population of the central region of the country.

Simpson dominance index

Measures the probability of finding two individuals with similar financial needs and belonging to different places - although within the same central region of the country-, even, that they use two different financial models of the Financial Intelligence Technology Platform. It is expressed with the following equation:

$$D = \frac{\sum_{i=1}^S n_i(n_i - 1)}{N(N - 1)}$$

Where:

S = Number of financial models that make up the FI technological platform

n = Number of entrepreneurs (individuals) by financial model

N = Total number of entrepreneurs in the central region that use financial models

When D has a value between 0 and 1, there is infinite diversity, but if the value is equal to 1, then there is no diversity, what there would be is dominance [14] in a financial model or place that predominates within the central region that is being studied.

Shannon diversity index

It indicates the fairness in the population of the central region, with respect to financial education needs, combining information on wealth and equity among individuals, this is known as diversity [15] and its values are between 1.5 and 3.5, is expressed as follows:

$$H' = \sum_{i=1}^S p_i \ln p_i$$

Where:

H' = Shannon-Wiener index

S = Number of models that make up the FI platform

Pi = Proportional abundance of the species, that is, the number of entrepreneurs who use a model of the financial intelligence platform with respect to the total number of entrepreneurs

Nonparametric Multidimensional Scaling (nMDS)

This analysis is common in biological ecosystems, because it compares species finding a similarity or dissimilarity between them, in addition, it indicates the proximity graphically to appreciate the degree of similarity in a group of data [16] that for this research, belongs to the central region of the country. Likewise, the Bray-Curtis distance adjusted to two dimensions is applied to measure the distance coefficient, indicating whether there are differences in the abundance of the data that make up the population [17].

ANOSIM

This analysis is applied to find the differences between two or more groups, in this research the central region of the country is divided into center-west and center-south, therefore, the analysis of similarities is applied by means of a test statistic R to denote dissimilarity as long as the value approaches 1 or is greater than 1. It is expressed as follows:

$$R = \frac{r_b - r_w}{N(N - 1)/4}$$

Where:

rb = mean range of all distances between groups
 rw = Average range of all distances within groups

The PAST (Paleontological Statistics) version 4.02 software was used to analyze the data and obtain the diversity indices, non-parametric multidimensional scaling (NMDS) and ANOSIM.

The data analyzed is obtained from a financial intelligence technological platform [18] composed of 13 financial simulators that are used by the population subscribing to said technology.

Stress

The Stress test is applied to measure the goodness of the non-parametric multidimensional scaling analysis (NMDS), in order to know the linearity of the data to know if there are dissimilarities between them. The criteria to determine how acceptable the test is and therefore the NMDS is shown in the following table [19].

Stress	
0.01=	Excellent
0.01 a 0.05=	Good
0.05 a 0.10=	Right
0.10 a 0.15=	Moderate
0.15=	Poor

Table 1. Criteria of the Stress test

Results

There are 1,642 users located in the central region subscribed to the financial intelligence technological platform located as follows:

Financial Simulator	Central-Western Region (CWR)	Central-South Region (CSR)	Number of users
Sales price estimation	28	159	187
Financial break-even point	29	189	218
Competitor analysis	8	46	54
Sensitivity study	4	37	41
Balance study	5	44	49

Financial profit	11	75	86
Business model	4	24	28
Sale objectives	9	93	102
Budget	47	267	314
Strategic position of the company	1	2	3
Sales Forecasts	8	77	85
Financing	67	309	376
Market value	19	80	99
Total Users	240	1402	1642

Table 2. Distribution of users by financial simulator in the central region by financial simulator

Table 2 shows the distribution of users in the central region by financial model, divided into central-western and central-southern regions.

It is necessary to mention that the population has characteristics of diverse financial needs, it is clearly observed that in the central-south region most of the users are concentrated with 1402 against 240 in the central-western region, however, this does not differ in the ubiquity of financial education needs among regions.

Diversity Index

To calculate the Simpson dominance index and Shannon's diversity index, the data from Table 2 were taken and analyzed in the aforementioned software.

	CWR	CSR
Dominance_D	0.1575	0.1325
Simpson_1-D	0.8425	0.8675
Shannon_H	2.113	2.221

Table 3. Simpson and Shannon indices of the central-west and central-south region

The Simpson index indicates the dominance and diversity of financial education needs with respect to financial simulators and by region. In the case of the central-south region, it is the one that shows the highest probability of finding users with ubiquitous financial education needs

among them, it has a value of 86.75%, in the case of the central-western region it has a probability of 84.25%. Although it also shows a certain dominance and diversity among the population, it is the lowest value.

Nonparametric Multidimensional Scaling (nMDS)

The non-parametric multidimensional scaling analysis (NMDS) developed with the database of the two regions of central Mexico indicates the diversification of the financial education needs of its population as shown in the following figure:

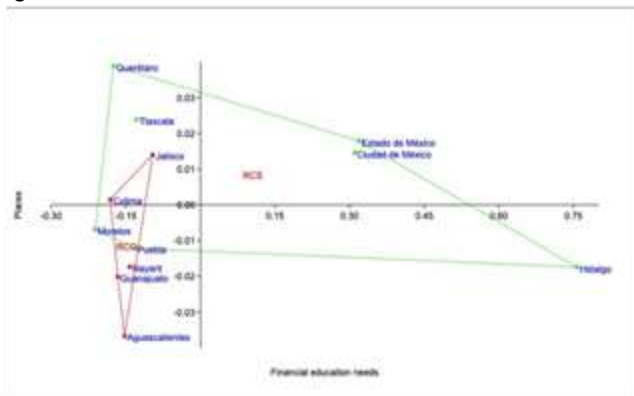


Figure 1. NMDS graph of financial education needs of the central-western region and central-southern region of the country

According to figure 1, there is low dissimilarity in the populations that are located in the central-western regions (RCO) and central-southern regions of the country (RCS) respectively, which indicates that the population of both regions has financial education needs similar between them. Where closer points are observed as in the RCO and considering that it is a region with the least number of users, similarity can be observed between them. In the case of the RCS, in some points of the convex hulls, it could be understood that there is a greater dissimilarity between its population, however, being the region with the highest number of users, it is observed that the places of Hidalgo, State of Mexico, Querétaro and Morelos have very similar characteristics regarding financial education, indicating that there is an abundance of population that uses financial simulators.

ANOSIM

R: -0.008295

p (same): 0.4843

The analysis of similarities indicates that the statistic of $R = -0.008295$, suggests a low dissimilarity, a reduced separation between the groups, according to the rule, when the value of R is closer to 1 then the difference between the data is greater, indicating that there would be no ubiquity among the population.

On the other hand, it is important to apply a measure of goodness called Stress, whose value in this research is 0.06515, as it is found in a criterion between 0.05 to 0.10, it means that the value is correct and therefore, the model is acceptable, since it indicates a minimum difference between the distances [19-10].

Conclusions

The analyzes applied in the present investigation are used in biological ecosystems, especially the NMDS because it helps to represent graphically and with few dimensions the proximities that exist between the groups, it is an ordering method for data that are considered as non-normal, that is, which are on discontinuous scales. Therefore, given the characteristics of the database made up of users in the central region of the country who use the financial intelligence technological platform, it is considered an ideal method to know the ubiquity of financial education needs in the populations of the CWR and CSR of the country.

The analyzes help to clearly identify the most dominant place and thus adapt the technology to meet the financial education needs of the population located in the central regions of the country. It is considered a useful method for interpreting distances and for ordering data that can be shown very sparse.

The application of the diversity indices used in biological and ecological studies, now also applied to an administrative economic study, it provides a different perspective with respect to traditional methods, it seeks to present methodologies that really help to interpret the data and thus suggest innovative strategies for the fulfillment of the objectives.

Qualitative analyzes that also provide valuable information in research and that definitely have a considerable impact on financial education needs should not be left out, each individual that makes up the population of the central region of the country has different characteristics and the way to approach the financial issue as well, however, by presenting a certain ubiquity among the population, it is easier to develop strategies that allow meeting the financial needs of a specific population.

It is necessary to mention that strategies are currently being carried out to comply with the National Financial Inclusion Policy and the National Financial Education Strategy on the exploitation of the use of technological innovation in the financial sector and thus be able to create synergies that allow promoting education financial in the population, therefore, the use of the financial intelligence technological platform, through its multiple simulators, provides financial education according to the needs of each individual.

Financial education implies the adequate and healthy management of finances at home, personal finances and of course, business finances, currently there are courses, workshops, coaching sessions, guides and mobile and web applications that help to learn finances in the items already mentioned, but it is important to consider that there is still resistance to the use of technology applied to finance and financial education becomes a great challenge for those who are dedicated to this work.

Referencias

- [1] Banco Mundial. (2013). Capacidades financieras en México: Resultados de la encuesta nacional sobre comportamientos, actitudes y conocimientos financieros; 1-124. Recuperado de de: <http://documents1.worldbank.org/curated/en/957321468057260244/pdf/821340Revised00Box379874B00SPANISH0.pdf>
- [2] Ferrera, J. & Pedraja F. (2018). La educación financiera en el contexto internacional. En Cuadernos Económicos de ICE, 239-257. doi: 10.32796/cice.2018.95.6649
- [3] Consejo Nacional de Inclusión Financiera. (2020). Política nacional de inclusión financiera, 1-158. Recuperado de: https://www.afi-global.org/sites/default/files/publications/2020-04/ES_Strategy_National_Financial_Inclusion_Strategy.pdf
- [4] Calzada, J., Pérez, F., & Escamilla, M. (2015). La relación entre la inclusión financiera y el rezago social en México. En Revista CIMEXUS, 10(1), 13-31. Recuperado de: <https://cimexus.umich.mx/index.php/cim1/article/view/203>
- [5] López, E. & Hidalgo, R. (2010). Escalamiento multidimensional no métrico. Un ejemplo con R empleando el algoritmo SMACOF. En Estudios sobre educación, 18, 9-35.
- [6] Causio, G. (2013). Análisis de datos de proximidad. MDS métrico y no métrico, 1-18.
- [18] Consultor virtual de negocios. (2020). IF. Disponible en: <https://if-bot.com/>
- [19] Kruskal, J. (1964). Nonmetric Multidimensional Scaling: A Numerical Method. Psychometrika, 2, 115-129. doi: <https://doi.org/10.1007/BF02289694>
- [7] Taguchi, Y. & Oono, Y. (2004). Relational patterns of gene expression via non-metric multidimensional scaling analysis. 2004: 21 (6), 730-740. doi:10.1093/bioinformatics/bti067
- [8] Guerrero, F. & Ramírez J. (2002). El análisis de escalamiento multidimensional: una alternativa y un complemento a otras técnicas multivariantes. En Revista Electrónica de Comunicaciones y Trabajos de ASEPUMA. Recuperado de: https://www.researchgate.net/publication/26440777_El_analisis_de_escalamiento_multidimensional_Una_alternativa_y_un_complemento_a_otras_tecnicas_multivariantes
- [9] Miret, E. (2005). Un enfoque unificado para técnicas de representación euclidiana. Tesis para optar por el grado de Doctor en Ciencias Matemáticas. UH. La Habana. Cuba, 1-148.
- [10] Real Academia Española. (2020). Diversidad. Disponible en: <https://dle.rae.es/diversidad>
- [11] Poturak, M., & Göksu, A. (2012). Usage of the Multidimensional Scaling in Exploring a Firm's Image and Competitiveness. Advanced Research in Scientific Areas, 3-7. doi: 10.13140/2.1.2848.1923
- [12] Campo, A. & Duval, V. (2014). Diversidad y valor de importancia para la conservación de la vegetación natural. Parque Nacional Lihué Calel (Argentina). En Anales De Geografía De La Universidad Complutense, 34(2): 25-42. doi.org/10.5209/rev_AGUC.2014.v34.n2.47071
- [13] Pla L. (2006). Biodiversidad: Inferencia basada en el índice de Shannon y la riqueza. En Interciencia, 31(8): 583-590. Recuperado de: <https://www.redalyc.org/pdf/339/33911906.pdf>
- [14] Hammer, Ø. & Harper, D. (2006). Paleontological Data Analysis. Blackwell. 2006.
- [15] Magurran, A. (2004). Measuring Biological Diversity. Blackwell Publishing, Malden. Disponible en: <http://www.bionica.info/Biblioteca/Magurran2004MeasuringBiological.pdf>
- [16] Navarro, C., Zamora, A., & Cano, R. (2015). Análisis de Escalamiento Multidimensional del turismo de los países que conforman la APEC. Revista Turismo y Sociedad, 17-30. doi: <http://dx.doi.org/10.18601/01207555.n16.02>
- [17] Giraldo, A. (2015). La suficiencia taxonómica como herramienta para el monitoreo de artrópodos epígeos: una primera aproximación en el desierto costero peruano. Ecología Aplicada, 14(2), 147-156. Disponible en: <https://www.redalyc.org/articulo.oa?id=34143179007>