Original Paper

Application of factor analysis to measure social capital in Slovak districts

Lukáš Varecha[*]

Slovak University of Agriculture in Nitra, Faculty of European Studies and Regional Development, Department of Regional and Rural Development, Nitra, Slovakia

ABSTRACT

Factor analysis is a technique particularly suitable for analysing the patterns of complex, multidimensional relationships. Given the multidimensional nature of social capital, a plethora of indicators is often utilized for measurement purposes. In this paper, we utilize factor analysis to explore patterns of social capital and to identify spatial differentiation in the level of social capital at the level of Slovak districts. Three factors have been extracted. The first factor represents low level of bridging social capital, the second factor represents activities of associations and the third factor represents low level of bonding social capital. Factor scores of extracted factors have been visualized in order to explore spatial differentiation of social capital. Visualisation shows significant differences in the levels of individual forms of social capital in Slovak districts.

KEYWORDS: social capital, factor analysis, social network, districts

JEL CLASSIFICATION: O43, C10

INTRODUCTION

Social capital is considered to be a multidimensional concept involving relationships and contacts between actors of social groups and networks, as well as trust in other members of the group or network, the entire community or the whole society and its institutions [4, 7]. Since the early 1990s, the concept of social capital has become a subject of broad attention. It became popular mainly thanks to the research of Burdieu [3], Coleman [4], and Putnam, Leonardi, and Nanetti [15]. The first two mentioned authors conducted analysis on a micro level (individuals, small groups). The latter authors analysed social capital on a macro level (Italian municipalities) and they considered it not as an individual asset but as an attribute of the community itself. They defined it as "features of social life – networks, norms, and trust". This concept is also perceived as a tool for explaining the differences in the economic development of the regions [6].

Measuring social capital is relatively complex. This is due to the amount of its definitions and also to a large number of its forms (especially individual and collective, bonding, bridging

---

[*] Corresponding author: Lukáš Varecha, Slovak University of Agriculture, Faculty of European Studies and Regional Development, 949 76 Nitra, Slovakia, e-mail: xvarecha@uniag.sk

and linking, structural and cognitive) [12]. Bonding social capital represents trust between individuals in close, homogeneous groups. Bridging social capital connects different groups of actors, who are similar in terms of hierarchical status in society. Weak ties are characteristic for this form of social capital. Weak ties and social trust in the territory facilitate access to other forms of capital [6]. Linking social capital represents a network of relationships where individuals interact at different hierarchical levels and enables the acquisition of information, resources and power [18]. Enhanced trust among actors in community facilitates the transfer of information and reduction of transaction costs [14]. In the context of regional development, it is of paramount importance to link regional actors with actors at a higher hierarchical level, who are able to provide external resources [19]. In the context of rural development, the importance of informal relations in Slovak conditions was confirmed by Melichová [11].

Multidimensional nature of social capital cannot be represented by a single indicator. Many authors (for example Putnam [14]) rely on broad sets of indicators to measure social capital. Van Deth [21] states that the most commonly used indicators are measures of voluntary association activities and measures of personal and social trust. A problem is the usage of macro indicators not directly related to social capital components. It is not clear whether they measure the social capital directly or just its outcomes. Using believed outcomes of social capital as indicators may lead to situation where we falsely attribute a change of outcome as an effect of social capital [16]. The confounding number of various aspects, characteristics, indicators, or dimensions of social capital makes a common operationalization problematic [21].

Factor analysis is a technique suitable for analysing the patterns of multidimensional relationships and can be utilized to examine the underlying structure of a large number of variables and to determine whether the information can be condensed in a smaller set of factors [8]. Subsequently, we can assert that variables more associated with similar factors can also be conceptually grouped with each other [20]. Many authors [6, 16, 20] utilized factor analysis in order to assess the impact of broad set of social capital indicators more effectively. At sub-national level, this analysis has been conducted in Czech Republic [12], Poland [6] or Italy [16].

MATERIAL AND METHODS

The aim of the paper is to demonstrate the application of factor analysis in exploring and identifying patterns of social capital dimensions in Slovakia and to explore spatial differentiation of social capital at the level of Slovak districts. Due to the unavailability of part of the data, the districts of Kosice and Bratislava (missing data about voluntary associations) and remaining districts of the Bratislava region (ROP indicator not applicable), were not included in the analysis. Data of 67 districts was therefore used as an input for factor analysis. According to Hair et al. [8], an input for this analysis should have a minimum of 50 observations – we met this condition. It is also necessary that the number of observations is greater than the number of variables at least in the ratio of 5 observations to 1 variable. For 67 observations and 10 variables, this condition is met.

We have used ten indicators as an input into the analysis. The first three indicators are the number of the social and health voluntary associations, sport voluntary associations, and trade unions per 1,000 inhabitants. In order to enhance these indicators, we have used not only the

residences of voluntary associations, but also their individual organizational units, which helps to reflect their spatial localisation in an improved way. The role of voluntary associations is emphasized by Putnam [13, 14]. He claims that they are able to link people from different social backgrounds. Bonds and contacts emerge and social networks form common norms and values. The most beneficial are activities that are undertaken directly in order to develop the local community [13]. By selecting multiple types of associations, we analyse multiple types of social networks.

Table 1 Selected social capital indicators

Indicator	Description	Year	Source
SP	Number of sport voluntary associations per 1,000 inhabitants	2017	MVSR
TRA	Number of trade unions per 1,000 inhabitants	2017	MVSR
SH	Number of social and health voluntary associations per 1,000 inhabitants	2017	MVSR
EDU	Education index [10] $EDU = 1*P_{elementary} + 2*P_{lower\ secondary} + 3*P_{upper\ secondary} + 4*P_{university}$ where P_x are ratios of inhabitants in respective category.	2011	SODB
ELEC	Voter turnout in parliamentary elections	2016	DATACUBE
NFRA	National fractionalisation [2] $NFRA = 1 - \sum_{i=1}^{N} p_i^2$ (i = 1,2,..., N), where p_i is a ratio of nationality on population; N is the number of nationalities.	2016	DATACUBE
ROP	Funds received from Regional Operational Programme in the 2007 – 2013 programming period per inhabitant.	2007 - 2015	ITMS
SUI	Average number of suicides including attempts per 1,000 inhabitants	2014, 2015, 2016	National health information center
DIV	Average divorce index	2014, 2015, 2016	DATACUBE
UNM	Unemployment rate	2016	DATACUBE

Source: own processing

Education index is another indicator of bridging social capital. It represents the level of human capital. Human and social capitals are mutually contingent. By creating social networks, there is an accumulation of individual human capital and it is transformed into social capital. Strengthening the level of human capital can thus lead to strengthening the cooperative character of social and institutional networks [9, 12]. The indicator of electoral participation represents the institutional dimension of social capital. It reflects the level of development of civil society and can express public interest in public affairs [9]. The formation of social capital is also affected by the heterogeneity of the community [4]. Individual can avoid members of other social groups and limit bridging social capital [1].

In the context of Slovak Republic, the level of national fractionalizations appears to be an appropriate indicator. Some researchers consider the consequences of a lack of social capital as inverse measures of this concept. For example they use crime rates or low levels of economic growth, which point to the absence of social capital. In this way, we utilized two indicators, measuring the lack of bonding social capital. We use divorce index and suicide rates including attempts per 1,000 inhabitants. These phenomena are tied to economic and social uncertainty [20]. The amount of ROP funds received in the programming period 2007 - 2013 reflects the ability of different actors to receive support from this program. We consider this an indicator of linking social capital. Following Sýkora and Matoušek [19], we have chosen the unemployment rate as an indicator of the "success" of social capital in regional development. Unemployment can lead to the decline of social networks of the individual and social exclusion. Unemployed people often do not have access or resources to participation in society and have limited opportunities to interact with other people [17].

RESULTS AND DISCUSSION

Since the factor analysis assumes the existence of mutual linear dependence of the variables, we inspect the correlation matrix (Table 2). Before we utilize factor analysis it is necessary to verify the assumption that the input variables are correlated with each other. We can observe that using Pearson correlation coefficient, majority of variables are significantly correlated. This indicates suitability for factor analysis. The overall measure of the suitability of the data is measured by Kaiser-Meyer-Olkin MSA statistic [8]. In our case its value is 0.774. We also examined the anti-image correlation matrix and the values of MSA on the main diagonal are greater than 0.5. Bartlett's test of sphericity showed significance ($p < 0.05$). Based on the KMO criterion, and also based on the Bartlett's test of sphericity, we consider input data suitable for the use of factor analysis.

Table 2 Correlation matrix of input variables

	ROP	SP	TRA	SH	EDU	ELEC	SUI	DIV	UNM	NFRA
ROP	1.000									
SP	-.386**	1.000								
TRA	-.012	.459**	1.000							
SH	-.426**	.580**	.456**	1.000						
EDU	-.377**	.627**	.361*	.573**	1.000					
ELEC	-.261*	.397**	.076	.246*	.647**	1.000				
SUI	-.312**	.186	-.196	.129	.037	-.005	1.000			
DIV	-.389**	.301**	-.073	.268*	.052	-.120	.377**	1.000		
UNM	.384**	-.415**	.068	-.325**	-.608**	-.693**	-.164	-.159	1.000	
NFRA	.164	-.163	.102	-.101	-.455**	-.764**	.098	.109	.553**	1.000

* significant at 5 %, ** significant at 1 %
Source: own processing, SPSS

As a method of factor extraction, we have used the principal components analysis. We applied the rule of retention of factors with values of eigenvalues greater than 1.0. This condition was

met by three factors which together explained 73.19 % of variability, a sufficiently high percentage. The choice of three factors was confirmed by the scree plot. By combining these criteria, we have come to the conclusion keep three factors. After examining communalities, we assume that the factors explain a sufficient amount of variability of each of the variables. Since there were only slight variations in different rotations, we decided to apply orthogonal rotation of varimax. According to Hair et al. [8], it is necessary to take into account that with the decreasing number of observation, the value of the factor loading considered significant increases. In the case of 70 observations they consider a factor loading greater than 0.65 as significant. The resulting rotated matrix of factor loadings contains significant values for all variables. In the case of one variable (EDU), factor loadings are high two factors. However, factor loadings have different signs. Factor loadings of variables are displayed in the Table 3. Only factor loadings greater than 0.4 are displayed.

Table 3 Factor loadings after varimax rotation

	Component		
	1	2	3
ELEC	-.912		
NFRA	.882		
UNM	.807		
EDU	-.637	.620	
TRA		.854	
SH		.775	
SP		.747	
DIV			.788
SUI			.766
ROP			-.643

Source: own processing, SPSS

The first factor explains 38.19 % of the variability. In the case of this factor, two variables have high positive factor loadings (nationality fractionalization, unemployment rate) and two have high negative factor loadings (voter turnout, education index). This factor represents the low level of bridging social capital resources. This is caused by the combination of low level of human capital, unemployment, and high national fractionalization, resulting in a lack of weak ties, meaning a low potential of information accumulation and transfer. This leads to low civic participation and an undeveloped civil society. We refer to this factor as to "Isolation". However, considering the national fractionalization in the context of Slovakia as the cause of low bridging social capital is questionable as it is given by historical context. It is stable and not caused, for example, by sudden migration. Spatial differentiation of the extracted factors is visualized using their factor scores (Figure 1). Indeed, the least developed districts in the southern and eastern Slovakia have the highest factor scores, namely districts of Revúca, Rimavská Sobota and Rožňava.

The second factor explains additional 18.89 % of variability and it is positively correlated with four variables. Three of these variables represent activities of the chosen associations – sport voluntary, associations, social and health voluntary associations and trade unions. The remaining variable is the education index, which also has a positive factor loading. This factor

represents diverse social networks and in combination of high level of human capital these variables represent resources for the creation and accumulation of bridging social capital. We name this factor "Associational activity". A possible limitation of this factor may be the fact that it is only the number of associations and does not account for the number of their members or the scope of their activity. This problem may be partly alleviated by the above-mentioned inclusion of organizational units of associations. Spatial differentiation of this factor is significantly different, with the highest factor scores in central Slovakia. In the context of regional development, low associational activity (districts of Detva and Poltár) may partially explain their development difficulties.
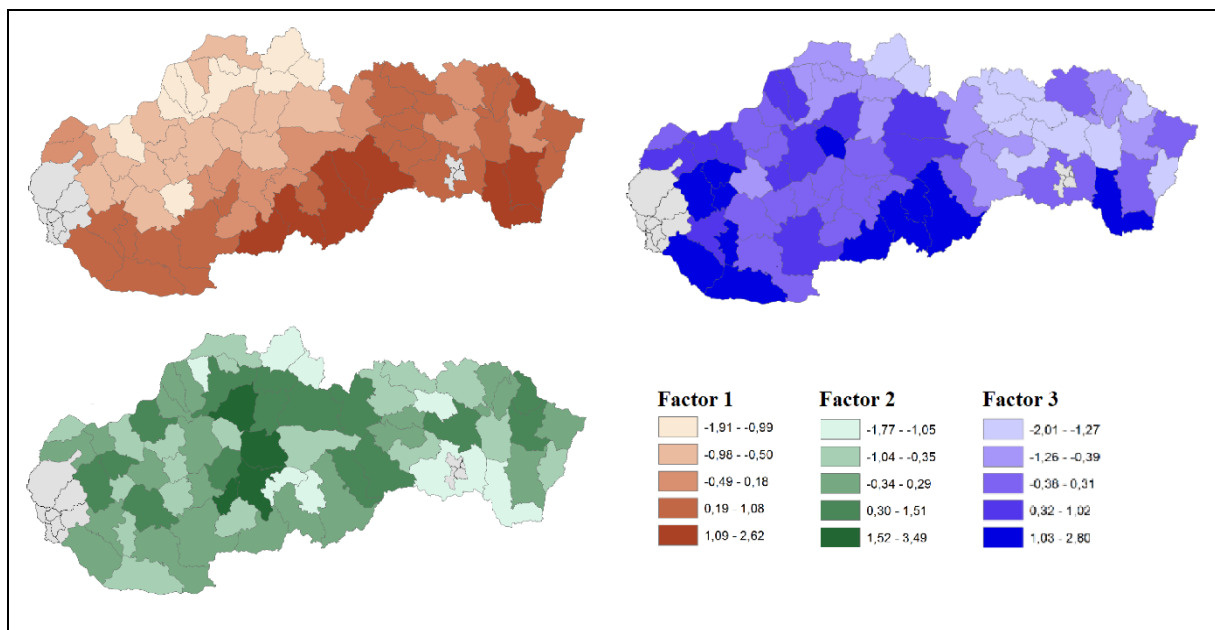

Figure 1 Factor scores of the three extracted factors
Source: own processing, ArcGis

The third extracted factor explains 16.02 % of variability. It comprises of negative societal phenomena − average divorce index and average number of suicides including attempts per 1,000 inhabitants have high positive factor loadings. Interesting is the fact that the amount of funds received from ROP per inhabitant has high although negative factor loading for this factor. We believe this factor may indicate the effects of low level of bonding social capital, meaning there is lower amount of strong bonds among the members of close, homogenous groups. We denote this factor as "Absence of trust". Concerning factor score differentiation in the districts, we can see that the highest values are in the western Slovakia (Hlohovec, Dunajská Streda) but also in the districts in the southern Slovakia.

CONCLUSIONS

Factor analysis has been utilized in order to explore social capital patterns and to identify spatial differentiation in the level of social capital in the districts of the Slovak Republic. The inputs for factor analysis were 10 variables, commonly used as social capital indicators. The suitability of data has been proven by Kaiser-Meyer-Olkin MSA statistic and Bartlett's test of sphericity. Factor analysis led to the extraction of three interpretable factors, with the factor

scores of each factor being visualized. The first factor "Isolation" represents a low level of bridging social capital; the second factor "Associational activity" represents social networks and human capital that serve as a resource for bridging social capital accumulation. The third factor, "Absence of trust" reflects the high level of negative social phenomena resulting from the lack of bonding social capital.

REFERENCES

[1] Abrams, D., Hogg, M. & Marques, J. (2005). *The social psychology of inclusion and exclusion*. New York: Psychology Press.

[2] Alesina, A., Devleeschauwer, A., Easterly W., Kurlat, S. & Wacziarg, R. (2003). Fractionalization. *Journal of Economic Growth*, 8(2), 155-194. doi: https://doi.org/10.1023/a:1024471506938

[3] Burdieu, P. (1986). The forms of capital. Riachradson, J. G. (ed.) *Handbook of Theory and Research for the Sociology of Education*. New York: Greenwood Press, 241-258.

[4] Coffé, H. (2009). Social capital and community heterogeneity. *Social Indicators Research*, 91(2), 155-170. doi: https://doi.org/10.1007/s11205-008-9275-y

[5] Coleman, J. (1988). Social Capital and the Creation of Human Capital. *American Journal of Sociology,* 94(1) 52-120. Retrieved 2018-09-21 from https://faculty.washington.edu/matsueda/courses/587/readings/Coleman%201988.pdf

[6] Działek, J. (2014). Is social capital useful for explaining economic development in Polish regions? *Geografiska Annaler, Series B: Human Geography*, 96(2), 177-193. doi: https://doi.org/10.1111/geob.12044

[7] Fukuyama, F. (1995). *Trust: the social virtues and the creation of prosperity*. New York: Free Press.

[8] Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2014). *Multivariate Data Analysis*. 7 ed. London: Pearson.

[9] Jančák, V., Havlíček, T., Chromý, P. & Marada, M. (2008). Regional differentiation of selected conditions for the development of human and social capital in Czechia. *Geografie,* 113(3), 269-284 Retrieved 2018-09-04 from: https://www.researchgate.net/publication/262526400_Regional_Differentiation_of_Selected_Conditions_for_the_Development_of_Human_and_Social_Capital_in_Czechia

[10] Krejčí, T. & Ptáček, P. (2007). Educational structure of the population in the Karpatský region. *GEOGRAPHIA CASSOVIENSIS,* 1(1), 95-102. Retrieved 2018-09-04 from: http://geografia.science.upjs.sk/images/geographia_cassoviensis/articles/GC-2007-1-1/Krejci-Ptacek_tlac1.pdf (in Czech).

[11] Melichová, K. (2015). Building social capital - does it facilitate development of rural areas?. *Forward - Moving frontiers of rural and regional development, proceedings of research conference*. Nitra: Slovenská poľnohospodárska univerzita, 86-92.

[12] Pileček, J. & Jančák, V. (2010). Can Social Capital Be Measured? An analysis of territorial differences among the districts of Czechia. *Geografie,* 115(1), 78-95. Retrieved 2018-09-15 from: http://geography.cz/sbornik/wp-content/uploads/downloads/2012/11/g10-1-5pilecek-jancak1.pdf (in Czech).

[13] Putnam, R. (1993). The Prosperous Community. *The American Prospect*, 4(13), 35-42. Retrieved 2018-09-24 from: http://prospect.org/article/prosperous-community-social-capital-and-public-life

[14] Putnam, R. (2000). *Bowling alone: The collapse and revival of American community*. New York: Simon & Schuster.

[15] Putnam, R., Leonardi, R. & Nanetti, R. Y. (1993). *Making Democracy Work*. Princeton: Princeton University Press.

[16] Sabatini, F. (2008). Social Capital and the Quality of Economic Development. *KYKLOS,* 61(3), 466-499. doi: https://doi.org/10.1111/j.1467-6435.2008.00413.x

[17] Stone, W., Gray, M. & Hughes, J. (2003). Social Capital at Work: how family, friends and civic ties relate to labour market outcomes. *Australian Institute of Family Studies*, 31(1), 1-42. Retrieved 2018-09-04 from: http://www.aifs.gov.au/institute/pubs/respaper/RP31.pdf

[18] Svendsen, G. T. & Svendsen, G. L. (2010). *Handbook of social capital: The troika of sociology, political science, and economics*. Cheltenham: Edward Elgar

[19] Sýkora, L. & Matoušek, R. (2009). Social capital and social network territoriality. Poštolka, V., Lipský, Z., Popková, K., & Špída, J. (eds.) *Geodays Liberec 2008*. Liberec: Technická univerzita v Liberci, 50-56 (in Czech).

[20] Thompson M. F. & Slaper, T. F. (2016). Social capital and regional economic performance: a study across US Metropolitan Statistical Areas. Westlund, H., & Larsson, J. P. *Handbook of Social Capital and Regional Development.* Cheltenham: Edward Elgar Publishing, 296-320.

[21] van Deth, J. W. (2008). Measuring Social Capital. Castiglione, D., van Deth, J. W., & Wolleb, G. *The Handbook of Social Capital.* Oxford: Oxford University Press, 150–176.