DIFFERENCES IN RESULTS OF RANKING DEPENDING ON THE FREQUENCY OF THE DATA USED IN MULTIDEMENSIONAL COMPARATINE ANALYSIS. EXAMPLE OF THE STOCK EXCHANGES IN CENTRAL-EASTERN EUROPE

Mariola Chrzanowska
Department of Econometrics and Statistics
Warsaw University of Life Sciences – SGGW
e-mail: mariola_chrzanowska@sggw.pl

Abstract: Advancing globalization provides access to more information. It also affects the frequency of data. Some events are listed on a monthly, daily and even minute basis. Thus, during the time-space study selecting appropriate and relevant information becomes a problem. The paper presents a suggested solution to this problem based on the example of stock exchanges in Central and Eastern Europe.

Keywords: multidimensional statistical analysis, stock market, synthetic development measure

INTRODUCTION

Appropriate selection of information is the basis of every economic research study. It is an essential factor in performing proper analysis and drawing correct conclusions. The problem of selecting relevant information is especially important in research studies where a vast spectrum of information is available and it is made accessible on an annual, monthly, daily or even minute basis. How then should one conduct a multidimensional comparative study for consecutive years if there are no straightforward guidelines regarding this issue? This article includes three suggestions of selecting the frequency of features in case of researching an event (observed continuously) over a number of years. The aim of the study is to answer the following question: How does the way of observing features affect the results in a multidimensional comparative analysis? The selection of information used in

the research study was determined by the high variability that occurs in this particular sector of the financial market. Information regarding stock exchanges in developing countries was used in this study and the period of analysis (years 2003-2008) covered both the time of global prosperity as well as the beginning of the financial crisis.

THE METHOD

The multidimensional comparative analysis is a method that allows for determining the ranking of objects described using a set of features according to a certain characteristic (which cannot be measured directly). This research method is based on constructing a certain synthetic variable. The first such measure was proposed by [Z. Hellwig 1968] to compare the level of regional development of selected European countries. Hellwig's synthetic measure of development (SM_i) groups information from a set of diagnostic features and assigns a single (aggregate) measure to an analyzed objects using values from 0 to 1 under the assumption that in doing so, a lower value SM_i determines a higher level of the analyzed occurrence.[1]

DESCRIPTION OF THE STUDY

The aim of the research study is to conduct a comparative analysis of the financial markets in countries of Central Eastern Europe with different aggregation of features. In the analysis the researcher used information from financial reports published by FESE between the years 2003-2008 as well as information from Internet websites of the analyzed stock exchanges. The following diagnostic variables were used in the study:
- − capitalization of the local market in mln EUR (X1);
- − the number of stock transactions (X2);
- − the number of listed companies(X3)[2;]
- − rate of return in the main stock market indexes (X4).

The study was conducted based on the synthetic development measure by Hellwig. This measure was calculated three times for each year and each time the method of selecting frequencies of the used features in the analysis differed from the others. In the first stage only the data from the end of December[3] was used; in the second stage of the research for each year all data from January through December was used. In the third approach, for each month a taxonomy measure was determined and in the final ranking only the appropriate mean measure

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[1] Propositions of analogous measures were presented by [Cieślak 1974]; [Bartosiewicz 1976]; [Strahl 1978]; [Zeliaś, Malina 1997].
[2] Due to the insufficient variability this feature was omitted in the initial analysis.
[3] This approach may be found in the literature [Majewska 2004].

(median) was used from the monthly values of the measure[4]. Finally, a comparative analysis of the effectiveness of the presented methods was implemented.

RESEARCH RESULTS

In the first stage of the research the traditional method of data selection was used; namely, for each year the December level was used as the value of variables. The calculations are presented in Table 1 while the ranking of stock exchanges is presented in Table 2.

The analysis of the presented results allows one to note that the best results were obtained for the Warsaw Stock Exchange. The Warsaw Stock Exchange became the leader of the Central Eastern Europe stock market in 2003 and in subsequent years its position strengthened. The differences in the calculated values of Hellwig's development measure account for the large discrepancies between the Polish stock market and other stock exchanges. In the last two years the value of Hellwig's measure for the Warsaw Stock Exchange equaled zero, which means that compared to other research objects, it is the ideal object.

The highest level of synthetic variable (equivalent to the lowest level of the object development) was obtained for Lithuanian Stock Exchange and Romanian Stock Exchange. Both objects received very similar value SM_i. It is worth noting that in subsequent research periods for both markets Hellwig's measure declined, which proves the systematic increase of the development level of Vilnius and Bucharest stock exchanges.

Table 1. Values of synthetic development measure for December data

Stock Exchange	2003	2004	2005	2006	2007	2008
Bratislava Stock Exchange	0.64	0.64	0.64	0.65	0.64	0.61
Bucharest Stock Exchange	0.83	0.74	0.72	0.70	0.65	0.67
Bulgarian Stock Exchange	0.67	0.65	0.61	0.57	0.53	0.52
CEESEG – Budapest	0.68	0.64	0.67	0.67	0.63	0.64
CEESEG – Ljubljana	0.70	0.67	0.71	0.68	0.63	0.64
CEESEG – Prague	0.71	0.63	0.66	0.67	0.59	0.56
OMX Nordic – Vilnius	0.85	0.80	0.78	0.76	0.71	0.71
Warsaw Stock Exchange	0.31	0.17	0.16	0.13	0.00	0.00

Source: own calculations

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[4] In order to be able to contrast the measures with each other in this case a single (common) pattern was used for the entire group.

Table 2. Ranking of stock exchanges based on the value of synthetic development measure

Stock Exchange	2003	2004	2005	2006	2007	2008
Bratislava Stock Exchange	2	3	3	3	6	4
Bucharest Stock Exchange	7	7	7	7	7	7
Bulgarian Stock Exchange	3	5	2	2	2	2
CEESEG – Budapest	4	4	5	4	5	5
CEESEG – Ljubljana	5	6	6	6	4	6
CEESEG – Prague	6	2	4	5	3	3
OMX Nordic – Vilnius	8	8	8	8	8	8
Warsaw Stock Exchange	1	1	1	1	1	1

Source: own calculations

In the second stage of the research a comparative study was conducted. This time, however, the method of selecting data for the analysis was modified. The synthetic development measure by Hellwig calculated using this method included all available data (namely, monthly values for each variable). The research results are presented in Tables 3 and 4.

Table 3. Values of synthetic development measure for monthly data

Stock Exchange	2003	2004	2005	2006	2007	2008
Bratislava Stock Exchange	0.75	0.77	0.77	0.77	0.79	0.80
Bucharest Stock Exchange	0.89	0.85	0.83	0.81	0.81	0.83
Bulgarian Stock Exchange	0.80	0.77	0.78	0.76	0.74	0.73
CEESEG – Budapest	0.78	0.73	0.76	0.78	0.79	0.80
CEESEG – Ljubljana	0.79	0.74	0.81	0.81	0.80	0.81
CEESEG – Prague	0.80	0.72	0.76	0.77	0.78	0.74
OMX Nordic - Vilnius	0.92	0.88	0.90	0.88	0.87	0.88
Warsaw Stock Exchange	0.57	0.50	0.49	0.47	0.47	0.49

Source: own calculations

Analyzing the presented results one may note the significant increase of Hellwig's measure level for the researched market. At the same time, the gap between the weakest markets and the best of the selected objects – the Warsaw market - narrowed. Likewise, as was the case previously, the weakest markets (from the viewpoint of the analyzed information) were the Vilnus Stock Exchange and Bucharest Stock Exchange. In the second ranking, the position of the markets from the middle part of the list. The stock exchanges in Budapest, Ljubljana and Prague slightly changed their position by moving one place up or down on the list.

In addition, it is worth pointing out that the greatest gap between the selected values of Hellwig's value measures for both rankings was noted between 2007 and 2008 (the final period of boom and beginning of decline in the market) and the global financial crisis.

Table 4. Ranking of stock exchanges based on the value of synthetic development measure

Stock Exchange	2003	2004	2005	2006	2007	2008
Bratislava Stock Exchange	2	5	4	3	5	4
Bucharest Stock Exchange	7	7	7	7	7	7
Bulgarian Stock Exchange	5	6	5	2	2	2
CEESEG – Budapest	3	3	3	5	4	5
CEESEG – Ljubljana	4	4	6	6	6	6
CEESEG – Prague	6	2	2	4	3	3
OMX Nordic - Vilnius	8	8	8	8	8	8
Warsaw Stock Exchange	1	1	1	1	1	1

Source: own calculations

In the third stage of the research Hellwig's synthetic measure of development was calculated separately for each month. Next, for all selected values of the synthetic variable the median was determined, which was assigned as SM_i value for a given year. The results of this stage are presented in Tables 5 and 6.

Table 5. Values of synthetic development measure for monthly SM_i medians

Stock Exchange	2003	2004	2005	2006	2007	2008
Bratislava Stock Exchange	0.56	0.65	0.64	0.63	0.65	0.62
Bucharest Stock Exchange	0.77	0.80	0.73	0.69	0.67	0.66
Bulgarian Stock Exchange	0.88	0.67	0.62	0.58	0.56	0.53
CEESEG – Budapest	0.65	0.67	0.66	0.66	0.65	0.63
CEESEG – Ljubljana	0.68	0.68	0.71	0.68	0.66	0.64
CEESEG – Prague	0.67	0.65	0.65	0.65	0.66	0.58
OMX Nordic - Vilnius	0.80	0.85	0.81	0.76	0.73	0.71
Warsaw Stock Exchange	0.33	0.27	0.19	0.11	0.07	0.00

Source: own calculations

As in the case of the previous analyses the first place among the researched objects was given to the Warsaw Stock Exchange and the Vilnius and Bucharest stock exchanges remained in the last positions. The markets with average level of development (positioned in the center) had similar positions than previously.

Table 6. Ranking of stock exchanges based on the median of monthly values of synthetic
            development measure

Stock Exchange	2003	2004	2005	2006	2007	2008
Bratislava Stock Exchange	2	3	3	3	3	4
Bucharest Stock Exchange	6	7	7	7	7	7
Bulgarian Stock Exchange	8	5	2	2	2	2
CEESEG – Budapest	3	4	5	5	4	5
CEESEG – Ljubljana	5	6	6	6	6	6
CEESEG – Prague	4	2	4	4	5	3
OMX Nordic - Vilnius	7	8	8	8	8	8
Warsaw Stock Exchange	1	1	1	1	1	1

Source: own calculations

Undoubtedly, a great advantage of the third method is the ability to analyze the development of each of the researched stock markets on a month to month basis. The sample graphic presentation of the monthly valued SM_i in 2003 clearly indicates the discrepancies between the levels of the synthetic variable (compare Figure 1).

The analysis of the SM_i value allows one to note that Bulgarian Stock Exchange during the first eleven months of 2003 was the weakest of the analyzed stock exchanges. However, in the last month its development level significantly increased. Consequently, the stock exchange in Sophia ranked third in December (compare method 1)

The results presented in Figure 1 indicate a significant resemblance of the Ljubljana, Prague and Budapest stock exchanges[5]. The graphic presentation of the results confirms the major difference in the level of development between the Warsaw Stock Exchange and other exchanges.

The joint comparative analysis (compare Table 7 and Table 8) of all the obtained results indicates a clear disproportion in the calculated values of the synthetic development measure. In 2003 the greatest difference was noted for Bulgarian stock exchange, which in subsequent rankings ranked third, fifth and then eighth. In 2004 Slovakian and Slovenian stock exchanges moved by two places. A major difference in positioning was noted in 2005 for Czech stock exchange while in 2007 the Czech and Slovakian stock exchanges moved by two places depending of the presented method.

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[5] The similarity between these stock exchanges is not accidental. Beginning in 2009 each of them along with the Vienna Stock Exchange is a member of Central Eastern Europe Stock Exchange Group.

Figure 1. Monthly values for Synthetic Development Measure in 2003
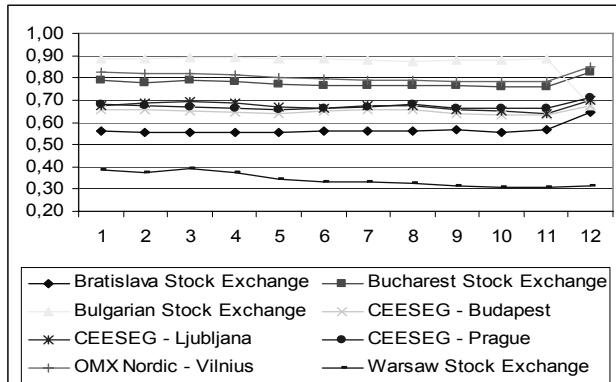
Source: own work

For the remaining stock exchanges no significant changes were noted. The objects moved one place up or down in single cases. It is worth noting that the stock exchanges whose development significantly differed from the others usually held the same position in every ranking (Warsaw, Vilnius and Bucharest Stock Exchanges). Analyzing the positioning of the objects in the rankings one may note that the greatest number of changes was noted in the third ranking (compared to the other rankings).

CONCLUSION

In the conducted study the Warsaw Stock Exchange is the best stock exchange (from the point of view of the assigned criterion). The exchange ranked highest throughout all the consecutive years. The results are confirmed in the literature. The Warsaw Stock Exchange as the only stock exchange in the analysis is included in the average-class stock exchanges and is compared to the Vienna Stock Exchange ([compare Ziarko-Siwek 2008]). The weakest (the least developed stock exchanges from the view point of the assigned criteria) are the Vilnius and Bucharest stock exchanges.

As a result of implementing three distinct methods of calculating the synthetic measure of development. significant differences in the ranking were achieved. Analyzing the obtained results it seems justifiable to include partial data from sub-periods in the longer period (the second and third method of selecting data presented in the article). In case of major changes of an occurrence this may have a significant impact on the conducted analysis.

Table 7. Comparison of the SM_f in 2003-2008

Stock Exchange	2003			2004			2005			2006			2007			2008		
	Method																	
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Bratislava Stock Exchange	0.64	0.75	0.56	0.64	0.77	0.65	0.64	0.77	0.64	0.65	0.77	0.63	0.64	0.79	0.65	0.61	0.80	0.62
Bucharest Stock Exchange	0.83	0.89	0.77	0.74	0.85	0.80	0.72	0.83	0.73	0.70	0.81	0.69	0.65	0.81	0.67	0.67	0.83	0.66
Bulgarian Stock Exchange	0.67	0.80	0.88	0.65	0.77	0.67	0.61	0.78	0.62	0.57	0.76	0.58	0.53	0.74	0.56	0.52	0.73	0.53
CEESEG - Budapest	0.68	0.78	0.65	0.64	0.73	0.67	0.67	0.76	0.66	0.67	0.78	0.66	0.63	0.79	0.65	0.64	0.80	0.63
CEESEG - Ljubljana	0.70	0.79	0.68	0.67	0.74	0.68	0.71	0.81	0.71	0.68	0.81	0.68	0.63	0.80	0.66	0.64	0.81	0.64
CEESEG - Prague	0.71	0.80	0.67	0.63	0.72	0.65	0.66	0.76	0.65	0.67	0.77	0.65	0.59	0.78	0.66	0.56	0.74	0.58
OMX Nordic - Vilnius	0.85	0.92	0.80	0.80	0.88	0.85	0.78	0.90	0.81	0.76	0.88	0.76	0.71	0.87	0.73	0.71	0.88	0.71
Warsaw Stock Exchange	0.31	0.57	0.33	0.17	0.50	0.27	0.16	0.49	0.19	0.13	0.47	0.11	0.00	0.47	0.07	0.00	0.49	0.00

Table 8. Ranking of stock exchanges in 2003-2004

Stock Exchange	2003			2004			2005			2006			2007			2008		
	Method																	
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Bratislava Stock Exchange	2	2	2	3	3	3	2	4	3	3	3	3	6	5	3	4	4	4
Bucharest Stock Exchange	7	7	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Bulgarian Stock Exchange	3	5	8	5	6	5	3	5	2	2	2	2	2	2	2	2	2	2
CEESEG - Budapest	4	3	3	4	3	4	4	3	5	4	5	5	4	4	4	5	5	5
CEESEG - Ljubljana	5	4	5	6	4	6	5	6	6	6	6	6	6	6	6	6	6	6
CEESEG - Prague	6	6	4	2	2	2	6	2	4	5	4	4	3	3	5	3	3	3
OMX Nordic - Vilnius	8	8	7	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Warsaw Stock Exchange	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

It is worth remembering that the second method (selection of all possible data) is connected with a certain risk. namely a large number of diagnostic variables.

According to [Zeliaś 2002] the number of diagnostic variables should be reduced since having too many variables may disturb or even block effective classification of objects. Therefore. the third method of data selection is recommended (to calculate the synthetic measure of each sub-period individually and then determine the correct average based on the analyzed occurrence). This will allow for including partial alterations of an occurrence and without increasing the number of diagnostic variables.

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