

Applying the self-organizing maps to analyze and interpret the clustering and characteristics of nascent entrepreneurs: A cross-country study

Li-Min Chuang¹, Cheng-Chung Yeh² and Chung-Wei Lin³

Abstract

Although research on entrepreneurship across countries has been popular over the last decade, the factors influencing entrepreneurs are varied and the approaches to analysis remain limited. Previous studies have helped to define numerous factors affecting nascent entrepreneurs; however, There are still potential limitations of the empirically based knowledge collected about nascent entrepreneurship. Additionally, the application of traditional statistical methods such as correlation analyses to entrepreneurship research seems insufficient for analysis of preceding data covering longer. Prior research also indicated some limitations of entrepreneurial research, including the lack of use of macroeconomic factors and the lack of a large number of countries or longitudinal data on individuals. In this study, we use data from the Global Entrepreneurship Monitor (GEM) to examine 14 factors in 10 countries by employing Kohonen self-organizing maps (SOM) as a means to identify the patterns that exist between selected countries and years (from 2011 to 2016). Our results identified 4 clusters (courageous, experienced, conservative and compensative) and the features associated with each of these clusters. These results illustrate some specific patterns of entrepreneurs and show how countries shift over time.

Keywords nascent entrepreneur ; entrepreneurial performance ; global entrepreneurship monitor (GEM) ; self-organizing maps (SOM);cross-country study

¹Department of International Business, Chang Jung Christian University, Tainan 71101, Taiwan; liming@mail.cjcu.edu.tw(L.-M.C.);

²Ph.D. Program in Business and Operations Management, Chang Jung Christian University, Tainan 71101, Taiwan; r78462027@mail.cjcu.edu.tw(C.-C.Y.)

³Master Program in Business and Operations Management, Chang Jung Christian University, Tainan 71101, Taiwan.

² Correspondence: r78462027@mail.cjcu.edu.tw; Tel.: +886-6-2138600

1 Introduction

Over the past several decades, entrepreneurship has been an important topic of academic research. Since the 1960s, researchers have put forward their own views on entrepreneurship and examined who becomes an entrepreneur [1-5]. Many of the key influencing factors identified and concluded by researchers are determining which members of society were prone to become an entrepreneur [6,7]. These individual factors may be further divided into demographic and economic factors [8]:i.e education, wealth, gender [9,10] and age. Still, some scholars stated that these individual factors were insufficiently in explaining the decision making of participating in entrepreneurial activity[11,12]. The empirical results done by Muñoz-Bullón, Sánchez-Bueno and Vos-Saz [11] showed that activeness, adventure and innovation are significant key factors for nascent entrepreneurs entering the market, while Brinckmann and Kim [12]proves the startup plans were driven by cognitive attributes and human capital of nascent entrepreneurs, in which self-efficacy enhances the development of formal startup plan, and the perseverance of entrepreneur enhances the planning of entrepreneur activities. Besides, advance academic training would also lead the nascent entrepreneurs through the process.

These scholars argued that such variables may not effectively predict entrepreneurial activities because the characteristics of individuals who actually succeed in starting a business could be different from those individuals who simply decide to start a business.

In recent years, scholars turned their attention to nascent entrepreneurs. In pioneering studies, Reynolds and Sammis [13]used a national pilot study in the U.S. to estimate logistic regression models for prediction of nascent entrepreneurs. Afterwards, the occurrence of nascent entrepreneurs in different countries was explored. These studies identified various factors that influence entrepreneurial activities and helped to define how these factors affect nascent entrepreneurs. There are still potential limitations of the empirically based knowledge collected about nascent entrepreneurship [14].Therefore, Davidsson and Honig (2003) [14]evaluated two major dimensions of factors that affect nascent entrepreneurs: human capital [12] and social capital. Recent studies indicate that there are additional factors that affect nascent entrepreneurship, such as the use of technology[15], financial status[16,17] and country of residence (in aspects of culture, regulation, and government policies) [18,19].

However, prior research indicated that there were limitations to entrepreneurial research. First, Arenius and Minniti [20] stated the data was insufficient in forming a causal relationship from the conceptual variables proposed to entrepreneurial behavior. Moreover, they indicated that the treatment of country effects was limited to the introduction of dummy variables. Through explorative investigation and analysis of aggregated concepts such as

macroeconomic technology transition or culture, future researchers may clarify how perceptions impact entrepreneurial behavior directly. Second, Engelen, Heinemann, and Brettel [21] indicated that in cross-cultural studies, the mechanisms underlying the casualties of nascent entrepreneurship are ambiguous. The authors believed a more complicated research model is needed to further verify the relationship between cultural factors and phenomena observed. Further, Sternberg and Wennekers [22] suggested that a sufficiently long period for dependent variables measurement is required in verifying the effects and data on entrepreneurship; therefore, time series data from various countries or great amount of individual longitudinal data could be more accurate in determining the factors influencing entrepreneurship.

More and more statistics and econometric scholars turn to highly computational, time variant and adaptive techniques for relevant social and economic issues. Neural network is one of a kind to help researcher improve the accuracy of prediction and classification, especially in extreme unstable structure, the self-adaptive learning and clustering characteristic of neural network is proven useful in the field of predictive application and research.

Following these suggestions, we use the Global Entrepreneurship Monitor (GEM) as our research sample, which provides harmonized, internationally comparable data on entrepreneurial activity and contains various entrepreneurial measures constructed based on surveys [23]. In addition, to address the research gap mentioned above, we use visualization techniques based on Kohonen self-organizing maps (SOM). The SOM method provides a nonlinear, ordered, smooth mapping of high-dimensional input data onto the elements of a regular, low-dimensional array [24]. It provides us with an understanding of how variables affect different patterns of entrepreneurs and how the level of entrepreneurship shifts in countries over time. The SOM has been widely applied in finance, economy and behavioral sciences [25-26]. However, SOM has not been applied in GEM analysis for some other reasons, regardless of the benefits it could bring.

This study aims to explore entrepreneurial patterns. We reviewed literature related to entrepreneurship to determine the direction of our research and identify factors that affect entrepreneurs, and we proposed several purposes of this study:

1. To identify and clarify how variables affect entrepreneurs within their own country.
2. To sort countries into clusters with discerning features.
3. To observe the shift in entrepreneurship in countries over time.
4. To observe how human and social capital affects entrepreneurs.
5. To observe how different cultures affect entrepreneurs.

6. To observe the differences in entrepreneurial patterns between higher GDP and lower GDP ranking countries.

2 Literature Review

2.1 Nascent entrepreneurship

In contrast to the general term of entrepreneurship, nascent entrepreneurship more accurately reflects the process of starting a business. In fact, only about half of the aspiring business founders entering into entrepreneurship are successful and established new organizations [27]. Therefore, studies taking samples in view of whether organizations created would easily face “survival” bias. Besides, asking successful entrepreneurs to recall the scenes and statuses in the old days might be intervened with “hindsight” bias [28]. To avoid the problems of survival and hindsight bias, researchers headed by Paul Reynolds[29] built two main specific data sets with attempts to solve the bias problems: the Panel Study of Entrepreneurial Dynamics (PSED) and the Global Entrepreneurship Monitor (GEM). Both data sets termed the respondents as “nascent entrepreneurs” and established three criteria for respondents. First, the respondent is trying to start a new business. Second, the new venture will be entirely or partly owned by the respondent. Third, the respondent has been active in starting a business in the past 12 months. By applying these criteria, we will not look at nascent intrapreneurs or evaluate the survival and growth pattern of active new firms. We will also not look at those who prefer being self-employed to being an employee [30], which is a group that can be labeled as latent entrepreneurs[31,32]. In this research, we adopt the definition of a nascent entrepreneur used by PSED and GEM to align our study with mainstream research studies.

2.2 Factors affecting nascent entrepreneurs

To realize how nascent entrepreneurs may successfully start their businesses is always a tough work for scholars in this field. Recent researches usually systematically gather the data of initial activities of representative nascent entrepreneurs, and keep track of these data [29]. Social capital denotes the norms and networks accelerating collective action[33] that is consistent with [34] definition about social capital, which could be divided as “cognitive” and “structural” manifestations. Social capital represent the actors’ ability to gain benefits through their memberships, social structure and networks. [35-38]. In the human capital theory, it considers that an individual’s ability could be enhanced by knowledge, and thus become more productive and efficient [39-41].

An investment in human capital includes experiences such as education and work experience; the outcomes of human capital investments are acquired knowledge and skills [42-44]. In addition to human and social capital, researchers have suggested that some other factors would influence entrepreneurs. At the macro level, [45-47] examined how some variables may influence entrepreneurship differently in different cultures (i.e., entrepreneurs may act differently due to their backgrounds). Accordingly, it is important to note that cultural context, such as social norms or other macro-level variables, is an important factor that influences entrepreneurship. At the individual level, age is widely considered to be a factor that affects entrepreneurial behavior. It has been suggested that as age increases, fewer individuals prefer self-employment [48,49]. In addition to age, gender is another important focus of entrepreneurial research. Previous studies reported that males are more likely than females to discover and exploit financial success or opportunities to create new products or technology [50,51].

In addition to the factors mentioned above, prior studies have added other variables to make the list of factors more exhaustive. For example, great deals of research focus on relationship between individual decision and work status, considering availability of employment options, originally employed individuals have greater chances to start new businesses [20]. Individuals may start new businesses due to satisfaction/dissatisfaction with their working status or (household) income status [52,53]. Also, opportunity perception, risk, and information ability are also factors determining whether individuals start new businesses [20]. Contín-Pilart and Larraza-Kintana [54] discussed the impact of social culture on individuals deciding to become an entrepreneur in view of role model, which proves the intervening effect of cultural distance and inhabit time on entrepreneur intention. While in the research done by Stedham, Stedham, Wieland and Wieland [9], they discussed whether the effect of masculine and different sexually discriminant level on individuals' entrepreneur intention.

As discussed above, we extracted culture (as defined by GEM), age, fear of failure, use of technology, work status and income status as our research variables.

3 Methodology

3.1 Research framework

According to the discussion above and considering the purposes of our research, we diagram the framework of this research as shown in Figure 1.

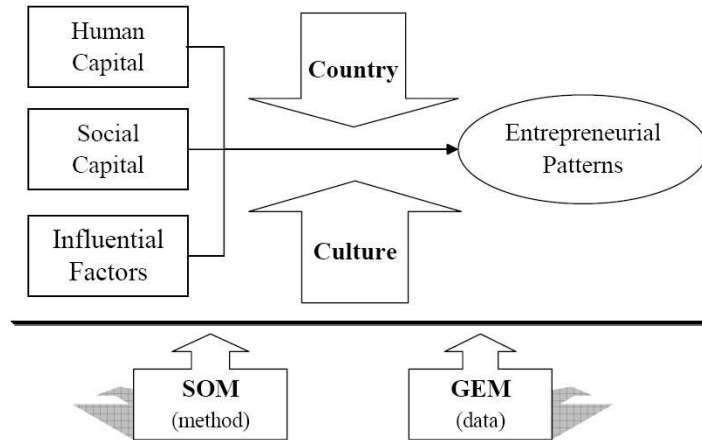


Figure 1 Research Framework

In contrast to the approach of multivariate analysis, the elements behind this research framework are that:

1. Human capital, social capital and other influential factors are not independent variables, and entrepreneurial patterns are not dependent variables.
2. In addition to micro-level variables, we add some macro-level variables to demonstrate the patterns of entrepreneurs.
3. We use the GEM as our data source to obtain multinational and longitudinal data of entrepreneurs; we use the SOM to solve statistical problems.

3.2 Measurement

To identify individuals in the process of starting a business, we define the variables as follows:

3.2.1 Criterion variables

The criterion variable is nascent entrepreneurs. To identify the respondents who were engaged in entrepreneurship and labeled as nascent entrepreneurs, respondents were asked the following three questions(GEM):

1. Are you, alone or with others, currently trying to start a new business, including self-employment, or selling any goods or services to others?
2. Over the past twelve months, have you done anything to help start a new business, such as looking for equipment or a location, organizing a start-up team, working on a business plan, beginning to save money, or any other activity that would help to launch a business?

3. Will you personally own all, part, or none of this business?

Respondents who answered “yes” to the first question were asked two more questions to separate those who were truly committed to a new business from those who were not yet committed to it. Those respondents who answered “yes” to question 2 and answered “all” or “part” to question 3 were labeled as nascent entrepreneurs.

3.2.2 Predictor variables

Our study includes individual- and country-level variables to account for nascent entrepreneur patterns. The detailed descriptions are shown in Table 1:

Table 1 Description of predictor variables

Variables	Descriptions of Variables	Original answers to question
Age	The respondents were asked to provide their year of birth.	
Experience	The respondents were asked to answer their experiences about owning or managing a business, any form of self-employment, or selling goods or services to anyone.	0=“No” 1=“Yes”
Knowing other entrepreneurs	Respondents were asked whether they knew someone who started a new business in the past 2 years.	0=“No” 1=“Yes”
Opportunity perception	Respondents were asked, “In the next six months, will there good opportunities for starting a new business in the area where you live?”	0=“No” 1=“Yes”
Skill	Respondents were asked whether they have the knowledge, skill and experience required to start a new business.	0=“No” 1=“Yes”
Fear of failure	Respondents were asked whether fear of failure would prevent them from starting a new business.	0=“No” 1=“Yes”
Career choice	Respondents were asked, “In your country, do most people consider starting a new business a desirable career choice?”	0=“No” 1=“Yes”
Social status	Respondents were asked, “In your country, do people who are successful at starting a new business have a high level of status and respect?”	0=“No” 1=“Yes”
Media	Respondents were asked, “In your country, will you often see stories in public media about successful new business?”	0=“No” 1=“Yes”

New technology	Respondents were asked, “How long have the technologies or procedures required for the product or service you provide been available?”	1=“Less than a year” 2=“Between one to five years” 3=“Longer than five years”
Work status	Respondents were asked to provide their working status.	1=“Full or part time” 2=“Part time only” 3=“Retired, disabled” 4=“Homemaker” 5=“Student” 6=“Not working, other” 7=“Self-employed”
Education	Respondents were asked to provide the highest degree they earned.	0=“None” 1=“Some secondary” 2=“Secondary degree” 3=“Post secondary” 4=“Graduate experience”
Income status	Respondents were asked to provide information about their household income.	1=“Lowest 33%” 2=“Middle 33%” 3=“Upper 33%”
Market expansion mode	Respondents were asked how they expect expansion to be in the market in which they start business.	1=“No market expansion” 2=“Some market expansion (no new technologies)” 3=“Some market expansion (new technologies)” 4=“Profound expansion”

Source: GEM

3.3 Method

The Kohonen SOM is a competitive artificial neural network algorithm that is based on unsupervised learning and is structured in two layers [55]. SOM is formed by two layers of units (neurons), in which input layer contains N neurons with correspondent input vector of dimension N. These units are then further linked with a second layer of units. Kohonen’s model usually is bi-dimensional and fully connected with a code vector, that is, weighted vector attached with each unit, or grid on the SOM output layer.

The training process is done with following phases in SOM: (a) competitive: through BMU (best match unit) with Euclidean distance measure, each input data is presented to all neurons to compete; (b) cooperative: units with neighborhood relationship from BMU are redefined with other neurons by the function $\eta(i, t)$ and (c) adaptive: an adaptive rule is applied to update the BMU and its neighbor’s weight vectors. During mapping process, a single winning neuron exists: whose weight vector located closest to the input vector through calculation of Euclidean distance.

SOM needs to be evaluated after the training procedure to determine whether further training is required. Quantization error (q_e) and topographic error (t_e) are usually applied to present the SOM quality. This study adopts classification quality to determine the optimal number of the clustering result with DB (Davies-Bouldin) index.

4 Results

4.1 Materials

GEM is the main data provider in this research which presents harmonized and international comparable data on entrepreneurial activity with considering individual, social and economic perceptions. The data are generated by surveys.

After applying two screening criteria, 10 countries were selected for our analysis in this study. First, we selected countries that participated in the GEM from 2011 to 2016. Second, we selected the top 5 and bottom 5 countries in terms of the GDP ranking provided by the United Nations. After screening, our survey database included the following country samples: Argentina (ARG), Germany (DEU), Denmark (DNK), Finland (FIN), France (FRA), United Kingdom (GBR), Ireland (IRE), Japan (JPN), United States (USA) and South Africa (ZAF).

To show country-level properties, we transformed our variables according to the arithmetic mean, the percentage of “yes” answers on items and the geometric mean rather than take them directly from the GEM database. In total, 8960 respondents were in the original data set; after transformation, 60 data points remained to represent the country-level properties, thus ensuring that each country and year is clearly mapped.

4.2 Results of the SOM

4.2.1 Component maps

Component maps shown in Figure 2 show the post-training vector prototype visualization that clearly point out the position of variables on the map. The estimated values are presented from red to blue zone on the component maps which indicating values from high to low in a vertical, horizontal or diagonal manner.

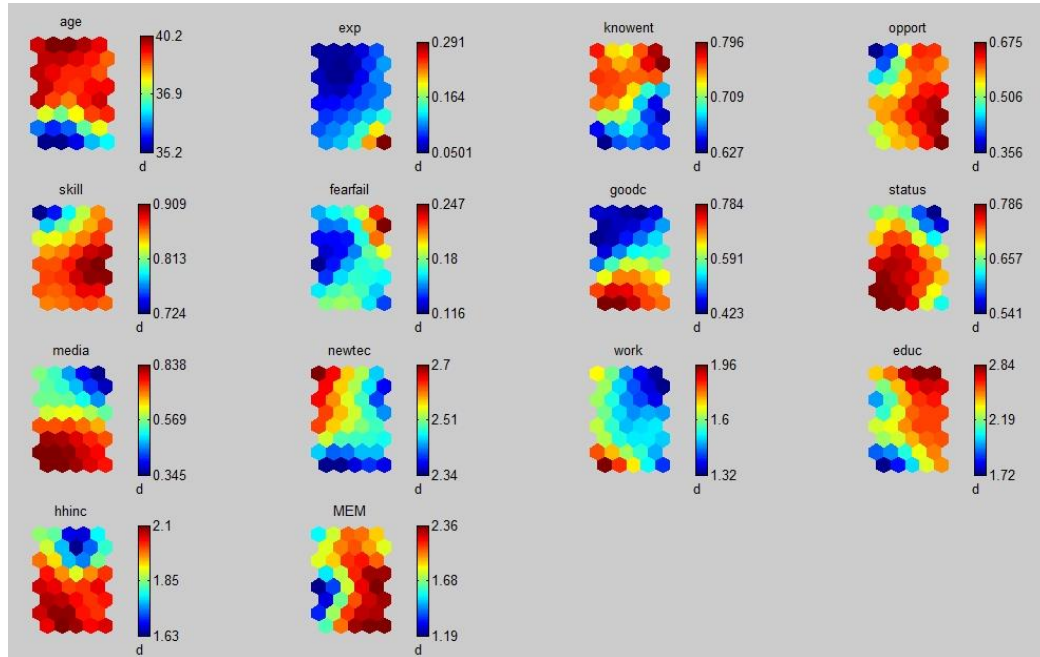


Figure 2 Component maps

4.2.2 Analysis of clusters

Figure 3 Display a clustered U-matrix generated from data training through the SOM.

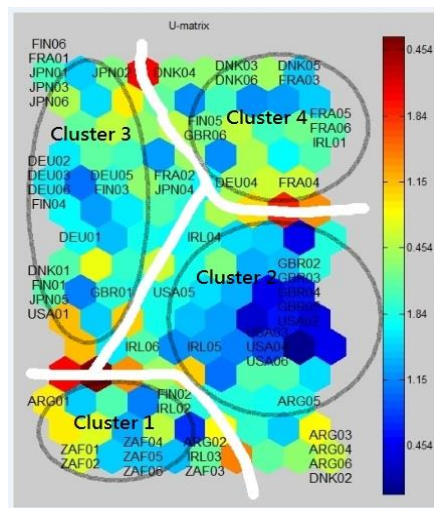


Figure 3 Clustered U-matrix

The results of the entrepreneurial patterns are summarized in Table 2, which shows the countries included in each cluster and the distinguishing features of the clusters.

Table 2 Division of countries into clusters

Clusters	Countries	Distinguishing Characteristics
<i>Cluster 1</i> <i>Courageous entrepreneurs</i>	Mainly South Africa; some Argentina, Finland and Ireland	<ul style="list-style-type: none"> ● Younger ● Know fewer entrepreneurs ● Stronger cultural support of entrepreneurship ● Use of novel technologies ● Relatively unstable work status ● Relatively lower level of education ● Higher income among respondents in the same country
<i>Cluster 2</i> <i>Experienced entrepreneurs</i>	Mainly U.S., U.K. and Argentina; some Ireland and Denmark	<ul style="list-style-type: none"> ● Managing experience ● Know fewer entrepreneurs ● Better opportunity perception ● Skills to start new businesses ● Higher income among respondents in the same country
<i>Cluster 3</i> <i>Conservative entrepreneurs</i>	Mainly Japan, Finland and Germany; some France, Denmark and U.S.	<ul style="list-style-type: none"> ● Older ● No managing experience ● Know some other entrepreneurs ● Low opportunity perception ● No skills to start new business ● No fear of failure ● Low use of novel technologies
<i>Cluster 4</i> <i>Compensative entrepreneurs</i>	Mainly Denmark and France; some Finland, Ireland, Germany and U.K.	<ul style="list-style-type: none"> ● Older ● Know more other entrepreneurs ● Some opportunity perception ● Fear of failure ● Weak cultural support of entrepreneurship ● Stable work status ● Highest level of education

Cluster 1: the courageous entrepreneurs

Cluster 1 is located in the bottom left corner of the map and can be defined as the cluster of countries with young and courageous nascent entrepreneurs. The average age of this cluster is lower than that of the other clusters. These nascent entrepreneurs use novel technologies, and their social network is relatively weak, which means that they may not be able to obtain information or support from other entrepreneurs, but they could use the latest technologies for starting a new business. They do not have a higher education than others,

and their work status is relatively unstable (although their income level is within the upper 33% of their countries), but their confidence that they have the skills to start new ventures, as well as cultural support (shown in career choice, social status and media), drives them into entrepreneurial activities.

Cluster 2: the experienced entrepreneurs

Cluster 2 is located in the lower right block of the map and can be defined as the cluster of countries with experienced nascent entrepreneurs. Entrepreneurs in this cluster have more confidence to start new businesses and more managing experience. In addition, these entrepreneurs have higher education degrees and are therefore better at perceiving opportunities for starting new ventures. They are also more optimistic in regard to future market expansion, which corresponds to prior studies that show that human capital may influence opportunity perception[35,56]. Although the entrepreneurs in this cluster have higher income than others in their countries, their experience, confidence in the skills needed to start new ventures and opportunity perception all motivate them to pursue entrepreneurial activities.

Clusters 3 and 4: the conservative and compensative entrepreneurs

Clusters 3 and 4 are located on the upper side of the map. These two clusters have some similarities and can only be distinguished by a few factors. The average age of the entrepreneurs in Clusters 3 and 4 is higher. They know some other entrepreneurs who can provide them with information or support, but they do not have much managing experience. Their average income level is in the middle to lower 33% in their countries, and their social culture does not strongly support entrepreneurship. Despite the similarities, entrepreneurs in Cluster 3 have less opportunity perception, fewer skills to start new businesses and a lower education level than those in Cluster 4. Entrepreneurs in Cluster 4 have a greater fear of failure and a more stable work status. For these reasons, entrepreneurs in Clusters 3 and 4 can be clearly distinguished. Cluster 3 can be defined as the cluster of countries with conservative entrepreneurs due to their lack of confidence in their skills and their low use of novel technologies. In other words, entrepreneurs in Cluster 3 cannot perceive entrepreneurial opportunities and do not have the skills for starting new ventures, so they use less novel technologies to start their new businesses. On the other hand, entrepreneurs in Cluster 4 are driven by their higher degree of education, opportunity perception and confidence in their skills to start new businesses. In other words, entrepreneurs in Cluster 4 rely on their strength of knowledge, perception of opportunity and strong social networks to counter their fear of failure. The anxiety surrounding failure is viewed as their most

prominent weakness. Thus, Cluster 4 can be defined as the cluster of countries with compensative entrepreneurs. Overall, each of the clusters has its own unique feature, and therefore we can identify the entrepreneurial patterns of these countries.

4.2.3 Analysis of path

To show the path of national movements, we drew two routes to represent higher GDP ranking and lower GDP ranking countries (as shown in Figure 4).

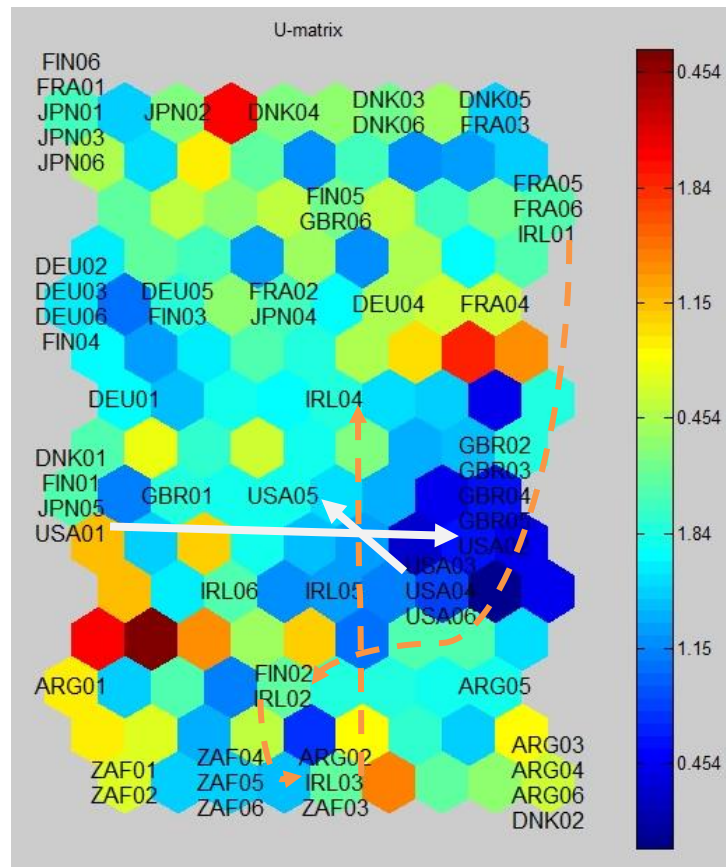


Figure 4 Routes of Countries

The United States, a country with a relatively high GDP ranking, was located in Cluster 3, with a pattern shift to Cluster 2 in 2012. Although the entrepreneurial pattern of the U.S. shifted slightly after 2012, it still remained close to its original pattern. This indicates that the entrepreneurial pattern in the United States would not easily change over time unless an abnormal event occurred; however, other high-ranking countries' patterns could easily change over time. On the other hand, Ireland, a country with a lower GDP ranking, shifted drastically across half of the map. This shift shows that Ireland's entrepreneurial pattern was without specific characteristics, which means we could observe

a variety of entrepreneurs in Ireland and there is no single pattern which is representative of entrepreneurs. The reason why the entrepreneurial patterns of lower-ranking countries were scattered over the map remains unclear.

In summary, the results of our analysis show an interesting outcome. The patterns in higher-ranking countries are fixed in specific clusters, whereas patterns in lower-ranking countries are scattered and moved across clusters. In addition, patterns in higher-ranking GDP countries seemed to be surrounded by nearby lower-ranking GDP countries; however, whether these countries will interact with each other or not still needs to be clarified.

5. Conclusions and suggestions

5.1 Conclusions and propositions

In this study, we found that each of the factors that we evaluated are influential in entrepreneurial behavior and further drive nascent entrepreneurs into “specific” patterns. For example, Cluster 1 (the courageous entrepreneurs) is characterized by younger age, social/cultural support, unstable working status and higher income (within the same country). These entrepreneurs get involved in entrepreneurial activities because of their dissatisfaction with their work[52,53]; therefore, with social/cultural support and high income (which allows them to have more money available), they tend to start their new businesses while they are still young. This corresponds to previous studies that demonstrate that age and social/cultural support are influential to entrepreneurs [48,49,57]. However, if we remove one variable or insert another variable, Cluster 1 may no longer exist or transform into another shape, and the explanation of clusters may become more accurate or inaccurate. Thus:

Proposition 1: If more factors are included in the analysis, we can more accurately predict entrepreneurs.

Second, we found that the shift in countries over time is connected with their economic growth and/or may be influenced by events that affect the international landscape. We found that countries with higher GDP rankings were fixed in a specific cluster, whereas countries with lower GDP rankings were scattered over the map. This indicates that entrepreneurs in higher-ranking countries are in a stable environment for economic development and that opportunities for entrepreneurship exist in various fields; therefore, the direction of entrepreneurship may not deviate much unless extraordinary events occur. However, entrepreneurs in lower-ranking countries are in a relatively unstable economic environment and opportunities may suddenly appear and then disappear in different fields; therefore, they

encounter unpredictable and multidirectional opportunities for starting new businesses. As a result, these entrepreneurs do not stick to a specific cluster. Thus:

Proposition 2: In a country with a higher GDP ranking, entrepreneurs are more likely to follow certain patterns of entrepreneurship.

Proposition 3: In a country with a lower GDP ranking, entrepreneurs are more likely to show multiple patterns of entrepreneurship.

Finally, we are somewhat surprised by the composition of clusters. The composition of clusters does not fit with the stereotypes of certain countries. For example, we usually think that when compared to other countries, the culture in the United States is more supportive of entrepreneurial activities. However, our results suggest that South Africa's culture is the most supportive of entrepreneurial activities. In addition, prior research indicated that higher education may lead to better opportunity perception; however, our results suggest that higher education does not prevent entrepreneurs from having a fear of failure. Our research indicates that education and knowledge are not sufficient to disperse psychological anxiety. Thus:

Proposition 4: Stereotypes cannot be used to predict what entrepreneurs would do.

Proposition 5: Acquired learning cannot fully compensate for innate psychological barriers.

In summary, our results correspond to our purposes: first, to identify how variables affect entrepreneurs in each country; second, to sort countries into clusters with discerning features; and third, to observe the shift of entrepreneurial activities in countries over time. Our research also provides a non-statistical method to avoid statistical problems when using cross-country and multi-scale data.

5.2 Implications

The implications of this research are multidimensional. First, the selection of variables and countries provides a good illustration of entrepreneurs' patterns. Because previous research had identified strong connections between certain factors, the factor component map and even the country itself both contribute to the meaningful clusters. This finding suggests that commenting on which cluster is better is without substantial value; however, it is useful to recognize each cluster's unique characteristics to further enhance the entrepreneurs' strengths and compensate for their weaknesses.

Second, the SOM has some additional benefits compared to traditional statistical methods. Given its ability to visualize data, the SOM can demonstrate data with different

scales in cluster maps at the same time, which traditional statistical methods cannot easily do. In addition, in this study, the SOM enabled us to observe the differences between higher- and lower-ranking countries. This leads to an unambiguous finding that even across higher-ranking countries, characteristics of entrepreneurs are significantly different.

Finally, even though the SOM (as far as we know) is not a predictive method, and therefore the definition of our variables as predictor and criterion variables may not be appropriate, our results indicate that, as mentioned above, the higher-ranking countries will stay in the same cluster unless a major event occurs and that lower-ranking countries are scattered across the map. Based on this result, it is our opinion that entrepreneurial patterns in higher-ranking countries will stay in the same clusters over the next few years, unless a major event occurs or we add a new variable. For lower-ranking countries, the patterns will remain scattered unless an extraordinary event affects the national economy.

5.3 Suggestions

In this study, we provide suggestions for future research. First, we suggest that research on the GEM can adopt data on the national level to avoid the phenomenon of data distortion and provide a sufficient quantity of samples. Furthermore, future research should try to obtain longitudinal data, which might better demonstrate the patterns over time. In addition, future research should increase the number of variables investigated, because patterns of entrepreneurs cannot be characterized using only 14 factors. Finally, the results provide a suggestion for each country included in the analysis. For example, countries in the compensative cluster should enact public policies to reduce the fear of failing. Countries in the courageous cluster should provide courses that teach the basics of problem solving.

References

- [1] Gartner, W. (1988). Who is an entrepreneur? Is the wrong question. *American Journal of Small Business*, 12(4), 11-32.
- [2] Bird, B. (1989). *Entrepreneurial Behavior*. Scott, Foresman and Company, IL: Glenview.
- [3] Shane, S. & Venkataraman, S. (2000). The promise of entrepreneurship as a field of research. *Academy of Management Review*, 25(1), 217-226.
- [4] Aldrich, H. E. & Martinez, M. A. (2001). Many are called but few are chosen: an evolutionary perspective for the study of entrepreneurship. *Entrepreneurship Theory & Practice*, 25, 41-56.
- [5] Baron, R. A. (2004). The cognitive perspective: a valuable tool for answering entrepreneurship's basic "why" questions. *Journal of Business Venturing*, 19(2), 221-239.
- [6] Shane, S. (2003). *A General Theory of Entrepreneurship: The Individual-Opportunity Nexus*. Cheltenham: Edward Elgar Publishing.
- [7] Nicolaou, N. & Shane, S. (2009). Can genetic factors influence the likelihood of engaging in entrepreneurial activity? *Journal of Business Venturing*, 24(1), 1-22.
- [8] Coteleur, C. A., King, S. & Solomon, G. (2003). Parental and gender influences on entrepreneurial intentions, motivations and attitudes. Paper presented at the conference of United States Association for Small Business and Entrepreneurship, Hilton Head, SC.
- [9] Stedham, Y., Stedham, Y., Wieland, A., & Wieland, A. (2017). Culture, benevolent and hostile sexism, and entrepreneurial intentions. *International Journal of Entrepreneurial Behavior & Research*, 23(4), 673–687.
- [10] Micozzi, A., Micozzi, A., Lucarelli, C., & Lucarelli, C. (2016). Heterogeneity in entrepreneurial intent: the role of gender across countries. *International Journal of Gender and Entrepreneurship*, 8(2), 173–194.
- [11] Muñoz-Bullón, F., Sánchez-Bueno, M. J., & Vos-Saz, A. (2015). Nascent entrepreneurs' personality attributes and the international dimension of new ventures. *International Entrepreneurship and Management Journal*, 11(3), 473–492.
- [12] Brinckmann, J., & Kim, S. M. (2015). Why we plan: the impact of nascent entrepreneurs' cognitive characteristics and human capital on business planning. *Strategic Entrepreneurship Journal*, 9(2), 153–166.

- [13] Reynolds, P. D. & Sammis B. W. (1997). *The Entrepreneurial Process. Economic Growth, Men, Women, and Minorities.* Westport, Connecticut, and London: Quorum Books.
- [14] Davidsson, P. & Honig, B. (2003). The role of social and human capital among nascent entrepreneurs. *Journal of Business Venturing*, 18(3), 301-331.
- [15] Dvira, D., Sadehb, A., & Malach-Pines, A. (2010). The fit between entrepreneurs' personalities and the profile of the ventures they manage and business success: An exploratory study. *The Journal of High Technology Management Research*, 21(1), 43-51.
- [16] Lerner, M., & Avrahami, Y. (2002). *Global Entrepreneurship Monitor: Israel Executive Report.* Tel Aviv: Tel Aviv University.
- [17] Zacharakis, A. L., & Shepherd, D. A. (2001). The nature of information and overconfidence on venture capitalists' decision making. *Journal of Business Venturing*, 16(4), 311-332.
- [18] Uhlaner, L., & Thurik, R. (2007). Post-Materialism: A Cultural Factor influencing Total Entrepreneurial Activity across Nations. *Journal of Evolutionary Economics*, 17, 161-185.
- [19] Stel, A. V., Storey, D. J., & Thurik, A. R. (2007). The Effect of Business Regulations on Nascent and Young Business Entrepreneurship. *Small Business Economics*, 28(2-3), 171-186.
- [20] Arenius, P., & Minniti, M. (2005). Perceptual Variables and Nascent Entrepreneurship. *Small Business Economics*, 24(3), 233-247.
- [21] Engelen, A., Heinemann, F., & Brettel, M. (2009). Cross-cultural entrepreneurship research: Current status and framework for future studies. *Journal of International Entrepreneurship*, 7(3), 163-189.
- [22] Sternberg, R, & Wennekers, S. (2005). Determinants and Effects of New Business Creation Using Global Entrepreneurship Monitor Data. *Small Business Economics*, 24, 193-203.
- [23] Amorós, J. E., & Cristi, O. (2008). Longitudinal analysis of entrepreneurship and competitiveness dynamics in Latin America. *International Entrepreneurship and Management Journal*, 4(4), 381-399.
- [24] Uriarte, E. A., & Martín F. D. (2006). Topology Preservation in SOM. *World Academy of Science, Engineering and Technology.* Retrieved January 30, 2010, from the world wide web: <http://www.waset.org/>.
- [25] Carlei, V., Colantonio, E., Furia, D., & Mattosco, N. (2010). Economic patterns of sustainable development: an analysis of absolute ecological footprint through

- self-organizing map. *Quality & Quantity*, 45(1), 157-171. doi:10.1007/s11135-010-9362-4.
- [26] Häkkinen, P. M. (2000). Neural network used to analyze multiple perspectives concerning computer-based learning environments. *Quality and quantity*, 34(3), 237–258.
- [27] Aldrich, H. E. (1999). *Organizations Evolving*. Newbury Park, CA: Sage.
- [28] Johnson, P. S., Parker S. C., & Wijbenga F. (2006). Nascent Entrepreneurship Research: Achievements and Opportunities. *Small Business Economics*, 27(1), 1-4.
- [29] Reynolds, P. D. (2016). Start-up Actions and Outcomes: What Entrepreneurs Do to Reach Profitability. *Foundations and Trends® in Entrepreneurship*, 12(6), 443–559.
- [30] Wagner, J. (2004). *Nascent Entrepreneurs*. IZA Discussion Papers, No. 1293, Institute for the Study of Labor (IZA).
- [31] Blanchflower, D. G., Oswald, A. & Stutzer, A. (2001). Latent entrepreneurship across nations. *European Economic Review*, 45(4-6), 680-691.
- [32] Blanchflower, D. G. (2004). Self-employment: More may not be better. *Swedish Economic Policy Review*, 11(2), 15-74.
- [33] Woolcock, M. (1998). Social Capital and Economic Development: Toward a Theoretical Synthesis and Policy Framework. *Theory and Society*, 27(2), 151-208.
- [34] Uphoff, N. (1990). Paraprojects as new modes of international development assistance. *World Development*, 18(10), 1401-1411.
- [35] Lin, N., Ensel, W., & Vaughn, J. (1981). Social resources and strength of ties: structural factors in occupational status attainment. *American Social Review*, 46(4), 393-405.
- [36] Portes, A. (1998). Social capital. *Annual Review of Sociol*, 23(1), 1-24.
- [37] Fornoni, M., Arribas, I., & Vila, J. E. (2011). Measurement of an individual entrepreneur's social capital: a multidimensional model. *International Entrepreneurship and Management Journal*, 1–13.
- [38] Fuentes Fuentes, M. del M., Ruiz Arroyo, M., Bojica, A. M., & Fernández Pérez, V. (2010). Prior knowledge and social networks in the exploitation of entrepreneurial opportunities. *International Entrepreneurship and Management Journal*, 6(4), 481-501. doi:10.1007/s11365-010-0136-1
- [39] Schultz, T. (1959). Investment in man: an economist's view. *Social Service Review*, 33(2), 69-75.
- [40] Becker, G.S. (1964). *Human Capital*. Chicago: University of Chicago Press.
- [41] Mincer, J. (1974). *Schooling, Experience and Earnings*. New York: Columbia Univ. Press.

- [42] Unger J. M., Rauch, A., Frese, M., Rosenbusch N. (2009). Human capital and entrepreneurial success: A meta-analytical review, *Journal of Business Venturing*, Retrieved October 31, 2009, from the World Wide Web: <http://www.sciencedirect.com>.
- [43] Hormiga, E., Batista-Canino, R. M., & Sánchez-Medina, A. (2010). The role of intellectual capital in the success of new ventures. *International Entrepreneurship and Management Journal*, 7(1), 71-92. doi:10.1007/s11365-010-0139-y
- [44] Liñán, F. (2008). Skill and value perceptions: how do they affect entrepreneurial intentions? *International Entrepreneurship and Management Journal*, 4(3), 257-272. doi:10.1007/s11365-008-0093-0
- [45] Jones, K. (2000). Psychodynamics, gender, and reactionary entrepreneurship in Metropolitan Sao Paulo, Brazil. *Women in Manage Review*, 15(4), 207-215.
- [46] Hechavarría, D. M., & Reynolds, P. D. (2009). Cultural norms & business start-ups: the impact of national values on opportunity and necessity entrepreneurs. *International Entrepreneurship and Management Journal*, 5(4), 417-437. doi:10.1007/s11365-009-0115-6
- [47] Lee, S. M., Lim, S.-bae, & Pathak, R. D. (2009). Culture and entrepreneurial orientation: a multi-country study. *International Entrepreneurship and Management Journal*, 7(1), 1-15. doi:10.1007/s11365-009-0117-4
- [48] Grilo, I. & Irigoyen, J. M. (2006). Entrepreneurship in the EU: To wish and not to be. *Small Business Economics*, 26(4), 305-318.
- [49] Henley, A. (2007). Entrepreneurial aspiration and transition into self-employment: evidence from British longitudinal data. *Entrepreneurship & Regional Development*, 19(3), 253-280.
- [50] Carter, N. M., Gartner, W. B., Shaver, K. G., & Gatewood, E. J. (2003). The Career Reasons of Nascent Entrepreneurs. *Journal of Business Venturing*, 18(1), 13-39.
- [51] Arenius, P., & Ehrstedt, S. (2008). Variation in the level of activity across the stages of the entrepreneurial startup process -evidence from 35 countries. *Estudios de Economía*, 35(2), 133-152.
- [52] Kihlstrom, R., & Laffont, J. (1979). A General Equilibrium Entrepreneurial Theory of Firm Formation Based on Risk Aversion. *Journal of Political Economy*, 87(4), 719-740.
- [53] Evans, D., & Jovanovic, B. (1989). An Estimated Model of Entrepreneurial Choice Under Liquidity Constraints. *Journal of Political Economy*, 97(4), 808-827.

- [54] Contín-Pilart, I., & Larraza-Kintana, M. (2015). Do entrepreneurial role models influence the nascent entrepreneurial activity of immigrants? *Journal of Small Business Management*, 53(4), 1146–1163.
- [55] Kohonen, T. (2001). *Self-organizing maps*. Springer. Third Edition.
- [56] Dimov, DP, and Shepherd, DA (2005) Human capital theory and venture capital firms: Exploring “Home Runs” and “Strike Outs”. *Journal of Business Venturing*, 20(1), 1-21.
- [57] Carsurd, A., Brauml, M., Elfving, J., Kickul, J., & Krueger, N. (2006). Florida International University. Pino Global Entrepreneurship Center. Working Paper.