CLUSTER ANALYSIS OF INTERNATIONAL INFORMATION AND SOCIAL DEVELOPMENT

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ABSTRACT: Data from 31 countries are examined in this paper. 5 variables representing the meeting of basic needs of the population, and 15 variables representing information activities are used as proxies of social and information development at national level. The statistical technique used to analyse these variables is cluster analysis. The results obtained suggest that information development is achieved mainly by countries which have also achieved social development. Therefore, nations with high incomes, but without social development lack information development. Moreover, the results show that the information gap between rich and poor nations seems to be greater than the social gap.

1 SCOPE OF THE STUDY

The goal in this paper is to analyse information activities in relation to socio-economic characteristics in low, middle and highly developed economies with cluster analysis. The data analysed ~~corresponds to 1960 and~~

1977. These two cross-sectional time slices mark the peak and the end of the fastest economic growth of this century. Despite the relevance of this period to information development worldwide, it has not been studied profoundly at an international level. So far, only two international studies have been conducted to evaluate information development, but using cross-temporal data from the 1970s [2] [7]. Therefore, no studies have been conducted using time-series analysis at an international level.

The population analysed in this study includes 31 countries. They were selected on the basis of data availability and represent a wide range of economic development (see Table 1). In 1975, these countries' GNP per capita spread from over US$100 to over US$15,000. If the countries' GNP per head is analysed, they can be grouped into the known economic strata of low, middle and highly developed nations. The World Bank grouped countries with an income of less than US$300 in 1977 as low income countries (LICs) and above as middle income countries (MICs) [27]. However, the World Bank parameters are not clear, because it fails to give the starting-income bracket for high developed nations (HDCs). As a result, although it is not directly implied, HDC countries are in any of the following groups: a) Southern European, b) East European non-market economies, c) Industrial market economies, and d) High-income oil exporters. Despite the limitation of this World Bank classification, it is used in this paper as an economic framework for the discussion of the the study results.

2 INDICATORS OF DEVELOPMENT

Socio-economic development of countries is assessed with a quantitative definition based on five basic needs indicators suggested by Hicks and Streeten [10]. The indicators are: food consumption in calories, life expectancy at birth, infant mortality rate, adjusted enrolment rate in primary schools, and adult literacy rate. All these variables were taken as indicators of national social development. Therefore, the use of purely economic indicators like Gross National Product (GNP) and its derivative indicators were avoided due to their partial measuring of the well-being of the population. Hicks and Streeten argue that GNP gives priority to how much is being produced, whereas basic needs measures highlight production in the context of who is being benefited and with what impact.

Information development is represented by three components: storage centres of information, accumulation of recorded information, and recording of information activities. The three information components are represented by library and publishing indicators, following the methodologies of Machlup [15] and King et al's [12]. Storage centres are represented by indicators of number of service points of a) national, b) university, c) school, d) special, and e) public libraries. Information stocks are, in turn, represented by the number of volumes of the same type of library centres. Information recording activities are limited to publishing, which is regarded as a good indicator of information growth [15] [12] [7]. Publishing activities are represented by a) the number of book titles, b) the circulation of daily general-interest newspapers, c) the circulation of non-daily newspapers, d) the titles of other periodicals, e) and the consumption of newsprint paper. No factors reflecting the quality and benefits of information are studied due to the lack of statistical time-series.

Data for the variables, 20 in total, were gathered from two sources. Statistics for the basic needs indicators are from the magnetic tape version of the World Bank Tables [26], while the information series are from Unesco Statistical Yearbooks [24]. A few data cells had to be estimated using regression analysis. The data and the methodology to build the data sets are included in Lau [13]. In regard to the reliability and validity of the data a full paper could be written describing the pitfalls of international time-series. The data is biased towards HDCs which provide fuller information to international organisations. Nevertheless, if the results are taken with care, they can serve as a guide to the social and information development achieved by countries between 1960 and 1977.

3 METHODOLOGY FOR THE CLASSIFICATION OF COUNTRIES

The use of many variables to assess the ranking of countries in terms of development is normally achieved by forming composite indices. However, the building of composite indices is meaningless if the parameters under study measure different socio-economic aspects. Besides the inherent problem of how to select the

relevant parameters, problems usually arise due to a) the weighting of variables, since they may not be equally relevant, and b) the scaling of variables, because they are normally in different measures. However, these problems can be avoided if variables are analysed independently.

The best way to analyse more than one indicator is by using multivariate statistical analysis. According to Ehrenberg [6] the two main methods which could be used when all variables are of similar interest are discriminant and cluster analysis. The first is a technique that "aims to establish whether two or more sets of objects differ from each other". The second is a form of classification in which the groups are not known a priori. Since the objective of this research is to identify what countries are similar, the second method was chosen.

3.1 Cluster analysis

Cluster analysis is a generic term used for a set of techniques which all seek to classify a set of data into groups or clusters. Literature on clustering methods is vast because there are many techniques available. Everitt [8] summarises the characteristics and the strengths of the most commonly used clustering techniques. According to this author they could be divided into more than five generic groups. However, Blashfield and Aldenderfer [1], consider that they could be grouped into two categories, that is, the partitioning and the hierarchical type. However, they also recognise that more categories could be identified but they are a combination of hierarchical and partitioning methodologies.

Partitioning methods assign each item to one or more clusters which exist in a single rank. In other words, they do not portray hierarchical relationships among entities. Moreover, they require the user to choose a statistic to be optimised during the cluster analysis. In addition, the user usually must choose the number of desired clusters. Hierarchical methods, on the other hand, result in a data set in which small clusters of similar objects are nested within large clusters of less similar objects until a general cluster is formed. These methods' results are normally represented in a tree-like structure called a dendrogram.

In this investigation, it was decided to rely on hierarchical methods because they do not require a pre-

requisite of knowing the possible number of clusters before the analysis. Moreover, they are regarded as robust methods which have been developed more than partitioning methodologies [1].

Hierarchical methods can be divided further into agglomerative and divisive techniques. Divisive methods successively partition the set of entities into smaller groups and are much less commonly used [1]. The hierarchical agglomerative methods, on the other hand, successively fuse the entities under study until all of them are in one group. A number of hierarchical agglomerative methods have been developed. Milligan [17] conducted a comprehensive review of the literature on comparative studies of experimental simulations, using many hierarchical methods. He concluded that the methods which were often considered the best were complete linkage, group average and Ward's method.

3.2 Selected methods

In this study, it was decided to use two of Milligan's recommended methods, that is group average and Ward's method. The group average method "defines distance between groups as the average of the distances between all pairs of individuals in the two groups." Ward's method is, on the other hand, a method that measures the total sum of squared deviations of every point from the mean of the cluster to which it belongs. Moreover, at each step in the analysis, union of every possible pair of clusters is considered, and the two clusters whose fusion results in the minimum increase in the error of the sum of the squares are combined [8].

3.3 Distance and similarity measures

Another decision that has to be taken when clustering techniques are used is the selection of measurement of distance and similarities. The distance measure used was Euclidean distance, which Everitt [8] considers as more accurate, and more popular among researchers who use standardised data. Data were, in this study, standardised to zero mean and unit variance, using the standard deviations derived from the complete set of countries. This transformation is recommended when variables are measured in different ways, as was the

case of the five social indicators, and to a certain extent some of the information variables. However, standardisation has the effect of diluting differences between groups of variables which are the best discriminators [8].

3.4 Stopping rules

The hierarchical agglomerative procedures generate every number of clusters from one to the number of entities in the data set. The determination of the correct number of clusters is usually performed with measurement procedures called stopping rules. In this study the Upper Tail Rule was applied. It selects the best number of clusters on the basis of the distribution of a clustering criterion. The criterion vector is a measure associated with each hierarchical level which satisfies or reproduces the underlying structure of the cases' data. If a significant change is not observed in such a criterion then no structure is assumed in the data set, meaning that no clusters are significantly formed [19]. Milligan and Cooper [18] evaluated 30 stopping rules, using four clustering methods, of which two were group average and Ward's method. The Monte Carlo evaluation used by the researchers showed that not all stopping rules were good at determining the correct number of clusters in the data. However, among the ninth best stopping rules was the Upper Tail Rule which was used by this study.

4 DISCUSSION OF THE RESULTS

The clustering methods were implemented with the CLUSTAN Package, version two, which is a suite of programs prepared by Wishart [25]. The package is regarded as the most comprehensive clustering system available [8]. The data sets were clustered independently to identify the underlying structure of the data. The basic needs indicators clustered well in the first trials, while library and publishing indicators required lengthy analysis to identify the best information indicators to classify countries. The discussion of the cluster results is based on the dendrograms obtained with Ward's method. The Group Average's dendrograms yielded similar fusions of countries and hence validated the robustness of Ward's clusters. The discussion of

results also focusses only on the dendrograms obtained with the social variables and a selection of information indicators. Therefore, there is only a brief mention of the cluster results yielded by the library and publishing indicators.

The dendrograms are explained by discussing their number of clusters. Cases which seem to have fused to the wrong group of countries are also analysed. The term cluster is used to denominate a set of countries that are more similar to each other [8]. Moreover, the word group, partition, and class are used as synonyms of the term cluster. The fusion level (the point at which the cases or the clusters join into a set) is quoted in all the analyses of the dendrograms in order to indicate the number of significant clusters. These values are on the vertical line of the left-hand side of the dendrograms, and the stopping rule's values are listed, on the other hand, in the upper part of the graphics. The dendrograms are also marked with an asterisk where the stopping rule indicates that there is a hierarchy. Furthermore, the clusters are numbered to make the identification of them easier.

4.1 Classification with the 1960 social data

If Dendrogram 1 is analysed (see graph 1), the 1960 analysis of social indicators shows that there are three clusters at around the 9.564 fusion level, according to the stopping rule. The first cluster groups socially developed countries into two subgroups. The first subgroup fuses European countries of market and non-market oriented economies, whereas the second subgroup fuses countries with a lower, but nonetheless, high social development. However, the grouping of Western Samoa is not completely homogenous. It fuses with LDCs in the 1977 social analysis (see Dendrogram 2). Therefore, Western Samoa's HDC 1960 fusion is likely to be wrong, result which is probably due to faulty data.

The second cluster includes countries that can be regarded as MIC nations, except Sri Lanka and Thailand which are low income countries (LICs), but have been pinpointed as having a higher social development than countries with the same economic development [10] [5]. In contrast Kuwait, which also joins the same group is regarded as a country which has a lower social development than the above due to its economic development. The third cluster in the dendrogram groups the poorest LDCs, that is, Comoros, Gambia and

Malawi. The three African countries have some of the lowest incomes in the world. Therefore, their social grouping is homogenous.

4.2 Classification with the 1977 social data

The classification of countries with social data corresponding to 18 years later (1977) reflects again that, at around the fusion level of 6.225, there are only three clusters which are significantly different, according to the stopping rule (see Dendrogram 2). From left to right, the first cluster fuses the most developed countries among capitalist and socialist nations of the sample. However, Hong Kong and Kuwait are also included in the partition. They look like odd cases in this group because they are regarded as middle income countries by the World Bank [26]. However, Hong Kong's economy is one of the most developed among LDCs, thus ranking it as a newly industrialised country [3]. It is even ranked as a socially developed state in McGranahan's [16] socio-economic index. On the other hand, Kuwait falls into the same cluster despite being a middle socially developed nation [5]. However, it is an oil-rich country which has one of the highest incomes of the world (see Table 1). Consequently, its joining with HDCs may show that its high oil-income was trickling down to the poor by 1977.

The third cluster fuses middle income countries, that is, Latin American nations included in the population, plus some Asian countries. Sri Lanka fuses with this group despite being a LIC, although it is in the upper tier of LIC nations (see Table 1), according to its GNP. Therefore, Sri Lanka's fusion may be correct. The third cluster groups the three African nations included in the investigation. Again, they show the lowest social development of the population and remain independent of the other nations just as they do in the 1960 cluster analysis, despite the 18 years in between.

4.3 Economic classification versus social classification

The social classifications of countries, which are represented in Dendrograms 1 and 2, can be taken as an indication that basic human needs indicators determine better what the well-being of the population is, than

GNP would. These results agree with previous studies [10]. The countries without high GNP per capita, that have fused as socially developed, have pursued policies in favour of meeting the basic needs of their populations [20]. For instance, the socialist countries of Rumania and Yugoslavia, have an income per capita which is lower than those from countries of the upper tier of MICs (see Table 1). Nonetheless, they cluster as highly socially developed nations.

The opposite situation is evident in cases with policies which are more production oriented, like South Korea, Mexico, Venezuela and Bahamas. These have strong MIC economies but lag behind in social development. South Korea and Mexico are considered newly industrialised countries, according to economists [3] [23]. However, some countries with market oriented economies like Cyprus, Hong Kong, Portugal and Sri Lanka rank higher in social attainment than they would if GNP per capita were considered.

The fusion of countries of different economic income near the cluster of socially developed nations, like Hong Kong and the Southern European countries is due to the fact that nations can reach a plateau in meeting basic needs. After a certain level of socio-economic development, countries show little or no increase in such indicators even if their economies are wealthier [9]. On the other hand, the social variables employed in this study measure only "basic needs" satisfaction, which have a limit. Literacy obviously approaches 100% when almost all the population knows how to read and write, but it does not measure any educational attainment beyond that level. Life expectancy also has a limit which is difficult to exceed even if a nation becomes richer, because any health increase is mainly linked to improvement of health-related technology. The other indicators have the same kind of upper limits. Therefore, some countries without a high GNP per capita, but with a good social welfare system, like socialist countries, can reach social levels similar to the USA, or any other "first world" nation [20] [4].

5 INFORMATION CLASSIFICATION OF COUNTRIES

Countries fused into three categories of development when social, indicators were analysed, but do countries group into the same groups if information characteristics are analysed? The answer to this question is

the concern of the following sections, where information clusters are compared with the social partitions obtained in the two previous cluster analyses. Information variables measure, like the social indicators, basic information activities. In other words, information variables do not take into account developments in electronically stored information, where HDCs have an almost exclusive lead [14]. As expressed before, not all dendrograms obtained in the cluster analyses of information activities are discussed here due to limited space. However, for a comprehensive discussion of the results see Lau [13].

5.1 Library and publishing classifications

Variables representing libraries, volume collections, and publishing activities underwent cluster analysis to identify the best indicators of information development. The ten library variables were aggregated into two indicators and divided by 100,000 inhabitants. They represented library service points and collections of national, university, special, school and public centres. The adding together of these variables was to avoid the change of library definitions adopted by countries between 1960 and 1977.

The cluster analysis of the aggregated library indicators yielded significant classifications. Countries fell, unlike the social clusterings, into two categories at the fusion level of 10.00 in the 1960 analysis (see dendrogram 3). The HDCs fused into two clusters, and the LDCs into one. Similar grouping came from the clustering of the 1977 library data at the fusion level of 9.255 (see Dendrogram 4), where LDCs remained in a single cluster, but HDCs fused again in two clusters. The classification in both years shows international library polarity. The results may be an indication of a library cleavage between countries with and without social development. However, this division is less sharp when a publishing indicator is included, analysis of which is described in the next paragraph.

The five publishing variables were analysed independently from library indicators. The cluster analysis showed that newsprint paper consumption yielded good results, but the rest of publishing variables did not yield a cluster hierarchy. The odd results may have been due to the fact that these indicators are in different measures. Two variables measure number of titles, another two newspaper circulation, and one consumption of paper. Moreover, it has been found that publishing trends are different among HDCs and

LDCs. Newspapers and magazines are increasing their circulation at a national level in HDCs, and as a consequence local published titles are being taken out of the market. Therefore, the number of titles is decreasing in HDCs, while it is still increasing in LDCs. Furthermore, newspaper circulation is decreasing in HDCs due to the competition of electronic mass media, like television, but it is rising in some LDCs [21]. Unfortunately, it was not possible to include other publishing indicators in this study because of limited data.

6 CLASSIFICATION WITH SELECTED INFORMATION INDICATORS

After identifying the best library and publishing indicators, the aggregated indicator of volumes and the variable representing newspaper consumption were cluster analysed. The number of volumes was used as a sole indicator of national library activity and information wealth possessed by countries. Tonnes of newsprint paper consumption per 1,000 inhabitants was, in turn, taken as an indicator of basic information recording activities at national level. Comoros was excluded of the population in these analyses due the lack of data in one indicator.

6.1 Cluster results with the 1960 data

The cluster analysis of the 1960 values of the two selected information variables fuses nations into two clusters and two singletons at around the fusion level of 10.322, according to the stopping rule (see Dendrogram 5). The information clusters show, in general, agreement with those obtained with the 1960 social data. The first cluster fuses the countries that can be regarded as information developed, since they have high values in number of volumes and newsprint paper consumption. Hong Kong and Trinidad and Tobago show high information development in spite of not matching their 1960 social development (see Dendrogram 1). They cluster with this group mainly due to their high consumption of newsprint consumption. Bahamas is, on the other hand, a misplaced case due to its limited data in newsprint consumption. The regression estimates of

its missing data seem to be too high, because they were based on later year cells which consequently had higher values.

The second cluster is formed by nations with LDC development, and with significantly lower information values. Spain, which was already socially developed in 1960, again fuses with this group and thus it shows a similar fusion to that yielded with the library data (see Dendrogram 3). The last sub-group of the second cluster is formed by slightly more information developed nations than the two other sub-groups, that is, Kuwait, Portugal and Yugoslavia. Their information values are slightly higher. However, Portugal and Yugoslavia show lower information development than their social attainment for 1960. They fused with HDCs in the 1960 library clustering (see Dendrogram 3).

Lastly, the USA and the USSR show independent characteristics. Both form singletons because of their high values which make them outliers in the population. Their potential effects on the clustering results were studied by removing both cases from the population and clustering the remaining cases independently. The dendrogram obtained had minor changes in the order of countries within the clusters, but nations basically remained in the same clusters. As a result, it was decided to study the two outliers along with the rest of the population.

The partitions in the Dendrogram 5 shows, therefore, agreement with the social clusters of 1960 (see Dendrogram 1). In other words, information development, characterised by total number of volumes and consumption of newsprint paper, seems to be in parallel with social development. Most countries with high social development also have high information development. However, the information differences among LDCs are less significant than their social differences. Comoros, Gambia and Malawi showed a significant difference with the rest of LDCs in social development, but not in information aspects.

6.2 Cluster results with the 1977 data

The number of clusters is greater in the 1977 Dendrogram than that of 1960 (see Dendrogram 6). At the fusion level of 4.000, there are five significantly different clusters, according to the stopping rule. However,

the significance of the hierarchy is borderline, and so countries of groups 4 and 5 were analysed independently from countries included in the other clusters. The reduced-case classification still showed that there were significant differences between both groups (results are not included).

The first and the second partition of the dendrogram fuses nations with high information development. The third cluster groups countries with even higher information development than the previous clusters. These three clusters fuse HDC countries whose values are high. Consequently, their information groupings are in agreement with their social and library development in 1977, even that of Hong Kong. The fourth cluster fuses countries with low information development. Spain again joined this group, as it did in the library clusterings, indicating that it is still behind in information development in 1977. Kuwait, despite its economic wealth per capita, and its already advanced social development, also lags behind in information activities in 1977. Both countries' results agree with literature that ranks them as being behind in information activities [7].

The last cluster joins together four European non-market economies. They show a higher information development than cluster 4 but lower than cluster 1, 2 and 3. These socialist countries form a group that can be regarded as middle information developed. They fall in between HDCs and LDCs. Dendrogram 6 shows, therefore, that the population of countries is less polarised when only volumes and newsprint paper consumption per 100,000 inhabitants are used as indicators of information development. However, LDCs still form a single cluster, showing no significant differences among them.

7 CONCLUSIONS

1) Cluster analysis was applied to social and information indicators independently. The first to be analysed were the five basic needs indicators. The social classification obtained showed that countries grouped differently from what they would do if GNP per capita were taken into account, e.g. Bahamas with a high income fused with nations of lower social development (see Table 1 and Dendrograms 1 and 2), whilst the opposite direction was taken by Rumania and Yugoslavia. Their incomes were not as high as those of HDCs, but

they grouped with them in social development. Nevertheless, the classification reflected the stratification of countries into three groups which coincides with the traditional division of low, middle and highly developed nations. However, the cases in each social stratum were not all in full agreement with known economic rankings.

2) The library clusters, on the other hand, fused most nations into two polarised classes: those with high library values and those with low library values (see Dendrograms 3 and 4). LDCs lacked significant library differences between them, despite the fact that some were MIC nations, and others were LICs. Publishing indicators were not good characteristics for classifying the population, because of the different trends in information-recording activities between HDCs and LDCs.

3) The aggregated number of volumes and of newsprint consumption were used as surrogate indicators of information development (see Dendrograms 5 and 6). The results indicated that HDC countries had, in general, an information development similar to their social development: a fact that would hold less true if the economic indicator of GNP per capita were the only factor to be taken into account. The East European non-market-oriented economies had, in general, social and information development similar to HDC market-oriented economies, like those of Austria and Japan, in spite of their lower incomes.

The results thus indicate that nations with socially-oriented policies can also have information development even without high income economies (see Table 1). Cases that fall into this category were Yugoslavia, Hong Kong, Bulgaria, and Hungary. Cyprus came partly into this category because it is developed in libraries, but underdeveloped in publishing. However, Kuwait, Portugal and Spain were the exceptions to the matching of social development with information development in the HDC group. Spain has been found to have before low information development in a previous study [7].

4) Countries that lacked social development, even when they had high income, did not register information development. Panama, Trinidad and Tobago, Venezuela, and Bahamas fell into this class. MIC nations that had not achieved the satisfaction of basic human needs showed almost no information differences with LIC countries if analysed along with HDCs. This result may be an indication that information differences are greater than social ones between HDCs and LDCs. Moreover, it might also be argued that MIC countries

may require full social development before they manifest tangible information differences from LICs.

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