A NEW PERSPECTIVE IN COMPETITIVENESS OF NATIONS

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Abstract

The capability of firms to survive and to have a competitive advantage in global markets depends on, amongst other things, the efficiency of public institutions, the excellence of educational, health and communications infrastructures, as well as on the political and economic stability of their home country. The measurement of competitiveness and strategy development is thus an important issue for policy-makers. Despite many attempts to provide objectivity in the development of measures of national competitiveness, there are inherently subjective judgments that involve, for example, how data sets are aggregated and importance weights are applied. Generally, either equal weighting is assumed in calculating a final index, or subjective weights are specified. The same problem also occurs in the subjective assignment of countries to different clusters. Developed as such, the value of these type indices may be questioned by users. The aim of this paper is to explore methodological transparency as a viable solution to problems created by existing aggregated indices. For this purpose, a methodology composed of three steps is proposed. To start, a hierarchical clustering analysis is used to assign countries to appropriate clusters. In current methods, country clustering is generally based on GDP. However, we suggest that GDP alone is insufficient for purposes of country clustering. In the proposed methodology, 178 criteria are used for this purpose. Next, relationships between the criteria and classification of the countries are determined using artificial neural networks (ANNs). ANN provides an objective method for determining the attribute/criteria weights, which are, for the most part, subjectively specified in existing methods. Finally, in our third step, the countries of interest are ranked based on weights generated in the previous step. Beyond the ranking of countries, the proposed methodology can also be used to identify those attributes that a given country should focus on in order to improve its position relative to other countries, i.e., to transition from its current cluster to the next higher one.

Keywords: Ranking, Competitiveness, Artificial Neural Network

1. Introduction

In today's global world, competitiveness has become a milestone of both advanced and developing countries. Because of recent pressures introduced by globalization, it is important to have a model for the analysis of a country's competitive position in the international market, and not simply its internal

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measure of productivity. It is common knowledge that the marketplace is no longer restricted to a particular geographic location. A business can no longer expect competition only from neighboring businesses or from businesses within its own region. The marketplace is now global and even the smallest of organizations competes on an international level. In order to provide firms the necessary opportunities to survive and realize global competitive advantage, it is essential to define the relative competitive position of their home country.

A nation's competitiveness can be viewed as a nation's relative competitive position in the international market compared to other nations of similar economic development. The capability of firms to survive and to have a competitive advantage in global markets depends, among other things, on the efficiency of the public institutions, the excellence of the educational, health and communication infrastructures as well as the political and economical stability in their home country. On the other hand, an outstanding macroeconomic environment alone cannot guarantee a high level of national competitive position unless firms create valuable goods and services with a commensurately high level of productivity at the micro level. Therefore, the micro and macroeconomic characteristics of an economy jointly determine its level of productivity and competitiveness.

A nation's competitiveness is defined as the degree to which a nation can, under free and fair market conditions, produce goods and services that meet the standards of international markets while simultaneously expanding the real income of its citizens, thus improving their quality of live [1, 29]. It includes the set of institutions, policies, and factors that determine the level of productivity of a country [28].

Although many view competitiveness as synonym for productivity [23], these two related terms are in fact different. Productivity refers to the internal capability of an organization while competitiveness refers to the relative position of an organization vis-à-vis its competitors.

This paper addresses two major methodological issues concerning the construction of a composite indicator of national competitiveness. The first is the choice of weights to use to aggregate the underlying primary data concerning micro and macroeconomic factors. Most composite indicators currently used either take predetermined fixed weight values that are applied uniformly to all

countries, or apply subjective weights to different clusters of countries. These types of weights may cause biased measurement, and, hence, inferences of relative measurement. The second issue is the specification of the stages of countries and understanding of the criteria that have the greatest impact on the specification of the relative position of the countries in terms of competition. Again, in most composite indicators, such as the ones developed by the World Economic Forum (WEF), although the countries are clustered according to their different stages of competitiveness, this classification is tends to be rather subjective in nature or, when attempts at objectively are made, is based solely on income per capita. Subjectively is also present when creating the threshold used to separate one stage from another. Some degree of objectivity is possible, however, if countries are clustered taking into consideration their similarities with respect to different criteria. By doing so, important criteria underlying the competitiveness position of each stage, and of particular counties at various stages, can be revealed. Therefore it will be much easier to understand the internal dynamics of each stage and provide useful and objective guidelines to each country in their attempt to improve their relative position with respect to countries located at higher stages.

In the second part of this research, different indices developed and used by the WEF to analyze the competitiveness of nations are summarized and the subjectivity in their weighting and clustering method is underlined. The third section introduces the proposed methodology to cluster the countries into stages and to reveal the weight of the criteria that play the dominant role at each stage (For a similar approach, see [25]). Finally, a new composite index is proposed using the calculated weights and the results are compared with those of Global Competitiveness Index of the WEF to determine whether the weight values adopted by the WEF incorrectly penalize some countries and/or reward others due to the resulting competitiveness index values and the subsequent ranking of countries being biased. Some useful guidelines are also provided to selected countries seeking to improve their position in terms of relative competitiveness. Finally, conclusions and suggestions are given.

2. Assessing Countries' Competitiveness Indexes: Current State of the Art

Although much research has been done on competitiveness measurements, it generally focuses on the firm [11, 13, 19, 20, 21, 23] or industry level [1, 2]. Very few studies have attempted to make a comparison of multi-country competitiveness [21, 22, 25, 29, 30, 32].

Each year, some organizations, such as the WEF and the Institute for Management Development (IMD) [34], publish rankings of national competitiveness among countries. These rankings serve as benchmarks for national policy makers and interested parties to judge the relative success of their country in achieving the competitiveness criteria represented by the corresponding competitiveness index.

The IMD, initially jointly with the WEF, has produced comparisons of nations' competitiveness through the annual publication of the World Competitiveness Yearbook (WCY) since 1989. The WCY analyzes and ranks the ability of nations to provide a sustainable environment for the competitiveness of enterprises. It develops a competitiveness score of selected OECD countries and newly industrialized countries based on political and socio-economic indicators. Until 2001, it provided a competitiveness score for each country by synthesizing all collected information into eight major factors: domestic economy, internationalization, government, finance, infrastructure, management, science and technology, and people. Since 2001, it has used four basic factors: economic performance (77 criteria), government efficiency (72 criteria), business efficiency (68 criteria), and infrastructure (95 criteria). Each of these four factors has been broken down into five sub-factors, each highlighting different aspects of competitiveness. Therefore, the WCY includes 20 sub-factors. These 20 sub-factors comprise more than 300 criteria, although each sub-factor does not necessarily have the same number of criteria and the inter-correlation among those criteria is difficult to avoid. Criteria can be hard data, which analyze competitiveness as it can be measured (e.g., GDP) or soft data, which analyze competitiveness as it can be perceived (e.g., availability of competent managers). Countries are given scores in each of these four factors, based on both quantitative and survey data, and then a weighted average is taken to produce the Overall Competitiveness Index. In the computation of this index, hard data represent a weight of two-thirds in the overall ranking whereas the survey data

represent a weight of one-third. In 2006, the WCY evaluated 61 countries and regional economies, all key players in world markets [35].

Oral and Chabchoub, after detailed mathematical programming modeling by sub-factor levels, showed that the methodology used in World Competitiveness Yearbook is hard to guess and suggest the need of other statistical or other mathematical programming techniques [21, 22].

For the last quarter-century, the WEF has lead in the evaluation of the competitiveness of nations through its publication, *The Global Competitiveness Report*, but the methodology that it used to assess national competitiveness has evolved over time.

The WEF uses three competitiveness indexes in order to analyze the competitiveness level from macroeconomic and microeconomic perspectives. The Growth Competitiveness Index (GCI), developed by McArthur and Sachs [15], and Blanke and Lopez-Claros [2], makes an evaluation based on critical, and mostly macroeconomic environmental, factors that influence the sustained economic growth over the medium to long term. Porter's Business Competitiveness Index (BCI) [26], however, investigates the company-specific factors that lead to improved efficiency and productivity indicators at the micro perspective and is complementary to the GCI. Recently, a Global Competitiveness Index [28], which is a synthesis of the GCI and the BCI, has also been provided. This new index is designed with the goal of unifying the GCI and the BCI, and it is meant eventually to replace them in the Global Competitiveness Report.

2.1 Growth Competitiveness Index

The Growth Competitiveness Index is composed of three factor groups, all being accepted as critical to economic growth. The detailed configuration of the GCI is given in Figure 1.

Insert Figure 1 here.

The GCI uses a combination of hard data and data from the WEF's Executive Opinion Survey, with responses ranging from 1 to 7. Standardization is achieved by converting the hard data to a scale of 1-to-7.

Because the importance of the role of technology differs between the countries depending on their stage of development, in estimating the GCI, the countries are divided into two groups: the "core" economies where the technological innovation is critical for growth and the "non-core" economies, which are still growing by adopting technology developed abroad. The separation is based on the threshold of 15 patents per million people.

For the core innovators (with more than 15 patents) the GCI is calculated as:

$$\text{Core GCI} = \underset{\text{index}}{1/2\ \text{technology}} + \underset{\text{index}}{1/4\ \text{public institution}} + \underset{\text{index}}{1/4\ \text{macroeconomic environment}}$$

For the non-core economies, however, the GCI is calculated as:

$$\text{Non-core GCI} = \underset{\text{index}}{1/3\ \text{technology}} + \underset{\text{index}}{1/3\ \text{public institution}} + \underset{\text{index}}{1/3\ \text{macroeconomic environment}}$$

The GCI aims to rank the countries and also track the changes in the ranks over time.

2.2 Business Competitiveness Index

The Business Competitiveness Index explores the underpinnings of a nation's prosperity, measured by its level of GDP per capita. The focus is on whether current prosperity is sustainable. The BCI accounts for 81 % of variation across countries in the level of GDP per capita. It accepts that true competitiveness is measured by productivity. A nation's standard of living is determined by the productivity of its economy, which is measured by the value of goods and services produced per unit of the nation's human, capital, and natural resources. Figure 2 shows the configuration of the BCI.

Insert Figure 2 here.

Although stable political, legal, and social institutions and sound fiscal and monetary policies create the potential to create wealth, they do not themselves create wealth. Wealth is created at the microeconomic level. Therefore, unless microeconomic capabilities improve, macroeconomic, political, legal and social reforms will not be sufficient [27].

As nations develop, they progress in terms of their competitive advantages and modes of competing. At the *factor-driven* stage, basic factors such as low-cost labor and unprocessed natural resources are the dominant sources of competitive advantage. At this stage, companies compete in terms of price and have limited roles in the value chain. For low-income countries at the factor-driven stage of development, the ability to move beyond competing vis-à-vis cheap labor and natural resources is the essential challenge. Those countries score low on most measures but especially on infrastructure, educational quality, capital access, cluster development and measures related to technology and innovation. In these countries, priority should be given to upgrading the quality of infrastructure and opening competition.

In the *investment-driven* stage, efficiency in producing standard products and services becomes the dominant source of competitive advantage. Heavy investment in efficiency structure, strong investment incentives and better access to capital allow major improvement in productivity. Improving production process sophistication is the most important corporate priority. Companies must also begin to increase the professionalism of management, create the capacity for technology absorption, overcome their dependence on exports to a few, advanced foreign markets. Middle-income countries score low especially on infrastructure, the legal and regulatory efficiency and transparency and the task is to move from *factor-driven* stage to *investment-driven* stage. Improving university-industry research collaboration and the quality of research institutions as well as the quality of the judicial system becomes an important success factor.

Finally, at the *innovation-driven* stage, the ability to produce innovative products and services using the most advanced methods becomes the dominant source of competitive advantage. To succeed in a high-income economy, it is necessary to move to the innovation-driven stage. Deep-cluster development, the quality of the regulatory environment, the sophistication of both demand conditions and of the local fiscal market, and the quality of management education are important distinguishing factors for most successful high-income economies.

2.3 Global Competitiveness Index

Recently the WEF introduced the Global Competitiveness Index to rank the countries. While the GCI refers to macroeconomic determinants of productivity, the BCI captures the microeconomic components of it. Additionally, while the GCI is supposed to capture the "dynamic" determinants of productivity, the BCI captures the "static" determinants. In reality, the macroeconomic and microeconomic determinants of competitiveness cannot be separated. The ability of firms to succeed depends, among other things, on the efficiency of the public institutions, the quality of the educational system, and the overall macroeconomic stability of the country in which they operate. Productivity has both static and dynamic implication for a country's standard of living. Only by reinforcing each other can the micro and macroeconomic characteristics of an economy jointly determine its level of productivity and competitiveness. That is why, in the 2004 WEF report a new index is developed with the goal of unifying the two indexes; namely the GCI and the BCI, and replaces them with the Global Competitiveness Index.

This new index is based on three principles: 1) the determinants of competitiveness are complex, with competitiveness consisting of twelve main components; 2) economic development is a dynamic process of successive improvement, i.e., it evolves in stages; 3) as economies develop, they move from one stage to the next in a smooth fashion.

The twelve main components of economic competitiveness in principle one are specified in Table 1.

Insert Table 1 here.

These twelve components are, in fact, related to each other and tend to be mutually reinforcing. For example, innovation (the 12th component) cannot be performed in a country lacking human capital (the 5th component) and will never take place in economies with inefficient markets (the 6th, 7th and 8th components), without infrastructures (the 2nd component) or nations at wars (the 4th component).

On the other hand, according to the second principle of the Global Competitiveness Index, the countries belong to one of three stages. Each of the twelve factors has different weights for each stage of development. At the most basic stage, called *factor-driven* stage, firms compete in terms of price and take advantage of cheap labor and/or unprocessed natural resources. At the second stage, called

the *efficiency-driven* stage, efficient production becomes the main source of competitiveness. Finally, at the *innovation-driven* stage, successful economies can no longer compete in terms of price or even quality and have to produce innovative products and practices using the most advanced methods of production and organization. In Table 1, the configuration of components can be seen in detail. In the computation of the global competitiveness index, the weighted averages of three groups of criteria – *basic requirements, efficiency enhancers* and *innovation and sophistication factors* - are calculated, with each group being weighted differently depending on the stage to which the country belongs (see Table 1).

In the allocation of countries to stages, the following criteria are taken into account:

1) If the country's GDP per capita is below US$2,000 or the fraction of its exports in the form of primary goods is above 70 %, the country belongs to the *factor-driven* stage.

2) If a country has a per capita income between US$3,000 and $9,000 and does not export more than 70 % in primary goods, it belongs to the *efficiency-driven* stage.

3) If a country has more than US$17,000 per capita income and less than 70 % of the exports in primary goods, it belongs to the *innovation-driven* stage.

4) Countries with income per capita between US$2,000 and 3,000 are said to be in transition from stage 1 to stage 2.

5) Countries with income per capita between US$9,000 and 17,000 are said to be in transition between stages 2 and 3.

Similar to the GCI and the BCI, both hard data and survey data collected by the WEF are used in the calculation of the Global Competitiveness Index. These data are combined to estimate the 12 components of economic development. The index is calculated for 104 countries, with the United States ranked as the most competitive country, Angola the least, followed by Chad, Ethiopia, Zimbabwe, and Mozambique.

As can be seen in all the above-given indices, although the weights given to different criteria is different for countries at different stages of development, the specification of these weights are

subjective in nature; at least there is no information about the way they are specified. Similarly, the assignment of the countries to different clusters at different stages of development is either arbitrary or based on their level of per capita income. Moreover, the threshold values used to separate each stage are subjective.

3. The Proposed Methodology

The aim of this research is, first, to provide an *objective clustering of the countries* according to their proximity to values specified within different criteria and to propose an *objective weighting procedure*. For this purpose, a three-step methodology is proposed.

In the first step, a complementary cluster analysis approach is proposed. Primarily, a hierarchical cluster analysis is used in order to determine the number of clusters and then the number of clusters emerging from this analysis is used as a parameter to determine the appropriate clusters of countries using Self-Organizing Maps.

In fact, as mentioned in earlier sections, the indexes used by the WEF are generally composed of many criteria and each is given a different weight according to the development stage of a country. However, the way these weights assigned is not explicitly given. For example, in the calculation of the Global Competitiveness Index, 177 criteria, consisting of basic requirements, efficiency enhancers, as well as innovation and sophistication factors, are used. All these groups of criteria, however, are given different weights according to whether the country belongs to the factor-driven, efficiency-driven, or innovation-driven stage. Although such differentiation may be important, the way of the specification of the weights for each group as well as the authorities specifying them are not made explicit. Therefore, in the second step of the proposed methodology, an Artificial Neural Network (ANN) is first used to determine the relationship between the criteria and the classification of the countries and then to specify the weights of different criteria for each cluster.

Thirdly, a new composite index, which consists of the weighted average of the indicators taken from the ANN, is proposed for the ranking of the countries. As a result, an attempt is made to base an evaluation of countries objective measurements. In the third step, the weights of the criteria for each

development stage are used to specify the ranking of the countries. Figure 3 gives the detailed flowchart of the proposed methodology.

Insert Figure 3 here.

4. An Application of the Proposed Methodology

The proposed methodology is applied to specify how the 103 countries evaluated by the WEF in 2004 using the Global Competitiveness Index can be clustered based on their level of competitiveness. All of the countries evaluated by the WEF, except Hong Kong, are included in the analysis. The latter is left out of the scope of the research due to the inconsistencies in its data. This is probably because Hong Kong became a special administrative region of China on 1 July 1997.

As far as the criteria are concerned, in addition to the 177 criteria used by the WEF to compute the Global Competitiveness Index, military expenditures are also considered as a criterion in the evaluation of competitiveness levels. The criteria are listed in Table 2. The reason for including military expenditures is that it has been proposed by Ulengin et al. that military power is one of the most important criteria that affect the power of countries [29]. The configuration of criteria used in this study is given in figure 6. This shows that there is a significant positive correlation between the World Competitiveness Index (WCI) and the economic, demographic power and a significant negative correlation between the World Competitiveness Index and the military power of countries. In other words, as the military power of a country increases, its WCI declines.

Insert Table 2 here
Insert Figure 4 here

4.1. Classification of Countries through Cluster Analysis

In the first part of this research, countries are grouped according to similarity of characteristics.. Cluster analysis, which is in fact a multivariate statistical technique, is used for this purpose.

4.1.1. Cluster Analysis

Cluster Analysis involves grouping similar objects into mutually exclusive subsets referred to as clusters [8]. The cluster definition problem is NP-complete, so a computationally efficient exact solution method, to the best knowledge of the authors, does not exist. However, a number of heuristic methods have been created for this purpose. These include agglomerative techniques, which are

widely known and used in such procedures. All hierarchical agglomerative heuristics begin with **n** clusters, where **n** is the number of observations. Then, the two most similar clusters are combined to form **n-1** clusters. On the next iteration, **n-2** clusters are formed with the same logic and this process continues until one cluster remains. Only the rules used to merge clusters differ in the various hierarchical agglomerative heuristics.

Although all hierarchical methods successfully define clusters for compact and isolated data, they generally fail to accurately provide defined clusters for "messy" data. The major issue with all clustering techniques is how to select the *number of clusters*. Different clustering methods may lead to different clusters, and the differences are generally due to the inherent characteristics of the methodology used. In fact, there is no single methodology that can be recommended in selecting the most appropriate number of clusters and the most suitable clustering method. That is why cluster analysis is generally accepted to be more of an art than a science [16].

In order to improve the accuracy of the cluster analysis and to reduce the subjectivity that plays an important role in hierarchical clustering, the Self-Organizing Map (SOM) Neural Network is used, as suggested by Mangiameli et al [14]. The SOM is, thus, not taken as an alternative, but rather as a complementary analysis that follows hierarchical clustering. The focus is, on the improvement of accuracy in the assignment of observations to appropriate clusters, given that the number of clusters in the data is known. The SOM's network learns to detect groups of similar input vectors in such a way that neurons physically close together in the neuron layer respond to a similar input vector [12].

SOM networks are used to separate outputs into categories. They are unsupervised networks; that is, they have no output value in the training pattern with which training can be compared. In most other network models, all neurons adjust their weights in response to a training presentation while in an SOM, that is not the case. In this kind of network, the neurons compete for the privilege of learning. SOM networks have two layers, the input layer of N variables and a Kohonen layer. In the Kohonen layer, the neurons are configured to reduce the size of N input neuron in the input layer to two dimensions. Each neuron in the input layer is related to Kohonen layer. All the neurons in the output layer are interrelated and located side by side. The neurons in the output layer are trained in a

way to conserve the topological structure of the input layer. As a result, the same topological structure is experienced among the neurons and the neurons that are close to each other respond to similar inputs [17].

The self-organization process begins by randomly assigning the weights between the input layer and the Kohonen layer. During the training process, the input vectors are added to the network sequentially. At the entry of each input, the neurons in the output layer compete to respond to this new comer. The neuron most similar to the input - i.e., the one closest to the input vector according to a selected distance measure, will be the winning neuron. The winning neuron and those that are in its vicinity are moved in such a way as to be closer to the input element [14]. Based on this ongoing process, the neurons of the Kohonen layer specialize in such a way as to respond to specific input groups - by being closer to them with respect to the other neurons. (Figure 5). As a result, the input vectors are grouped according to a prespecified number of clusters, which are represented by the neuron in the output layer specialized for this cluster.

Insert Figure 5 here.

The Kohonen network is used for classification problems. Once the value of the output neurons is specified, the neuron stimulated at the highest value is identified as the winner and the weights of the relations in the network are updated accordingly. After several iterations, the system reaches a state of equilibrium - i.e., after several iterations of training, any further significant change in the vector becomes impossible. Once this situation occurs, the training is terminated and the classification made according to the most stimulated output can be applied to any data set that is required.

4.1.2. Determining the Cluster of Countries

The basic drawback of a study based solely on ranking is that the ordinal scale does not reflect the appropriate competitiveness level of a country (entity) relative to other countries (entities). The most accurate position of a country within the total configuration can only be determined after the grouping of countries showing similarities to the evaluated country in terms of competitiveness.

In this study, a hierarchical cluster analysis is used initially. The Ward hierarchical method, an agglomerative clustering technique, and the Squared Euclidean distance measure are selected as the most appropriate clustering technique and distance measure throughout the evaluations using MATLAB software [36]. In Ward's method, the distance is the ANOVA sum of squares between the two clusters summed over all variables [8].

The analysis of dendogram (Figure 6) and ANOVA used to test the significance of differences between the cluster means produced three significant clusters.

Insert Figure 6 here.

Next, the appropriate number of clusters resulting from the first stage was used to carry out the same analysis using the SOM and the MATLAB software. Since we ought to categorize the countries into three classes, there are three outputs in the ANN's configuration. This leads to a 3*1 matrix of the weight vector. The topology function used is "HEXTOP," which means that the neurons are arranged in hexagonal topology at the Kohonen layer, while the distance function is "MANDIST," meaning that the used distance function is Manhattan distance (city block distance). Training of a self-organizing map using MATLAB is achieved through two steps: ordering phase and tuning phase. At the ordering phase, ordering phase learning rate and neighborhood distance are decreased from ordering phase learning rate and maximum distance between two neurons to tuning phase learning rate and tuning phase neighborhood distance, respectively. The ordering phase lasts for a given number of steps. At the tuning phase, the learning rate is decreased much more slowly than the ordering phase and the neighborhood distance stays constant [37]. In this study, the ordering phase learning rate, ordering phase steps, and tuning phase learning rate are taken as 0.9, 1000, and 0.02, respectively.

The countries corresponding to the resulting clusters are summarized in Table 3.

Insert Table 3 here.

For each cluster, Table 4 shows the mean, standard deviation and coefficient of variation (CV= σ/μ) of the resulting clusters for overall, basic requirements, efficiency enhancers, and innovation and sophistication factors perspectives. As can be seen in Table 4, the countries assigned to the first cluster have a low overall index (mean 3.4) and, as can be expected, their basic requirement index values are higher compared to their efficiency enhancer and innovation factor values. Those countries can be accepted as non-competitive countries, at the *factor-driven* stage. Finally, the average overall index value of the first cluster is well below the global average (3.89). Among the countries in this cluster Turkey can be given as a typical example.

On the other hand, the countries belonging to the second cluster have a higher overall index value (mean: 4.06), basic requirements (mean: 4.90) as well as efficiency enhancers (mean: 3.54), and innovation and sophistication factors scores (mean: 3.24) when compared to those of the 1st cluster. However, their innovation and sophistication factors scores are relatively lower when compared to the others. These countries can be accepted to be competitive countries, at the *efficiency–driven* stage. It is interesting to note that China, accepted as one of the most promising country in terms of competitiveness, belongs to this category.

Finally, the countries assigned to the last cluster have the highest scores concerning the overall index (mean: 4.73), basic requirements (mean: 5.63), efficiency enhancers (mean: 4.36), and innovation and sophistication factors (mean: 4.33) scores. In fact, their innovation and sophistication factors score is almost the same as their efficiency score and hence can be accepted as highly competitive countries, at the *innovation-driven* stage. The United States, Finland and Denmark are the top three countries according to the overall index values [31].

Insert Table 4 here.

The mean of the two separate clusters - non-competitive countries (3.4) and that of the highly competitive ones (4.73) - is significantly different from the overall mean of countries combined (3.89).

The homogeneity of countries in a cluster - i.e., the variation around the cluster average, is calculated using the standard deviation of the overall indexes, basic requirements, efficiency enhancers and innovation and sophistication factors values of each stage (see Table 5). When the equality of cluster variances is tested using the Levene homogeneity test [8], the significance values show that there is no significant difference of variance between the three clusters. Therefore, the hypothesis of equal variances is rejected with a 5 % confidence level.

The ANOVA test results, on the other hand, show that the three clusters have no common means for each of the scores. The means of the clusters are not equal at 5 % significance level for all variables (Table 5).

Insert Table 5 here.

In order to account for within-group variances and their corresponding cluster averages simultaneously, the coefficients of variation were also calculated for each stage. The cluster having the highest overall index mean (0.04) had a coefficient-of-variation value close to that of the cluster with the lowest overall mean (0.08). The same situation held for both the second and third clusters as well. Further, the variances of the two extreme clusters (1 and 3) were almost the same, as they were for the second and third clusters. As a result, it can be said that, for the three clusters, each has the same level of homogeneity. Although their within-group variances are the same, it is necessary to note that their respective cluster averages differ from one another.

4. 2. Identification of Basic Criteria Underlying Country Stages through ANN

At this step of the study, the basic factors underlying the reasons for a country belonging to a specific cluster is analyzed using ANN. The feed-forward back propagation algorithm is used for this purpose.

4.2.1. Artificial Neural Networks

ANN techniques have been applied to a variety of problem areas and have, in many instances, provided superior results to conventional methods [32]. The literature [3, 10, 29] suggests the potential advantages of ANN over statistical methods. The basic model of ANN techniques consists of computational units that emulate the functions of a nucleus in a human brain. The unit receives a

weighted sum of all its inputs and computes its own output value by a transformation or output function. The output value is then propagated to many other units via connections between units. The learning process of ANN can be thought of as a reward and punishment mechanism [9]. When the system reacts appropriately to an input, the related weights are strengthened. As a result, it will be possible to generate outputs, which are similar to those corresponding to the previously encountered inputs. In contrast, when undesirable outputs are produced, the related weights are reduced. Therefore, the model will learn to give a different reaction when similar inputs occur. Thus, the system is "trained" to produce desirable results while "punishing" undesirable ones.

In multilayer networks, all the inputs are related to outputs through hidden neurons - i.e., there is no direct relation among them. As a result, the specification of the characteristics of each input neuron and the strength of relation between input X_i and output O_i can be found using the formula method proposed by Yoon et al. [320]:

$$RS_{ji} = \frac{\sum_{k=0}^{n}(W_{ki} * U_{jk})}{\sum_{i=0}^{m}\left|\left(\sum_{k=0}^{n}(W_{ki} * U_{jk})\right)\right|}$$

In this formula, RS_{ji} shows the strength of the relation between the input i and the output j. W_{ki} is the weight between the j^{th} output U_{jk} and the k^{th} hidden neuron. Therefore, the above-given measure is the ratio of the strength of relation between i^{th} input and j^{th} output level to the sum of all the strength of relation among all the input and outputs. The absolute value in the denominator is used in order to avoid the possibility of positive relations to eliminate the impact of negative relations. Additionally, in order to increase the efficiency of the measure, the square of both the numerator and the denominator is taken, as suggested by Onsel et al. [17]. The sum of the weights is set equal to 1 and in this study, the resulting modified formula is used as the basis of the analysis.

$$RS_{ji} = \frac{\left[\sum_{k=0}^{n}(W_{ki} * U_{jk})\right]^2}{\sum_{i=0}^{m}\left[\sum_{k=0}^{n}(W_{ki} * U_{jk})\right]^2}$$

4.2.2. Basic Criteria Weights

The information about the cluster to which a country belongs, which was obtained as the output of the SOM at the previous stage, is used as the output of this new ANN and the 178 criteria (as mentioned in Section 4, in addition to 177 criteria used by the WEF, the military expenditures are also considered) are treated as inputs.

Ninety-three countries are used for training and 10 for testing stages. In order to obtain robust results based on different trials, for each hidden neuron number, the ANN is computed 10 times and the best results obtained from each are taken. In this way, an attempt is made to detect different points of weight space corresponding to the network by several experiments. The smallest error ratio is obtained in a configuration with one hidden layer with 10 hidden neurons. The logistics function (logsig) is used to show the relation between input and hidden neurons, while the linear function (purelin) is preferred for the relation between the hidden neurons and the output neurons. The training algorithm is gradient-descent method with momentum and adaptive learning ratio ("traingdx"). The resulting ANN configuration can be seen in Figure 7.

Insert Figure 7 here.

The training was stopped after 1000 runs, when the test error began to increase (see Figure 8). At this point, the mean square error, selected as the performance measurement, was found to be 0.00021.

Insert Figure 8 here.

The ten most important inputs (criteria), playing the dominant role in the allocation of the countries to its related cluster are obtained through the modified Yoon et al. [32] formula and can be seen for each cluster in Table 6, Table 7, and Table 8 respectively.

Insert Table 6 here.

As can be seen in Table 6, it may be interesting to underline that the criterion playing the most important role in the construction of Cluster 1, which is composed of non-competitive countries, is military expenditure (cluster average is 6.4123). This is followed by basic requirements criteria – e.g., health and transportation, as well as to those related to bureaucracy levels.

On the other hand, due to the fact that the basic requirements concerning health, transportation and communications structure have already reached, in Cluster 2, the criterion related to improving the quality and efficiency of the electricity, transportation, communication and fiscal infrastructures, for example, are of primary importance.

Insert Table 7.

Finally, it can be seen that the criteria fundamental to the composition of cluster 3 have to do with science, research and development and technology rankings (Table 8).

Insert Table 8 here.

4.2.3. Comparison of the Relative Importance of the Criteria in Different Country Clusters

An overall evaluation can also be realized by comparing the relative importance of each criterion in the ranking of the countries belonging to different clusters. For example, the "quality of education," which is one of the sub-criteria used in the GCI evaluation, has a mean equal to 2.8686 and it is the 75th most important factor in the ranking of the 1st cluster (non-competitive) countries. This means that, the quality of education is not a dominant factor in the specification of the ranking of these countries. However, in the second cluster (competitive countries), the same sub-criterion has a mean equal to 3.76 and is the 42nd most important criterion in the ranking while in the last cluster (highly competitive countries), it is the 4th most important sub-criterion with a mean of 4.93. A similar type of analysis can be conducted for other sub-criteria.

When we analyze Table 9, Table 10, and Table 11, we can see that there are highly contrasting differences among the criteria that are of primary importance in each cluster. For example for Cluster 1 (non-competitive countries) *military expenditures* is the most important criterion while its relative rank is only 153 and 98 in the second and third cluster respectively. Similarly *life expectancy* is the 4th important criterion in the first cluster, while its rank is very low in the second and third clusters of countries (148 and 149 respectively) (see Table 9).

Insert Table 9 here.

On the other hand, although the *quality of electricity supply* is of primary importance for the second cluster of countries, its rank is 126 and 116 for the first and third cluster of countries, respectively. Similar contrasting results can also be seen for *business costs of terrorism*, *railroad infrastructure development*, *postal efficiency*, and *extent and effect of taxation* (Table 10).

Insert Table 10 here.

Finally, as can be seen in Table 11, the factors that are very important for the highly competitive countries (i.e., *willingness to delegate authority*, *buyer sophistication*, *availability of scientists and engineers*, *quality of the educational system*, *cost of importing foreign equipment*) have very low ranks in the other clusters.

Insert Table 11 here.

4.3. How Can Countries Switch to a Higher Cluster?

The proposed methodology can serve as a useful benchmarking guide to countries attempting to increase their levels of competitiveness. For a country to switch to a higher cluster, initially, this country is expected to reach the competitiveness value of the top ranked country in its own cluster and, subsequently, reach the value of the last ranked country of the next higher cluster. For this second iteration, however, the criteria weights corresponding to this next higher cluster are taken into consideration. For illustration purposes, Turkey is chosen as the special case of the 3rd cluster.

The main reason for selecting Turkey as a special country of the non-competitive cluster (3rd cluster) is that Turkey is the authors' home country and it has been subject to debate in its entrance process to the EU. Additionally, in the cluster to which it belongs, Turkey's relative position is over the average. In fact, the 3rd cluster to which Turkey is assigned has an average score of 3.70 while Turkey's original score is 4.13. For the first step of improvement, El Salvador, which is the top ranked country of the 3rd cluster, is used as the first stepping-stone. For Turkey to attain El Salvador's index value (4.27), it must increase its own index value by

0.14 [(4.27 - 4.13 = 0.14]. For this purpose, once the criteria are ranked according to their importance weights, it can be seen that it is sufficient to increase the value of five criteria to the average value of the 2nd cluster (see Table 12).

Insert Table 12 here.

So, at this initial step of improvement, fiscal discipline is very important for Turkey. In addition, a decrease in military expenses will also have a great impact on improvement. Once Turkey reaches the index value of the top ranked country of its own cluster, it must take steps to attain the index value of Egypt (3.61), which is at the bottom of the 2nd cluster of countries. The difference between the two indices is 0.26 [3.61-3.35 = 0.26]. This second jump, however, will necessitate an improvement in the values of 8 criteria given in Table 13.

Insert Table 13 here.

According to the above criteria, it can be said that improving the transparency and efficiency of public institutions is needed the most in order to switch to the cluster of the transient-cluster. Therefore, government attitude toward markets and the efficiency of its operations are very important. In fact, when the clustering analysis is redone using the SOM neural network, with the revised values of Turkey for the above-mentioned 13 criteria, its switch to the transient cluster is also verified and validated. According to this revision, Turkey's rank moves from 60th to 54th.

4.4. Ranking of the Countries Based on the Proposed Weighted Criteria Index

At the third step of this research, the weights of 178 criteria for each cluster calculated at the previous step are used to specify the ranking of the countries. For this purpose, initially, the criteria weights are normalized. Then, the score obtained by each country from each of the 178 criteria is multiplied by the normalized weight of that criterion. The ranking of the 103 countries is done according to these weighted index values (Table 14).

Insert Table 14 here.

If the ranking of the proposed model is compared with the one obtained using the WEF's Global Competitiveness Index, it can be seen that, although there is an overall similarity, there are some important differences between the two, e.g., country rankings. For example, the Global Competitive Index ranks Turkey and the United States at 66th and 1st place, respectively. On the other hand, when the proposed weighted index is used, Turkey climbs to 60th place while the United States drops to 4th place. The countries that differ on at least 10 ranks in absolute value between the two indices are given in Figure 9.

Insert Figure 9 here.

It is necessary to emphasize that the subjectivity of the WEF clustering as well as of the weighting process sometimes result in contradictory results with respect to the WEF's global competitiveness ranking index. In other words, important discrepancies may occur between the stage to which a country is assigned and the rank that it gets based on the Global Competitiveness Index. For example, although authorities agree that China is one of the most promising countries, the WEF assigned it to Stage 1 (factor-driven economies) countries. In contrast, it ranks 31st according to the WEF's global competitiveness ranking, which is contrary to its assignment at the previous stage. Bahrain, a Stage 1 country, is ranked as 24th according to the WEF's Global Competitiveness Index. Similarly, Taiwan is assigned by the WEF to the transition stage between Stage 2 (efficiency-driven economies) and Stage 3 (innovation-driven economies), while it is found to be 10th according to the Global Competitiveness Index. In contrast, Spain and Italy, which are assigned as Stage 3 countries, are 33rd and 55th, respectively, according to Global Competitiveness ranking and thus they both show a lower performance than expected.

As was mentioned in Section 2.3, according to the WEF, the countries having a GDP below a threshold level are accepted as Stage 1 countries, which means that what is most important to them is performance with respect to basic requirement factors. However, this is a non-compensatory approach since there may be some countries performing well vis-à-vis basic requirements while still having a low level of GDP. Therefore, it may be unfair to assign a country to a stage based solely on its GDP

level. This is why it may actually be more accurate to use a compensatory approach for this purpose. On the other hand, a country may be unfairly rewarded due to having a high GDP level, even though it may be performing poorly in terms of its basic requirement factors. For example, The United States does not score well in terms of basic requirements. Nevertheless, it is the world's leader in both efficiency enhancers and innovation and sophistication factors. This is mainly due to the fact that the United States is at the third stage of development (the innovation stage) and the weight of basic requirements is relatively minor. Consequently, the high values that it receives from the other two sub-indexes put this country in the leading position. In contrast, Finland leads the world in basic requirements, but it only ranks 6th in efficiency enhancers and 4th in innovation and sophistication factors.

When the same countries are analyzed using our methodology, however, complete parallelism can be seen between the cluster to which a country is assigned and its place with respect to the global ranking. For example, China is assigned to Cluster 2 (transition countries, according to our terminology) and it is in 44th place according to our global ranking, which corresponds to its assignment in the previous cluster. Similarly, Taiwan is ranked among the 3rd cluster countries (high competitive countries according to our terminology) and it is 16th according to global ranking. On the other hand, Italy is assigned to Cluster 2 and it is the 50th country according to global ranking, while Spain assigned to Cluster 2 is the 27th country according to global ranking.

5. Conclusions and Further Suggestions

Despite attempts to provide objectivity in the development of indicators for the analysis of the competitiveness of countries, there are obviously subjective judgments about how data sets are aggregated and what weighting is applied. Generally, either equal weighting is applied to calculate the final index or subjective weights are specified. The same problem also occurs in the subjective assignment of countries into different clusters. For example the WEF assigns countries to different stages of development mainly on the basis of their GDP level and the application of different subjective weights for each stage. These subjectivities may create a bias, as selecting specific data simultaneously overestimates the level of competitiveness of some countries, making them look

unrealistically good, while underestimating that of others. This precludes intelligent use of these types of indices by executives and policy makers, which is against the very idea of publishing it.

The aim of this paper is to explore whether methodological transparency can be an adequate solution to the above-given problems posed by the current aggregated indices. For this purpose, a methodology is proposed to objectively group countries into clusters as well as to specify the weight of the criteria that play the dominant role in each cluster. A new composite index that uses calculated weights has been created. By doing so, the criticism that it is simply an attempt to make some countries more competitive than they actually are can be avoided. What's more, by focusing on the criteria necessary to move a country into a higher cluster, the index can be used by both policymakers and executives responsible for making their countries more competitive.

The methodology can also be applied to evaluate how well prepared the actual or potential future accession countries are to join the EU and where attention should be focused to ensure that they contribute effectively to the competitiveness of an expanded EU. The impact of the new accessions on the EU can be easily evaluated and precautions taken in order to avoid the decline of the EU to a lower cluster due to the enlargement process.

Moreover, this study may be further improved by including more appropriate variables that reflect a nation's intellectual capital or knowledge assets. In its current form, the study uses the criteria suggested by the WEF to measure the production of knowledge. However, it is necessary to underline that such criteria focus on an evaluation based on inputs of knowledge assets and intellectual capital. Such an assessment may lead to incorrect conclusions since while the inputs may have potential for being utilized for production of knowledge, they do not themselves represent production of knowledge. Competitiveness is linked with creation, transmission and timely application of new knowledge resulting in technological advance. Knowledge traditionally considered for technological advance has been restricted to natural sciences and engineering. However, if a knowledge economy is emerging, then not only the hard side but also the "soft side" of competitiveness in this respect needs to be better researched. Therefore, it is necessary to differentiate the prerequisite inputs that are

necessary but not sufficient for knowledge management from those that play a discriminatory role in specifying the relative position of the countries in terms of knowledge management level.

In addition, inferential techniques - specifically the classification and regression trees (CART) algorithm, which allows both the predictor and target variables to be continuous, can be used to improve the accuracy of cluster analysis. There is no implicit assumption that the underlying relationships between the predictor variables and the dependent variable are linear, follow some specific non-linear link function, or that they are even monotonic in nature. In those types of data analyses, tree methods can often reveal simple relationships between just a few variables that can easily go unnoticed using other analytic techniques.

In this study "subjectivity" is taken to mean "researcher- dependent." It is important to avoid any bias originating from researchers; but this does not necessarily mean that "countries" make their choices or take their decisions "objectively." In fact, countries make their choices "subjectively," according to their own conditions and preferences in connection with their positions in world politics and economy. This paper is trying to avoid researcher-dependent bias. However, the "subjectivity" of countries needs to be taken into consideration because their subjective perception of "reality" is the reality for them and they act according to this perceived reality. A Data Envelopment Analysis (DEA) approach could be of some use in this respect and the authors are aware of this potentiality. As a further suggestion, a DEA can be used to benchmark the countries in order to provide more precise policy changes for each country under investigation [4, 5, 25]. For more details of the DEA approach in this context, see [25].

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FIGURES AND TABLES

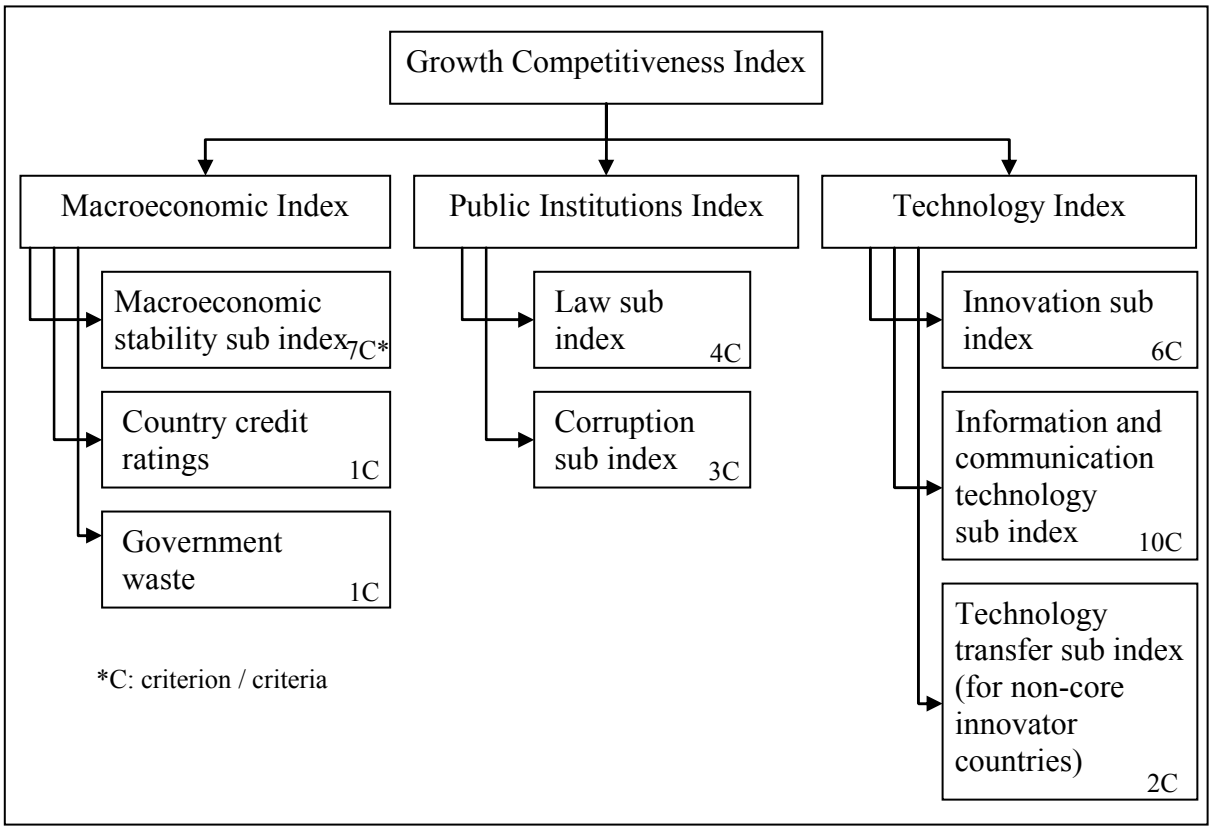

Figure 1. Configuration of Growth Competitiveness Index

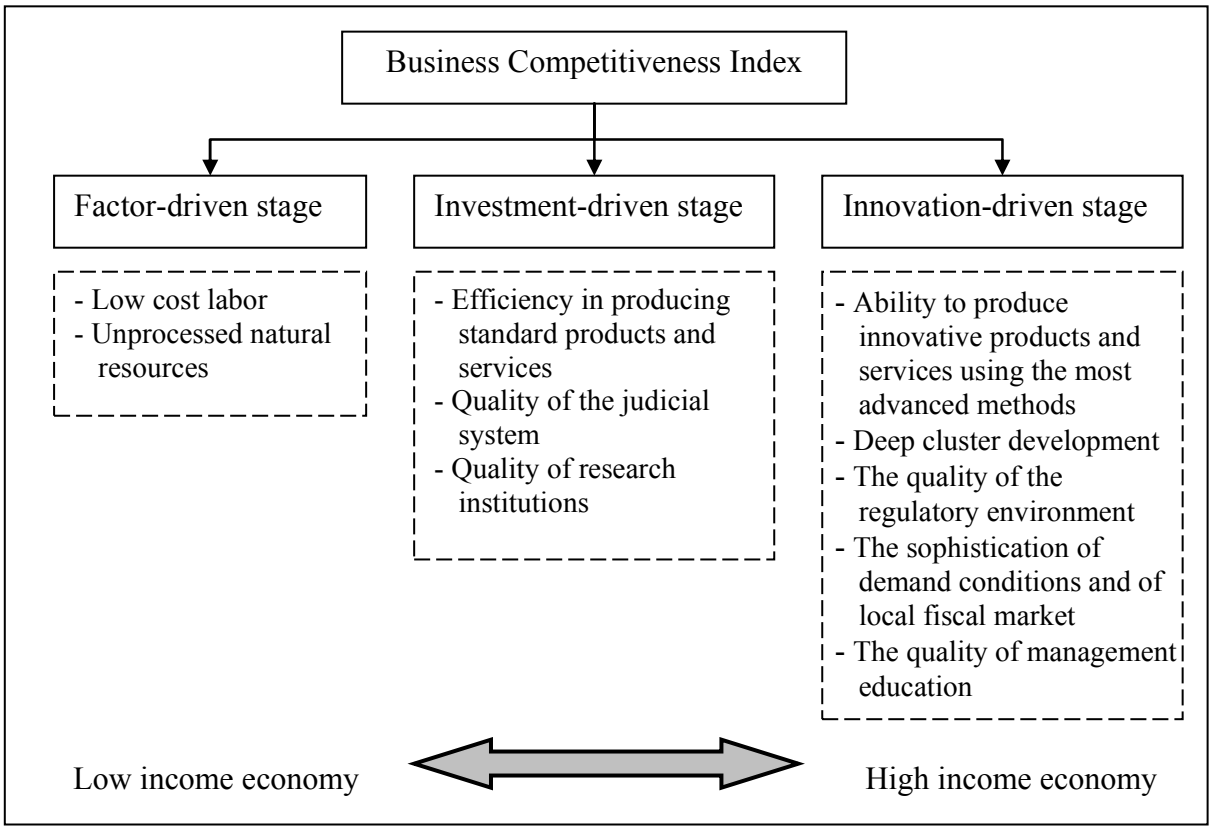

Figure 2. Configuration of Business Competitiveness Index

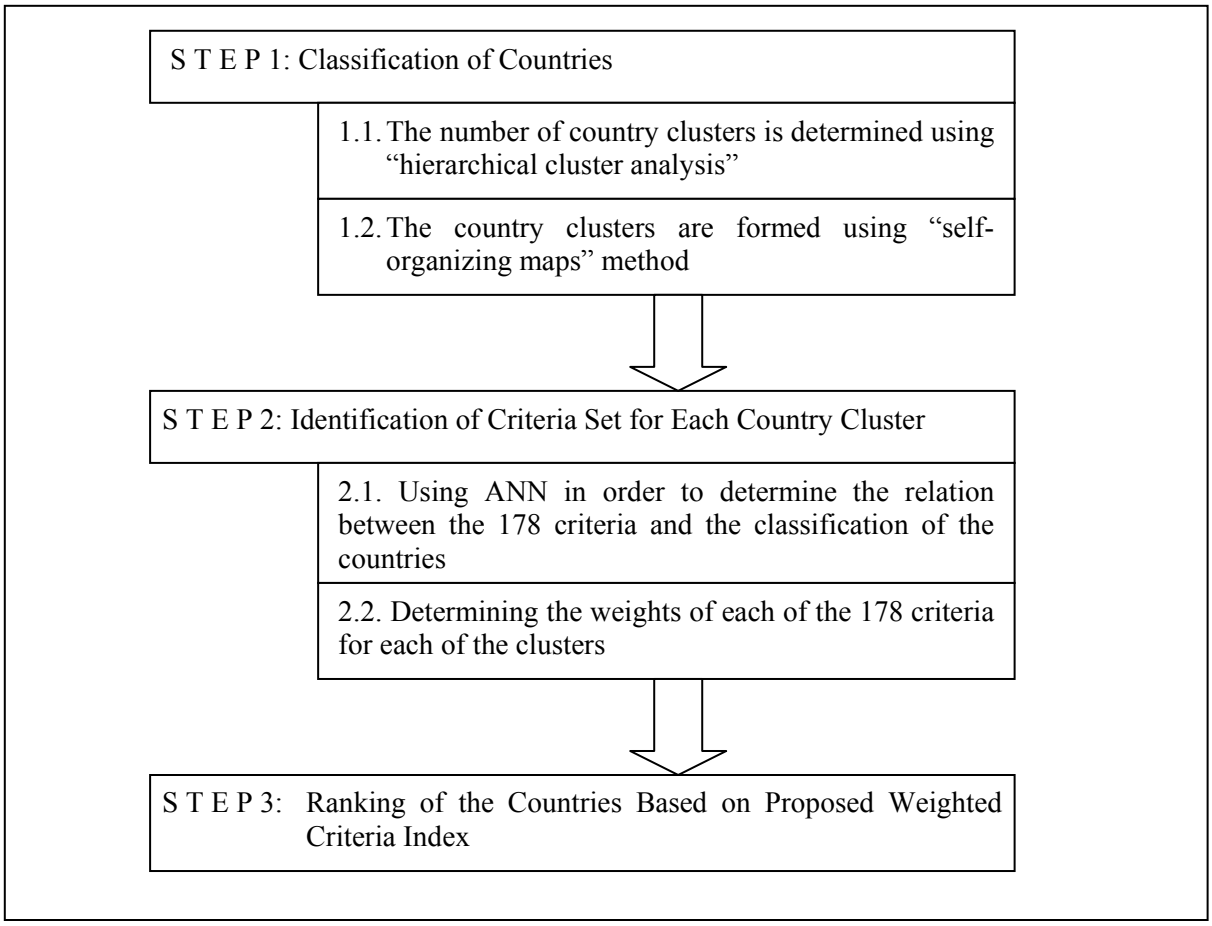

Figure 3. Flowchart of the proposed methodology

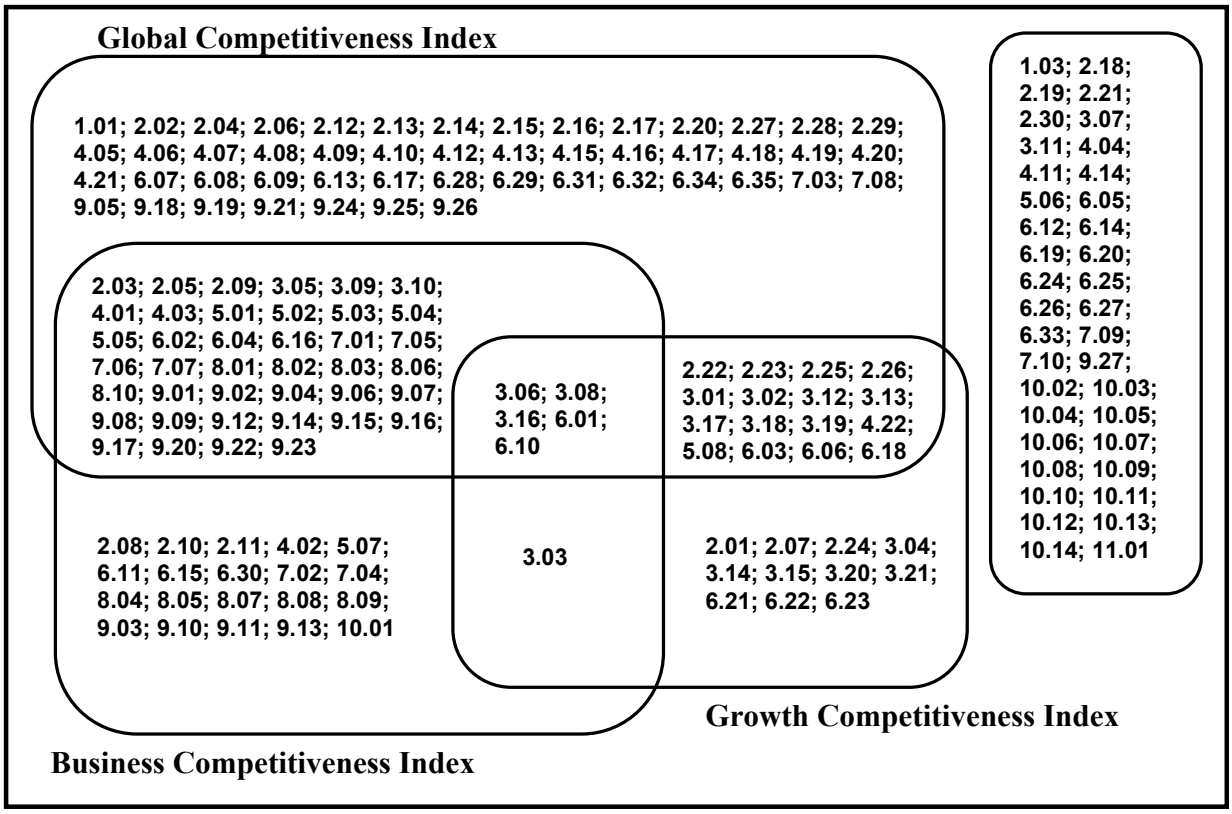

Figure 4. The configurations of criteria in this study

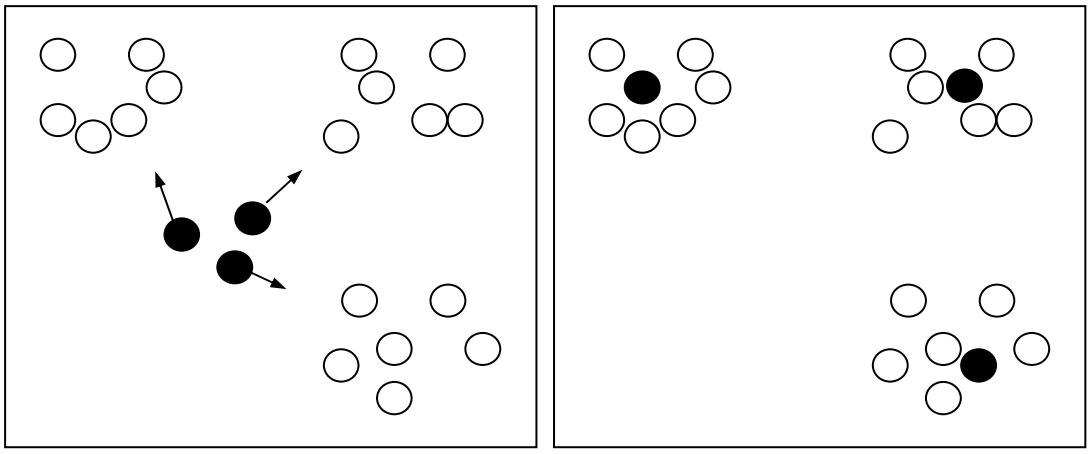

Figure 5. The movement of the neurons in the output layer toward to clusters caused by the input vectors

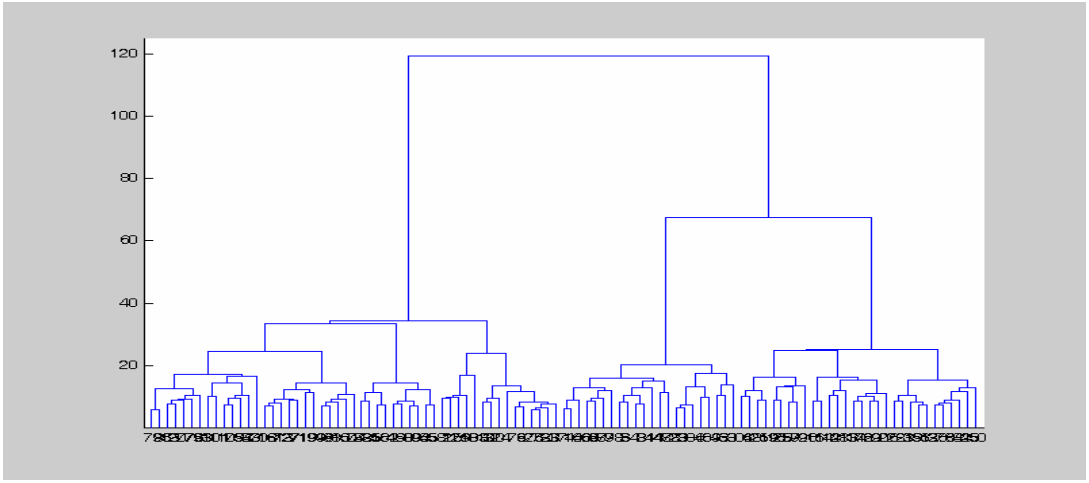

Figure 6. Dendogram of the clusters of the countries

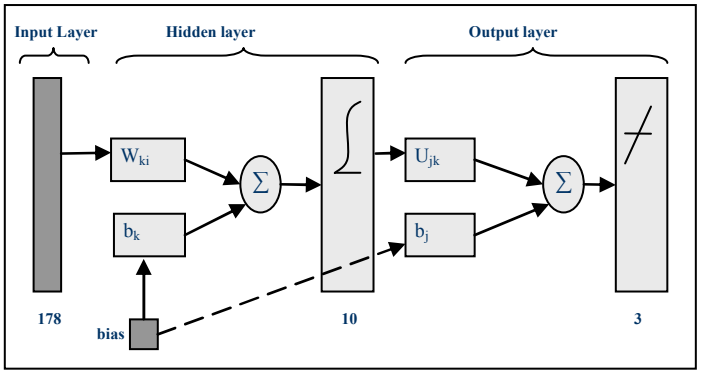

Figure 7. The resulting multilayer feed forward neural network configuration

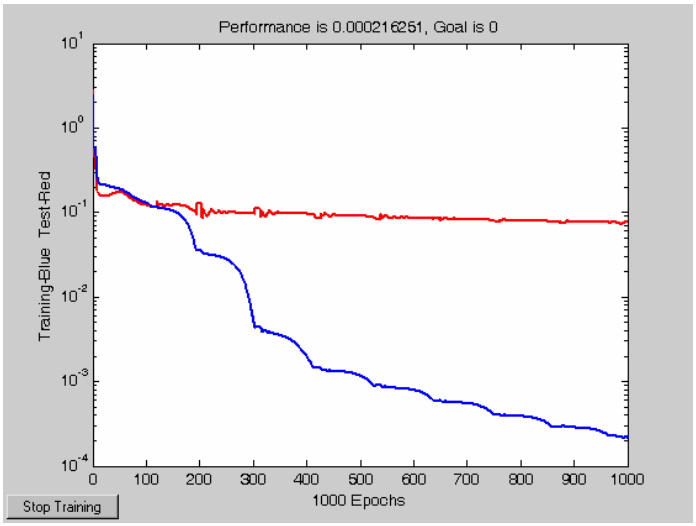

Figure 8. The learning curve of ANN

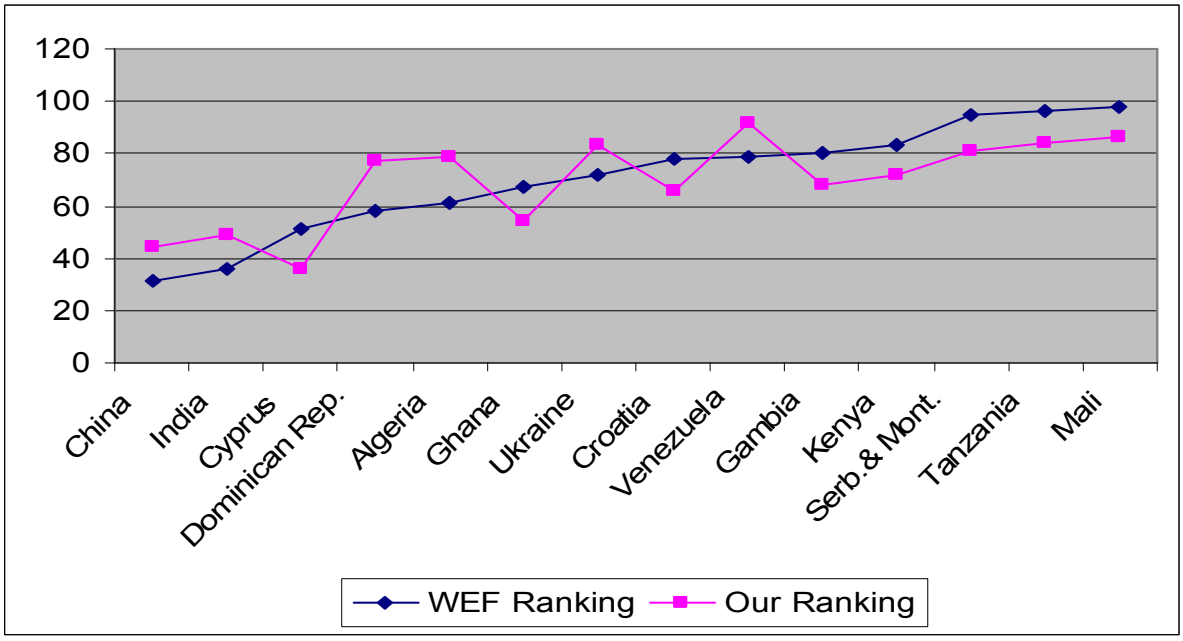

Figure 9. Significant differences between the proposed model's and WEF's rankings

Table 1. Twelve components of economic competitiveness

#	Pillar	Main Group	Weights of the three main groups of pillars at each stage of development		
			Factor-driven stage	Efficiency-driven stage	Innovation-driven stage
1	Institutions	Basic requirements	50%	40%	30%
2	Physical infrastructure				
3	Macro-stability				
4	Security				
5a	Basic human capital				
5b	Advanced human capital	Efficiency enhancers	40%	50%	40%
6	Goods market efficiency				
7	Labor market efficiency				
8	Financial market efficiency				
9	Technological readiness				
10	Openness and market size				
11	Business sophistication	Innovation and sophistication factor	10%	10%	30%
12	Innovation				

Table 2. List of criteria in the WEF Report

Section I. Aggregate Country Performance Indicators	
Total GDP, 2003	
Total population, 2003	
GDP per capita (PPP), 2003	
Section II. Macroeconomic Environment	
Recession expectations	
Business costs of terrorism	
Financial market sophistication	
Soundness of banks	
Ease of access to loans	
Venture capital availability	
Access to credit	
Local equity market access	
Regulation of securities exchanges	
Effectiveness of bankruptcy law	
Hidden trade barriers	
Cost of importing foreign equipment	
Business impact of domestic trade barriers	
Business impact of foreign trade barriers	
Business impact of customs procedures	
Business impact of rules on FDI	
Tax burden	
Efficiency of customs procedures	
Openness of customs regime	
Agricultural policy costs	
Organized efforts to improve competitiveness	
Government surplus/deficit, 2003	
National savings rate, 2003	
Real effective exchange rate, 2003	
Inflation, 2003	
Interest rate spread, 2003	
Exports, 2003	
Imports, 2003	
Government debt, 2003	
Country credit rating, 2004	
Section III. Technology: Innovation and Diffusion	
Technological readiness	
Firm-level technology absorption	
Prevalence of foreign technology licensing	
FDI and technology transfer	
Quality of scientific research institutions	
Company spending on research and development	
Subsidies and tax credits for firm-level research and development	
University/industry research collaboration	
Government procurement of advanced technology products	
Availability of scientists and engineers	
Availability of mobile or cellular telephones	
Internet access in schools	
Quality of competition in the ISP sector	
3.14	Government prioritization of ICT
3.15	Government success in ICT promotion
3.16	Laws relating to ICT
3.17	Utility patents, 2003
3.18	Cellular telephones, 2003
3.19	Internet users, 2003
3.20	Internet hosts, 2003
3.21	Personal computers, 2003
Section IV. Human Resources: Education, Health, and Labor	
4.01	Quality of the educational system
4.02	Quality of public schools
4.03	Quality of math and science education
4.04	Disparity in healthcare quality
4.05	Business impact of malaria
4.06	Business impact of tuberculosis
4.07	Business impact of HIV/AIDS
4.08	Medium-term business impact of malaria
4.09	Medium-term business impact of tuberculosis
4.10	Medium-term business impact of HIV/AIDS
4.11	Ease of hiring foreign labor
4.12	Brain drain
4.13	Maternity laws' impact on hiring women
4.14	Childcare availability
4.15	Infant mortality
4.16	Life expectancy
4.17	Tuberculosis prevalence
4.18	Malaria prevalence
4.19	HIV prevalence
4.20	Primary enrollment
4.21	Secondary enrollment
4.22	Tertiary enrollment
Section V. General Infrastructure	
5.01	Overall infrastructure quality
5.02	Railroad infrastructure development
5.03	Port infrastructure quality
5.04	Air transport infrastructure quality
5.05	Quality of electricity supply
5.06	Postal efficiency
5.07	Telephone/fax infrastructure quality
5.08	Telephone lines, 2003
Section VI. Public Institutions	
6.01	Judicial independence
6.02	Efficiency of legal framework
6.03	Property rights
6.04	Intellectual property protection
6.05	Freedom of the press
6.06	Wastefulness of government spending
6.07	Burden of central government regulation
6.08	Burden of local government regulation
6.09	Transparency of government policymaking
6.10	Favoritism in decisions of government officials

6.11 Extent of bureaucratic red tape
6.12 Effectiveness of law-making bodies
6.13 Extent and effect of taxation
6.14 Efficiency of the tax system
6.15 Centralization of economic policymaking
6.16 Reliability of police services
6.17 Business costs of crime and violence
6.18 Organized crime
6.19 Informal sector
6.20 Government effectiveness in reducing poverty and inequality
6.21 Irregular payments in exports and imports
6.22 Irregular payments in public utilities
6.23 Irregular payments in tax collection
6.24 Irregular payments in public contracts
6.25 Irregular payments in loan applications
6.26 Irregular payments in government policymaking
6.27 Irregular payments in judicial decisions
6.28 Business costs of irregular payments
6.29 Diversion of public funds
6.30 Business costs of corruption
6.31 Public trust of politicians
6.32 Prevalence of illegal political donations
6.33 Policy consequences of legal political donations
6.34 Pervasiveness of money laundering through banks
6.35 Pervasiveness of money laundering through non-bank channels

Section VII. Domestic Competition

7.01 Intensity of local competition
7.02 Extent of locally based competitors
7.03 Extent of market dominance
7.04 Sophistication of local buyers' products and processes
7.05 Administrative burden for startups
7.06 Effectiveness of anti-trust policy
7.07 Prevalence of mergers and acquisitions
7.08 Private sector employment of women
7.09 Wage equality of women in the workplace
7.10 Regional disparities in quality of business environment

Section VIII. Cluster Development

8.01 Buyer sophistication
8.02 Local supplier quantity
8.03 Local supplier quality
8.04 Presence of demanding regulatory standards
8.05 Decentralization of corporate activity
8.06 State of cluster development
8.07 Extent of collaboration among clusters
8.08 Local availability of components and parts
8.09 Local availability of process machinery
8.10 Local availability of specialized research and training services

Section IX. Company Operations and Strategy

9.01 Nature of competitive advantage
9.02 Value chain presence
9.03 Extent of branding
9.04 Capacity for innovation
9.05 Ethical behavior of firms
9.06 Production process sophistication
9.07 Extent of marketing
9.08 Degree of customer orientation
9.09 Control of international distribution
9.10 Extent of regional sales
9.11 Breadth of international markets
9.12 Extent of staff training
9.13 Willingness to delegate authority
9.14 Extent of incentive compensation
9.15 Reliance on professional management
9.16 Quality of management schools
9.17 Efficacy of corporate boards
9.18 Hiring and firing practices
9.19 Flexibility of wage determination
9.20 Cooperation in labor-employer relations
9.21 Pay and productivity
9.22 Protection of minority shareholders' interests
9.23 Foreign ownership restrictions
9.24 Strength of auditing and reporting standards
9.25 Charitable causes involvement
9.26 Company promotion of volunteerism
9.27 Importance of corporate social responsibility

Section X. Environment

10.01 Stringency of environmental regulations
10.02 Clarity and stability of regulations
10.03 Effects of compliance on business
10.04 Compliance with international agreements
10.05 Prevalence and effectiveness of environmental reporting
10.06 Political context of environmental gains
10.07 Subsidies for energy or materials
10.08 Prevalence of environmental marketing
10.09 Prevalence of environmental management systems
10.10 Prevalence of corporate environmental reporting
10.11 Importance of environmental management for companies
10.12 Prioritization of energy efficiency
10.13 Importance of environment in business planning
10.14 Prevalence of socially responsible investing

Section XI. Military

11.01 Military Expenses

Table 3. Non-competitive, competitive and highly competitive countries

NON-COMPETITIVE COUNTRIES		COMPETITIVE COUNTRIES		HIGHLY COMPETITIVE COUNTRIES	
Algeria	Mexico	Bahrain	Korea	Australia	Japan
Angola	Mozambique	Botswana	Latvia	Austria	Luxembourg
Argentina	Nicaragua	Brazil	Lithuania	Belgium	Netherlands
Bangladesh	Nigeria	Chile	Malaysia	Canada	New Zealand
Bolivia	Pakistan	China	Malta	Denmark	Norway
Bosnia and Herzegovina	Panama	Costa Rica	Mauritius	Finland	Singapore
Bulgaria	Paraguay	Cyprus	Morocco	France	Sweden
Chad	Peru	Czech Republic	Namibia	Germany	Switzerland
Colombia	Philippines	Egypt	Portugal	Iceland	Taiwan
Croatia	Poland	Estonia	Slovak Republic	Ireland	The United Kingdom
Dominican Republic	Romania	Ghana	Slovenia	Israel	The United States
Ecuador	Russian Federation	Greece	South Africa		
El Salvador	Serbia and Montenegro	Hungary	Spain		
Ethiopia	Sri Lanka	India	Thailand		
Gambia	Tanzania	Indonesia	Tunisia		
Georgia	Trinidad and Tobago	Italy	United Arab Emirates		
Guatemala	Turkey	Jordan			
Honduras	Uganda				
Jamaica	Ukraine				
Kenya	Uruguay				
Macedonia, FYR	Venezuela				
Madagascar	Vietnam				
Malawi	Zambia				
Mali	Zimbabwe				

Table 4. The mean, standard deviation and CV

	Overall			Basic Requirement			Efficiency Enhancer			Innovation Factor		
	Mean	Std Dev.	CV	Mean	Std Dev.	CV	Mean	Std Dev.	CV	Mean	Std Dev.	CV
Non-competitive countries	3.40	0.28	0.08	4.03	0.4	0.1	2.87	0.27	0.09	2.66	0.3	0.11
Competitive countries	4.06	0.21	0.05	4.90	0.31	0.06	3.54	0.22	0.06	3.24	0.28	0.09
Highly competitive countries	4.73	0.2	0.04	5.63	0.25	0.05	4.36	0.22	0.05	4.33	0.37	0.08

Table 5. Tests of homogeneity of stage variances and stage means

	Cluster Variances		Cluster Means	
	Levene statistic	**Significance**	**F statistic**	**Significance**
Overall	2.249	0.111	232.2	0.000
Basic	2.647	0.076	172.4	0.000
Efficient	2.166	0.120	290.7	0.000
Innovation	0.921	0.401	219.7	0.000

Table 6. The ten most important criteria in the specification of Cluster 1

	Criteria (Input of ANN)	**Cluster 1**		
		Weight Impact Score	**Stage Average**	**Impact Rank**
11.01	Military expenses	0.065	6.412	1
4.18	Malaria prevalence	0.050	6.473	2
4.07	Business impact of HIV/AIDS	0.030	4.911	3
4.16	Life expectancy	0.024	4.607	4
2.24	Real effective exchange rate, 2003	0.022	3.232	5
5.04	Air transport infrastructure quality	0.022	3.632	6
10.03	Effects of compliance on business	0.021	4.037	7
6.11	Extent of bureaucratic red tape	0.021	2.845	8
6.28	Business costs of irregular payments	0.019	3.321	9
9.25	Charitable causes involvement	0.018	3.830	10
		Mean	4.330	
		Standard Deviation	1.274	
		CV	0.294	

Table 7. The ten most important criteria in the specification of Cluster 2

	Criteria (Input of ANN)	Cluster 2		
		Weight Impact Score	Stage Average	Impact Rank
5.05	Quality of electricity supply	0.051	4.739	1
2.02	Business costs of terrorism	0.038	5.041	2
5.02	Railroad infrastructure development	0.030	3.186	3
5.06	Postal efficiency	0.027	4.173	4
6.13	Extent and effect of taxation	0.024	3.097	5
3.17	Utility patents, 2003	0.024	1.450	6
6.04	Intellectual property protection	0.023	3.751	7
2.20	Agricultural policy costs	0.023	3.464	8
3.18	Cellular telephones, 2003	0.023	3.204	9
8.01	Buyer sophistication	0.022	4.116	10
		Mean	3.622	
		Standard Deviation	1.012	
		CV	0.279	

Table 8. Ten most important criteria in the specification of Cluster 3

	Criteria (Input of ANN)	Cluster 3		
		Weight Impact Score	Stage Average	Impact Rank
9.13	Willingness to delegate authority	0.043	4.406	1
8.01	Buyer sophistication	0.040	5.514	2
3.10	Availability of scientists and engineers	0.038	5.466	3
4.01	Quality of the educational system	0.032	4.930	4
2.12	Cost of importing foreign equipment	0.030	4.687	5
3.06	Company spending on research and development	0.028	4.476	6
2.03	Financial market sophistication	0.022	4.966	7
6.35	Pervasiveness of money laundering through non-bank channels	0.021	4.698	8
3.12	Internet access in schools	0.021	5.425	9
9.06	Production process sophistication	0.020	5.046	10
		Mean	4.961	
		Standard Deviation	0.404	
		CV	0.082	

Table 9. Criteria of primary importance for non-competitive countries

	Criteria	Cluster 1			Cluster 2			Cluster 3		
		Weight Impact Score	Stage average	Rank	Weight Impact Score	Stage average	Rank	Weight Impact Score	Stage average	Rank
11.01	Military expenses	0.065	6.412	1	0.00019	6.3467	153	0.002418	6.3642	98
4.18	Malaria prevalence	0.050	6.473	2	0.00335	6.6733	88	0.002141	6.9227	102
4.07	Business impact of HIV/AIDS	0.03	4.911	3	0.00063	5.3788	137	0.006746	6.0779	51
4.16	Life expectancy	0.024	4.607	4	0.00032	5.2128	148	0.000269	6.0829	149
2.24	Real effective exchange rate, 2003	0.024	3.232	5	0.00044	3.4468	142	0.006359	3.6291	53

Table 10. Criteria of primary importance for competitive countries

	Criteria	Stage 1			Stage 2			Stage 3		
		Weight Impact Score	Stage average	Rank	Weight Impact Score	Stage average	Rank	Weight Impact Score	Stage average	Rank
5.05	Quality of electricity supply	0.0006	3.7572	126	0.05108	4.7392	1	0.001428	5.9415	116
2.02	Business costs of terrorism	0.0022	4.7634	105	0.03753	5.0406	2	5.81E-05	5.2649	163
5.02	Railroad infrastructure development	0.0035	2.2988	85	0.02963	3.186	3	0.000797	4.3916	134
5.06	Postal efficiency	0.0033	3.0331	90	0.02694	4.1733	4	0.013585	5.6242	20
6.13	Extent and effect of taxation	0.0003	2.6252	141	0.02386	3.097	5	0.000262	3.5416	151

Table 11. Criteria of primary importance in highly competitive countries

	Criteria	Cluster 1			Cluster 2			Cluster 3		
		Weight Impact Score	Stage average	Rank	Weight Impact Score	Stage average	Rank	Weight Impact Score	Stage average	Rank
9.13	Willingness to delegate authority	0.0108	2.5776	28	0.00043	3.3216	143	0.043035	4.4057	1
8.01	Buyer sophistication	0.0002	3.125	150	0.02174	4.1163	10	0.040244	5.5143	2
3.10	Availability of scientists and engineers	0.008	4.1405	42	0.00208	4.7059	104	0.038409	5.466	3
4.01	Quality of the educational system	0.0043	2.8686	75	0.00802	3.7618	42	0.031932	4.9302	4
2.12	Cost of importing foreign equipment	0.0011	2.3703	124	1.1E-05	3.3149	175	0.030088	4.6873	5

Table 12. The criteria on which Turkey should improve in order to reach a more competitive position in the 3rd Cluster

	Name of Criterion	Turkey (1)	Average of the 2nd Cluster (2)	Weights in 3rd Cluster (3)	Weighted Difference ((2)-(1)) *3	Cumulative weights
11.01	Military expences	5.55	6.35	0.0650	0.0515	0.0515
2.04	Soundness of banks	1.82	4.84	0.0108	0.0326	0.0841
2.14	Business impact of foreign trade barriers	2.83	4.30	0.0147	0.0216	0.1058
6.28	Business costs of irregular payments	3.14	4.23	0.0195	0.0212	0.1270
7.10	Regional disparities in quality of business environment	1.65	3.39	0.0110	0.0191	0.1461

Table 13. The criteria on which Turkey should improve in order to get into 2nd Cluster

	Name of Criterion	Turkey (1)	Average of the 2nd Cluster (2)	Weights in 2nd Cluster (3)	Weighted difference ((2)-(1))* (3)	Cumulative weights
5.05	Quality of electricity supply	3.54	4.74	0.0511	0.0611	0.0611
6.13	Extent and effect of taxation	1.52	3.10	0.0239	0.0376	0.0987
5.02	Railroad infrastructure development	1.93	3.19	0.0296	0.0372	0.1359
6.04	Intellectual property protection	2.33	3.75	0.0228	0.0323	0.1682
2.20	Agricultural policy costs	2.17	3.46	0.0227	0.0294	0.1976
6.14	Efficiency of the tax system	1.92	3.41	0.0184	0.0274	0.2250
6.08	Burden of local government regulation	1.77	3.11	0.0201	0.0268	0.2518
2.02	Business costs of terrorism	4.43	5.04	0.0375	0.0230	0.2748

Table 14. Ranking of the countries based on the proposed weighted criteria index

Cluster 3			Cluster 2			Cluster 1		
Country	Our Ranking	WEF Ranking	Country	Our Ranking	WEF Ranking	Country	Our Ranking	WEF Ranking
Finland	1	2	Bahrain	32	24	El Salvador	56	54
Denmark	2	3	Slovak Rep.	33	40	Jamaica	57	64
Sweden	3	5	South Africa	34	35	Mexico	58	59
US	4	1	Jordan	35	27	Colombia	59	68
Switzerland	5	4	Cyprus	36	51	Turkey	60	66
Singapore	6	7	Czech Rep.	37	37	Tri. and Tob.	61	62
UK	7	8	Thailand	38	32	Romania	62	56
Netherlands	8	11	Namibia	39	42	Panama	63	53
Germany	9	6	Lithuania	40	38	Sri Lanka	64	65
Japan	10	9	Hungary	41	45	Uruguay	65	70
Iceland	11	12	Greece	42	50	Croatia	66	78
Australia	12	15	Brazil	43	48	Russian Fed.	67	63
Norway	13	13	China	44	31	Gambia	68	80
New Zealand	14	19	Malta	45	41	Peru	69	75
Canada	15	14	Morocco	46	44	Vietnam	70	60
Taiwan	16	10	Botswana	47	57	Bulgaria	71	69
Luxembourg	17	20	Latvia	48	43	Kenya	72	83
Austria	18	17	India	49	36	Nigeria	73	76
Belgium	19	18	Italy	50	55	Macedonia	74	81
France	20	16	Mauritius	51	49	Philippines	75	73
Ireland	21	26	Costa Rica	52	52	Argentina	76	74
Israel	22	21	Indonesia	53	47	Dominican Rp.	77	58
Malaysia	23	22	Ghana	54	67	Uganda	78	77
UAE	24	30	Egypt	55	46	Algeria	79	61
Estonia	25	23				Poland	80	71
Korea	26	25				Ser. and Mon.	81	95
Spain	27	33				Georgia	82	85
Chile	28	28				Ukraine	83	72
Slovenia	29	34				Tanzania	84	96
Tunisia	30	29				Pakistan	85	86
Portugal	31	39				Mali	86	98
						Guatemala	87	82
						Madagascar	88	84
						Nicaragua	89	91
						Zambia	90	90
						Bangladesh	91	93
						Venezuela	92	79
						Bos. and Her.	93	97
						Paraguay	94	89
						Ecuador	95	87
						Honduras	96	88
						Malawi	97	92
						Bolivia	98	94
						Ethiopia	99	101
						Zimbabwe	100	100
						Mozambique	101	99
						Chad	102	102
						Angola	103	103