

DETECTION OF POSSIBLE REASONS OF UNCONVINCING FINANCIAL PERFORMANCE OF CLUSTER ORGANIZATIONS

Vladimíra Hovorková Valentová – Kateřina Gurinová – Natalie Pelloneová

Abstract

The presented paper analyses the financial performance of companies that are members of a selected cluster organization in the Czech Republic. The researched sample consists of member companies of the Cluster of Czech Furniture Manufacturers. This cluster organization was established in 2006 and its headquarters is Brno. It operates almost in the South Moravia Region. Firms that form the core of the cluster operate in the sectors with the following classification statistics: CZ-NACE 161000, 310900 and 433200. Data were collected in the frame of the work on the grant No. GA18-01144s. The main goal of the research is to analyse the development trend of selected indicators of companies within the Cluster of Czech Furniture Manufacturers and to find out if there are significant differences in the development of selected financial indicators among individual companies or not. Indeed, anomalies in the development of financial indicators may signal that the activities of some companies disrupt and degrade the overall functioning of clusters, as a result of which clusters cannot reach their full potential. The statistical methods and procedures from the field of time series analysis and cluster analysis were used to achieve the goal of our activities.

Key words: cluster analysis, cluster organisation, financial performance, furniture, time series

JEL Code: C10, C38, L25, L68

Introduction

In a global economy that is constantly changing and bringing new threats and challenges, various forms of partnerships, networks and regionally connected companies are increasingly being used. The increased interest in research on cluster organisations is a consequence of the growing importance of the local level and endogenous potential. The findings of M. E. Porter are considered to be the seminal studies in the field of cluster organisations. In his work, Porter describes clusters as geographic concentrations of interconnected companies,

specialized suppliers, firms, and other associated institutions (e.g., universities) that compete but also cooperate. However, over the course of almost three decades, new concepts have emerged that emphasise on the one hand and challenge the above characteristics on the other. For example, (Piore, 1990) defines a cluster as a network of inter-organisational relationships, while (Rosenfeld, 1997) argues that the essence of cluster organisations is access to information and collaborative learning enabling the flow of knowledge between participants. Porter also places great emphasis on the geographical proximity of individual firms. Some studies disagree with this e.g. (Martin and Sunley, 2003) and state that the proximity of the participants does not affect the success of the cluster.

A successful cluster organisation increases the productivity of member companies. Some empirical studies making comparisons between clustered and non-clustered firms conclude that firms within clusters tend to perform better than firms that are not part of a cluster. Cluster organizations are emerging in all sectors of the economy. They can be found in heavy industry, services, high-tech and traditional industries. Clusters can vary in size and the firms in them can also vary in size, but this diversity is not important. They also adopt different strategies and pursue different directions and growth opportunities.

This paper focuses on cluster organization in the furniture industry in the Czech Republic. In the last few years, the number of newly established cluster organizations in the Czech Republic has decreased. However, there are still about 98 of them (74 active and 24 inactive). This means that, apart from networks and strategic alliances, they still represent an interesting and not fully exploited model of cooperation between entities. Moreover, they are an important part of the economy and should be approached more broadly, not as industries. However, despite the importance of cluster organisations, only a limited number of studies have addressed their specific problems. One of the under-researched topics is the impact of cluster organisations on the financial performance of member firms.

1 Literature review

Every business strives to achieve the highest possible performance. Research on the effects of geographic agglomeration on the financial performance of firms is currently receiving a great deal of attention. Existing research has so far been relatively insufficient in studying the mechanism of cluster interaction as well as their effects on the financial performance of member firms. The impact of clusters on member firms, innovation and financial performance

in general has been examined from different perspectives, for different sectors and for different types of organizations.

(Boasson and MacPherson, 2001) identify and map regional clusters and examine the role of geographic location on the financial and innovation performance of publicly traded companies in the US pharmaceutical industry. They focus on company performance, which they hypothesize is positively affected by geographic location and other strategic and location variables. They then test the hypothesis using a series of t-tests and regression models based on secondary data. The results show that companies located in large clusters exhibit better financial performance than similar companies located elsewhere. The research also concludes that cluster membership also plays a positive role in product innovation (as measured by the number of patents).

In his empirical study, (Ruland, 2013) examines a sample of over 4,000 firms from 86 different industries and compares the profitability of firms in industry clusters and non-member firms in other locations using ROA. The sample is divided into two groups, small and large firms, to account for expected differences in profitability. The results of the research conducted show that especially for smaller firms, the profitability of cluster members is significantly lower than for firms that chose not to join the cluster. For the sample of large firms, no significant difference in firm profitability was found. (Ruland, 2013) concludes that smaller firms should carefully evaluate the decision to join an industry cluster.

Innovation performance was also addressed by (Delgado et al., 2014) in their research found evidence of complementarity between employment and innovation performance in regional clusters.

From the point of view of theoretical knowledge, the contribution of this research is a deeper elaboration of the concept of clusters and expansion of knowledge on the impact of membership of business entities in cluster organizations on financial performance.

2 Data and methodology

The database of cluster organizations in the Czech Republic was created within the project GA18-01144S An Empirical Study of the Existence of Clusters and Their Effect on the Performance of Member Enterprises, supported by the Grant Agency of the Czech Republic. The data from this database are the basis for examining the relationships of selected economic indicators used to evaluate the financial performance of enterprises.

In 2019, 113 cluster organisations were registered in the Czech Republic, of which only 78 were active. For the research project GA18-01144S, 7 cluster organisations were

selected from the textile, engineering, automotive, furniture and packaging, ICT and nanotechnology sectors. An important criterion for the selection was the duration of the cluster's existence, as a sufficiently long existence is a prerequisite for the potential economic benefits of the cluster to be realised.

The subject of our current research is the Cluster of Czech Furniture Manufacturers, which was founded in 2006. This cluster is the largest cluster focusing on furniture, woodworking and interior design in the Czech Republic. The necessary complete data is available in our database for 12 companies of this cluster.

The financial performance of companies can be assessed by traditional indicators based on profit maximisation as the basic objective of the business, or by value-based performance measurement criteria. The traditional measures include earnings before interest and taxes (EBT), earnings after interest and taxes (EAT), earnings before interest and taxes (EBIT) and earnings before interest, taxes, depreciation and amortisation (EBITDA). Traditional ratios also include cash flow figures and profitability ratios, in particular return on assets (ROA), return on equity (ROE), return on invested capital (ROIC) and return on sales (ROS).

Another option is the use of more sophisticated indicators or value-based performance measurement criteria (Rajnoha and Dobrovič, 2011), which primarily include economic value added (EVA). Although the calculation of EVA is relatively simple, its practical application is associated with a number of problems and limitations. In view of this, in the first part of our research we focus only on the use of traditional ratio indicators, namely ROA, current liquidity, inventory turnover time and debt ratio, for which we have a time series for the period 2012-2019. In the next part of the research, which is devoted to cluster analysis, these traditional ratios from the four basic groups of ratio indicators are used.

The first step is to perform a cluster analysis, which has the potential to reveal whether some organisations in the cluster under study have a statistically significant difference from others, or whether the specifics of these organisations are beneficial or not in terms of the functioning of the cluster as a whole.

The cluster analysis method is based on the idea of sorting the objects of a statistical set into clusters. These clusters should be formed in such a way that the objects in them show the greatest similarity in terms of the properties observed. Conversely, objects belonging to different clusters should be as heterogeneous as possible (Aggarwal and Reddy, 2014; Řezanková et al., 2007). There are a number of similarity or distance measures, for the purpose of this work the squared Euclidean distance was chosen, which eliminates the

influence of the used units of measure on the results of the calculations (Hebák et al., 2007; Pacáková et al., 2009; Hindls et al. 2011).

The clustering procedure used in this work is the furthest neighbour method, which is based on combining objects that exhibit a minimum distance between their furthest elements into a single cluster (Saraçlı et al., 2013). Determination of the optimal number of clusters was performed by a heuristic approach. To graphically represent the results of hierarchical clustering procedures, it is convenient to use a tree diagram, called a dendrogram, to determine the appropriate number of clusters (Forina et al., 2002).

To perform the cluster analysis, four financial performance indicators of the firm, namely return on assets (ROA), current liquidity, inventory turnover time and debt ratio were selected as input variables. Each of them represents a different one of the four basic groups of ratio indicators and they are not correlated with each other. For the purposes of cluster analysis, it does not make sense to include too many ratios, because the situation would then become rather opaque. As the cluster analysis is a state-based method and therefore cannot capture the evolution of financial performance indicators over time, it was carried out at the beginning and end of the original period under review, i.e. in 2012 and 2017. To these two periods, the year 2019 was added, which is the last year for which the necessary data can be obtained.

To supplement the information obtained from the cluster analysis, the bankruptcy model, specifically the IN 99 index, which emphasizes the owner's perspective, was applied to the selected financial ratios. It is a very strict index and only those firms that show significant value creation pass through its sieve.

3 Research results

The first outputs that will be commented on here relate to the cluster analysis conducted in 2012, 2017 and 2019. As already mentioned, cluster analysis is a method that is not able to capture the evolution of indicators over time, so it is conducted in three selected years of the period under study. Applying it to the data for all the years would not make sense, because it could make the situation less transparent. Let us therefore look at the outputs in detail.

In 2012, it seems meaningful to divide the companies of the Cluster of Czech Furniture Manufacturers into 4 groups. It is portrayed in Figure 1. It can be seen that the first cluster consists of 6 companies, which represents 50% of the total number. In the second

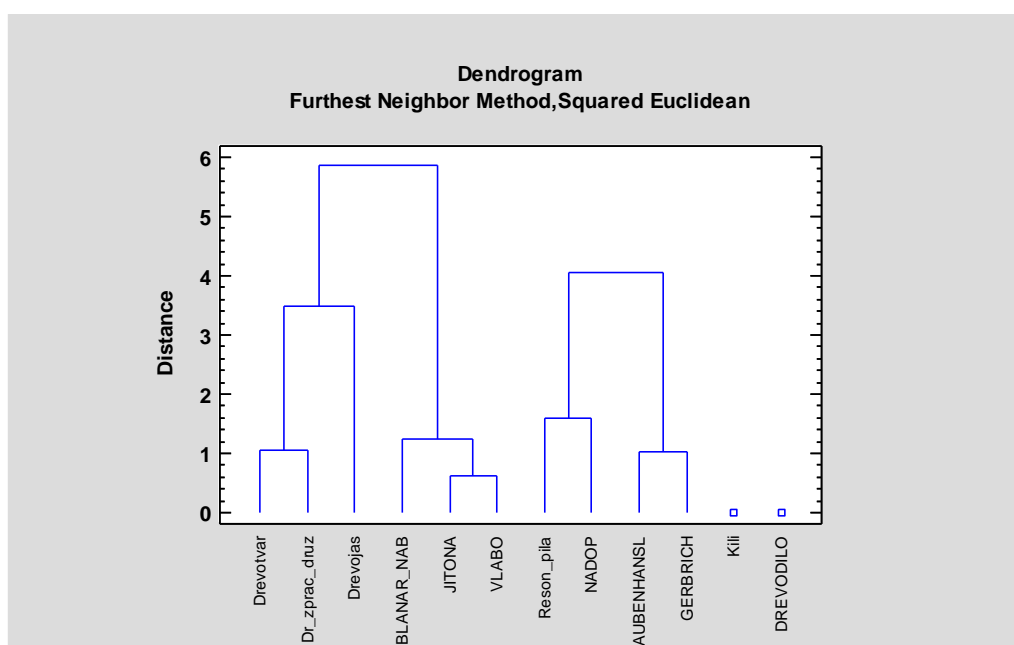
cluster we find 4 firms (33.3%) and in the last two clusters there is always one firm. In Table 1 we can find the centroid values of each indicator in these clusters.

Tab. 1: Centroids of selected indicators in clusters in 2012

Cluster	ROA	Current liquidity	Inventory turnover time	Debt ratio
1	0.0015	1.5883	72.8932	0.5520
2	0.0433	3.1232	70.5972	0.3319
3	-0.0110	1.2069	192.1680	2.2990
4	-0.2040	0.7360	16.8776	1.6287

Source: own calculation

Fig. 1: Dendrogram in 2012 (division of companies into clusters)



Source: own processing

We can see that the first cluster is characterized by a very low ROA, a satisfactory value of current liquidity, a standard inventory turnover time and a solid value of debt ratio. In the second cluster, there are firms whose average ROA value is just below the satisfactory value, current liquidity exceeds the upper bound, which may indicate expensive financing of the firm's operations, inventory turnover time is standard for the industry, and the debt ratio is very low. The third cluster consists of just one firm (Kili, Ltd.), which also appeared to be an outlier. However, this did not prove to be the case in the end (P- Value = 0.2997). This is due to the negative ROA value, very high inventory turnover time and high debt ratio. In the fourth cluster we also find only one firm (Dřevodílo, Rousínov, production cooperative),

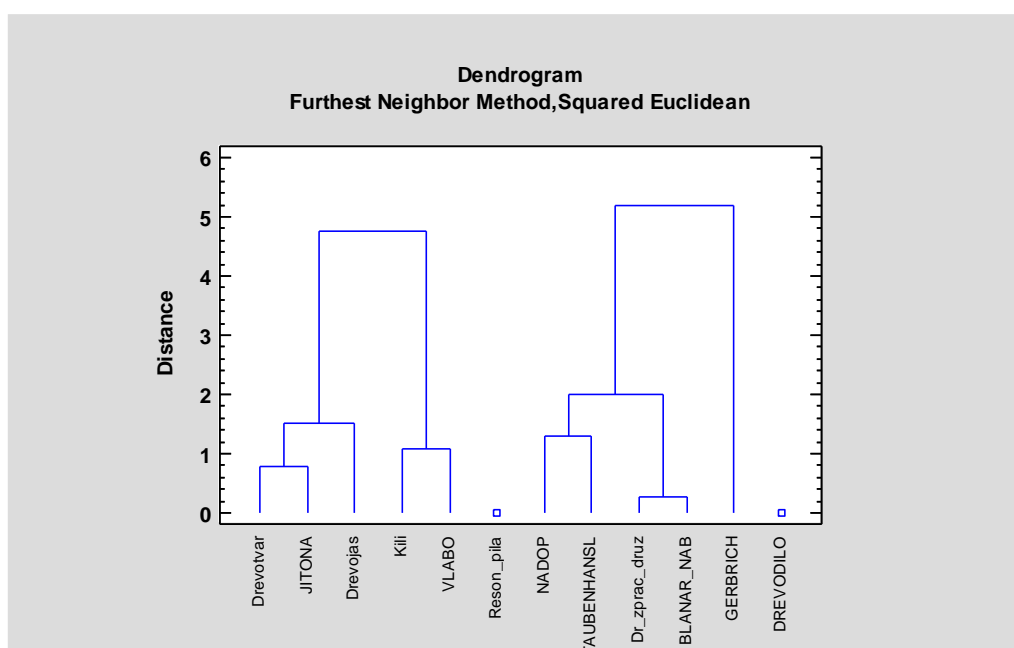
which was also tested for being an outlier. The test did not prove that this firm could be considered an outlier (P-Value = 0.3173), however, the values of the selected indicators are substantially different from the other firms - there is a significantly negative ROA, a very low value of current liquidity, a very low value of inventory turnover time and a high level of the debt ratio.

Tab. 2: Centroids of selected indicators in clusters in 2017

Cluster	ROA	Current liquidity	Inventory turnover time	Debt ratio
1	0.0166	0.9922	48.0122	1.0359
2	-0.1094	3.5371	169.5320	0.2190
3	0.0897	2.9757	51.6357	0.4086
4	0.0406	1.1537	74.6942	3.0516

Source: own calculation

Fig. 2: Dendrogram in 2017 (division of companies into clusters)



Source: own processing

If we look at the results for 2017, which are shown in Fig. 2 and recorded in Table 2, it is clear that firms were also divided into 4 groups. The first cluster consists of 5 firms (41.7%) whose average ROA is very low, current liquidity is below the recommended value, inventory turnover time is the lowest among all groups and debt ratio is at a reasonable level. The second cluster contains one firm (Resonanční pila, Inc.), which appeared to be an outlier, but the test was unable to prove this (P-Value = 0.3381). However, it has a negative ROA value, an unhealthily high current liquidity value, a very high inventory turnover time and a very low

debt ratio. In the third cluster, we find 5 firms that have an average ROA value at a reasonable level, but the current liquidity ratio is higher than it should be, the inventory turnover time is standard and the debt ratio is low. The last cluster includes only one firm (Dřevodílo Rousínov, production cooperative), which was subject to the test of outliers, but the test could not detect the outliers of this firm (P-Value = 0.3351). Even so, it has values of selected indicators at a different level than other firms. Both ROA and current liquidity are below the recommended value, inventory turnover time is standard, and debt ratio is extremely high.

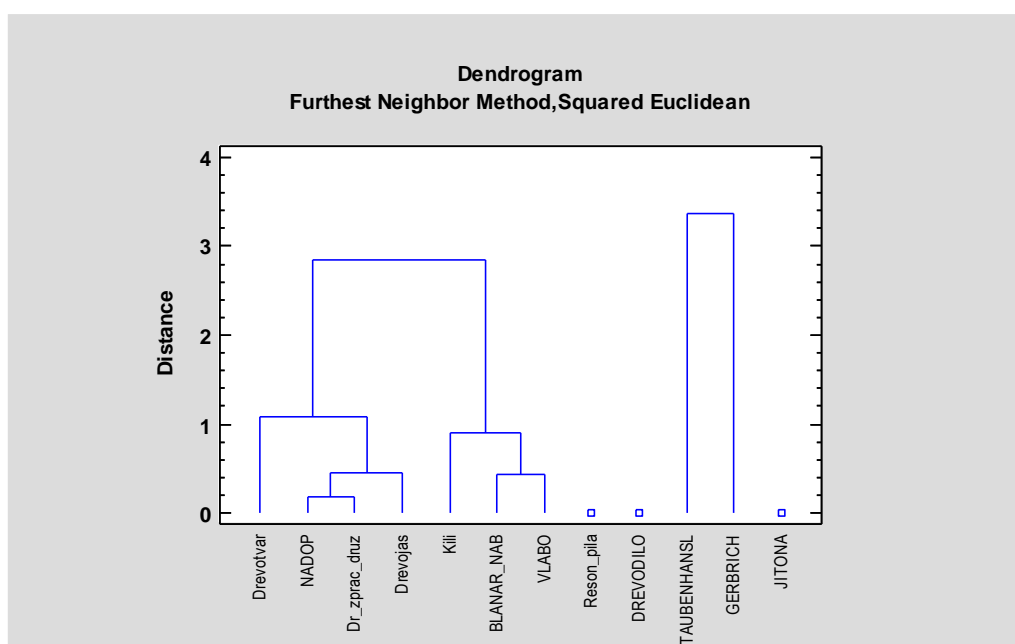
Tab. 3: Centroids of selected indicators in clusters in 2019

Cluster	ROA	Current liquidity	Inventory turnover time	Debt ratio
1	0.0216	1.2524	49.1164	0.9169
2	-0.0856	1.5468	216.3570	0.6629
3	-0.0419	0.3722	74.4017	7.7376
4	0.0361	4.8804	44.7528	0.4231
5	-0.3817	2.0551	8.7505	0.1821

Source: own calculation

In Table 3 and Fig. 3, the outputs of the cluster analysis for 2019 are recorded. It can be seen that 5 clusters have emerged, the first of which includes 7 firms whose average ROA is significantly below the recommended value, even the value of current liquidity is not satisfactory. The inventory turnover time is among the lower ones and the value of debt ratio is reasonable. The second cluster is represented by only one firm (Resonanční pila, Inc.), which is not confirmed to be an outlier in the test (P-Value = 0.2618), but the values of its ratios are significantly different from the other firms. It has a negative ROA, a satisfactory value of current liquidity, an extremely high inventory turnover time and an unproblematic debt ratio. In the third cluster, we also find one firm (Dřevodílo Rousínov, production cooperative), which has a negative ROA, an unhealthily low current liquidity ratio, a standard inventory turnover time and an extremely high debt ratio. In the fourth cluster, we find 2 firms that have an average value of ROA indicator quite low - below the recommended value. The current liquidity ratio has an inappropriately high value, which could indicate inefficient use of resources. The inventory turnover time belongs to the lower ones and the debt ratio is low. There is only one firm in the fifth cluster (JITONA Inc.), which was also tested for outliers. This was not proved by the test (P-Value = 0.2915). It is characterised by a negative ROA, a satisfactory value of the current liquidity ratio, a very low inventory turnover time and a very low level of the debt ratio.

Fig. 3: Dendrogram in 2019 (division of companies into clusters)



Source: own processing

To briefly summarise what is described here, no group of firms was found to be successful in terms of the indicators examined. The cluster analysis was further supplemented by a detailed examination of the selected indicators and the following findings were found. In the case of the inventory turnover time indicator, a comparison of firms in the industry can be used to determine the most favourable value for the firm. This depends, for example, on the business focus and other factors. In general, it can be stated that in the case of lower inventory turnover times, enterprises do not weigh as much money in inventories as in situations where the value of this indicator is very high. There is the only one enterprise with the inventory turnover time of less than 30 days throughout the period under review. This company is VLABO, Ltd. Other enterprises with inventory turnover times below 30 days include TAUBENHANSL Ltd., DŘEVODÍLO Rousínov, production cooperative and Kili, Ltd., but especially in the last named enterprise there are large fluctuations over the years under review. The turnover time of inventories between 30 and 60 days throughout the whole period under study was recorded in BLANÁŘ NÁBYTEK, Inc. In several other companies, the value of the indicator was below 60 days at most in the half of the monitored years. On the other hand, very long inventory turnover times were reported by Resonanční pila, Inc., which is in liquidation, and Dřevotvar družstvo during the period under review.

The average absolute difference in inventory turnover time in the years under review was also calculated and it can be stated that in eight firms there was an average absolute

decrease, which was most significant in Kili, Ltd. (24.03 days), and in Dřevojas, production cooperative, 13.35 days. This indicates a significant reduction in inventory turnover time during the period. On the other hand, the highest average absolute increase was recorded by Resonanční pila, Inc., which is in liquidation.

The ROA value can be considered favourable from the point of view of the company's operation if it reaches at least 5%. Of the twelve companies analysed, the ROA value was below this limit in three of them for the whole period under review, in six companies for most of the years under review. In a number of companies, even negative ROA values were recorded over the years, the worst situation was in Resonanční pila, Inc. and JITONA Inc., where negative values were seen in six of the eight years studied.

None of the companies recorded ROA of at least 5 % over the whole period under examination. Clearly, the best results in terms of this indicator were achieved by GERBRICH Ltd., where the ROA exceeded 10 % in six years and fell below the 5% limit in only one year, and then only slightly. The favourable development of ROA values is also evident in TAUBENHANS� Ltd. and BLANÁŘ NÁBYTEK, Inc., where ROA values were unfavourable only occasionally.

The values of the current ratio can be considered as positive if they are between 1.5 and 2.5. In all years of the period under review, the current liquidity ratio was not within the desirable range in any of the companies surveyed. The best situation was in the firms NADOP-VÝROBA NÁBYTKU, Inc. and Dřevozpracující družstvo, where the current liquidity was within the desirable range for most of the years under review.

In several companies the value of current liquidity was lower than 1.5 in all years, the worst situation was recorded by Kili, Ltd. and DŘEVODÍLO Rousínov, production cooperative. Very low values of current liquidity in the monitored years are also evident in the enterprises JITONA Inc. and VLABO, Ltd. The values of current liquidity above 2.5 were recorded in all years by GERBRICH Ltd., while unfavourable values were recorded in more than half of the monitored years by Resonanční pila, Inc. and TAUBENHANS� Ltd.

In the case of the interpretation of the debt ratio, it should be taken into account that if the value of this ratio is one, the amount of external and equity capital is the same. In essence, it can be stated that a value below one indicates a situation where the firm uses more equity

capital than external capital. Except for three firms in our sample, the debt ratio was below one during all the years under study.

Two firms, namely DŘEVODÍLO Rousínov, production cooperative and Kili Ltd., had a debt ratio higher than one in all the years under review, in some years even significantly. For example, in 2019, the debt ratio of DŘEVODÍLO Rousínov rose to 7.7, which is an alarming value. The company Dřevojas, production cooperative recorded debt ratio values higher than one in all years of the period under review except the first two, but globally the values do not significantly exceed the value of 1.5.

As mentioned in Chapter 2, the outputs of the cluster analysis here were complemented by the application of Neumaier's bankruptcy model - the IN 99 index value was calculated for all firms in all years under study. An overview of the calculated values is presented in Table 4. It is known from (Neumaierová and Neumaier, 2002) that firms can be divided into 5 groups according to the IN 99 value. When the value of IN 99 is greater than 2.070 the enterprise creates new value and achieves a positive value of economic profit. When the value of IN 99 is between 1.420 and 2.070 the enterprise rather creates value. Values between 1.089 and 1.420 form a grey area where it is not possible to determine whether or not the enterprise is creating value. Values between 0.684 and 1.089 indicate that the business is not likely to create value and is characterised by financial problems. Values less than 0.684 indicate that the business is not creating value or is reducing value and the value of economic profit is negative. In Table 4, we can see that there is only one firm that has IN 99 values for all years in the range of 1.420 to 2.070 - Kili, Ltd. and hence is more likely to create value. There are also two values of TAUBENHANSL, Ltd. (2017 and 2018) and GEBRICH Ltd. (2015 and 2016) and one value of VLABO, Ltd. (2018) in this interval. For none of the firms the IN 99 value exceeds 2.070, so none of the firms are in the best ranking. Five firms have an IN 99 value in the grey zone in some of the years under review, otherwise all other values are in the zone where the firm is more likely to be non-value creating or not value creating. The worst performer in terms of this indicator is Dřevojas, production cooperative, whose IN 99 values are below 0.684 throughout the examined period.

Tab. 4: Values of IN 99 in years 2012-2019

Name of the firm	2012	2013	2014	2015	2016	2017	2018	2019
Dřevotvar družstvo	0.290	0.698	0.778	0.777	0.686	0.503	0.536	0.492
Resonanční pila, a.s.	0.679	0.309	0.698	0.597	0.108	0.134	-0.532	0.075
NADOP-VÝROBA NÁBYTKU, a.s.	0.417	0.562	0.745	0.392	0.309	1.187	1.058	0.587
Dřevozpracující družstvo	0.602	0.673	1.013	0.894	0.946	0.991	0.892	0.775
Kili, s.r.o.	1.621	1.725	1.884	1.994	1.845	1.913	1.915	1.983
DŘEVODÍLO Rousínov, výrobní družstvo	-0.380	0.525	-0.982	0.854	1.059	0.779	0.415	0.260
Dřevojas, výrobní družstvo	0.553	0.533	0.666	0.677	0.628	0.485	0.424	0.374
TAUBENHANSL s.r.o.	1.267	0.772	1.208	1.212	1.002	1.700	1.915	0.397
BLANÁŘ NÁBYTEK, a.s.	0.929	0.675	1.255	1.266	0.978	0.949	0.767	0.975
GERBRICH s.r.o.	1.203	1.247	1.071	1.613	1.425	0.966	0.741	1.109
JITONA a.s.	0.578	0.370	0.301	0.482	0.643	0.694	0.837	-0.214
V L A B O, s.r.o.	0.912	0.863	0.936	1.266	0.965	1.207	1.837	0.774

Source: own calculation

Conclusion

The aim of this paper was to try to uncover the reasons for the unsatisfactory financial performance of cluster organisations. The cluster organization that was investigated here was the Cluster of Czech Furniture Manufacturers. Using cluster analysis, it was found that the firms in the cluster were sometimes significantly different from each other in terms of the examined indicators, and none of the clusters had convincingly good values for all examined indicators in 2012, 2017 and 2019. Thus, if the cluster consists of weak links, which is the majority, then it obviously cannot perform well. If we calculate the average ROA value for the whole cluster, it does not reach the value of 5% in any of the years studied, and in two cases it is even negative. The weak performance of the member firms can also be derived from the values of the IN 99 index, where only one firm is in the value-creating range during the period under study. At the same time, it was found that the trend of the monitored indicators is not favourable in most cases. Therefore, it is not possible to forecast that the values of the indicators will improve for most firms in the future either. Therefore, the

conclusions of the presented research do not support the claim that membership in a cluster organization has a significant positive impact on the financial performance of member firms.

Acknowledgment

This study was supported by grant No. GA18-01144S “An Empirical Study of the Existence of Clusters and Their Effect on the Performance of Member Enterprises” of the Czech Science Foundation.

References

- Aggarwal, C. C., & Reddy. C. K. (2014). *Data clustering: Algorithms and applications*. CRC Press/Taylor & Francis Group.
- Boasson, V. & MacPherson, A. (2001). The Role of Geographic Location in the Financial and Innovation Performance of Publicly Traded Pharmaceutical Companies: Empirical Evidence from the Untied States. *Environment and Planning A: Economy and Space*, 33(8). <https://doi.org/10.1068/a3431>
- Delgado, M., Porter, M. E., & Stern, S. (2014). Clusters, convergence, and economic performance. *Research Policy*, 43(10), 1785–1799. <https://doi.org/10.1016/j.respol.2014.05.007>
- Forina, M., Armanino, C., & Raggio, V. (2002). Clustering with dendrograms on interpretation variables. *Analytica Chimica Acta*, 454(1), 13–19. [https://doi.org/10.1016/s0003-2670\(01\)01517-3](https://doi.org/10.1016/s0003-2670(01)01517-3)
- Hebák P., Hustopecký J., Jarošová E., & Malá I. (2004). *Vícerozměrné statistické metody*. Informatorium.
- Hindls, R., Hronová S., Seger, J., & Fischer, J. (2007). *Statistika Pro Ekonomy*. Professional Publishing.
- Martin, R., & Sunley, P. (2003). Deconstructing clusters: Chaotic concept or policy panacea? *Journal of Economic Geography*, 3(1), 5–35. <https://doi.org/10.1093/jeg/3.1.5>
- Neumaierová I., & Neumaier, I. (2002). *Výkonnost a tržní hodnota firmy*. Grada Publishing.
- Pacáková, V. et al. (2009). *Štatistické metódy pre ekonómov*. Bratislava: Iura Edition.
- Piore, M. J. (1990). Work, labour and action: Work experience in a system of flexible production. In F. Pyke, G. Becattini, & W. Sengenberger (Eds.), *Industrial districts and inter-firm cooperation in Italy* (pp. 52–74). International Institute for Labour Studies.
- Rajnoha R. & Dobrovič, J. (2011). Simultánne riadenie ekonomiky a procesov znalosťou pridanej hodnoty. *E+M Ekonomie a Management*, 2011(1), 53–69.

Rosenfeld, S. A. (1997). Bringing business clusters into the mainstream of economic development. *European Planning Studies*, 5(1), 3–23.
<https://doi.org/10.1080/09654319708720381>

Ruland, W. (2013). Does Cluster Membership Enhance Financial Performance? *iBusiness*, 5(1)1–11. <https://doi.org/10.4236/ib.2013.51001>

Řezanková H., Húsek D., & Snášel V. (2009). *Shluková analýza dat*. Professional Publishing.

Saraçlı, S., Doğan, N., & Doğan, İ. (2013). Comparison of hierarchical cluster analysis methods by cophenetic correlation. *Journal of Inequalities and Applications*, 2013(1).
<https://doi.org/10.1186/1029-242x-2013-203>.

Contact

Vladimíra Hovorková Valentová

Technical University of Liberec, Faculty of Economics

Studentská 1402/2, 461 17 Liberec

vladimira.valentova@tul.cz

Kateřina Gurinová

Technical University of Liberec, Faculty of Economics

Studentská 1402/2, 461 17 Liberec

katerina.gurinova@tul.cz

Natalie Pelloneová

Technical University of Liberec, Faculty of Economics

Studentská 1402/2, 461 17 Liberec

natalie.pelloneova@tul.cz