

Measuring degree of globalization of African Countries on almost equimarginal contribution principle

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Abstract. This paper is an exercise in construction of an alternative globalization index for 43 countries in Africa. It has used a new method for measurement of the degree of globalization (or construction of a globalization index) based on minimization of the Euclidean norm of the Shapley values, the concept borrowed from the cooperative game theory. It assigns weights to constituent variables such that their mean expected marginal contribution to the synthetic index is as equitable as possible. Since this index is based on combinatorial logic, it is also less likely to be affected by outlier data points. Globalization index for 43 African countries (for a time series of 45 years, 1970-2014) has been constructed. The new index has been compared with the KOF index of globalization for the countries under study. As its validation, it has been found that the index has stronger correlation (vis-à-vis the KOF index) with Human Development index, Corruption Perception index, Freedom index and the indicators of abject poverty in the African countries. Viewed as such the new index represents globalization closely in connection with other relevant socio-economic measures than its rival (KOF index of globalization) as well as it is based on more plausible theoretical premises based on marginal contribution rather than correlation.

Keywords. Globalization, Synthetic index, African Countries, Shapley values, Equimarginal contribution.

JEL. C43, C71, F02, F60, O55.

1. Introduction

Africa, the second largest continent of the World, covers about 20% of the Earth's land and 6% of the Earth's surface. It is inhabited by about 1216 million people that make about 16.36% of the total population of the World. It has 54 nation states: Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo Rep., Congo (DRC), Cote d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome & Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, South Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia and Zimbabwe. Some areas of the continent are yet to have their own government.

Africa has abundant natural resources. The continent is believed to hold 90% of the world's cobalt, 90% of its platinum, 50% of its gold, 98% of its chromium, 70% of its tantalite, 64% of its manganese and one-third of its uranium. Some African countries (e.g. Algeria, Angola and Libya) have large proven oil reserves. However, it is the World's poorest and most underdeveloped continent. It is partly so because of European colonialism that exploited resources and kept the people and the area underdeveloped. Prospects of economic development are by and large

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path dependent. For the last 30 years or more, the main reasons behind the poor progress of African countries are domestic conflicts among different factions for power, blatant human right violations and large scale genocide, wide spread corruption in the governments, failed central planning, illiteracy, poor state of health, transport and communication infrastructure, lack of integration among different African countries, and so on. In 2015, about 2/3rd of the countries in Africa had low human development (index values ranging from 0.54 to 0.35), about 1/4th of the countries had medium level of human development (index values ranging from 0.70 to 0.56) and only 5 countries had the human development index values ranging from 0.78 to 0.72. Almost 2/3rd of the total number of countries in Africa have under 40 score for perceived corruption. As to poverty, in more than a half of the total number of African countries about 1/3rd of people live with daily income less than 2 US dollars and about 2/3rd of people live with income well below 3.5 US dollars.

2. Economic development of African Countries

On an average, African countries have a Gross Domestic Product (GDP at PPP) of about \$116 billion and per capita GDP \$5809 thousand (Table 1) which appears to be impressive vis-à-vis many less developed countries in other regions. However, this impressive picture is marred by inequalities and poor growth rate. Overall, income is increasing only with a meagre growth rate of 4.6% per annum. About a half of the total income of these countries is claimed by only three countries and about 2/3rd of the total income is due only to five countries. The Gini coefficient of GDP in Africa is 0.72 and that of its per capita GDP is 0.56. The countries at the southern end of the continent (Botswana, Namibia and South Africa) have the highest intrastate income disparities (exceeding Gini coefficient > 0.6), followed by Zambia, Rwanda, Lesotho, Swaziland, Comoros, Guinea_Bissau and Central African Republic (Gini coefficient between 0.5 and 0.57). Among the countries having appreciable income equality are: Mali, Niger, Libya, Egypt, South Sudan, Ethiopia, Somalia, Burundi and Zimbabwe (Gini coefficient less than 0.33).

Table 1. Gross Domestic product (GDP at PPP) and its Growth rate in Select African Countries (2011)

| Country | Gross Domestic Product PPP | | | Country | Gross Domestic Product PPP | | |
|---------------|----------------------------|---------------------|------------------------|--------------|----------------------------|-------------------|------------------------|
| | In \$ Billions | Per Capita (\$ 000) | Annual Growth Rate (%) | | In \$ Billions | Per Capita \$ 000 | Annual Growth Rate (%) |
| Algeria | 555.34 | 13757 | 3.80 | Lesotho | 5.4 | 2500 | 3.40 |
| Angola | 171.91 | 6662 | 4.80 | Madagascar | 34.5 | 1386 | 3.30 |
| Benin | 20.42 | 1830 | 6.40 | Malawi | 16.5 | 931 | 5.70 |
| Botswana | 35.69 | 15496 | 4.10 | Mali | 27.69 | 1528 | 7.00 |
| Burkina_Faso | 29.74 | 1597 | 4.20 | Mauritania | 12.03 | 2890 | 5.60 |
| Burundi | 8.29 | 718 | 4.50 | Mauritius | 24.39 | 19091 | 3.60 |
| Cameroon | 68.54 | 2867 | 5.90 | Morocco | 252.25 | 7245 | 2.60 |
| Cape_Verde | 2.91 | 5515 | 0.60 | Mozambique | 32.23 | 1122 | 7.40 |
| C_Africa_Rep | 2.35 | 469 | 1.00 | Namibia | 24.04 | 9567 | 6.50 |
| Chad | 25.35 | 1750 | 6.90 | Niger | 19.18 | 927 | 7.00 |
| Comoro_Iss | 1.17 | 1445 | 2.00 | Nigeria | 1,162.44 | 6221 | 6.30 |
| Congo_DRep. | 58.49 | 12346 | 9.50 | Rwanda | 20.85 | 1756 | 7.60 |
| Congo_Rep. | 27.27 | 342 | 6.80 | Senegal | 37.34 | 2397 | 4.30 |
| Cote_d'Ivoire | 77.31 | 3326 | 8.80 | Seychelles | 2.77 | 28528 | 6.20 |
| Djibouti | 3.17 | 3523 | 6.00 | Sierra_Leone | 9.49 | 1441 | 4.60 |
| Egypt | 995.42 | 10663 | 2.90 | South_Africa | 659.59 | 11998 | 1.70 |
| Eq_Guinea | 26.5 | 30497 | -0.50 | Sudan | 184.75 | 4490 | 1.60 |
| Ethiopia | 171.56 | 1685 | 10.30 | Swaziland | 8.63 | 6619 | 3.60 |
| Gabon | 33.48 | 18999 | 4.40 | Tanzania | 99.92 | 1813 | 7.00 |
| Gambia | 3.54 | 1726 | 0.90 | Togo | 10.29 | 1374 | 5.40 |
| Ghana | 111.39 | 3975 | 4.00 | Tunisia | 122.32 | 10754 | 2.30 |
| Guinea | 15.16 | 1172 | 1.10 | Uganda | 56.53 | 1403 | 5.20 |
| Guinea_Biss | 2.43 | 1287 | 1.00 | Zambia | 48.86 | 2925 | 4.70 |
| Kenya | 116.02 | 2457 | 5.30 | Average | 115.65 | 5809 | 4.60 |

Source: GDP PPP data, World Economics Population data, United Nations

Although it is possible to achieve a very high momentum in economic development through a command economy and proper planning, it necessitates a

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very high level of cultural development, discipline and a sense of social concern among the people, particularly in those who are decision-makers at the apex level. This condition has not largely been met with in reality. Failure of the USSR is one of the telling examples (Mishra, 2017b). Therefore, economic development is considered to be dependent on right to property and freedom to decision-making in augmenting, nurturing, protecting and employing one's property as one chooses in one's own interest. Property rights together with fiscal freedom, business freedom, labour freedom, monetary freedom, trade freedom, financial freedom and freedom from corruption are considered necessary for economic development. It also responds to Govt. expenditure (as a % to GDP). However, a closed economy working in indigenous socio-political and socio-psychological set up may show up resilience to maintain a low level equilibrium and resist changes. It is partly so due to the vested interests of the class that is beneficiary of such a low level equilibrium. It is required, therefore, that a country should open itself to ideas, culture, capital, skill and technology outside national boundaries. This approach to economic development calls for globalization.

3. The globalization wave

Globalization is the process of integration of a national economy with the world economies through trade, financial flows, exchange of technology, information and ideas, cultural modalities and movement of people. Historically, the countries of the First World always preferred globalization in their own economic interests. Countries of the Second World made their own Bloc and interacted with the First World countries only with caution. The reason was that they had two different economic systems with conflicting ideologies. The countries of the Third World had different degrees of association with the First and the Second World countries. However, most of the countries in the Third World borrowed substantially from the international organizations for financing their development efforts, although ideologically they remained closer to the Socialist Bloc. After the fall of the USSR, the socialist ideology suffered a great setback. The countries of the Third World (including the countries in the Socialist Bloc that emerged after the dissolution of the USSR) rushed in for establishing economic relationship with the countries of the First World. Thus came the wave of globalization that swept Asia as well as Africa.

However, globalization has not been much successful in African countries, nor have they benefitted much from the wave of globalization (Ouattara, 1997). Kataoke (2008) observes: "Africa's share (Sub-Saharan African countries) of the global economy is little more than 2.5%, and with the exception of oil-producing countries profiting from the recent price hikes and countries rich in mineral resources such as rare metals, few countries are enjoying the benefits of globalization." This is so because African countries have concentrated on primary sector (and export of its products) without developing the processing industries to raise value-added component. This has, first of all, arrested the emergence and growth of possible industries having a backward linkage to the primary resources and secondly it could not generate employment. Also, they have depended on international prices that are fluctuating. The worst affected countries have been exporters of mainly agricultural products, due to the slump in cacao and coffee prices since the beginning of the 1990s.

4. Quantitative measure of globalization

Samimi (2011) reviews several synthetic indices that make an attempt to quantify globalization visualized as a multi-faceted process and incident. It has been pointed out by Samimi that Kearney (2002, 2003) is the first attempt to introduce a multi-faceted measurement for globalization. This index (also called the Kearney/Foreign Policy Globalization or KFP) measures not only economic integration but also technological connectivity, personal contact and political

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engagement. Weights are assigned based on construction belief, based on the judgment of the analyst as to the relative importance of different aspect variables. Variables are weighted double or single relative to others. The reason for a priori weights is that they have some normative significance. Another is the CSGR2 Globalization Index. This index is complementary to the KFP index that measures the economic, social and political dimensions of globalization. Instead of subjective or judgmental weights, it uses the Principal Component Analysis (PCA) for weight assignment. The third is the MGI index. It uses seven group of variables including global politics, organized violence, global trade and finance, social and cultural, technology and environment to cover all dimensions of globalization. This is the only index that incorporates the environmental dimension of globalization (Samimi, 2011). A mention has also been made of the G-Index (Randolph, 2001) and NGI or New Globalization Index (Vujakovic, 2010). NGI incorporates several new variables and as a novelty also includes geographical distances between countries so as to account for the distinction between globalisation and regional integration. It uses PCA for weight assignment.

Konjunkturforschungsstelle (The Economic Research Centre), Zurich, Switzerland has regularly been constructing globalization index year-wise now for over a decade. It is known as the KOF index of globalization (Dreher, 2006; Dreher *et al.*, 2008). It visualizes three aspects of globalization; economic, social and political. It does not incorporate environmental variables. The economic dimension of globalization has two sub-aspects: (1) actual economic flows (such as trans-border trade, direct investment and portfolio investment, E1) and (2) restrictions on trans-border trade as well as capital movement by means of taxation, tariff, etc, E2. Once synthesized they make E. The social dimension has three sub-aspects: (1) trans-border personal contacts (degree of tourism, telecom traffic, postal interactions, etc.), S1, (2) flow of information, S2, and (3) cultural proximity, S3. Once synthesized, they make S. The political dimension has only one aspect, P. At the second stage, E, S and P are synthesized to give the KOF Index of globalization. For synthesis (and weight assignment) the method of PCA is used.

Methodologically, globalization indices listed and describe above use either subjective (judgmental) weights or the PCA for weight assignment and synthesis. It has been pointed out that subjective assignment of weights has many limitations (Lockwood, 2001; Andersen & Herbertsson, 2003; 2005). It has also been pointed out that the PCA, since it depends on correlation coefficients, has elitist bias for poorly correlated variables (Mishra, 2016, 2017a) as well as it may severely be affected by outliers. Moreover, correlation coefficients do not measure importance. It has been proposed, therefore, that instead of correlation, the Shapley values of constituent variables (contributing to the synthetic index) may be used as criterion for deriving weights. The proposed method is named as the Almost Equi-marginal Contribution (AEMC) index of globalization.

The AEMC index is obtained by the weighted aggregation of constituent variables such that the Euclidean norm of the Shapley values (which are mean expected marginal contributions) of the constituent variables to the aggregate (synthetic) index is minimized. In the process of optimization suitable weights are automatically assigned to the constituent variables. Shapley values have their origin in cooperative (collusive) game theory and have been credited for many desirable properties (Roth, 1988). It claims that it provides the most efficient or optimal measure of expected marginal contribution of an agent (constituent variable) to the total value of the game (synthetic index). Additionally, since Shapley values are worked out combinatorially, it is expected to overcome the outlier problem unless every aspect of a case is vitiated by the outliers, which is much less likely. Nevertheless, the method has a demerit in being computation-intensive.

5. The present study

The present study is based on the data pertaining to the three aspects of globalization (E1, E2, S1, S2, S3 and P) of 43 African countries provided by the KOF for the years 1970 through 2014. E1 and E2 were used by the KOF for constructing E and S1, S2 and S3 were used to construct S. Finally KOF obtained the (synthetic) index of (overall) globalization in 2017 by fusing (aggregating) E, S and P at the second stage. In contrast, we fuse E1, E2, S1, S2, S3 and P all at one go. All African countries could not be used in our enterprise on account of inavailability of data on some aspects of globalization for the one or the other years for the countries excluded from our study. Hence, the present study covers only 43 countries.

In view of the fact that we are using a new method for constructing a synthetic index, we have used our own computer program for computation of Shapley values and also for optimization of the Euclidean norm of the Shapley values. Algorithmically, we have used the Host-Parasite Co-Evolutionary (HPC) algorithm for global optimization (Mishra, 2013). To be doubly sure of our optimization efforts, we have also solved the problem by another method of global optimization called as the Differential Evolution (DE) method (Storn & Price, 1997; Mishra, 2006). These methods gave very close results and thus corroborated each other. To avoid duplication we have presented the HPC results only.

6. The findings

We have presented our results in Table-2 and Table-3. In Table-2 we have presented the Shapley values obtained by the KOF Index of globalization (for 2017, countries as included in the study at hand) as well as the AEMC index of globalization. It may be observed that in KOF index the Shapley values for S1 and S3 are much smaller than those of E1, E2, S2 and P. Thus, trans-border personal contacts and cultural proximity have been contributing much less (than they could) to the KOF index. However, the AEMC, by virtue of (almost) equalizing the marginal contribution of each constituent variable to the synthetic index, improves the Shapley values of S1 and S3. In so doing, S2 has been assigned a smaller weight vis-à-vis other constituent variables, although it does not lose its marginal contribution unduly on account of the assignment of a smaller weight.

In Table-3 we present the KOF and the AEMC indices side by side to facilitate comparison. It is relevant to mention that although we have used the time series data (for 1970 through 2014; 45 years) for all the 43 countries in the process of computation, we have presented only the largest value of AEMC globalization index that any country has obtained during 1970-2014. We have mentioned the year in which a particular country scored maximum value of AEMC globalization index. Alongside that, the KOF index value also is presented for that year. This choice not only facilitates presentation, it also preserves the information on the realized maximum degree of globalization that a country has attained. If we would have used any other measure (say, mean level globalization attained by a country in the study period 1970-2014) we could have lost this information. The terminal year (2014) also could not have been appropriate on account of pervasive effect of slow-down since 2007-08.

The most globalized five countries in Africa (see Table-3) are: Egypt, Mauritius, South Africa, Morocco and Seychelles. Of these, two are islands. Their (AEMC) score of globalization is between 50 and 67. The least globalized 9 countries are: Angola, Cameroon, Madagascar, Ethiopia, Tanzania, Chad, Congo Democratic Republic, Burundi and Central African Republic having AEMC globalization score between 35 and 27. Average score of AEMC globalization is 40.60. It may also be pertinent to point out that the KOF index of globalization and the AEMC index of globalization are highly correlated, exhibiting Kendall's Tau = 0.7785 (see Table-4) and Spearman's Rho = 0.9251 (see Table-5). The Gini

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coefficient of the KOF index is 0.0913 against AEMC Gini=0.115, which indicates that AEMC index has more variability.

Table-2. *Shapley Value of Constituent Variables in KOF and AEMC Indices and their Euclidean Norm*

| Globalization Aspect | E1 | E2 | S1 | S2 | S3 | P | Norm |
|----------------------|---------|---------|---------|---------|---------|---------|---------|
| Shapley Value (KOF) | 0.20294 | 0.13317 | 0.07634 | 0.25523 | 0.06651 | 0.26424 | 0.45181 |
| Shapley Value (AEMC) | 0.16483 | 0.16532 | 0.16484 | 0.17465 | 0.16563 | 0.16472 | 0.40834 |
| AEMC Weights | 0.47479 | 0.67665 | 0.83955 | 0.00816 | 0.57448 | 0.91453 | - |

7. Validation of KOF and AEMC indices on other socio-economic measures

Validation of the results of an analysis is often done through testing its corroborative or explanatory power as to the external information or the information that was not a part of the analysis. The KOF uses correlation and the AEMC uses Shapley values. They obtain optimal values with respect to their own criterion. To judge between them we must use extraneous information.

7.1. Validation on human development index

The potential of globalization is dependent not only on natural resources but also on the quality of human resources or the degree of human development. In turn, economic benefits accruing from globalization must be reflected in an improvement in human development index partly on account of an increase in income and partly due to increased public expenditure on education (literacy) and health infrastructure/facilities made available to the people. It is expected, therefore, that the indices of globalization are positively correlated with the Human Development Index (HDI). We find (table-4) that the values of Kendall's Tau between HDI and the two alternative indices of globalization, KOF and AEMC, are 0.4787 and 0.5518 respectively. The values of Spearman's coefficient of correlation for them are 0.6694 and 0.7414 respectively. On both counts, HDI is more strongly correlated with the AEMC index vis-à-vis the KOF index of globalization.

7.2. Validation on corruption perception index

The corruption perception index (CPI) is an important measure that correlates with growth not only in boosting up globalization but also in rendering the benefits of globalization to the people. It has been discussed by many scholars that prevalence of corruption discourages foreign investment and thwarts globalization (Alfaro *et al.*, 2005; Montiel, 2006; Kedir, 2015). We find that the Kendall's Tau of CPI with the KOF index and the AEMC index are 0.4138 and 0.4725. The values of Spearman's correlation of CPI with the two alternative indices are 0.5839 and 0.6509. Once again, the CPI is more strongly correlated with the AEMC index (in comparison to the KOF index).

7.3. Validation on Economic freedom index

Freedom index (EFI) provides a good measure of preconditions for the benefits of globalization to trickle down or percolate to spur domestic economic forces for vigorous working. They make the forward linkages to globalization efforts by stimulating the domestic enterprises leading to 'globalization-led growth'. Table-4 and Table-5 indicate that EFI is more strongly associated with the AEMC index (Kendall's tau=0.3744; Spearman's Rho =0.5237) than the KOF index (Kendall's tau=0.2989; Spearman's Rho =0.4589).

7.4. Validation on poverty indicators

Percentage of people living on meagre income is measured by two indicators: Income1.9 and income3.1, which mean the percentage of people living on daily income below \$1.9 and \$3.1 respectively. They are the measures of poverty. They

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may work very well to gauge the beneficial effects of globalization in promoting the social welfare. They may also work the other way round. It may be hypothesized that countries with wide-spread intense poverty cannot do well in globalization efforts. We observe (Table 4 and Table 5) that both of these measures are more strongly associated with the AEMC (vis-à-vis the KOF) index. The strength of relationship validates the appropriateness of the AEMC index of globalization. It may also be noted that Income3.1 is more strongly (negatively) associated with globalization indices than the Income1.9 is. It indicates that abject poverty (Income1.9) is not as strongly associated with globalization as the relatively less acute poverty (Income 3.1). This fact should suggest active government policies to alleviate the conditions of abject poverty which may not automatically respond to globalization efforts.

Table 3. Globalization Indices and Some Other Indices Showing Socio-economic Attributes of African Countries

| Country | Globalization Index | | Human Development Index-2014 (1) | Corruption Perception Index 2016 (2) | Percent Persons Living on Daily Income (in \$) (3) | | | Freedom Index (4) | Type of Colonization | |
|---------------|---------------------|-------|----------------------------------|--------------------------------------|--|------|--------|-------------------|----------------------|--------|
| | Year | KOF | | | AEMC | Year | < 1.90 | | | < 3.10 |
| Egypt | 2014 | 63.2 | 66.72 | 0.691 | 34 | N/A | N/A | N/A | 55.2 | 3 |
| Mauritius | 2014 | 66.61 | 63.57 | 0.745 | 54 | 2012 | 0.53 | 2.96 | 76.5 | 3 |
| South_Africa | 2014 | 66.72 | 62.47 | 0.666 | 45 | 2011 | 16.56 | 34.68 | 62.6 | 2 |
| Morocco | 2012 | 66.28 | 59.48 | 0.647 | 37 | 2007 | 3.12 | 15.53 | 60.1 | 3 |
| Seychelles | 2014 | 59.88 | 50.14 | 0.781 | 55 | N/A | N/A | N/A | 57.5 | 3 |
| Namibia | 2007 | 54.74 | 49.19 | 0.64 | 52 | 2009 | 22.6 | 45.72 | 59.6 | 2 |
| Botswana | 2008 | 55.5 | 47.72 | 0.698 | 60 | 2009 | 18.24 | 35.74 | 69.8 | 1 |
| Tunisia | 2005 | 60.18 | 46.64 | 0.725 | 41 | 2010 | 1.99 | 8.4 | 57.7 | 3 |
| Ghana | 2004 | 52.44 | 45.58 | 0.579 | 43 | 2005 | 25.15 | 49.04 | 63.0 | 1 |
| Gambia | 2003 | 51.24 | 44.85 | 0.452 | 26 | 2003 | 45.29 | 68 | 57.5 | 3 |
| Gabon | 2014 | 55.96 | 44.16 | 0.697 | 35 | 2005 | 7.97 | 24.43 | 58.3 | 3 |
| Zambia | 2007 | 52.96 | 42.27 | 0.579 | 38 | 2010 | 64.43 | 78.87 | 58.7 | 3 |
| Senegal | 2009 | 53.35 | 42 | 0.494 | 45 | 2011 | 37.98 | 66.26 | 57.8 | 3 |
| Algeria | 2006 | 54 | 40.85 | 0.782 | 34 | N/A | N/A | N/A | 48.9 | 3 |
| Cape_Verde | 2001 | 44.62 | 40.81 | 0.648 | 59 | 2007 | 17.57 | 39.26 | 66.4 | 3 |
| Nigeria | 2007 | 53.33 | 40.42 | 0.527 | 28 | 2009 | 53.47 | 60.5 | 55.6 | 3 |
| Swaziland | 2014 | 47.48 | 40.36 | 0.541 | 43 | 2009 | 42.03 | 63.12 | 59.9 | 1 |
| Congo_R | 2014 | 51.83 | 40.24 | 0.592 | 20 | 2011 | 28.71 | 52.91 | 45.0 | 3 |
| Cote_d'Ivoire | 2007 | 49.83 | 39.9 | 0.474 | 34 | 2008 | 29.02 | 55.14 | 58.5 | 3 |
| Togo | 2014 | 53.7 | 39.73 | 0.487 | 32 | 2011 | 54.18 | 74.54 | 53.0 | 3 |
| Niger | 2014 | 47.92 | 39.06 | 0.353 | 35 | 2011 | 50.34 | 81.75 | 54.6 | 3 |
| Zimbabwe | 1995 | 44.41 | 39.01 | 0.516 | 22 | N/A | N/A | N/A | 37.6 | 2 |
| Mauritania | 2014 | 51.45 | 38.63 | 0.513 | 27 | 2008 | 10.91 | 32.48 | 53.3 | 3 |
| Kenya | 2003 | 46.01 | 38.24 | 0.555 | 26 | 2005 | 33.6 | 58.85 | 55.6 | 2 |
| Mozambique | 2013 | 47.63 | 38.07 | 0.418 | 27 | 2008 | 68.74 | 87.54 | 54.8 | 2 |
| Malawi | 2013 | 45.4 | 37.34 | 0.476 | 31 | 2010 | 70.91 | 87.64 | 54.8 | 3 |
| Rwanda | 2014 | 45.56 | 37.26 | 0.498 | 54 | 2010 | 60.25 | 80.66 | 64.8 | 1 |
| Lesotho | 1997 | 40.58 | 37.24 | 0.497 | 39 | 2010 | 59.65 | 77.28 | 49.6 | 1 |
| Benin | 2014 | 46.67 | 37.14 | 0.485 | 36 | 2011 | 53.11 | 75.63 | 58.8 | 1 |
| Uganda | 2004 | 43.36 | 37.02 | 0.493 | 25 | 2012 | 33.24 | 63.03 | 59.7 | 3 |
| Burkina_Faso | 2013 | 47.81 | 36.68 | 0.402 | 42 | 2009 | 55.29 | 80.47 | 58.6 | 3 |
| Sierra_Leone | 2012 | 45.42 | 35.98 | 0.42 | 30 | 2011 | 52.33 | 79.96 | 51.7 | 3 |
| Mali | 2006 | 44.65 | 35.44 | 0.442 | 32 | 2009 | 49.25 | 77.71 | 56.4 | 3 |
| Guinea | 2003 | 41.41 | 35.1 | 0.414 | 27 | 2012 | 35.27 | 68.65 | 52.1 | 3 |
| Angola | 1998 | 43.92 | 34.89 | 0.533 | 18 | 2008 | 30.13 | 54.52 | 47.9 | 2 |
| Cameroon | 2004 | 42.96 | 33.08 | 0.518 | 26 | 2007 | 29.27 | 54.27 | 51.9 | 3 |
| Madagascar | 2014 | 42.9 | 31.07 | 0.512 | 26 | 2010 | 81.76 | 92.91 | 61.7 | 3 |
| Ethiopia | 2014 | 39.33 | 30.94 | 0.448 | 34 | 2010 | 33.54 | 71.27 | 51.5 | 1 |
| Tanzania | 2007 | 37.71 | 30.71 | 0.531 | 32 | 2011 | 46.6 | 76.1 | 57.5 | 3 |
| Chad | 2006 | 38.37 | 30.52 | 0.396 | 20 | 2011 | 38.43 | 64.82 | 45.9 | 3 |
| Congo_DR | 2013 | 41.67 | 29.54 | 0.435 | 20 | 2012 | 77.18 | 90.73 | 42.7 | 3 |
| Burundi | 2014 | 35.04 | 28.07 | 0.404 | 20 | 2006 | 77.65 | 92.17 | 53.7 | 1 |
| Afric_Rep_C | 2010 | 36.14 | 27.6 | 0.352 | 20 | 2008 | 66.27 | 82.27 | 45.9 | 3 |

Notes: (1). Source: [Retrieved from]; (2). Source [Retrieved from]; (3). Source: [Retrieved from]; (4). Source: [Retrieved from].

Table 4. Kendall's Tau Among Different Measures that may Relate to Globalization Index

| Measure | KOF Index | AEMC | HDI | CPI | Income1.9 | Income3.1 | EFI | HTCD |
|-----------|-----------|---------|---------|---------|-----------|-----------|---------|---------|
| KOF | 1.0000 | 0.7785 | 0.4787 | 0.4138 | -0.4035 | -0.4548 | 0.2989 | 0.1093 |
| AEMC | 0.7785 | 1.0000 | 0.5518 | 0.4725 | -0.4170 | -0.4791 | 0.3744 | 0.0406 |
| HDI | 0.4787 | 0.5518 | 1.0000 | 0.3543 | -0.5024 | -0.5915 | 0.3002 | -0.0234 |
| CPI | 0.4138 | 0.4725 | 0.3543 | 1.0000 | -0.2365 | -0.2337 | 0.5453 | -0.1463 |
| Income1.9 | -0.4035 | -0.4170 | -0.5024 | -0.2365 | 1.0000 | 0.8677 | -0.2341 | -0.0416 |
| Income3.1 | -0.4548 | -0.4791 | -0.5915 | -0.2337 | 0.8677 | 1.0000 | -0.2422 | -0.0227 |
| EFI | 0.2989 | 0.3744 | 0.3002 | 0.5453 | -0.2341 | -0.2422 | 1.0000 | -0.1160 |
| HTCD | 0.1093 | 0.0406 | -0.0234 | -0.1463 | -0.0416 | -0.0227 | -0.1160 | 1.0000 |

Notes: KOF = KOF Index of Globalization; AEMC = AEMC Index of Globalization; HDI = Human Development Index; CPI = Corruption Perception Index; Income1.9 = % of People with Daily

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Income less than \$1.9; Income3.1 = % of People with Daily income less than \$3.1; EFI = [Economic] Freedom Index; HTCD = Historical Type of Colonization Dummy.

Table 5. Spearman's Rho Among Different Measures that may Relate to Globalization Index

| Measure | KOF Index | AEMC | HDI | CPI | Income1.9 | Income3.1 | EFI | HTCD |
|-----------|-----------|---------|---------|---------|-----------|-----------|---------|---------|
| KOF | 1.0000 | 0.9251 | 0.6694 | 0.5839 | -0.5433 | -0.6176 | 0.4589 | 0.1405 |
| AEMC | 0.9251 | 1.0000 | 0.7414 | 0.6509 | -0.6071 | -0.6775 | 0.5237 | 0.0396 |
| HDI | 0.6694 | 0.7414 | 1.0000 | 0.4964 | -0.6752 | -0.7663 | 0.4181 | -0.0355 |
| CPI | 0.5839 | 0.6509 | 0.4964 | 1.0000 | -0.3541 | -0.3491 | 0.7177 | -0.1978 |
| Income1.9 | -0.5433 | -0.6071 | -0.6752 | -0.3541 | 1.0000 | 0.9591 | -0.3305 | -0.0514 |
| Income3.1 | -0.6176 | -0.6775 | -0.7663 | -0.3491 | 0.9591 | 1.0000 | -0.3489 | -0.0241 |
| EFI | 0.4589 | 0.5237 | 0.4181 | 0.7177 | -0.3305 | -0.3489 | 1.0000 | -0.1457 |
| HTCD | 0.1405 | 0.0396 | -0.0355 | -0.1978 | -0.0514 | -0.0241 | -0.1457 | 1.0000 |

Notes: KOF = KOF Index of Globalization; AEMC = AEMC Index of Globalization; HDI = Human Development Index; CPI = Corruption Perception Index; Income1.9 = % of People with Daily Income less than \$1.9; Income3.1 = % of People with Daily income less than \$3.1; EFI = [Economic] Freedom Index; HTCD = Historical Type of Colonization Dummy.

Heldring & Robinson (2013) have classified African countries in three different classes: (1) Those with a centralised state at the time of Scramble for Africa (Berlin Conference 1884-85) such as Benin, Botswana, Burundi, Ethiopia, Ghana, Lesotho, Rwanda, and Swaziland; (2) Those of white settlement, such as Kenya, Namibia, South Africa, Zimbabwe, Angola and Mozambique; (3) Other African countries - colonies which did not experience significant white settlement and where there was either no significant pre-colonial state formation (like Somalia or South Sudan) or where there was a mixture of centralised and un-centralised societies such as in Congo, Nigeria, Uganda and Sierra Leone. It is interesting to note that while human development has in general been better in the first two classes of countries, it has been relatively low in the last class. Accordingly, we have used the dummy 1, 2 and 3 (making the variable HTCD) to classify the African countries. As we find in Table-4 and Table-5, globalization indices are only poorly (though positively) associated with HTCD meaning thereby that type 1 countries (those with a centralised state at the time of Scramble for Africa) have not come much forward to globalize in comparison to type-2 and type-3 countries. This inference remains valid even if we use binary dummies for the historical types. It may be noted that the countries of types 2 and 3 such as Nigeria, South Africa, Angola, Chad, Congo, Tanzania, Zambia, Cameroon and Côte d'Ivoire have attracted sizeable foreign direct investment (Sundaram *et al.*, 2011). Larmer *et al.* (2008) bring out the case of four southern African countries (Zimbabwe, Zambia, Malawi and Swaziland) where civil societies and social movement actors came forward against the ill effects of globalization such as unaccountable decision-making, profound inequality of access to resources, and an imposed and uniform organizational form that fails to consider local conditions. Social movements in Africa have used the real or perceived socio-economic misgivings of globalization as one of the planks for their struggle (Larmer, 2010).

8. Concluding remarks

This study has used a new method for measurement of the degree of globalization (or construction of a globalization index) based on minimization of the Euclidean norm of the Shapley values, the concept borrowed from the cooperative game theory. It assigns weights to constituent variables such that their mean expected marginal contribution to the synthetic index is as equitable as possible. Since this index is based on combinatorial logic, it is also less likely to be affected by outlier data points. We construct globalization index for 43 African countries (for a time series of 45 years, 1970-2014). The new index has been compared with the KOF index of globalization for the countries under study. It has been found that the index has stronger correlation (*vis-à-vis* the KOF index) with Human Development index, Corruption Perception index, Freedom index and the indicators of abject poverty in the African countries. Such relationship validates the

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new index as it represents globalization closely in connection with other relevant socio-economic measures than its rival (KOF index of globalization) as well as it is based on more plausible theoretical premises based on marginal contribution rather than correlation.

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