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Economic Modelling

A multivariate approach in measuring socio-economic development of MENA countries

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ABSTRACT

Socio-economic development of countries is a complex problem that has been constantly elaborated upon over the past few decades. An analysis of a country's welfare cannot be limited to either economic or social factors; it must be determined by combining both of these aspects. As technology has advanced, those indicators crucial for describing this phenomenon have also changed. internet connectedness has been introduced as an indicator of socio-economic development. Furthermore, the development of a health system is essential for a country's development. The aim of this paper has been to present one synthesized indicator that is able to quantitatively demonstrate any country's welfare. The statistical I-distance method is thoroughly explained and has been applied to 22 countries. Crucial indicators for ranking are also elaborated.

1. Introduction

Socio-economic development is a concept that is often cited in contemporary literature, but approaches to its evaluation are scarce and unstructured at best. In the absence of well-defined measures of development, many researchers have utilized various indicators that have been rather arbitrarily chosen. In order to overcome these obstacles, the development of countries should be observed as a multi-dimensional concept.

The measure of a country's development is one of the most critical and highly debated issues in economic research. Different approaches have been applied and numerous indicators have been used in the process to do so, but the most common ranking of countries is done according to their GDP. Nevertheless, due to the fact that this method is unable to capture real inequalities among countries in terms of the different and sometimes contrasting dimensions of the well-being of their populations (Cracolici et al., 2010), it is only a partial measure of socio-economic development at best. Furthermore, small and medium enterprises are one of the main factors for national economic development, especially in developing countries where transitional processes are ever the more common (Gveroski et al., 2011). However, development is much more than economic growth; therefore, non-economic factors must be included in the analysis of a country's welfare.

One potential improvement is the Human Development Index (HDI) developed by The World Bank. Due to its simplicity, the HDI has been both remarkably successful and much criticized. The actual problem facing the Index is its small number of variables (merely three) and the high correlation among them. Therefore, meaningful inferences about the development of countries are hardly able to be drawn from the variations of this Index (Neumayer, 2001). The HDI has been described as "yet another redundant composite development indicator" (McGillivray, 1991) and "conceptually weak and empirically unsound" (Srinivasan, 1994). Attempts at improvement of the HDI have also been made, based on increasing the number of its variables; therein, the 2010 Human Development Report (HDR) introduced several changes in the HDI. Life expectancy remains the indicator used for health, while Gross National Income has replaced GDP as the measure used for living standards. The mean number of years of schooling and expected years of schooling now make up the dimension used for education. Furthermore, these four indicators represent the most basic elements of human development.

There have been numerous attempts for further improvement of HDI. One of them has been the Calibrated Human Development Index, which has a simpler structure and places greater weight on life expectancy and

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less on education. This variant of HDI is calculated to reflect peoples' revealed evaluations of education and the productivity of work (Lind, 2010). The CDI is similar to the Life Quality Index, both of which express the lifetime expected utility of consumption. Irrespective of any improvements, a country's HDI index only has a low level of sensitivity to changes from year to year. In contrast, the value of the CDI is more adaptable, as it takes changes in socio-economic development into account.

Certain researchers have elaborated on a development index that presents a more general concept of wellbeing; one which contains the basis of the HDI with its notions of social and economic progress. Three key areas can be drawn upon for its identification and determination: resources, infrastructure, and the environment (Natoli and Zuhair, 2011). These three dimensions form the basis of the resource–infrastructure-environment (RIE) index, which also includes analyzing ICT infrastructure. Over the last few decades, internet connectedness has been introduced as an indicator of socio-economic development and several papers have emphasized its importance (Dobrota et al., 2012; Gholami et al., 2010). Considering this, it is essential to note this indicator as being hugely important. Furthermore, the capacity of humans to process – otherwise known as IT literacy – can be considered a form of literacy for the 21st century (Leung, 2010). For instance, at present, it is impossible to plan any research without IT experts (Jeremic et al., 2011a), not to mention that the whole range of one's daily activities is dependent upon the internet and upon telecommunications (Jeremic et al., 2011b). Their upper fast broadband and numerous Wi-Fi access points characterize wealthy and powerful countries. Developing countries have a significantly lower level of IT development. Therein, it is necessary to provide wider connectivity that would improve overall information infrastructure and promote positive changes in socio-economic development (Madon, 2000). Still, even when internet access is readily available, its use is limited only to its basic possibilities.

Furthermore, developing countries cannot afford to ignore the socio-economic implications of the internet. This requires combining the analysis of social and economic indicators with a country's ICT dimension as to determine a country's development level. By using these three groups of indicators, countries would be able to be ranked according to their welfare. Concerning the fact that a great deal of research has emphasized the importance of a health system's development, this ranking could be even more accurate if health indicators were also to be included. In this respect, it has also been shown that use of ICT improves and ensures health, and a country's health system (Jovanovic-Milenkovic, 2011).

Most studies that rank countries based on their health status have used countries' life expectancies or mortality rates as an indicator of their health status (Nolte and McKee, 2008). These methods of ranking are not precisely accurate, as health is not a one-dimensional concept (Klomp and Haan, 2010). According to the WHO, health is "a state of complete physical, social and mental well-being and not merely the absence of disease or infirmity" (WHO, 2011). As such, health is considered a fundamental contributor to the welfare of every country. Some studies even rank countries by their development based on their health status (Jeremic et al., 2011c, 2012). Al-Lagilli et al. (2011) compared Middle East and North Africa (MENA) countries using indicators of the health of individuals and indicators of health services. In line with this, an analysis of health indicators is included in this research paper presented here.

As mentioned above, a country's welfare must be considered a multidimensional problem and numerous indicators that greatly influence the socio-economic development of countries must be included. In this research paper, the multivariate I-distance approach shall be conducted on selected indicators and numerous different variables will be synthesized into one value that shall thereafter represent a country's rank. Differences among the countries observed shall be evaluated and crucial indicators for their ranking emphasized.

Those problems present in carrying out such research are the availability and accuracy of data, especially for developing countries, which forces a selection of only those indicators whose values are available for all the countries observed. Only a few empirical studies have dealt with the MENA region (Abu-Bader and Abu-Qarn, 2008; Ben Naceur et al., 2008; Kar et al., 2011; Sassi and Goaied, 2013), largely due to lack of data (Andreano et al., 2013).

2. The I-distance method

In order to create a synthesized socio-economic development indicator, selected variables are incorporated into the analysis through use of the statistical I-distance method; one which has been utilized by Ivanovic (1973), Ivanovic and Fanchette (1973), Jeremic and Radojicic (2010), Jeremic et al. (2011d,e), and Radojicic et al. (2012), among others (Jovanovic et al., 2012; Knezevic et al., 2012).

I-distance is a metric distance in an n-dimensional space. Ivanovic had originally devised this method to rank countries according to their level of development based on several indicators. Many socio-economic development indicators were considered and the problem was how to use all of them in order to calculate a single synthetic indicator, which would thereafter represent the rank.

For a selected set of variables $X^T = (X_1, X_2, ..., X_k)$ chosen to characterize the entities, the I-distance between the two entities $e_r = (x_{1r}, x_{2r}, ..., x_{kr})$ and $e_s = (x_{1s}, x_{2s}, ..., x_{ks})$ is defined as

$$D(r,s) = \sum_{i=1}^{k} \frac{|d_i(r,s)|}{\sigma_i} \prod_{j=1}^{i-1} \left(1 - r_{ji.12...j-1}\right)$$

where $d_i(r, s)$ is the distance between the values of variable X_i for e_r and e_s e.g. the discriminate effect,

$$d_i(r,s) = x_{ir} - x_{is}, \quad i \in \{1, ..., k\}.$$

σ_i the standard deviation of X_i, and $r_{ji.12 ... j-1}$ is a partial coefficient of the correlation between X_i and X_j, $(j < i)$ (Ivanovic, 1977).

The construction of the I-distance is iterative; it is calculated through the following steps:

- Calculate the value of the discriminate effect of the variable X_1, the most significant variable, that which provides the largest amount of information on the phenomena that is to be ranked,
- Add the value of the discriminate effect of X_2 which is not covered by X_1,
- Add the value of the discriminate effect of X_3 which is not covered by X_1 and X_2,
- Repeat the procedure for all variables.

Occasionally, it is not possible to achieve the same sign mark for all variables in all sets. As a result, a negative correlation coefficient and a negative coefficient of a partial correlation may occur. This makes the use of the square I-distance even more desirable. The square I-distance is given as

$$D^2(r,s) = \sum_{i=1}^{k} \frac{d_i^2(r,s)}{\sigma_i^2} \prod_{j=1}^{i-1} \left(1 - r_{ji.12...j-1}^2\right).$$

The entity with the minimal value for each indicator or a fictive maximal or average values entity can be set up as the referent entity. The ranking of entities in the set is based on the calculated distance from the referent entity.

By using the calculated I^2-distance, the intensity of the observed phenomena and rank entities can be observed. When a correlation coefficient of each indicator with the I^2-distance is calculated with the ranking indicators of those values, the importance of each indicator can also be examined. As the correlation coefficient is stronger, the amount of information that is provided with the observed indicator is also greater, when the $p < 0.05$ indicator is significant. Otherwise, the indicator is not important in measuring the phenomenon observed. One of two reasons might explain this: either this indicator is not relevant in measuring the phenomenon observed, or its discriminate effect is already

contained in previous variables. Whatever the reason, the indicator must be excluded from further analysis, since, in order to select only significant indicators, it is necessary to calculate the I^2-distance and its correlation with the indicators used several times, excluding the one insignificant indicator that has the smallest correlation coefficient. Through use of the stepwise method, one indicator is eliminated in every calculation until the results show that all the indicators used are significant, whereupon the results are obtained.

3. The results

In order to examine the socio-economic development of MENA countries and to propose a potential framework for measuring it, a data set of 22 countries were selected. The latest data available were obtained and officially, proposed indicators of The World Bank and World Health Organization (WHO) were selected. Somalia was excluded from the analysis due to a lack of data. As previously mentioned, selection of indicators was limited by the availability of the data for all 22 countries, which prevented the use of certain indicators that would be more suitable for this analysis. The initial indicators of socio-economic development were divided into four groups as follows (Table 1).

The results achieved by the square I-distance ranking method in the first calculation for evaluating socio-economic development are presented in Table 2.

This data set was further examined and a correlation coefficient of each indicator with the I^2-distance value was determined. The results are presented in Table 3 (using the Pearson correlation test).

The correlation coefficients between the I^2-distance and initial indicators demonstrate which indicators are important in analyzing a country's socio-economic development. As has been noted above, the stepwise method excludes one insignificant indicator that possesses the smallest value of the correlation coefficient. Calculating the I^2-distance should be repeated stepwise until the results show that all selected indicators are statistically significant. In this case, the stepwise method eliminated those five indicators that were insignificant in the first calculation and the results achieved in the sixth calculation are those, which are final. The result need not include all indicators that had been significant in first calculation, but may include those indicators that had been insignificant in first calculation. The results are presented in Table 4.

Once again, a correlation coefficient of each indicator was examined with the I^2-distance, the results of which are presented in Table 5.

As it could be seen, all observed indicators from the last calculation are statistically significant, meaning that this is the final calculation of the last two tables presenting the results in examining socio-economic development of the countries observed. The two most important indicators are those from health, which proves the assertion that such indicators are a fundamental contributor to the socio-economic development of any country. As can be readily seen, the most significant variable is a country's total expenditure on health per capita, at $r = 0.955$, $p < 0.01$, and the second most significant is a country's mortality rate ($r = 0.935$, $p < 0.01$). As has already been noted above, the vast majority of researchers have used a country's mortality rate as an indicator of the development in its respective health system; the results of this paper are also in accordance with this supposition. The third and fifth indicators are from the ICT group, confirming the fact that ICT development is also central in evaluating a country's development.

Of the selected indicators, GDP per capita ranks 6th in importance. Previous researchers (Davidson, 2000) have addressed the hypothesis that GNP (or GDP) per capita cannot be considered the only and crucial indicator of a country's performance, as it does not capture the overall well-being of its population. Nevertheless, this paper has demonstrated that GDP is a very significant indicator. ($r = 0.768$, $p < 0.01$).

In Table 5 the final results of the I^2-distance method, I^2-distance value, and rank are presented. The highest values of health indicators belong to Israel, which tops the list. However, the most significant difference between Israel and the other countries observed is in their

Table 2
The results of the I^2-distance method, I^2-distance value, and rank — first calculation.

Country	I^2-distance	Rank
Israel	41.78	1
Qatar	37.12	2
United Arab Emirates	25.49	3
Kuwait	20.56	4
Libyan Arab Jamahiriya	17.36	5
Bahrain	17.34	6
Oman	14.74	7
Saudi Arabia	14.62	8
Lebanon	13.77	9
Jordan	11.77	10
Islamic Republic of Iran	11.02	11
Syrian Arab Republic	9.55	12
Tunisia	8.92	13
Egypt	8.68	14
Iraq	6.99	15
Algeria	6.60	16
Morocco	5.71	17
Sudan	4.61	18
Afghanistan	3.79	19
Pakistan	3.40	20
Djibouti	3.22	21
Yemen	2.57	22

Table 1
The initial indicators of socio-economic development.

Group	Indicator	Source
Economic indicators	GDP per capita, PPP (current international $)	The World Bank
	GDP growth (annual %)	The World Bank
	Imports of goods and services (% of GDP)	The World Bank
	Exports of goods and services (% of GDP)	The World Bank
	Agriculture, value added (% of GDP)	The World Bank
	Industry, value added (% of GDP)	The World Bank
	Services, etc., value added (% of GDP)	The World Bank
Social indicators	Primary completion rate, total (% of relevant age group)	The World Bank
	Literacy rate, adult total (% of people ages 15 and above)	The World Bank
	Unemployment, total (% of total labor force)	The World Bank
ICT indicators	Telephone lines (per 100 people)	The World Bank
	Internet users (per 100 people)	The World Bank
	Mobile cellular subscriptions (per 100 people)	The World Bank
	Secure internet servers (per 1 million people)	The World Bank
Health indicators	Life expectancy at birth (years)	WHO
	Mortality rate, under-5 (per 1000 live births)	WHO
	Number of nursing and midwifery personnel (per 1000 people)	WHO
	Number of physicians (per 1000 people)	WHO
	Total expenditure on health per capita (PPP international $)	WHO

Table 3
The correlation between the I^2-distance and the initial indicators.

Indicator	r
Total expenditure on health per capita (PPP international \$)	0.955**
Mortality rate, under-5 (per 1000 live births)	0.928**
Secure internet servers (per 1 million people)	0.850**
Number of nursing and midwifery personnel (per 1000 people)	0.812**
GDP per capita, PPP (current international \$)	0.808**
Internet users (per 100 people)	0.784**
Number of physicians (per 1000 people)	0.723**
Telephone lines (per 100 people)	0.722**
Literacy rate, adult total (% of people ages 15 and above)	0.717**
Life expectancy at birth (years)	0.677**
Mobile cellular subscriptions (per 100 people)	0.628**
Primary completion rate, total (% of relevant age group)	0.585**
Agriculture, value added (% of GDP)	0.580**
Unemployment, total (% of total labor force)	0.573**
Industry, value added (% of GDP)	0.416
GDP growth (annual %)	0.398
Exports of goods and services (% of GDP)	0.333
Services, etc., value added (% of GDP)	0.143
Imports of goods and services (% of GDP)	0.013

$^{**}p < 0.01$; $^{*}p < 0.05$.

total expenditures for health. In this respect, Israel spends 2186 dollars per capita in a year, by far the highest value for this indicator. Stemming from the fact that it has also developed the best health care system, Israel possesses the highest level of socio-economic development from the group of MENA countries.

In contrast to Israel, ranking at the bottom of this list are countries with the lowest level of socio-economic development — Afghanistan, Yemen and Djibouti. Bearing in mind the social situation in these countries (especially for Afghanistan), these results are to be expected. The MENA region is a region with a wide range of variability in attitudes and terrorist incidents (Krueger and Maleckova, 2009). More than a decade after US-led invasion of Afghanistan in October 2001, the conflicts in this country are still ongoing (Coyne and Pellillo, 2011). However, the military presence in Afghanistan is being reduced (Paris, 2013) and the combat operations should be terminated by the end of 2014 (Clements, 2013). As for Yemen, it is an oil-exporting country with the highest levels of poverty in the Middle East and North Africa and one of the most food-import-dependent countries in the world (Breisinger et al., 2011). Djibouti is at the very bottom of the list which is not surprising, knowing that it is one of the most inhospitable and barren environments on the planet; it has virtually no arable land, no permanent

Table 4
The results of the I^2-distance method, I^2-distance value, and rank — last calculation.

Country	I^2-distance	Rank
Israel	41.54	1
Qatar	32.52	2
United Arab Emirates	23.23	3
Kuwait	18.90	4
Libyan Arab Jamahiriya	15.29	5
Bahrain	15.03	6
Oman	13.81	7
Lebanon	13.46	8
Saudi Arabia	13.15	9
Islamic Republic of Iran	10.76	10
Jordan	10.64	11
Syrian Arab Republic	9.26	12
Egypt	8.40	13
Tunisia	8.17	14
Algeria	5.80	15
Morocco	5.35	16
Iraq	4.39	17
Sudan	4.33	18
Pakistan	3.38	19
Afghanistan	3.02	20
Yemen	2.04	21
Djibouti	1.65	22

Table 5
The correlation between I^2-distance and final indicators.

Indicator	r
Total expenditure on health per capita (PPP international \$)	0.955**
Mortality rate, under-5 (per 1000 live births)	0.935**
Secure internet servers (per 1 million people)	0.875**
Number of nursing and midwifery personnel (per 1000 people)	0.787**
Internet users (per 100 people)	0.776**
GDP per capita, PPP (current international \$)	0.768**
Telephone lines (per 100 people)	0.758**
Number of physicians (per 1000 people)	0.745**
Literacy rate, adult total (% of people ages 15 and above)	0.706**
Life expectancy at birth (years)	0.686**
Mobile cellular subscriptions (per 100 people)	0.614**
Primary completion rate, total (% of relevant age group)	0.598**
Agriculture, value added (% of GDP)	0.550**
Unemployment, total (% of total labor force)	0.524**

$^{**}p < 0.01$; $^{*}p < 0.05$.

fresh water source, no significant mineral resources and very little vegetation (Brass, 2008).

4. Conclusion

In this paper, the I-distance method has been applied in order to measure the level of socio-economic development of a defined selection of countries, as based on different indicators. Two groups of indicators have herein been added – health and ICT – which provide a large amount of new information concerning the phenomena observed. The research itself started with initial indicators and several calculations led to the final set of indicators, which were then used in order to measure countries' welfare and rank them according to their level of socio-economic development. The approach that has been proposed in this work and the indicators elaborated upon could further prove useful in future research on the economic and social performance of MENA countries. According to the results that Dastjerdi and Isfahani (2011) presented, there is an ample capacity for having a high economic growth for MENA zone. Furthermore, Abid and Bahloul (2011) showed that some of MENA countries had reached an undeniably high level of financial development and stabilization.

The I-distance method is able to synthesize many indicators into one single numerical value that represents rank. With this approach, not only can countries be ranked, but the differences between them can be better explored as well. In addition, the approach utilized in this paper can identify crucial indicators for the ranking process. With that, it is hoped that this method shall be able to complement the rising number of studies concerning the measurement of socio-economic development.

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