A CLUSTER ANALYSIS OF FINANCIAL PERFORMANCE IN CENTRAL AND EASTERN EUROPE

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The paper studies the pattern of financial performance for listed companies originating from different industries - financial intermediation, beverage and food industry, energy, pharmaceuticals and chemicals - in four Central and Eastern European countries - Czech Republic, Hungary, Poland and Romania over a four year period (2003-2006). The financial performance is addressed by taking into account companies' return on assets (ROA) and return on equity (ROE). The research methodology consists of hierarchical and k-means clustering amalgamation techniques, in order to distinguish between naturally occurring similar groups that are statistically significant in terms of industry and/or national influences. Our analysis encompasses a dynamic approach, as it refers to changes in clusters' structure in time and searches for possible explanations of corporate financial performance in this region.

Key words: financial performance, cluster, profitability, Central and Eastern Europe

1. Introduction

The research undertaken in the case of financial markets from Central and Eastern Europe is relatively recent, and it is trying, in general, to adapt the analysis already made in the case of developed markets to the region's particularities. The relative degree of novelty and the reduced number of research in this field can be explained by the recent opening of these markets towards the market economy and, consequently, by the lack of information and data necessary for the carrying of consistent and robust analysis. The use of multivariate statistical techniques such as cluster analysis, principal components analysis, discriminant analysis and factor analysis, is present in the international literature that addresses companies' financial performance. Pandit, Cook, Swann (2001) examine the cluster building mode in the financial services industry in Great Britain and study the effect of the cluster power in explaining companies' growth and their survivorship rates on the market. Fifield et al. (2002) investigate the measure in which the global and local factors can explain the returns on the emerging markets, the factors being identified through the principal component analysis. Bensmail and DeGennaro (2004) apply cluster modelling to financial data, their purpose being that of analyzing the missing data and identifying homogenous groups in the interior of the available data. Having a flexible approach and working with complex data structures in the case of missing quantitative and qualitative observations, the authors include the data in a new structure that does not depend on the hypothesis connected to the traditionally necessary distributions for choosing homogenous groups of observation. Dhankar and Singh (2005) use principal components analysis to estimate the factors that influence the returns on the Indian capital market, while Sueyoshi (2005) compares the financial performances of a number of 147 companies without financial difficulties with those of 24 companies in the American energy industry, using non-parametric discriminant analysis, which assigns a set of weights to a linear discriminating function that consequently generates a score regarding its belonging to a group. Ganesalingam and Kumar (2001) use a set of financial indicators for 71 companies from the Australian capital market to determine the chances of success of an investment made in these companies. The authors identify a discrimination rule between the companies and a series of factors that explain the profitability of the companies, which is afterwards used to predict the companies's stability and to build diversified portfolios.

The purpose of our research is to identify sector groups that are natural, and at the same time significant, of companies from Romania, Bulgaria, Hungary, Poland and the Czech Republic, depending on their financial performance, by considering two integrative measures of performance: return on assets (ROA) and return on equity (ROE). Section II presents the data used in the analysis and the research methodology, Section III outlines the main results and Section IV concludes.

2. Data and research methodology

Our paper uses data collected on a number of 115 companies from Romania, Czech Republic, Hungary and Poland and from five industries: financial intermediation, food and beverages, chemicals, energy (oil and gas production and distribution), and pharmaceuticals. The industry sample was constructed in such a way as to allow the observation of financial performance from one industry to another. The data on companies' ROA and ROE was gathered from REUTERS and covers the 2003-2006 financial years. The selection of companies in our sample was based on the following criteria: (1) the company had to be listed on the country's stock exchange at the end of 2006; (2) the company had to be listed on the stock exchange at least during the financial years 2003, 2004, 2005 and 2006: (3) the financial data on the company had to be available during the 2003-2006 period.

Two clustering algorithms were used in our research: a joining tree algorithm and a partitioning algorithm, specifically the k-means. From our research point of view, we used the hierarchical algorithm to identify the number of clusters to be included in the k-means algorithm, by the use of the City-block (Manhattan) distance and following the Ward's amalgamation rule. From the plot of linkage distances across steps we selected the distance that we subsequently used in the vertical icicle plots to determine how many clusters to retain and interpret. In the k-means algorithm we introduced the number of clusters previously identified and have studied the analysis of variance (ANOVA) in order to evaluate the appropriateness of the classification. We afterwards identified the members of each cluster and studied their characteristics. Before the application of the clustering amalgamation techniques, all data has been standardized.

3. Results

Before the application of clustering amalgamation techniques to financial performance data, we consider necessary a brief depiction of financial performance in terms of ROA and ROE, at an industry and country level, both static and dynamic. The maximum and minimum ROA are quite fluctuating from a year to another, regardless of the industry, which suggests that companies are struggling to stabilise their financial position and do not operate in mature markets yet. In all years, the lowest ROA are negative, while the maximum ROA are more or less similar across industries, with the only exception of the financial intermediation industry in 2004 that displays a maximum ROA of 81.03, which belongs to a Polish company. Also, for the financial intermediation industry, 2006 seemed to be the best of the years, since the lowest ROE is slightly positive – 0.07. In dynamics, all industries included at least one company with increasing ROA from 2003 to 2006, the highest number (7) being recorded in the financial intermediation industry and the energy industry. Two companies with increasing ROA were found in the food and beverage industry, and one company each in chemicals and pharmaceuticals. For what concerns the companies with decreasing ROA, the highest number (3) is recorded in the financial intermediation industry, followed by two companies in the chemicals, energy and pharmaceuticals industries. The only industry with no declining ROA was the food and beverages industry. Nevertheless, the majority of companies have seen their ROA oscillating from one year to another, no easily discernible pattern of evolution being identified.

In terms of ROE we can notice a higher diversity for the maximum and minimum values, as well as high differences in the values between industries, particularly for some years. A couple of returns on equity are quite surprising: an astonishing 1004.23 recorded in 2003 in the energy industry, followed by 745.01 found in the same year for the chemicals industry, and at some distance by a ROE of 167.41 also in the chemicals industry, but in 2004, and by a ROE of 121.21 in the financial intermediation industry in 2003. As known, the difference between ROA and ROE is given by the financial leverage multiplier (the well-known Du Pont system decomposes decomposes ROE in three parts, as follows: ROE = profit margin × Total assets turnover × Financial leverage multiplier = ROA × Financial leverage multiplier), therefore we may interpret these considerable differences between ROA and ROE as a high degree of indebtedness of the companies included in the analysis, particularly in 2003 and 2004. From 2003 to 2006, a number of 16 companies see their ROE increasing: 7 from the financial intermediation industry, 3 from the food and

beverages, 5 from the energy sector and only one from the pharmaceuticals. Decreasing ROE from 2003 to 2006 are identified for two companies in the financial intermediation industry, one for the food and beverages, 3 from the chemicals, one from the energy sector and 2 from the pharmaceuticals. All other companies show oscillating ROE during 2003-2006.

The cluster methodology was used to analyse companies' financial performance on two grounds: the first one took into account the main profitability ratios – ROA and ROE – for each of the four years, and the second one tried to identify groups of companies depending on the evolution of each of these two indicators in time. In terms of ROA and ROE considered for each year, we used a number of 8 clusters in the k-means clustering algorithm, as indicated by the observation of clusters previously formed by the use of the joining tree algorithm. For all years, the analysis of variance (ANOVA) indicated that the within-cluster variability was statistically significantly lower than the between-cluster variability, as shown by the F-statistic. As a general observation, the clusters' structure in terms of countries and industries of origin changes from a year to another, as one would normally expect given the fluctuating performance in during the period. Figure 1 shows the plot of clusters means for 2006, the similar plots being available for all years.
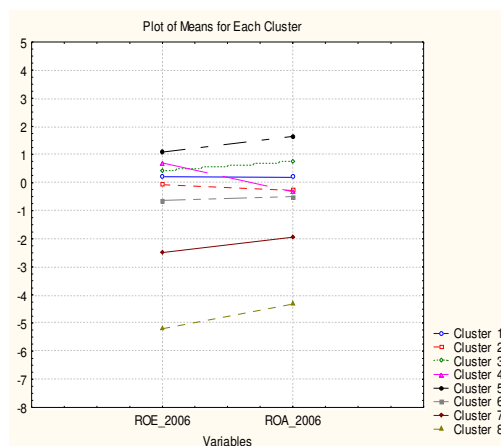

Figure 1. Plot of means for ROA-ROE clusters, 2006

For 2003 we identified three big clusters – one formed of 41 companies, another one of 35, and another one of 20 -, each of them including companies from all countries and industries. One company is excluded from all clusters – a chemical Czech company, due to its very low ROA and ROE. The highest average ROE is displayed by cluster 8 that includes two Romanian companies, one from the chemicals industry and then other one from the energy sector. At the same time, cluster 8 shows the second worst performance in terms of ROA, while also being the least homogeneous from the perspective of both indicators. For what concerns ROA, then highest average ROA belongs to cluster 7, that includes companies from all industries and from all countries except for the Czech Rep. The highest homogeneity in ROA terms is demonstrated by cluster 3, which includes the highest number of companies of all, but it is also an "average" cluster in terms of both ROA and ROE. From the point of view of companies' distribution among clusters depending on their country and industry of origin, the big clusters collect the largest part of companies, maybe the most interesting being cluster 4 that includes more than half of the companies in the financial intermediation industry, and clusters 3 and 4, that gather 40% each of the Czech companies. Both are "average" type of clusters. 2004 is a different year in terms of clustering results. A big cluster is formed, including 73 companies (cluster 3), the vast majority of firms from all countries and industries entering this cluster. As expected, this is a cluster with an average performance in both ROA and ROE. At the other extreme, three companies belong to their own cluster: a Polish company from the energy sector, displaying the highest ROA and ROE (cluster 5), a Czech company from the pharmaceutical industry with the lowest ROA and the second lowest ROA (cluster 6), and another Polish company, but from the financial intermediation industry, enjoying an average ROE accompanied by the highest ROA (cluster 8). Also interesting are clusters 1 and 4. Cluster 1 includes 10 companies, of which 9 are from the financial intermediation industry and is characterised by the highest homogeneity in terms of ROA and a ROE above average. Cluster 4 consists of 14 companies, from all industries and countries – this cluster shows the

highest homogeneity in terms of ROE, but the lowest in terms of ROA, the mean for this indicator being above average.

The clusters formed by taking into account the performance for 2005 and 2006 are different from the ones in 2003 and 2004. The first important observation is that no company forms its own cluster, which generally indicates a higher homogeneity of performances among companies. The second observation is that the eight clusters formed for each of the two years manage to spread the companies between them, as we do not find anymore a cluster that collects more than 50% of the total number of companies, either on a geographical or industry basis. In 2005, only two clusters have an average performance – cluster 5 and cluster 1, with 28 and 36 companies from all countries and industries -, while the others are easily identified either by their high or low performance. The worst performers are grouped in cluster 3: the two companies are both from Poland and come from the food and beverages and energy industries, respectively. The best performers from both ROA and ROE perspective – two Romanian companies and two Polish companies, from the financial intermediation, food and beverages and energy industries - are grouped in cluster 8. Cluster 2, with 8 companies mostly from Romania and Hungary, is the second lowest in both ROA and ROE, while cluster 6, including mostly companies from Romania, Hungary and Poland, and from all industries except for financial intermediation, shows the second performance in ROA terms. The best performing cluster in 2006 – cluster 5, includes 12 companies, of which none is originating from the Czech Republic and also none from the pharmaceutical industry. The lowest performing companies are included in cluster 8 – a Hungarian and a Czech company, one from the food and beverages industry and one from the energy sector, while the second lowest performance is displayed by cluster 7, with 4 companies from Romania, Hungary and Poland, and from the chemicals, energy and pharmaceutical industries. Cluster 6 is also interesting, as it is the cluster with the highest homogeneity in ROA, with 20 companies, mostly from Romania (8) and Poland (9), spread equally among four industries (financial services, food and beverages, chemicals and energy). Also, cluster 3 shows the highest homogeneity on a ROE basis, and it includes companies from all countries and industries, except for the food and beverages industry.

Another manner of observing the overall financial performances of these companies that we used involved the application of hierarchical and partitioning clustering methods to the same financial indicator, but using as variables in the clustering algorithm its values in all years, 2003 to 2006. Under this approach, the joining tree clustering indicated also the configuration of eight clusters, and the ANOVA methodology showed us that this number of clusters in statistically significant both for ROA and ROE. Figures 2 and 3 show the plot of means for these clusters.
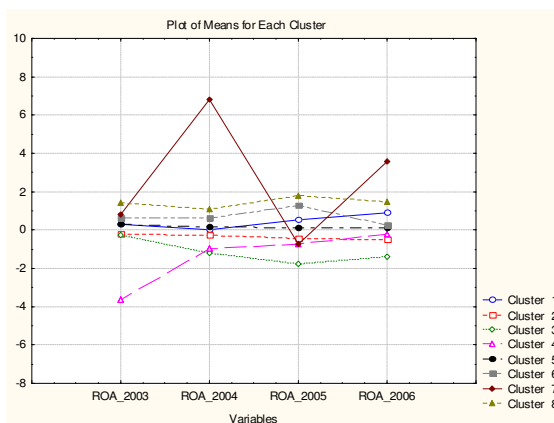

Figure 2. Plot of means for ROA clusters, 2003-2006
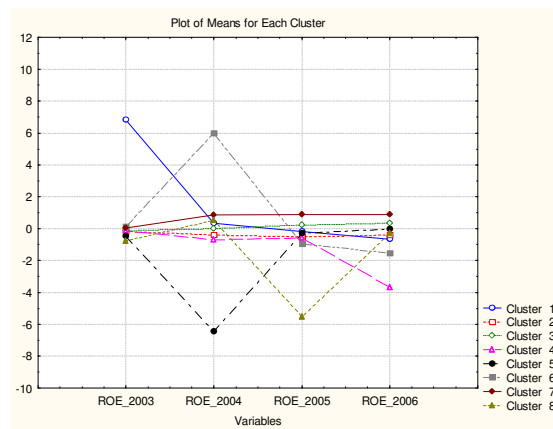
Figure 3. Plot of means for ROE clusters, 2003-2006

A number of characteristics of ROA clusters are interesting to notice. There are two companies that form a cluster on an individual basis – cluster 5 includes a Czech company from the pharmaceutical industry and cluster 6 includes a Polish company from the energy sector. While cluster 5 is an average cluster, cluster 6 has an oscillating performance from one year to another, albeit in all years its performance is above the average. The cluster showing the highest fluctuation is number 7 that groups 16 companies from all industries and countries. Another interesting cluster is number 3, but its fluctuation during 2003-2006 is lower as compared to cluster 8. The only cluster showing an increasing performance between 2003 and 2006 is number 4, which includes companies from two industries only – chemicals and pharmaceuticals -, but from three of the countries: Hungary, Czech Republic and Poland.

Taking into account ROE, the number of companies in the eight identified clusters varies from 1 (cluster 7) to 46 (cluster 2). The company in cluster 7 – a Polish company from the financial services industry – shows the highest oscillating performance of all companies included in our sample: ROE was 121.21 in 2003, then it declined to 58.66 in 2004, then it reached a negative value of -1.44 in 2005, to return to a positive ROE of 33.34 in 2006. Another interesting cluster is number 4, with 5 companies split between countries and industries, showing improved performance from 2003 to 2006, since their average ROE moves from the lowest in 2003 progressively towards the average of all clusters, although somehow below the average, in 2006. The best performing cluster is number 8, demonstrating an above average performance in all years. Cluster 3, with 9 companies, includes companies with declining ROE in 2003, 2004 and 2005, but somehow improving in 2006, although it remains below the average in all years.

4. Conclusions

Our research analyzed the financial performances of companies from four Central and Eastern European countries and from five industries: financial services, food and beverages, chemicals, energy and pharmaceuticals. The main objective of the research was to identify natural groups of companies depending on corporate performance. When observing the changes in financial performances over four years (2003 to 2006), and forming clusters of companies taking into account these financial performance, no clear-cut evidence on their grouping according to industries and/or countries can be identified. Moreover, since their performance is sometimes widely oscillating during the four years, we might reasonably say that corporate performance in the area is more or less similar, with just a couple of companies showing deviating performance in a particular year, but in most cases followed by a correction towards the average in the subsequent years.

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