

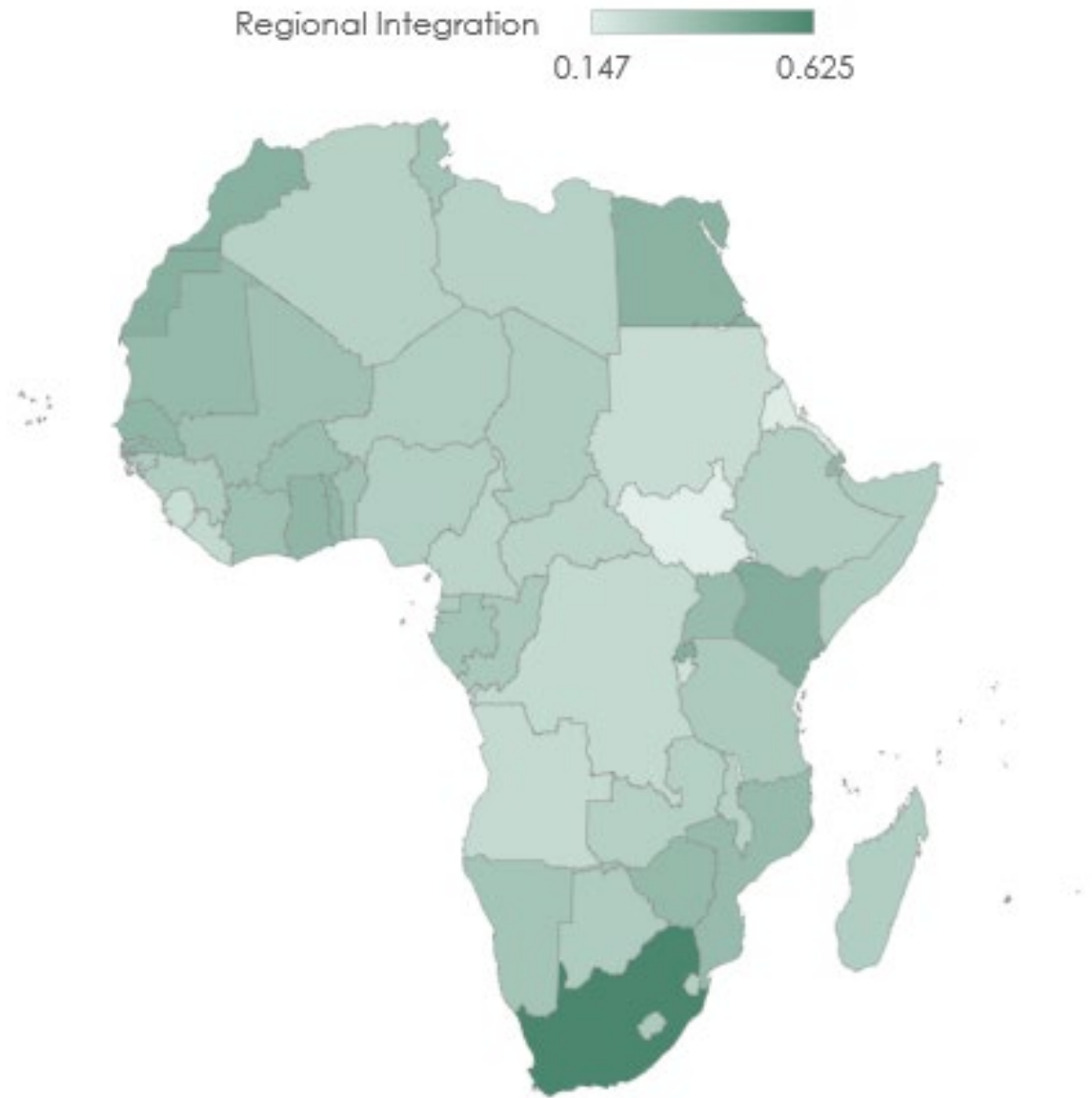


United Nations  
Economic Commission for Africa

# AFRICA REGIONAL INTEGRATION INDEX (ARII): METHODOLOGICAL NOTE

2019

## ARII 2019 – Regional integration in Africa



The more integrated a country is the darker is the shade of green.

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## 1. Introduction

Regional integration is a complex concept. It is generally conceived as englobing several aspects of economic integration from production to social cross-border linkages that contribute to enhancing economic growth. Moreover, the actual workings of regional integration are far from being homogenous, its mechanism differs from region to region. The advantages it brings along, however, in terms of increased economic activities and growth, are regionwide.

The Africa Regional Integration Index (ARII) 2019 is constructed as a composite index: it is made up of several indicators that reflect the state and efforts towards achieving greater regional integration in Africa. It draws from the economic literature on the subject and the experiences of the different collaborating partners and international institutions to define its conceptual framework. After robust sensitivity analyses and reviews by experts, the final index is composed of 16 indicators grouped into 5 dimensions<sup>1</sup>, namely, trade, productive, macroeconomic, infrastructural and free movement of people dimensions.

Although all the indicators used in ARII are relevant, their influence on regional integration may vary. As such, the use of an equal weighting system where all indicators have the same weight is deemed problematic as it can overweigh and/or underweigh some indicators thereby producing biased scores. However, it is a daunting task to assign weights in an objective manner as there exists no consensus in the literature as to which method is the best (Nardo et al., 2005). There are many ways to give weights to indicators including weights obtained through expert judgements also known as budget allocation systems. The latter method is costly and often criticised for unduly adding subjective bias to indexes. Therefore, it is highly recommended to resort to a statistical methodology<sup>2</sup> that allows the robust computation of weights while maintaining objectivity.

One such technique is principal components analysis (PCA). This methodology has been tested previously in the construction of well-known regional integration indexes and other indexes (Huh & Park, 2017; König, 2015). Its use is motivated by its capacity to derive weights based on the structure of the data and its ability to preserve the variations in the data. Thus, it does not rely on subjective judgements to assign weights. ARII 2019 makes use of PCA to determine the weights of both single indicators and the dimensions. In other words, a two-stage weighting procedure is adopted, i.e., where the single indicators inside each dimension are first assigned weights and then weights are given to the dimensions.

---

<sup>1</sup> Readers can refer to the ARII 2019 report for more details. The following section of this Note describes the indicators used in each dimension.

<sup>2</sup> Statistical methodology although objective they may sometimes provide results that go against intuition, this is largely because the quality of data is never perfect. The best weighting methodology would be a combination of expert judgements with statistical methodology.

This methodological note is organized as follows. The following section details the data sources for the variables used in ARII 2019. It also documents the treatment of missing data and any other calculations that were performed. Section 3 describes the normalization procedure and the eligibility tests that are recommended when PCA is used. The weighting procedure, that is, principal components analysis, is documented in section 4; the choice of the number of components together with the aggregation procedure is also described. Section 5 describes the sensitivity analyses that were made to control the validity of the index structure, that is the variables in the dimensions and the credibility of the ranking. Section 6 discusses the empirical results in light of the relevance of the indicators and dimensions. The significance of the weights assigned through PCA is controlled for by computing the index using an alternative methodology that uses equal weights. The following sections report the empirical results for Africa and the 8 RECs: the descriptive statistics, the overall correlation structures, the eligibility tests for the conduct of PCA, the computation of weights, a summary of the weights, a comparison of the weights assigned through PCA and equal weights.

## 2. Data sources, coverage and treatment of missing data

### Overview of dimensions and indicators used in ARII 2019

- |                                       |                                                                                                                                                                                                                                                                                   |
|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1. Trade Integration</b>           | <ul style="list-style-type: none"> <li>a. Average tariff on imports</li> <li>b. Share of intra-regional exports over GDP</li> <li>c. Share of intra-regional imports over GDP</li> <li>d. Share of intra-regional trade</li> <li>e. AfCFTA (Only at continental level)</li> </ul> |
| <b>2. Productive Integration</b>      | <ul style="list-style-type: none"> <li>a. Share of intra-regional intermediate exports</li> <li>b. Share of intra-regional intermediate imports</li> <li>c. Merchandise trade complementarity index</li> </ul>                                                                    |
| <b>3. Macroeconomic Integration</b>   | <ul style="list-style-type: none"> <li>a. Number of bilateral investment treaties</li> <li>b. Regional convertibility of currency</li> <li>c. Regional inflation differential</li> </ul>                                                                                          |
| <b>4. Infrastructural Integration</b> | <ul style="list-style-type: none"> <li>a. AfDB Composite Infrastructure index</li> <li>b. Proportion of intra-regional flight connections</li> </ul>                                                                                                                              |
| <b>5. Free Movement of People</b>     | <ul style="list-style-type: none"> <li>a. Free Movement of Persons Protocol (Kigali)</li> <li>b. Number of countries that may obtain a visa on arrival</li> <li>c. Number of countries that require a visa</li> </ul>                                                             |

## Detailed description of indicators and variables

|                           |                                                                                                                                                                                                                                                                                                                                                                              |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Dimension</b>          | <b>Trade</b>                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Indicator</b>          | <b>Level of tariff on imports (intra-regional import)</b>                                                                                                                                                                                                                                                                                                                    |
| Data sources              | Market Access Map, International Trade Centre (International Trade Centre, 2018)                                                                                                                                                                                                                                                                                             |
| Variables used            | Ad valorem equivalents of applied tariffs at minimum rates                                                                                                                                                                                                                                                                                                                   |
| Year coverage             | Latest data available. For most countries data date back to 2017, 2016 and 2015 except for Eritrea, Libya and Sierra Leone where data date back to 2006                                                                                                                                                                                                                      |
| Country coverage          | All except Somalia and South Sudan                                                                                                                                                                                                                                                                                                                                           |
| Calculation               | Bilateral tariff rate (import-weighted) that each country <i>i</i> applied to country <i>j</i> and averaged over all countries in the region                                                                                                                                                                                                                                 |
| Details                   | Applied tariffs refer to actual tariffs imposed by the importing country and this is an appropriate measure of actual trade integration. Moreover, these rates also include the preferences that a country may grant to certain trading partners                                                                                                                             |
| Treatment of missing data | <ul style="list-style-type: none"> <li>Data for Somalia is sourced from the Somalian Chamber of Commerce, Industry and Agriculture</li> <li>Data for South Sudan is obtained from the PWC tax summary <a href="https://www.pwc.co.za/en/assets/pdf/tax-summaries/south_sudan_2014.pdf">https://www.pwc.co.za/en/assets/pdf/tax-summaries/south_sudan_2014.pdf</a></li> </ul> |

|                           |                                                                                                                                                                                                                                                |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Dimension</b>          | <b>Trade</b>                                                                                                                                                                                                                                   |
| <b>Indicator</b>          | <b>Share of intra-regional goods export (%GDP)</b>                                                                                                                                                                                             |
| Data sources              | UNCTAD, (UN COMTRADE, 2018)                                                                                                                                                                                                                    |
| Variables used            | Merchandise exports and GDP                                                                                                                                                                                                                    |
| Year coverage             | Latest available and consistent data (2014, 2015, 2016)                                                                                                                                                                                        |
| Country coverage          | All except South Sudan                                                                                                                                                                                                                         |
| Calculation               | The ratio of merchandise exports of country <i>i</i> over GDP. Exports and GDP are the averages of 2014-2016 data.                                                                                                                             |
| Details                   | The average of the 3 years is used so as to minimize data discrepancies that often exist for trade data in the African context                                                                                                                 |
| Treatment of missing data | Data for South Sudan is retrieved from the UN Comtrade database. However, since there is no data on the exports of South Sudan, South Sudan's exports are imputed by adding up each of its partner's imports. To be consistent, the average of |

2014-2016 is used. Moreover, the same classification as UNCTAD, i.e., SITC Rev. 3 is used.

| Dimension                 | Trade                                                                                                                                                                                                                                                                                                                                   |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Indicator</b>          | <b>Share of intra-regional goods import (%GDP)</b>                                                                                                                                                                                                                                                                                      |
| Data sources              | UNCTAD                                                                                                                                                                                                                                                                                                                                  |
| Variables used            | Merchandise imports and GDP                                                                                                                                                                                                                                                                                                             |
| Year coverage             | Latest available and consistent data (2014, 2015, 2016)                                                                                                                                                                                                                                                                                 |
| Country coverage          | All except South Sudan                                                                                                                                                                                                                                                                                                                  |
| Calculation               | The ratio of merchandise imports of country i over GDP. Imports and GDP are the averages of 2014-2016 data.                                                                                                                                                                                                                             |
| Details                   | The average of the 3 years is used so as to minimize data discrepancies that often exist for trade data in the African context                                                                                                                                                                                                          |
| Treatment of missing data | Data for South Sudan is retrieved from the UN Comtrade database. However, since there is no data on the imports of South Sudan, South Sudan imports are imputed by adding up each of its partner's exports. To be consistent, the average of 2014-2016 is used. Moreover, the same classification as UNCTAD, i.e., SITC Rev. 3 is used. |

| Dimension                 | Trade                                                                                                                                                                                                 |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Indicator</b>          | <b>Share of intra-regional goods trade (%total regional trade)</b>                                                                                                                                    |
| Data sources              | UNCTAD                                                                                                                                                                                                |
| Variables used            | Merchandise exports and merchandise imports                                                                                                                                                           |
| Year coverage             | Latest available and consistent data (2014, 2015, 2016)                                                                                                                                               |
| Country coverage          | All except South Sudan                                                                                                                                                                                |
| Calculation               | The sum of country i merchandise exports and imports to all other countries in the region over the total regional merchandise exports and imports. Exports and imports are the averages of 2014-2016. |
| Details                   | The average of the 3 years is used so as to minimize data discrepancies that often exist for trade data in the African context                                                                        |
| Treatment of missing data | Same as previous                                                                                                                                                                                      |

| Dimension        | Trade                                    |
|------------------|------------------------------------------|
| <b>Indicator</b> | <b>AfCFTA</b>                            |
| Data sources     | African Union (African Union, 2019)      |
| Variables used   | Signature and ratification of the AfCFTA |

|                           |                                                                                                                                       |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Year coverage             | Latest available update up to July 2019 (Niamey Summit)                                                                               |
| Country coverage          | All                                                                                                                                   |
| Calculation               | Countries are assigned a score of 0 if they did not sign, a score of 1 if they signed and a score of 2 if they ratified the agreement |
| Details                   |                                                                                                                                       |
| Treatment of missing data | Not applicable                                                                                                                        |

| Dimension                 | Productive                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Indicator</b>          | <b>Share of intra-regional exports of intermediate goods</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Data sources              | UN Comtrade                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Variables used            | Intermediate goods exports                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Year coverage             | Latest available and consistent data (2014, 2015, 2016)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Country coverage          | 41 + 13 imputations (Chad, Comoros, Dem. Rep. of the Congo, Djibouti, Equatorial Guinea, Eritrea Ethiopia, Gabon, Guinea-Bissau, Liberia and Somalia)                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Calculation               | The sum of country i intermediate exports to all other countries in the region over the total regional exports. Exports are the average of 2014-2016 data.                                                                                                                                                                                                                                                                                                                                                                                                            |
| Details                   | Intermediate goods are defined as the sum of the following categories in BEC:<br><br>111* Food and beverages, primary, mainly for industry<br>121* Food and beverages, processed, mainly for industry<br>21* Industrial supplies not elsewhere specified, primary<br>22* Industrial supplies not elsewhere specified, processed<br>31* Fuels and lubricants, primary<br>322* Fuels and lubricants, processed (other than motor spirit)<br>42* Parts and accessories of capital goods (except transport equipment)<br>53* Parts and accessories of transport equipment |
| Treatment of missing data | Missing data for country i, is imputed by summing up intermediate imports for each country importing from country i for which data are available. The resulting value provide an                                                                                                                                                                                                                                                                                                                                                                                      |

underestimate of the intermediate exports of country i (as data is not available for all countries)

| Dimension                 | Productive                                                                                                                                                                                                                              |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Indicator</b>          | <b>Share of intra-regional imports of intermediate goods</b>                                                                                                                                                                            |
| Data sources              | UN Comtrade                                                                                                                                                                                                                             |
| Variables used            | Intermediate goods imports                                                                                                                                                                                                              |
| Year coverage             | Latest available and consistent data (2014, 2015, 2016)                                                                                                                                                                                 |
| Country coverage          | 41 + 13 imputations (Chad, Comoros, Dem. Rep. of the Congo, Djibouti, Equatorial Guinea, Eritrea Ethiopia, Gabon, Guinea-Bissau, Liberia and Somalia)                                                                                   |
| Calculation               | The sum of country i intermediate imports to all other countries in the region over the total regional exports. Imports are the average of 2014-2016.                                                                                   |
| Details                   | Intermediate goods are defined as above                                                                                                                                                                                                 |
| Treatment of missing data | Missing data for country i, is imputed by summing up intermediate exports for each country exporting to country i for which data are available. The resulting value provides an underestimate of the intermediate imports of country i. |

| Dimension        | Productive                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Indicator</b> | <b>Merchandise trade complementarity index Africa / RECs</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Data sources     | UNCTAD                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Variables used   | Merchandise exports and merchandise imports                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Year coverage    | Latest available and consistent data (2014, 2015, 2016)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Country coverage | All except South Sudan                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Calculation      | <p>As per Michaely (1996), TCI of a country is the sum of the absolute value of the difference between the import shares and the export shares (at 3-digit SITC, Revision 3 level) of the countries or country groups under study, divided by two:</p> $Se_jm_k = 1 - \frac{\sum_i  E_{ij} - M_{ik} }{2}$ <p> <math>Se_jm_k</math> = the index of trade complementarity of exporter j with importer k<br/> i = goods in 3 digit SITC Revision 3<br/> j = exporter<br/> k = importer<br/> <math>E_{ij}</math> = the share of goods i in country j's total exports to the region </p> |

|                           |                                                                                                                                                                                                                                       |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Details                   | $M_{ik}$ = the share of goods $i$ in country $k$ 's total imports from the region                                                                                                                                                     |
|                           | Michaely (1996) formula is adapted to the African level and at each REC level to better capture regional integration. TCI measures to what extent the export profile of each African country matches the import profile of the region |
| Treatment of missing data | South Sudan value is estimated as 1 standard deviation below the average (South Sudan performance on similar variables tends to be below the average).                                                                                |

| Dimension                 | Infrastructure                                              |
|---------------------------|-------------------------------------------------------------|
| <b>Indicator</b>          | <b>Infrastructure development index</b>                     |
| Data sources              | <b>AfDB Infrastructure development index</b> , (AfDB, 2016) |
| Variables used            | Overall Infrastructure development index                    |
| Year coverage             | 2016                                                        |
| Country coverage          | All                                                         |
| Calculation               | As is                                                       |
| Details                   |                                                             |
| Treatment of missing data | Not applicable                                              |
|                           |                                                             |

| Dimension                 | Infrastructure                                                                                                                                           |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Indicator</b>          | <b>Proportion of intra-regional flight connections</b>                                                                                                   |
| Data sources              | <b>African Airlines Association</b> (AFRAA, 2018)                                                                                                        |
| Variables used            | Flight connections from each country to the remaining countries in the region                                                                            |
| Year coverage             | 2017                                                                                                                                                     |
| Country coverage          | All                                                                                                                                                      |
| Calculation               | The total number of flight connections from country $i$ to each of the countries in the region over the total number of flight connections in the region |
| Details                   |                                                                                                                                                          |
| Treatment of missing data | Not applicable                                                                                                                                           |

| Dimension        | Macroeconomic                                    |
|------------------|--------------------------------------------------|
| <b>Indicator</b> | <b>Number of bilateral investment treaties</b>   |
| Data sources     | <b>World Bank, 2017</b>                          |
| Variables used   | Number of bilateral investment treaties in force |
| Year coverage    | Up to 2017                                       |

|                           |                                                                                                                                          |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| Country coverage          | All                                                                                                                                      |
| Calculation               | The total number of bilateral investment treaties net of those that have not been ratified and/or have been terminated within the region |
| Details                   |                                                                                                                                          |
| Treatment of missing data | Not applicable                                                                                                                           |

|                           |                                                                                                                                                                        |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Dimension</b>          | <b>Macroeconomic</b>                                                                                                                                                   |
| <b>Indicator</b>          | <b>Regional convertibility of national currencies</b>                                                                                                                  |
| Data sources              | <b>National and regional central banks</b>                                                                                                                             |
| Variables used            | Number of convertible currencies                                                                                                                                       |
| Year coverage             | Latest data up to October 2018                                                                                                                                         |
| Country coverage          | All except Eritrea                                                                                                                                                     |
| Calculation               | The number of countries in a region with which a country shares a common currency or with which its currency is convertible as reported by each country's central bank |
| Details                   |                                                                                                                                                                        |
| Treatment of missing data | Eritrea's value takes the same value as that reported in ARII 2016                                                                                                     |

|                           |                                                                                                                                                                                                                                |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Dimension</b>          | <b>Macroeconomic</b>                                                                                                                                                                                                           |
| <b>Indicator</b>          | <b>Regional inflation differential</b>                                                                                                                                                                                         |
| Data sources              | <b>World Economic Outlook, IMF</b> (International Monetary Fund, 2018)                                                                                                                                                         |
| Variables used            | Inflation differential                                                                                                                                                                                                         |
| Year coverage             | October 2017                                                                                                                                                                                                                   |
| Country coverage          | All except Somalia                                                                                                                                                                                                             |
| Calculation               | Inflation differential is the difference between country i inflation rate and that of the official target for the region. In the absence of the official target, the minimum positive value for the region is set as a target. |
| Details                   | The inflation rate of South Sudan of 380 has been winsorised <sup>3</sup> to 35 so as to reduce the variability of the data but care has been taken so that it remains the highest value.                                      |
| Treatment of missing data | Somalia's value is imputed from an external source value, <a href="https://tradingeconomics.com/somalia/inflation-cpi">https://tradingeconomics.com/somalia/inflation-cpi</a>                                                  |

|                  |                                |
|------------------|--------------------------------|
| <b>Dimension</b> | <b>Free movement of people</b> |
|------------------|--------------------------------|

<sup>3</sup> Winsorisation, named after the biostatistician Charles P. Winsor, is the transformation of statistical data so as to render extreme values less extreme so as to reduce the effect of spurious outliers

|                           |                                                                                                                                                                               |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Indicator</b>          | <b>Ratification of the Protocol on the Free Movement of Persons</b>                                                                                                           |
| Data sources              | <b>African Union</b>                                                                                                                                                          |
| Variables used            | Ratification of the Protocol on the Free Movement of Persons, Right of Residence and Right of Establishment (Article 43(2) Treaty establishing the African economic community |
| Year coverage             | Up to July 2019 (Niamey Summit as stopping point)                                                                                                                             |
| Country coverage          | All                                                                                                                                                                           |
| Calculation               | The variable takes a value of 1 if the country has ratified the protocol and 0 otherwise                                                                                      |
| Details                   |                                                                                                                                                                               |
| Treatment of missing data | Not applicable                                                                                                                                                                |
|                           |                                                                                                                                                                               |

|                           |                                                                                                                                                                                                                        |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Dimension</b>          | Free movement of people                                                                                                                                                                                                |
| <b>Indicator</b>          | <b>The number of countries which citizens may obtain a visa on arrival</b>                                                                                                                                             |
| Data sources              | <b>African Development Bank, Visa Openness Index 2018 version</b>                                                                                                                                                      |
| Variables used            | The number of countries whose citizens may obtain a visa on arrival                                                                                                                                                    |
| Year coverage             | 2018 (latest data available)                                                                                                                                                                                           |
| Country coverage          | All                                                                                                                                                                                                                    |
| Calculation               | The variable sums the number of countries whose citizens may obtain a visa on arrival to enter country i.                                                                                                              |
| Details                   | Rwanda has completely opened up its borders to EAC members but if the Visa Openness database record that the country does not grant visa on arrival. This information was corrected so as not to penalize the country. |
| Treatment of missing data | Not applicable                                                                                                                                                                                                         |
|                           |                                                                                                                                                                                                                        |

|                  |                                                                   |
|------------------|-------------------------------------------------------------------|
| <b>Dimension</b> | Free movement of people                                           |
| <b>Indicator</b> | <b>The number of countries that require a visa</b>                |
| Data sources     | <b>African Development Bank, Visa Openness Index 2018 version</b> |
| Variables used   | The number of countries whose citizens require a visa             |
| Year coverage    | 2018 (latest data available)                                      |
| Country coverage | All                                                               |

Calculation

The variable sums the number of countries whose citizens strictly require a visa to enter country i.

Details

Treatment of missing data

Not applicable

## 6. Normalisation of data and eligibility tests

### Min-Max normalisation

ARII is made up of extremely varied indicators measured in different units from the rate of inflation differential to the ratification of the AfCFTA. This renders aggregation of the single indicators into a composite index difficult and comparison between themselves and between RECs not straightforward. Additionally, a common scale is a pre-requisite before applying principal components analysis. Therefore, all the indicators are normalised so that they range between 0 and 1 where 0 denotes the lowest integration level and 1 the highest level. A simple normalisation procedure known as the min-max rescaling procedure is used.

This basic normalisation method is used to avoid influencing the data which is often the case when making use of more sophisticated techniques such as the z-scores (Nardo et al., 2005; Gu, Greensmith, Oates, & Aickelin, 2009). Each indicator  $q$  for each country is normalized as follows

$$\frac{q - q_{min}}{q_{max} - q_{min}}$$

where  $q_{max}$  and  $q_{min}$  are the maximum and minimum values of each indicator  $q$  across all countries in the region.

Note that for indicators where the lowest value reflects more integration, for example, a high tariff rate would mean less integration than a low tariff rate, the formula is adjusted as follows

$$1 - \frac{q - q_{min}}{q_{max} - q_{min}}$$

The adjusted formula has been applied to the following indicators:

1. Level of tariff on imports
2. Regional inflation differential
3. Number of countries that require a visa

### Eligibility tests

The following tests are performed for each dimension in ARII to ensure that the data are suitable to undergo PCA. They are also performed on the aggregated dimensions.

#### i. Cronbach Coefficient Alpha

Cronbach's alpha is the most common estimate of the internal consistency of indicators. It is performed to measure the extent to which indicators in each of the five dimensions of ARII are interrelated and, therefore, may measure a single unidimensional phenomenon. However, a high alpha may also be the result of separate clusters that intercorrelate highly even though the clusters themselves do not have a high correlation.

ii. **Bartlett's test of sphericity**

Since PCA is only useful when there is some degree of correlation between the variables, Bartlett's test of sphericity is used to check whether the observed correlation matrix diverges significantly from the identity matrix.

iii. **Kaiser-Meyer-Olkin (KMO)**

Sampling adequacy is ensured by checking the Kaiser-Meyer-Olkin (KMO) index where partial correlation is used to measure the relation between two variables excluding the effects of other variables. A high KMO (usually > 0.5) indicates that PCA is relevant.

## **4. Weighting and Principal Components Analysis**

The different items of a composite index do not necessarily have the same economic significance; therefore, weights are necessary to account for these differences. However, heavy weights on sub-indicators can strongly influence the final scores of countries and they should, therefore, be assigned using a sound methodology (Nardo et al., 2005). Principal components analysis is used to compute non-subjective weights to assign to each indicator and dimensions before building the aggregate index.

There are many ways to assign weights and they all have advantages and disadvantages. However, weights based on statistical models prevail as they require no a priori assumptions. The use of PCA as a weighting scheme is now established in the literature that covers the construction of social indices and, particularly, regional integration indices (Huh & Park, 2017; König, 2015). Often items of composite indicators tend to be correlated, i.e., they measure the same concept, and using an equal weighting scheme will lead to double-counting. Weights given through PCA correct for overlapping information of correlated indicators. The following briefly describes the PCA methodology (Giri, 1996; Jolliffe, 2002).

## What is PCA?

PCA is a statistical data reduction technique. Its aim is to reduce the number of observed variables to a resulting set of orthogonal components that maximise the variance in the data. The extracted components reveal the set of variables that are highly correlated, and the latter will have high factor loadings on a specific component. Mathematically, each component  $P$  is a linear combination of the original set of variables  $X_1$  to  $X_n$  and they are sorted in descending order according to the amount of variance they account for in the original set of variables

$$\begin{aligned}P_1 &= a_{11}x_1 + a_{12}x_2 + \dots + a_{1n}x_n \\P_2 &= a_{21}x_1 + a_{22}x_2 + \dots + a_{2n}x_n \\&\vdots \\P_m &= a_{m1}x_1 + a_{m2}x_2 + \dots + a_{mn}x_n\end{aligned}$$

where  $a_{mn}$  represents the weight of the  $m^{\text{th}}$  principal component for the  $n^{\text{th}}$  variable. The variance  $\lambda$  of each principal component is given by the eigenvalue of the corresponding eigenvector of the correlation matrix<sup>4</sup> where  $\lambda_1 \geq \lambda_2 \dots \geq \lambda_m$ . The first principal component  $P_1$  explains the largest possible variation in the data and the second principal component  $P_2$  explains additional but less variation than the first component and is orthogonal to the first component. Each subsequent component captures additional dimensions but explains a smaller proportion of the variation in the original variables. Since the sum of the eigenvalues equals the number of variables in the data,  $\frac{\lambda_m}{n}$  is the proportion of variance explained by the  $m^{\text{th}}$  component.

## Number of components and computation of weights

The term loadings refer to the correlation coefficients between the original variables and the principal components. Factor loadings are squared and normalised and multiplied by the proportion of explained variance of the number of components considered (Huh & Park (2017) for details). The results are aggregated to compute the weights for each indicator in each of the five dimensions.

The number of components that should be retained is quite arbitrary as it often depends on how much random variability is left. However, there are guidelines that have been documented in the literature. The most common methods used are outlined below:

---

<sup>4</sup> Principal components can either be based on the correlation or covariance matrix. ARII 2018 uses the former method. As explained in Jolliffe (2002), the use of correlation matrices to define principal components ensures that the results of analysis for different sets of random variables are more directly comparable than for analysis based on covariance matrices. Moreover, principal components that are defined using covariance matrices are sensitive to the units of measurement of the variables and, as such, variables with very large variances will dominate the first few principal components.

- **Scree plot**

The use of the scree plot is one of the simplest ways of determining the appropriate number of components that mostly accounts for the phenomenon under study. It graphs the eigenvalue against the number of components and it is recommended to keep only components that are above the sharp drop-off in the plot (Cattell, 1966).

- **Kaiser criterion**

One of the most popular methods is to drop components whose eigenvalues is less than 1 because the variance they explain is lower than in a single variable (Kaiser, 1960).

- **Variance explained**

Rather than relying on the methods above where the variance explained varies, it is common practice to set a threshold for the amount of variance explained and only keep the number of components that satisfies this criterion.

- **Jolliffe's rule**

It is simply a less strict rule compared to the Kaiser criterion and recommends dropping components with eigenvalues below 0.70.

- **Broken-stick model**

It recommends retaining components that explain more variance than would be expected by randomly dividing the variance into  $p$  parts (Peres-Neto, Jackson, & Somers, 2005).

ARII relies on a combination of the first three rules listed above. While the scree plots provide the basis for the number of significant components, it is ensured that the number of components finally retained cumulatively account for more than 70 per cent of the total variance in the data and individually contribute to more than 10 per cent of the variance in the data.

## **Aggregation scheme**

Indicators in a composite index can be aggregated using a linear or a geometric aggregation method. Linear aggregation is an additive method that involves the summation of individual indicators. It ensures full compensability, that is poor performance in some indicators can be compensated by good performance on others. Geometric aggregation is a multiplicative method and it involves partial compensability where countries with higher scores are given more importance.

Given that indicators in ARII have been normalized and are on the same scale and that indicators have already been weighted to reflect their importance, a linear aggregation method is used. The weighted scores for each indicator are summed to obtain grand scores for each dimension. PCA is then applied to the dimensions to obtain dimensional

weights. The weighted dimensions are then linearly aggregated to obtain the final regional integration index.

### **Pitfalls of PCA**

Although lauded with advantages that are convenient for the construction of indexes, such as the maintenance of objectivity and the preservation of the variations that exist in the data, PCA has to be used with caution.

1. As explained above, PCA relies on the correlation of the data. However, correlation may not be a good indicator of the real influence that some variables have on the phenomenon that is being studied.
2. Data revisions and updates completely change the results obtained through PCA as new correlations are explored.
3. PCA is still sensitive to small sample size.
4. Outliers have a major influence on PCA.
5. The importance of individual indicators that may be relevant for policy is masked when using PCA.

## 5. Sensitivity analysis pre- and post-computations

The recommended eligibility tests have been performed in the conduct of PCA as reported in the previous section. Moreover, a few controls were made post-computations. An alternative method of constructing ARII has been considered, the correlation structure re-analysed and the robustness of the dimensions to variable changes has also been checked.

### 1. Equal weights versus PCA weights

Rankings have been computed using an equal weighting scheme rather than using weights generated by PCA. This is to test whether the assignment of weights derived from PCA that uses the structure of the data is relevant. The ranks are compared, and their significance is controlled for by performing the Kendall tau rank correlation tests. The results are reported further below.

### 2. Analysis of overall correlation structure

The variables, indicators and dimensions used in ARII 2019 have been predefined as previously explained by a rigorous review of the literature on the concept of regional integration and its measurement through composite indexes. Insights have been taken from the previous version of the Africa regional integration index, the EU index of integration, the Asia-Pacific regional integration index and the KOF globalization index among others (ARII, 2016; König, 2015; Huh & Park, 2017; Gygli, Haelg, & Sturm, 2018). This information was complemented by reviews and advice from experts, partner institutions and officials from member States and RECs at various stages of this project. As such, the dimensions and variables to be included in each dimension were defined. In order to validate all the information gathered, particularly, to validate variables in their respective dimensions, their correlation structures were examined.

### 3. Robustness of the dimensions as a result of the removal of single variables

An important step in the definition of the dimensions is to assess whether they remain robust if some variables are included or removed. In essence, the changes in the statistical tests were further controlled as a result of the removal of each of the variables in the dimensions that were considered problematic due to low correlation structures.

## Results of sensitivity analysis

Before arriving at the final choice of the 16 final indicators that make up ARII, the index was composed of 18 indicators. However, the results were not satisfactory. ARII suffers from some conceptual issues in terms of both ranking and statistical results. The statistical tests of internal consistency reveal that there were structural issues in both the macroeconomic dimension and the infrastructural dimension. These issues affected the overall validity of the rankings.

The sub-sections below describe the sensitivity analyses<sup>5</sup> that have been conducted to identify the most optimal set of indicators so as to render ARII more robust while maintaining the validity of the concept of regional integration that echoes the current state of affairs.

## Macroeconomic dimension

### Step 1

**Issue:** The investment variable computed as the number of bilateral investment treaties in force has a low correlation in its dimension and it is also negatively correlated with the currency convertibility variable. As shown in Table 1, its scale reliability coefficient, 0.15, is low compared to the acceptable level of 0.5. Moreover, it fails to pass the Barlett test of sphericity.

**Action:** Removing the investment variable to check whether there are improvements in the consistency test and the ranking of the dimension.

**Result:** Table 1, second column, shows little improvement in the Cronbach alpha coefficient measuring scale reliability. Moreover, the p-value for the Bartlett test of sphericity is not significant, i.e., there appears to be no relation between the two variables considered, inflation differential and currency convertibility.

Figure 1 reports considerable changes in the rankings, particularly, the drastic decline in the positions of Egypt and Mauritius. The rank of South Africa's worsens in the macroeconomic dimension. Sierra Leone becomes the second-best integrated country on macroeconomic dimension and Libya remains at an abnormally high rank of seventh.

It appears that the not so realistic position of these countries may be driven by other factors.

Table 1 Statistical tests before and after the removal of the investment variable at the macroeconomic dimension and overall dimensions

| <i>Variables used:</i>                         | <b>Macroeconomic:<br/>Inflation<br/>Currency<br/>Investment</b> | <b>Macroeconomic:<br/>Inflation<br/>Currency</b> | <b>Dimensions</b> | <b>Dimensions<br/>revised</b> |
|------------------------------------------------|-----------------------------------------------------------------|--------------------------------------------------|-------------------|-------------------------------|
| <b>Test scale = mean(unstandardized items)</b> |                                                                 |                                                  |                   |                               |
| <b>Average interitem covariance:</b>           | 0.0021098                                                       | 0.0034478                                        | 0.0051976         | 0.0040324                     |
| <b>Number of items in the scale:</b>           | 3                                                               | 2                                                | 5                 | 5                             |
| <b>Scale reliability coefficient:</b>          | 0.1529                                                          | 0.1859                                           | 0.4885            | 0.4051                        |
| <b>Determinant of the correlation matrix</b>   | 0.968                                                           | 0.987                                            | 0.462             | 0.509                         |
| <b>Bartlett test of sphericity</b>             |                                                                 |                                                  |                   |                               |
| <b>Chi-square</b>                              | 1.643                                                           | 0.69                                             | 39.049            | 34.098                        |

<sup>5</sup> The sensitivity analyses were conducted before the final adjustment of the data for the following two variables: AfCFTA and number of countries that grant visas on arrival. Since the sensitivity analyses focus on the macroeconomic and infrastructural dimensions where the data was not affected, the results of the sensitivity analyses remain valid.

|                                                        |       |       |       |       |
|--------------------------------------------------------|-------|-------|-------|-------|
| <b>Degrees of freedom</b>                              | 3     | 1     | 10    | 10    |
| <b>p-value</b>                                         | 0.65  | 0.406 | 0     | 0     |
| <b>H0: variables are not intercorrelated</b>           |       |       |       |       |
| <b>Kaiser-Meyer-Olkin Measure of Sampling Adequacy</b> |       |       |       |       |
| <b>KMO</b>                                             | 0.452 | 0.5   | 0.505 | 0.527 |

## Step 2

**Issue:** Given that the removal of the investment variable does not improve the results, it is suspected that the problem lies in the other variables. It was identified that the inflation differential variable suffers from the presence of outlier which increases the variance in the data and consequently affects the PCA results, and possibly the overall rankings

**Action:** The inflation variable is winsorised to cater to the extreme value reported for South Sudan inflation rate. This will reduce the variance that was unduly inflated by the outlier.

**Result:** Statistical test shows some improvement. The scale reliability coefficient increases only to 0.19 which is still far from the accepted benchmark of 0.5 but better than before. The Bartlett test remains insignificant.

However, ranking seems to be more in line with reality. In particular, the positions of Libya and Sierra Leone decline in the macroeconomic dimension. The ranking of South Africa improves from 33rd to 25th.

Table 2 Statistical tests before and after the winsorisation of the inflation variable at the macroeconomic dimension and overall dimensions

|                                                        | <b>Macroeconomic:<br/>Inflation<br/>Currency<br/>Investment</b> | <b>Macroeconomic:<br/>Inflation-<br/>Winsorised<br/>Currency<br/>Investment</b> | <b>Dimensions</b> | <b>Dimensions<br/>revised</b> |
|--------------------------------------------------------|-----------------------------------------------------------------|---------------------------------------------------------------------------------|-------------------|-------------------------------|
| <b>Test scale = mean(unstandardized items)</b>         |                                                                 |                                                                                 |                   |                               |
| <b>Average interitem covariance:</b>                   | 0.0021098                                                       | 0.0036542                                                                       | 0.0051976         | 0.0051159                     |
| <b>Number of items in the scale:</b>                   | 3                                                               | 3                                                                               | 5                 | 5                             |
| <b>Scale reliability coefficient:</b>                  | 0.1529                                                          | 0.1941                                                                          | 0.4885            | 0.4759                        |
| <b>Determinant of the correlation matrix</b>           | 0.968                                                           | 0.976                                                                           | 0.462             | 0.459                         |
| <b>Bartlett test of sphericity</b>                     |                                                                 |                                                                                 |                   |                               |
| <b>Chi-square</b>                                      | 1.643                                                           | 1.245                                                                           | 39.049            | 39.369                        |
| <b>Degrees of freedom</b>                              | 3                                                               | 3                                                                               | 10                | 10                            |
| <b>p-value</b>                                         | 0.65                                                            | 0.742                                                                           | 0                 | 0                             |
| <b>H0: variables are not intercorrelated</b>           |                                                                 |                                                                                 |                   |                               |
| <b>Kaiser-Meyer-Olkin Measure of Sampling Adequacy</b> |                                                                 |                                                                                 |                   |                               |
| <b>KMO</b>                                             | 0.452                                                           | 0.498                                                                           | 0.505             | 0.489                         |

Figure 1 Comparing integration rankings with (old) and without (revised) the investment variable for the overall regional and macroeconomic rankings

| Country              | Regional integration |         |        | Macroeconomic dimension |         |        |
|----------------------|----------------------|---------|--------|-------------------------|---------|--------|
|                      | Old                  | Revised | Change | Old                     | Revised | Change |
| Algeria              | 50                   | 51      | -1     | 14                      | 34      | -20    |
| Angola               | 39                   | 44      | -5     | 42                      | 52      | -10    |
| Benin                | 28                   | 22      | 6      | 30                      | 20      | 10     |
| Botswana             | 27                   | 27      | 0      | 45                      | 41      | 4      |
| Burkina Faso         | 9                    | 9       | 0      | 10                      | 15      | -5     |
| Burundi              | 52                   | 52      | 0      | 36                      | 29      | 7      |
| Cabo Verde           | 29                   | 25      | 4      | 12                      | 8       | 4      |
| Cameroon             | 51                   | 48      | 3      | 28                      | 18      | 10     |
| Central African Rep. | 30                   | 24      | 6      | 34                      | 26      | 8      |
| Chad                 | 23                   | 17      | 6      | 32                      | 22      | 10     |
| Comoros              | 15                   | 14      | 1      | 38                      | 32      | 6      |
| Côte d'Ivoire        | 24                   | 20      | 4      | 25                      | 14      | 11     |
| D. Rep. of the Cong  | 42                   | 40      | 2      | 23                      | 11      | 12     |
| Djibouti             | 8                    | 8       | 0      | 48                      | 45      | 3      |
| Egypt                | 14                   | 39      | -25    | 2                       | 53      | -51    |
| Equatorial Guinea    | 45                   | 42      | 3      | 29                      | 19      | 10     |
| Eritrea              | 54                   | 53      | 1      | 53                      | 51      | 2      |
| Eswatini             | 31                   | 29      | 2      | 51                      | 49      | 2      |
| Ethiopia             | 47                   | 49      | -2     | 11                      | 37      | -26    |
| Gabon                | 20                   | 19      | 1      | 18                      | 23      | -5     |
| Ghana                | 3                    | 2       | 1      | 13                      | 6       | 7      |
| Guinea               | 18                   | 16      | 2      | 16                      | 12      | 4      |
| Guinea-Bissau        | 35                   | 28      | 7      | 31                      | 21      | 10     |
| Kenya                | 5                    | 5       | 0      | 40                      | 30      | 10     |
| Lesotho              | 33                   | 33      | 0      | 49                      | 46      | 3      |
| Liberia              | 36                   | 38      | -2     | 52                      | 50      | 2      |
| Libya                | 48                   | 46      | 2      | 5                       | 7       | -2     |
| Madagascar           | 34                   | 35      | -1     | 39                      | 36      | 3      |
| Malawi               | 32                   | 30      | 2      | 37                      | 31      | 6      |
| Mali                 | 10                   | 13      | -3     | 6                       | 24      | -18    |
| Mauritania           | 7                    | 7       | 0      | 8                       | 5       | 3      |
| Mauritius            | 17                   | 36      | -19    | 4                       | 40      | -36    |
| Morocco              | 21                   | 34      | -13    | 1                       | 3       | -2     |
| Mozambique           | 4                    | 6       | -2     | 20                      | 28      | -8     |
| Namibia              | 25                   | 26      | -1     | 46                      | 43      | 3      |
| Niger                | 22                   | 18      | 4      | 24                      | 13      | 11     |
| Nigeria              | 37                   | 32      | 5      | 15                      | 10      | 5      |
| Rep. of the Congo    | 16                   | 15      | 1      | 19                      | 25      | -6     |
| Rwanda               | 1                    | 1       | 0      | 3                       | 1       | 2      |
| Sao Tome & Princi    | 38                   | 31      | 7      | 21                      | 9       | 12     |
| Senegal              | 13                   | 10      | 3      | 17                      | 16      | 1      |
| Seychelles           | 41                   | 43      | -2     | 47                      | 44      | 3      |
| Sierra Leone         | 43                   | 37      | 6      | 9                       | 2       | 7      |
| Somalia              | 19                   | 23      | -4     | 41                      | 42      | -1     |
| South Africa         | 2                    | 3       | -1     | 33                      | 35      | -2     |
| South Sudan          | 53                   | 54      | -1     | 54                      | 54      | 0      |
| Sudan                | 49                   | 50      | -1     | 35                      | 47      | -12    |
| The Gambia           | 26                   | 21      | 5      | 7                       | 4       | 3      |
| Togo                 | 6                    | 4       | 2      | 27                      | 17      | 10     |
| Tunisia              | 46                   | 47      | -1     | 22                      | 33      | -11    |
| Uganda               | 11                   | 11      | 0      | 44                      | 39      | 5      |
| Utd Rep. of Tanzar   | 40                   | 41      | -1     | 26                      | 27      | -1     |
| Zambia               | 44                   | 45      | -1     | 50                      | 48      | 2      |
| Zimbabwe             | 12                   | 12      | 0      | 43                      | 38      | 5      |

Figure 2 Comparing integration rankings before (old) and after (revised) the inflation variable is winsorised for the overall regional and macroeconomic rankings

| Country             | Regional integration |         |        | Macroeconomic dimension |         |        |
|---------------------|----------------------|---------|--------|-------------------------|---------|--------|
|                     | Old                  | Revised | Change | Old                     | Revised | Change |
| Algeria             | 50                   | 48      | 2      | 14                      | 13      | 1      |
| Angola              | 39                   | 50      | -11    | 42                      | 53      | -11    |
| Benin               | 28                   | 26      | 2      | 30                      | 21      | 9      |
| Botswana            | 27                   | 25      | 2      | 45                      | 37      | 8      |
| Burkina Faso        | 9                    | 9       | 0      | 10                      | 6       | 4      |
| Burundi             | 52                   | 52      | 0      | 36                      | 31      | 5      |
| Cabo Verde          | 29                   | 28      | 1      | 12                      | 8       | 4      |
| Cameroon            | 51                   | 47      | 4      | 28                      | 19      | 9      |
| Central African Rep | 30                   | 29      | 1      | 34                      | 28      | 6      |
| Chad                | 23                   | 22      | 1      | 32                      | 23      | 9      |
| Comoros             | 15                   | 14      | 1      | 38                      | 29      | 9      |
| Côte d'Ivoire       | 24                   | 23      | 1      | 25                      | 17      | 8      |
| D. Rep. of the Cong | 42                   | 46      | -4     | 23                      | 46      | -23    |
| Djibouti            | 8                    | 8       | 0      | 48                      | 39      | 9      |
| Egypt               | 14                   | 15      | -1     | 2                       | 3       | -1     |
| Equatorial Guinea   | 45                   | 42      | 3      | 29                      | 20      | 9      |
| Eritrea             | 54                   | 54      | 0      | 53                      | 50      | 3      |
| Eswatini            | 31                   | 31      | 0      | 51                      | 48      | 3      |
| Ethiopia            | 47                   | 43      | 4      | 11                      | 10      | 1      |
| Gabon               | 20                   | 19      | 1      | 18                      | 11      | 7      |
| Ghana               | 3                    | 5       | -2     | 13                      | 40      | -27    |
| Guinea              | 18                   | 24      | -6     | 16                      | 26      | -10    |
| Guinea-Bissau       | 35                   | 32      | 3      | 31                      | 22      | 9      |
| Kenya               | 5                    | 4       | 1      | 40                      | 38      | 2      |
| Lesotho             | 33                   | 33      | 0      | 49                      | 45      | 4      |
| Liberia             | 36                   | 35      | 1      | 52                      | 49      | 3      |
| Libya               | 48                   | 51      | -3     | 5                       | 41      | -36    |
| Madagascar          | 34                   | 34      | 0      | 39                      | 34      | 5      |
| Malawi              | 32                   | 38      | -6     | 37                      | 51      | -14    |
| Mali                | 10                   | 10      | 0      | 6                       | 5       | 1      |
| Mauritania          | 7                    | 7       | 0      | 8                       | 7       | 1      |
| Mauritius           | 17                   | 16      | 1      | 4                       | 2       | 2      |
| Morocco             | 21                   | 18      | 3      | 1                       | 1       | 0      |
| Mozambique          | 4                    | 6       | -2     | 20                      | 43      | -23    |
| Namibia             | 25                   | 27      | -2     | 46                      | 44      | 2      |
| Niger               | 22                   | 21      | 1      | 24                      | 14      | 10     |
| Nigeria             | 37                   | 40      | -3     | 15                      | 35      | -20    |
| Rep. of the Congo   | 16                   | 17      | -1     | 19                      | 15      | 4      |
| Rwanda              | 1                    | 2       | -1     | 3                       | 4       | -1     |
| Sao Tome & Princi   | 38                   | 36      | 2      | 21                      | 24      | -3     |
| Senegal             | 13                   | 12      | 1      | 17                      | 9       | 8      |
| Seychelles          | 41                   | 37      | 4      | 47                      | 36      | 11     |
| Sierra Leone        | 43                   | 44      | -1     | 9                       | 30      | -21    |
| Somalia             | 19                   | 20      | -1     | 41                      | 32      | 9      |
| South Africa        | 2                    | 1       | 1      | 33                      | 25      | 8      |
| South Sudan         | 53                   | 53      | 0      | 54                      | 54      | 0      |
| Sudan               | 49                   | 49      | 0      | 35                      | 47      | -12    |
| The Gambia          | 26                   | 30      | -4     | 7                       | 12      | -5     |
| Togo                | 6                    | 3       | 3      | 27                      | 18      | 9      |
| Tunisia             | 46                   | 41      | 5      | 22                      | 16      | 6      |
| Uganda              | 11                   | 13      | -2     | 44                      | 42      | 2      |
| Utd Rep. of Tanzar  | 40                   | 39      | 1      | 26                      | 27      | -1     |
| Zambia              | 44                   | 45      | -1     | 50                      | 52      | -2     |
| Zimbabwe            | 12                   | 11      | 1      | 43                      | 33      | 10     |

### Step 3

**Issue:** Winsorisation seems to have improved to some extent the result, but it is still not at the acceptable level. The correlation structure remains low

**Action:** Nevertheless, STEP 1 can be repeated using the winsorised variable, that is, removing the investment variable to check whether there are improvements in the consistency test and the ranking of the dimension.

**Result:** At the macroeconomic dimension, the scale reliability coefficient increases to 0.20 but is still below acceptable level as shown in Table 3. The scale reliability coefficient for the dimensions consequently decreased. The Bartlett test for the macroeconomic dimension reveals once again that the variables in this dimension are not related.

As suspected, the rankings show no apparent improvements as depicted in Figure 3. The sharp decline in the positions of Morocco, South Africa and Mauritius do not match expectations.

Table 3 Statistical tests with and without the investment variable at the macroeconomic dimension and overall dimensions (winsorised data)

|                                                        | Macroeconomic:<br><i>Inflation-<br/>Winsorised<br/>Currency<br/>Investment</i> | Macroeconomic:<br><i>Inflation-Winsorised<br/>Currency</i> | Dimensions | Dimensions<br>revised |
|--------------------------------------------------------|--------------------------------------------------------------------------------|------------------------------------------------------------|------------|-----------------------|
| <i>Test scale = mean(unstandardized items)</i>         |                                                                                |                                                            |            |                       |
| <i>Average interitem covariance:</i>                   | 0.0036542                                                                      | 0.0058471                                                  | 0.0051976  | 0.0051159             |
| <i>Number of items in the scale:</i>                   | 3                                                                              | 2                                                          | 5          | 5                     |
| <i>Scale reliability coefficient:</i>                  | 0.1941                                                                         | 0.2035                                                     | 0.4885     | 0.4759                |
|                                                        |                                                                                |                                                            |            |                       |
| <i>Determinant of the correlation matrix</i>           | 0.976                                                                          | 0.987                                                      | 0.462      | 0.459                 |
|                                                        |                                                                                |                                                            |            |                       |
| <i>Bartlett test of sphericity</i>                     |                                                                                |                                                            |            |                       |
| <i>Chi-square</i>                                      | 1.245                                                                          | 0.667                                                      | 39.049     | 39.369                |
| <i>Degrees of freedom</i>                              | 3                                                                              | 1                                                          | 10         | 10                    |
| <i>p-value</i>                                         | 0.742                                                                          | 0.414                                                      | 0          | 0                     |
| <i>H0: variables are not intercorrelated</i>           |                                                                                |                                                            |            |                       |
|                                                        |                                                                                |                                                            |            |                       |
| <i>Kaiser-Meyer-Olkin Measure of Sampling Adequacy</i> |                                                                                |                                                            |            |                       |
| <i>KMO</i>                                             | 0.498                                                                          | 0.5                                                        | 0.505      | 0.489                 |

Figure 3 Comparing integration rankings with (old) and without (revised) the investment variable (winsorised inflation data) for the overall regional and macroeconomic rankings

| Regional integration |     |         |        |  | Macroeconomic dimension |     |         |        |
|----------------------|-----|---------|--------|--|-------------------------|-----|---------|--------|
| Country              | Old | Revised | Change |  | Country                 | Old | Revised | Change |
| Rwanda               | 2   | 1       | 1      |  | Morocco                 | 1   | 2       | -1     |
| Togo                 | 3   | 2       | 1      |  | Mauritius               | 2   | 27      | -25    |
| South Africa         | 1   | 3       | -2     |  | Egypt                   | 3   | 48      | -45    |
| Kenya                | 4   | 4       | 0      |  | Rwanda                  | 4   | 1       | 3      |
| Ghana                | 5   | 5       | 0      |  | Mali                    | 5   | 17      | -12    |
| Mauritania           | 7   | 6       | 1      |  | Burkina Faso            | 6   | 7       | -1     |
| Mozambique           | 6   | 7       | -1     |  | Mauritania              | 7   | 3       | 4      |
| Djibouti             | 8   | 8       | 0      |  | Cabo Verde              | 8   | 4       | 4      |
| Burkina Faso         | 9   | 9       | 0      |  | Senegal                 | 9   | 8       | 1      |
| Senegal              | 12  | 10      | 2      |  | Ethiopia                | 10  | 41      | -31    |
| Zimbabwe             | 11  | 11      | 0      |  | Gabon                   | 11  | 16      | -5     |
| Mali                 | 10  | 12      | -2     |  | The Gambia              | 12  | 11      | 1      |
| Uganda               | 13  | 13      | 0      |  | Algeria                 | 13  | 34      | -21    |
| Comoros              | 14  | 14      | 0      |  | Niger                   | 14  | 5       | 9      |
| Niger                | 21  | 15      | 6      |  | Rep. of the Congo       | 15  | 20      | -5     |
| Rep. of the Congo    | 17  | 16      | 1      |  | Tunisia                 | 16  | 26      | -10    |
| Chad                 | 22  | 17      | 5      |  | Côte d'Ivoire           | 17  | 6       | 11     |
| Gabon                | 19  | 18      | 1      |  | Togo                    | 18  | 9       | 9      |
| Côte d'Ivoire        | 23  | 19      | 4      |  | Cameroon                | 19  | 10      | 9      |
| Guinea               | 24  | 20      | 4      |  | Equatorial Guinea       | 20  | 12      | 8      |
| Benin                | 26  | 21      | 5      |  | Benin                   | 21  | 13      | 8      |
| Somalia              | 20  | 22      | -2     |  | Guinea-Bissau           | 22  | 14      | 8      |
| Cabo Verde           | 28  | 23      | 5      |  | Chad                    | 23  | 15      | 8      |
| Central African Rep  | 29  | 24      | 5      |  | Sao Tome & Princi       | 24  | 19      | 5      |
| The Gambia           | 30  | 25      | 5      |  | South Africa            | 25  | 38      | -13    |
| Botswana             | 25  | 26      | -1     |  | Guinea                  | 26  | 22      | 4      |
| Guinea-Bissau        | 32  | 27      | 5      |  | Utd Rep. of Tanzan      | 27  | 23      | 4      |
| Namibia              | 27  | 28      | -1     |  | Central African Rep     | 28  | 21      | 7      |
| Morocco              | 18  | 29      | -11    |  | Comoros                 | 29  | 24      | 5      |
| Mauritius            | 16  | 30      | -14    |  | Sierra Leone            | 30  | 18      | 12     |
| Sao Tome & Princi    | 36  | 31      | 5      |  | Burundi                 | 31  | 30      | 1      |
| Eswatini             | 31  | 32      | -1     |  | Somalia                 | 32  | 37      | -5     |
| Lesotho              | 33  | 33      | 0      |  | Zimbabwe                | 33  | 28      | 5      |
| Madagascar           | 34  | 34      | 0      |  | Madagascar              | 34  | 40      | -6     |
| Equatorial Guinea    | 42  | 35      | 7      |  | Nigeria                 | 35  | 29      | 6      |
| Liberia              | 35  | 36      | -1     |  | Seychelles              | 36  | 32      | 4      |
| Seychelles           | 37  | 37      | 0      |  | Botswana                | 37  | 33      | 4      |
| Utd Rep. of Tanzan   | 39  | 38      | 1      |  | Kenya                   | 38  | 31      | 7      |
| Egypt                | 15  | 39      | -24    |  | Djibouti                | 39  | 35      | 4      |
| Nigeria              | 40  | 40      | 0      |  | Ghana                   | 40  | 25      | 15     |
| Sierra Leone         | 44  | 41      | 3      |  | Libya                   | 41  | 45      | -4     |
| Malawi               | 38  | 42      | -4     |  | Uganda                  | 42  | 39      | 3      |
| Tunisia              | 41  | 43      | -2     |  | Mozambique              | 43  | 49      | -6     |
| D. Rep. of the Cong  | 46  | 44      | 2      |  | Namibia                 | 44  | 42      | 2      |
| Cameroon             | 47  | 45      | 2      |  | Lesotho                 | 45  | 43      | 2      |
| Zambia               | 45  | 46      | -1     |  | D. Rep. of the Cong     | 46  | 36      | 10     |
| Ethiopia             | 43  | 47      | -4     |  | Sudan                   | 47  | 51      | -4     |
| Algeria              | 48  | 48      | 0      |  | Eswatini                | 48  | 44      | 4      |
| Angola               | 50  | 49      | 1      |  | Liberia                 | 49  | 46      | 3      |
| Sudan                | 49  | 50      | -1     |  | Eritrea                 | 50  | 47      | 3      |
| Libya                | 51  | 51      | 0      |  | Malawi                  | 51  | 50      | 1      |
| Burundi              | 52  | 52      | 0      |  | Zambia                  | 52  | 52      | 0      |
| South Sudan          | 53  | 53      | 0      |  | Angola                  | 53  | 53      | 0      |
| Eritrea              | 54  | 54      | 0      |  | South Sudan             | 54  | 54      | 0      |

#### Step 4

**Issue:** The removal of the investment variable does not improve the statistical tests.

**Action:** Removing the variable regional convertibility of currency to check for its impact on the test results and on the macroeconomic dimension.

**Result:** Statistical test deteriorates. The scale reliability coefficient becomes close to zero; this indicates the poor relationship between the variable inflation and investment. The removal of the currency variable is not recommended.

Table 4 Statistical tests with and without the currency variable at the macroeconomic dimension and overall dimensions (winsorised data)

|                                                        | Macroeconomic:<br>Inflation-<br>Winsorised<br>Currency<br>Investment | Macroeconomic:<br>Inflation-<br>Winsorised<br>Investment | Dimensions | Dimensions<br>revised |
|--------------------------------------------------------|----------------------------------------------------------------------|----------------------------------------------------------|------------|-----------------------|
| <i>Test scale = mean(unstandardized items)</i>         |                                                                      |                                                          |            |                       |
| <i>Average interitem covariance:</i>                   | 0.0036542                                                            | 0.0001716                                                | 0.0051976  | 0.0058734             |
| <i>Number of items in the scale:</i>                   | 3                                                                    | 2                                                        | 5          | 5                     |
| <i>Scale reliability coefficient:</i>                  | 0.1941                                                               | 0.0069                                                   | 0.4885     | 0.5035                |
| <i>Determinant of the correlation matrix</i>           |                                                                      |                                                          |            |                       |
|                                                        | 0.976                                                                | 1                                                        | 0.462      | 0.478                 |
| <i>Bartlett test of sphericity</i>                     |                                                                      |                                                          |            |                       |
| <i>Chi-square</i>                                      | 1.245                                                                | 0.001                                                    | 39.049     | 37.329                |
| <i>Degrees of freedom</i>                              | 3                                                                    | 1                                                        | 10         | 10                    |
| <i>p-value</i>                                         | 0.742                                                                | 0.98                                                     | 0          | 0                     |
| <i>H0: variables are not intercorrelated</i>           |                                                                      |                                                          |            |                       |
| <i>Kaiser-Meyer-Olkin Measure of Sampling Adequacy</i> |                                                                      |                                                          |            |                       |
| <i>KMO</i>                                             | 0.498                                                                | 0.5                                                      | 0.505      | 0.547                 |

## Step 5

**Issue:** Given the above results, for completeness, the problem may be lying in the inflation variable.

**Action:** Removing the inflation variable to check for its impact on the test results and on the macroeconomic dimension.

**Result:** Statistical test deteriorates. Thus, the resulting ranking is not reported.

Table 5 Statistical tests with and without the inflation variable at the macroeconomic dimension and overall dimensions (winsorised data)

|                                                        | Macroeconomic:<br>Inflation-Winsorised<br>Currency<br>Investment | Macroeconomic:<br>Currency<br>Investment |
|--------------------------------------------------------|------------------------------------------------------------------|------------------------------------------|
| <i>Test scale = mean(unstandardized items)</i>         |                                                                  |                                          |
| <i>Average interitem covariance:</i>                   | 0.0036542                                                        | 0.004944                                 |
| <i>Number of items in the scale:</i>                   | 3                                                                | 2                                        |
| <i>Scale reliability coefficient:</i>                  | 0.1941                                                           | 0.1916                                   |
| <i>Determinant of the correlation matrix</i>           |                                                                  |                                          |
|                                                        | 0.976                                                            | 0.989                                    |
| <i>Bartlett test of sphericity</i>                     |                                                                  |                                          |
| <i>Chi-square</i>                                      | 1.245                                                            | 0.583                                    |
| <i>Degrees of freedom</i>                              | 3                                                                | 1                                        |
| <i>p-value</i>                                         | 0.742                                                            | 0.445                                    |
| <i>H0: variables are not intercorrelated</i>           |                                                                  |                                          |
| <i>Kaiser-Meyer-Olkin Measure of Sampling Adequacy</i> |                                                                  |                                          |
| <i>KMO</i>                                             | 0.498                                                            | 0.5                                      |

## Infrastructural dimension

### Step 1

**Issue:** The statistical tests at the infrastructural dimension show some structural issues. It has a low scale reliability coefficient pointing to the poor internal consistency of the variables in the dimension. The low KMO indicates that PCA may not be very useful in defining weights. The variable SAATM seems to be the problem at hand given its negative correlation with the variable infrastructure index.

**Action:** Removing the SAATM variable to check whether there are improvements in the consistency test and the ranking of the dimension.

Table 6 Statistical tests with and without the SAATM variable at the infrastructural dimension and overall dimensions

|                                                                                                   | Infrastructure:<br>Infrastructure<br>Connections<br>Electricity<br>SAATM | Infrastructure:<br>Infrastructure<br>Connections<br>Electricity | Dimensions | Dimensions<br>revised ** |
|---------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|-----------------------------------------------------------------|------------|--------------------------|
| <i>Test scale = mean(unstandardized items)</i>                                                    |                                                                          |                                                                 |            |                          |
| <i>Average interitem covariance:</i>                                                              | 0.00415                                                                  | 0.00385                                                         | 0.0051159  | 0.0049669                |
| <i>Number of items in the scale:</i>                                                              | 4                                                                        | 3                                                               | 5          | 5                        |
| <i>Scale reliability coefficient:</i>                                                             | 0.159                                                                    | 0.2479                                                          | 0.4759     | 0.4868                   |
| <i>Determinant of the correlation matrix</i>                                                      | 0.776                                                                    | 0.913                                                           | 0.459      | 0.354                    |
| <i>Bartlett test of sphericity</i>                                                                |                                                                          |                                                                 |            |                          |
| <i>Chi-square</i>                                                                                 | 12.921                                                                   | 4.671                                                           | 39.369     | 52.459                   |
| <i>Degrees of freedom</i>                                                                         | 6                                                                        | 3                                                               | 10         | 10                       |
| <i>p-value</i>                                                                                    | 0.044                                                                    | 0.198                                                           | 0          | 0                        |
| <i>H0: variables are not intercorrelated</i>                                                      |                                                                          |                                                                 |            |                          |
| <i>Kaiser-Meyer-Olkin Measure of Sampling Adequacy</i>                                            |                                                                          |                                                                 |            |                          |
| <i>KMO</i>                                                                                        | 0.359                                                                    | 0.482                                                           | 0.489      | 0.46                     |
| <b>** Macroeconomic dimension includes Inflation (winsorised). Investment, currency variables</b> |                                                                          |                                                                 |            |                          |

**Results:** The scale reliability coefficient increases both at the infrastructural dimension and at overall dimensions level as shown in Table 6 above. However, at the infrastructural dimension, the Bartlett test statistic loses its significance pointing to possible incongruencies in variables in the dimension.

Ranking on the infrastructural dimension appears to be in line with expectations. There is a sharp decline in the ranks of Central African Rep., Liberia, Sierra Leone and Chad by 25 positions. Contrarily the positions of Seychelles, Tunisia, Libya, Mauritius and Algeria improved considerably.

Overall regional integration ranking tends to reflect the current state of integration. The position of Namibia improves by 13 ranks upwards while that of Mali declines from 10<sup>th</sup> to 18<sup>th</sup> position.

## Step 2

**Issue:** The removal of the SAATM variable in the infrastructural dimension improves the scale reliability coefficient, however, the Barlett's test of sphericity becomes insignificant because of the low correlation in the dimension.

**Action:** Removing both the electricity and SAATM variables to check whether there are improvements in the consistency test.

**Result:** The scale reliability coefficient improves considerably on the infrastructural dimension and slightly on the overall dimension. The sphericity test becomes significant as reported in Table 7.

There are considerable reshuffling of the rankings following the removal of the two variables, particularly at the top and bottom of the list: Seychelles, Tunisia, Mauritius, Libya and Algeria gain more than 20 places upwards. Contrarily, Central African Republic, Liberia, Sierra Leone, Niger and Chad lose 24 places and more. Eswatini suffers the most dropping from 5<sup>th</sup> to 40<sup>th</sup> position; this is because it is a top importer of electricity which is not accounted for anymore. Overall, the new regional ranking is in line with expectations.

Table 7 Statistical tests with and without the SAATM variable and Electricity variable at the infrastructural dimension and overall dimensions

|                                                                                                   | Infrastructure:<br>Infrastructure<br>Connections<br>Electricity | Infrastructure:<br>Infrastructure<br>Connections | Dimensions | Dimensions<br>revised ** |
|---------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|--------------------------------------------------|------------|--------------------------|
| <i>Test scale = mean (unstandardized items)</i>                                                   |                                                                 |                                                  |            |                          |
| <i>Average interitem covariance:</i>                                                              | 0.00385                                                         | 0.01177                                          | 0.0051159  | 0.005863                 |
| <i>Number of items in the scale:</i>                                                              | 3                                                               | 2                                                | 5          | 5                        |
| <i>Scale reliability coefficient:</i>                                                             | 0.2479                                                          | 0.4199                                           | 0.4759     | 0.5115                   |
| <i>Determinant of the correlation matrix</i>                                                      | 0.913                                                           | 0.902                                            | 0.459      | 0.352                    |
| <i>Bartlett test of sphericity</i>                                                                |                                                                 |                                                  |            |                          |
| <i>Chi-square</i>                                                                                 | 4.671                                                           | 4.308                                            | 39.369     | 52.759                   |
| <i>Degrees of freedom</i>                                                                         | 3                                                               | 1                                                | 10         | 10                       |
| <i>p-value</i>                                                                                    | 0.198                                                           | 0.038                                            | 0          | 0                        |
| <i>H0: variables are not intercorrelated</i>                                                      |                                                                 |                                                  |            |                          |
| <i>Kaiser-Meyer-Olkin Measure of Sampling Adequacy</i>                                            |                                                                 |                                                  |            |                          |
| <i>KMO</i>                                                                                        | 0.482                                                           | 0.5                                              | 0.489      | 0.462                    |
| <b>** Macroeconomic dimension includes Inflation (winsorised). Investment, currency variables</b> |                                                                 |                                                  |            |                          |

Figure 4 Comparing integration rankings with (old) and without (revised) the SAATM variable for the overall regional and infrastructural rankings

| Regional integration |     |         |        | Infrastructural dimension |     |         |        |
|----------------------|-----|---------|--------|---------------------------|-----|---------|--------|
| Country              | Old | Revised | Change | Country                   | Old | Revised | Change |
| South Africa         | 1   | 1       | 0      | Namibia                   | 9   | 1       | 8      |
| Rwanda               | 2   | 2       | 0      | South Africa              | 1   | 2       | -1     |
| Togo                 | 3   | 3       | 0      | Botswana                  | 2   | 3       | -1     |
| Kenya                | 4   | 4       | 0      | Morocco                   | 21  | 4       | 17     |
| Mauritania           | 7   | 5       | 2      | Egypt                     | 3   | 5       | -2     |
| Djibouti             | 8   | 6       | 2      | Seychelles                | 27  | 6       | 21     |
| Ghana                | 5   | 7       | -2     | Tunisia                   | 28  | 7       | 21     |
| Mozambique           | 6   | 8       | -2     | Libya                     | 29  | 8       | 21     |
| Senegal              | 12  | 9       | 3      | Mauritius                 | 30  | 9       | 21     |
| Uganda               | 13  | 10      | 3      | Kenya                     | 4   | 10      | -6     |
| Mauritius            | 16  | 11      | 5      | Eswatini                  | 5   | 11      | -6     |
| Comoros              | 14  | 12      | 2      | Algeria                   | 31  | 12      | 19     |
| Morocco              | 18  | 13      | 5      | Gabon                     | 6   | 13      | -7     |
| Namibia              | 27  | 14      | 13     | Ethiopia                  | 8   | 14      | -6     |
| Somalia              | 20  | 15      | 5      | Côte d'Ivoire             | 7   | 15      | -8     |
| Burkina Faso         | 9   | 16      | -7     | Cameroon                  | 33  | 16      | 17     |
| Zimbabwe             | 11  | 17      | -6     | Cabo Verde                | 32  | 17      | 15     |
| Mali                 | 10  | 18      | -8     | Zambia                    | 34  | 18      | 16     |
| Egypt                | 15  | 19      | -4     | Togo                      | 13  | 19      | -6     |
| Cabo Verde           | 28  | 20      | 8      | Zimbabwe                  | 10  | 20      | -10    |
| The Gambia           | 30  | 21      | 9      | Senegal                   | 35  | 21      | 14     |
| Gabon                | 19  | 22      | -3     | Nigeria                   | 12  | 22      | -10    |
| Rep. of the Congo    | 17  | 23      | -6     | Ghana                     | 11  | 23      | -12    |
| Botswana             | 25  | 24      | 1      | Benin                     | 14  | 24      | -10    |
| Lesotho              | 33  | 25      | 8      | Utd Rep. of Tanzania      | 36  | 25      | 11     |
| Guinea-Bissau        | 32  | 26      | 6      | Mozambique                | 16  | 26      | -10    |
| Côte d'Ivoire        | 23  | 27      | -4     | Rwanda                    | 15  | 27      | -12    |
| Madagascar           | 34  | 28      | 6      | Mali                      | 17  | 28      | -11    |
| Niger                | 21  | 29      | -8     | Comoros                   | 38  | 29      | 9      |
| Chad                 | 22  | 30      | -8     | The Gambia                | 37  | 30      | 7      |
| Guinea               | 24  | 31      | -7     | Uganda                    | 39  | 31      | 8      |
| Seychelles           | 37  | 32      | 5      | Burkina Faso              | 18  | 32      | -14    |
| Benin                | 26  | 33      | -7     | Lesotho                   | 44  | 33      | 11     |
| Sao Tome & Principe  | 36  | 34      | 2      | Djibouti                  | 40  | 34      | 6      |
| Tunisia              | 41  | 35      | 6      | Sao Tome & Principe       | 41  | 35      | 6      |
| Malawi               | 38  | 36      | 2      | Angola                    | 42  | 36      | 6      |
| Eswatini             | 31  | 37      | -6     | Malawi                    | 43  | 37      | 6      |
| Utd Rep. of Tanzania | 39  | 38      | 1      | Equatorial Guinea         | 45  | 38      | 7      |
| Central African Rep. | 29  | 39      | -10    | Sudan                     | 46  | 39      | 7      |
| Equatorial Guinea    | 42  | 40      | 2      | Rep. of the Congo         | 19  | 40      | -21    |
| Zambia               | 45  | 41      | 4      | Madagascar                | 47  | 41      | 6      |
| Liberia              | 35  | 42      | -7     | Guinea                    | 20  | 42      | -22    |
| D. Rep. of the Congo | 46  | 43      | 3      | Mauritania                | 48  | 43      | 5      |
| Algeria              | 48  | 44      | 4      | D. Rep. of the Congo      | 49  | 44      | 5      |
| Cameroon             | 47  | 45      | 2      | Burundi                   | 50  | 45      | 5      |
| Nigeria              | 40  | 46      | -6     | Niger                     | 22  | 46      | -24    |
| Sudan                | 49  | 47      | 2      | Guinea-Bissau             | 51  | 47      | 4      |
| Ethiopia             | 43  | 48      | -5     | Central African Rep.      | 23  | 48      | -25    |
| Angola               | 50  | 49      | 1      | Liberia                   | 24  | 49      | -25    |
| Libya                | 51  | 50      | 1      | Sierra Leone              | 25  | 50      | -25    |
| Sierra Leone         | 44  | 51      | -7     | Chad                      | 26  | 51      | -25    |
| Burundi              | 52  | 52      | 0      | Somalia                   | 52  | 52      | 0      |
| South Sudan          | 53  | 53      | 0      | Eritrea                   | 53  | 53      | 0      |
| Eritrea              | 54  | 54      | 0      | South Sudan               | 54  | 54      | 0      |

Figure 5 Comparing integration rankings with (old) and without (revised) both the SAATM and Electricity variables for the overall regional and infrastructural rankings

| Regional integration |     |         |        | Infrastructural dimension |     |         |        |
|----------------------|-----|---------|--------|---------------------------|-----|---------|--------|
| Country              | Old | Revised | Change | Country                   | Old | Revised | Change |
| South Africa         | 1   | 1       | 0      | South Africa              | 1   | 1       | 0      |
| Kenya                | 4   | 2       | 2      | Egypt                     | 3   | 2       | 1      |
| Rwanda               | 2   | 3       | -1     | Seychelles                | 27  | 3       | 24     |
| Mauritius            | 16  | 4       | 12     | Morocco                   | 21  | 4       | 17     |
| Ghana                | 5   | 5       | 0      | Tunisia                   | 28  | 5       | 23     |
| Togo                 | 3   | 6       | -3     | Mauritius                 | 30  | 6       | 24     |
| Djibouti             | 8   | 7       | 1      | Libya                     | 29  | 7       | 22     |
| Morocco              | 18  | 8       | 10     | Kenya                     | 4   | 8       | -4     |
| Mauritania           | 7   | 9       | -2     | Algeria                   | 31  | 9       | 22     |
| Senegal              | 12  | 10      | 2      | Ethiopia                  | 8   | 10      | -2     |
| Mozambique           | 6   | 11      | -5     | Côte d'Ivoire             | 7   | 11      | -4     |
| Egypt                | 15  | 12      | 3      | Cabo Verde                | 32  | 12      | 20     |
| Uganda               | 13  | 13      | 0      | Zimbabwe                  | 10  | 13      | -3     |
| Comoros              | 14  | 14      | 0      | Zambia                    | 34  | 14      | 20     |
| Zimbabwe             | 11  | 15      | -4     | Nigeria                   | 12  | 15      | -3     |
| Burkina Faso         | 9   | 16      | -7     | Gabon                     | 6   | 16      | -10    |
| Cabo Verde           | 28  | 17      | 11     | Cameroon                  | 33  | 17      | 16     |
| Mali                 | 10  | 18      | -8     | Ghana                     | 11  | 18      | -7     |
| Somalia              | 20  | 19      | 1      | Botswana                  | 2   | 19      | -17    |
| Seychelles           | 37  | 20      | 17     | Senegal                   | 35  | 20      | 15     |
| Tunisia              | 41  | 21      | 20     | Namibia                   | 9   | 21      | -12    |
| Côte d'Ivoire        | 23  | 22      | 1      | Utd Rep. of Tanzania      | 36  | 22      | 14     |
| The Gambia           | 30  | 23      | 7      | Rwanda                    | 15  | 23      | -8     |
| Gabon                | 19  | 24      | -5     | Benin                     | 14  | 24      | -10    |
| Rep. of the Congo    | 17  | 25      | -8     | Comoros                   | 38  | 25      | 13     |
| Guinea-Bissau        | 32  | 26      | 6      | The Gambia                | 37  | 26      | 11     |
| Madagascar           | 34  | 27      | 7      | Uganda                    | 39  | 27      | 12     |
| Sao Tome & Principe  | 36  | 28      | 8      | Mali                      | 17  | 28      | -11    |
| Guinea               | 24  | 29      | -5     | Djibouti                  | 40  | 29      | 11     |
| Namibia              | 27  | 30      | -3     | Sao Tome & Principe       | 41  | 30      | 11     |
| Chad                 | 22  | 31      | -9     | Togo                      | 13  | 31      | -18    |
| Lesotho              | 33  | 32      | 1      | Angola                    | 42  | 32      | 10     |
| Utd Rep. of Tanzania | 39  | 33      | 6      | Malawi                    | 43  | 33      | 10     |
| Niger                | 21  | 34      | -13    | Burkina Faso              | 18  | 34      | -16    |
| Benin                | 26  | 35      | -9     | Equatorial Guinea         | 45  | 35      | 10     |
| Malawi               | 38  | 36      | 2      | Mozambique                | 16  | 36      | -20    |
| Equatorial Guinea    | 42  | 37      | 5      | Sudan                     | 46  | 37      | 9      |
| Botswana             | 25  | 38      | -13    | Rep. of the Congo         | 19  | 38      | -19    |
| Central African Rep. | 29  | 39      | -10    | Madagascar                | 47  | 39      | 8      |
| Zambia               | 45  | 40      | 5      | Eswatini                  | 5   | 40      | -35    |
| Algeria              | 48  | 41      | 7      | Guinea                    | 20  | 41      | -21    |
| Nigeria              | 40  | 42      | -2     | Mauritania                | 48  | 42      | 6      |
| Libya                | 51  | 43      | 8      | D. Rep. of the Congo      | 49  | 43      | 6      |
| Cameroon             | 47  | 44      | 3      | Burundi                   | 50  | 44      | 6      |
| Eswatini             | 31  | 45      | -14    | Guinea-Bissau             | 51  | 45      | 6      |
| Liberia              | 35  | 46      | -11    | Lesotho                   | 44  | 46      | -2     |
| D. Rep. of the Congo | 46  | 47      | -1     | Central African Rep.      | 23  | 47      | -24    |
| Ethiopia             | 43  | 48      | -5     | Liberia                   | 24  | 48      | -24    |
| Angola               | 50  | 49      | 1      | Sierra Leone              | 25  | 49      | -24    |
| Sudan                | 49  | 50      | -1     | Niger                     | 22  | 50      | -28    |
| Sierra Leone         | 44  | 51      | -7     | Chad                      | 26  | 51      | -25    |
| Burundi              | 52  | 52      | 0      | Somalia                   | 52  | 52      | 0      |
| South Sudan          | 53  | 53      | 0      | Eritrea                   | 53  | 53      | 0      |
| Eritrea              | 54  | 54      | 0      | South Sudan               | 54  | 54      | 0      |

### Step 3

**Issue:** The removal of both the electricity and SAATM variables tend to improve the scale reliability coefficient on the infrastructural dimension. It is, however, pertinent to test how the combination of other variables affects the robustness of the dimension.

**Action:** Test how the combination of the other variables affects the scale reliability coefficient and Bartlett test.

**Result:** As reported in Table 8 Statistical tests showing various combinations of variables there is no improvement in the scale reliability coefficient.

Table 8 Statistical tests showing various combinations of variables

| Variables used:                                        | Infrastructure | Infrastructure | Infrastructure | Infrastructure | Infrastructure | Infrastructure | Infrastructure | Infrastructure |
|--------------------------------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
|                                                        | Connections    | Connections    | Connections    | Connections    | Connections    | Connections    | Connections    | Connections    |
|                                                        | Electricity    | Electricity    |                | Electricity    | Electricity    | Electricity    | Electricity    | Electricity    |
|                                                        | SAATM          |                |                | SAATM          | SAATM          | SAATM          | SAATM          | SAATM          |
|                                                        | Original       | v1             | v2             | v3             | v4             | v5             | v6             | v7             |
| <b>Test scale = mean(unstandardized items)</b>         |                |                |                |                |                |                |                |                |
| Average interitem covariance:                          | 0.00415        | 0.00385        | 0.01177        | 0.00610        | 0.00974        | 0.00640        | 0.00749        | 0.17941        |
| Number of items in the scale:                          | 4              | 3              | 2              | 3              | 3              | 2              | 3              | 2              |
| Scale reliability coefficient:                         | 0.159          | 0.2479         | 0.4199         | 0.1457         | 0.2388         | 0.0876         | 0.1754         | 0.2068         |
| Determinant of the correlation matrix                  | 0.776          | 0.913          | 0.902          | 0.792          | 0.906          | 0.994          | 0.97           | 0.979          |
| Bartlett test of sphericity                            |                |                |                |                |                |                |                |                |
| Chi-square                                             | 12.921         | 4.671          | 4.308          | 11.908         | 5.043          | 0.3            | 1.58           | 1.117          |
| Degrees of freedom                                     | 6              | 3              | 1              | 3              | 3              | 1              | 3              | 1              |
| p-value                                                | 0.044          | 0.198          | 0.038          | 0.008          | 0.169          | 0.584          | 0.664          | 0.291          |
| H0: variables are not intercorrelated                  |                |                |                |                |                |                |                |                |
| <b>Kaiser-Meyer-Olkin Measure of Sampling Adequacy</b> |                |                |                |                |                |                |                |                |
| KMO                                                    | 0.359          | 0.482          | 0.5            | 0.381          | 0.463          | 0.5            | 0.47           | 0.5            |

### **Discussion of the results of the sensitivity analysis**

The various sensitivity analyses carried out show how the tests vary with the different combination of variables on the macroeconomic and infrastructural dimensions.

The macroeconomic dimension benefitted from the winsorisation of the inflation differential variable and overall ranking shows improvement. Nevertheless, the dimension suffers from very poor correlation among its variables and sensitivity analyses failed to provide a combination of variables that passes the statistical tests. This result points to the incongruency in the dimension that regroups variables that are not measuring the same concept. It would have been best to revise the variables used in this dimension or re-allocate them to other dimensions. However, because no other exhaustive variables are available at this stage, the three variables are retained but the inflation differential variable is winsorised.

The infrastructural dimension benefitted to some extent from the removal of the SAATM variable as the scale reliability coefficient improves. It benefitted even further when both the SAATM and the electricity trade variables were removed so that the Bartlett test also becomes significant. Thus, these two variables were removed. The AfDB composite index in the infrastructural dimension is itself capturing various key components of infrastructure including electricity, and transport and communication. These two variables account to some extent for the two variables previously removed, thus, ensuring comprehensiveness of the dimension.

## **6. Overview of final empirical results**

### **The relevance of indicators in their dimensions**

In general, indicators in their dimensions are correlated and statistical tests performed on the overall dimensions show acceptable results. However, there are some issues at individual dimensions levels that should be addressed in future editions of the index.

The scale reliability coefficients tend to be low for some dimensions. The macroeconomic dimension has the lowest scale reliability coefficients for many regions, for instance, for Africa and CEN-SAD (See Table 27 and Table 30). The infrastructural dimension for the ECOWAS region also suffers from a low scale reliability coefficient. These results reveal that not all the indicators in these dimensions are measuring the same underlying concept they are supposed to reflect.

The trade integration dimension also has a low scale reliability coefficient, for instance, it is only 0.45 for Africa and 0.37 for COMESA ((See Table 27 and Table 31). It is suspected that the indicator AfCFTA is acting as noise as it is only reflecting an institutional arrangement status and not measuring actual trade integration as compared to the

other indicators in the dimension. In fact, removing the AfCFTA as an indicator improves the scale reliability coefficient. Results are not reported here.

An analysis of the correlation structures as shown in the tables in section 8 reveal low correlations. In the case of Africa, as depicted in Table 18, there are very few cells on the diagonals that are highlighted green, that is, that have a high positive correlation (greater than 0.3). In the macroeconomic dimension, two cells are red-coloured pointing to the negative correlation between its variables. This evidences that the variables included in this dimension are not well-related and should not in principle be grouped together. This issue should be addressed in subsequent editions of ARII to arrive at a more robust conceptual framework.

The latter problem persists even for the RECs: all the variables on the macroeconomic dimensions are negatively correlated for CEN-SAD as shown in Table 21. ECOWAS also suffers from the same flaw, see Table 20. Low correlation is also a feature of the free movement of people dimension for SADC and the smaller communities, EAC and AMU as shown in Table 25 and Table 26 respectively.

Most dimensions at the African level pass the Bartlett's test of sphericity except for the infrastructural and macroeconomic dimension as evidenced in Table 27; the p-values on these dimensions are insignificant. On the contrary, most dimensions at the RECs level fail to pass the test. Moreover, the free movement of people dimension appears to have some specification problems as it reveals collinearity when we consider the tests performed for AMU and ECOWAS.

The KMO tests at the dimensional level are more or less around 0.5 for Africa. However, the results for the trade dimension is lowest indicating that there is poor coherence amongst its indicators. AMU and EAC also suffer from very weak KMOs for the trade dimensions.

On a positive note, generally speaking, the tests performed on the aggregated dimensions have better performances revealing that the 5 dimensions together, trade, productive, macroeconomic, infrastructure and free movement of people, are contributing to measure regional integration. This result does not hold for the small REC AMU.

### **The significance of the weights assigned through PCA**

Table 45 reports all the weights that have been assigned to indicators and dimensions using PCA. The details of the computation of the weights are reported in the section Empirical results: PCA and weightings. As is evident, PCA assigned different weights to the same indicators and dimensions for different regions. This is because the structure of the data is different for different regions.

At the African level, the macroeconomic dimension is assigned the highest weight while the free movement of people dimension has the lowest weight. The macroeconomic dimension has more variance which explains its weight. In general, the free movement of people dimension has less variability as such it has the lowest weight. The productive dimension also has a low weight; it is relatively more related to the trade dimension, thus less significant overall. Contrarily, the trade dimension has the highest weight for ECOWAS while its macroeconomic dimension has the lowest weight.

To cross-check the validity of the results, rankings of countries are computed using an equal weighting system (using the final structure of ARII with 16 indicators) rather than using weights assigned through PCA. The results are reported in Figure 6 and show no drastic change in rankings. The most obvious changes are Morocco and Egypt that lose nine positions with the equal weights ranking (due to their low performance on the free movement of people dimension) and Somalia that gains 8 positions. Statistical tests are performed on the two sets of results both at the overall regional integration level and at the level of each dimension to determine whether they are statistically different. The non-parametric statistical test Kendall tau reveals that there is no statistical difference between the PCA-weighted and equal-weighted rankings as revealed in Figure 8.

However, it should be noted that when comparison of the rankings using PCA weights and equal weights was done using the previous ARII structure with 18 indicators, the results were different, revealing considerable changes in the ranking of some countries as is evident by the longer red bars (negative change) and blue bars (positive change). For instance, Ivory Coast gains eight places with equal weight and is positioned 16th. The Gambia loses six places while Nigeria gains six.

It can be concluded that PCA weights were compensating for some of the discrepancies that exist in the data and dimensions. It is therefore especially useful when the structure of the index is not well-defined due to poor data quality. It provides results that reflect the current state of regional integration. Therefore, the use of PCA is warranted.

When the conceptual framework is better defined, as in the case of ARII 2019 after modifications have been made following sensitivity analysis, PCA results tend to be closer to those using equal weights. The use of variables that are all explaining the same underlying concept provides no room for giving more importance to one variable over another.

## Empirical results: Descriptive statistics

### Description of variables abbreviation:

| <i>Variable name</i>        | <i>Description</i>                                                                               |
|-----------------------------|--------------------------------------------------------------------------------------------------|
| <i>Tariff</i>               | Average intra-regional import tariffs                                                            |
| <i>Trade</i>                | Share of intra-regional trade (over regional trade)                                              |
| <i>Exports</i>              | Share of intra-regional exports over GDP                                                         |
| <i>Imports</i>              | Share of intra-regional imports over GDP                                                         |
| <i>ACFTA</i>                | AfCFTA                                                                                           |
| <i>Intermediates import</i> | Share of intra-regional intermediate exports                                                     |
| <i>Intermediates export</i> | Share of intra-regional intermediate imports                                                     |
| <i>TCI</i>                  | Merchandise trade complementarity index                                                          |
| <i>Inflation</i>            | Regional inflation differential                                                                  |
| <i>Investment</i>           | Number of bilateral investment treaties in force                                                 |
| <i>Currency</i>             | Regional convertibility of currency                                                              |
| <i>AfDB Infrastructure</i>  | AfDB Composite Infrastructure index                                                              |
| <i>Connections</i>          | Number of intra-regional flight connections                                                      |
| <i>Required</i>             | Number of countries that require a visa<br>Number of countries that may obtain a visa on arrival |
| <i>Arrival</i>              |                                                                                                  |
| <i>Protocol</i>             | Free movement of persons protocol (Kigali)                                                       |
| <i>Trade_d</i>              | Aggregated trade dimension                                                                       |
| <i>Productive_d</i>         | Aggregated productive dimension                                                                  |
| <i>Macro_d</i>              | Aggregated macroeconomic dimension                                                               |
| <i>Infrastruc~d</i>         | Aggregated infrastructural dimension                                                             |
| <i>Movement_d</i>           | Aggregated free movement of people dimension                                                     |

Table 9 Descriptive statistics - Africa

| Trade dimension           |                       | Obs | Mean | Std Dev. | Min  | Max  |
|---------------------------|-----------------------|-----|------|----------|------|------|
|                           | Tariff                | 54  | 0.83 | 0.20     | 0    | 1    |
|                           | Trade                 | 54  | 0.06 | 0.14     | 0    | 1    |
|                           | Exports               | 54  | 0.17 | 0.19     | 0    | 1    |
|                           | Imports               | 54  | 0.11 | 0.17     | 0    | 1    |
|                           | ACFTA                 | 54  | 0.65 | 0.35     | 0    | 1    |
|                           |                       |     |      |          |      |      |
| Productive dimension      |                       | Obs | Mean | Std Dev. | Min  | Max  |
|                           | Intermediates imports | 54  | 0.12 | 0.17     | 0    | 1    |
|                           | Intermediates exports | 54  | 0.08 | 0.17     | 0    | 1    |
|                           | TCI                   | 54  | 0.38 | 0.18     | 0    | 1    |
|                           |                       |     |      |          |      |      |
| Macroeconomic dimension   |                       | Obs | Mean | Std Dev. | Min  | Max  |
|                           | Inflation             | 54  | 0.79 | 0.23     | 0    | 1    |
|                           | Currency              | 54  | 0.26 | 0.22     | 0    | 1    |
|                           | Investment            | 54  | 0.12 | 0.21     | 0    | 1    |
|                           |                       |     |      |          |      |      |
| Infrastructural dimension |                       | Obs | Mean | Std Dev. | Min  | Max  |
|                           | AfDB Infrastructure   | 54  | 0.25 | 0.24     | 0    | 1    |
|                           | Connections           | 54  | 0.19 | 0.17     | 0    | 1    |
|                           |                       |     |      |          |      |      |
| Free movement of people   |                       | Obs | Mean | Std Dev. | Min  | Max  |
|                           | Required              | 54  | 0.49 | 0.37     | 0    | 1    |
|                           | Arrival               | 54  | 0.27 | 0.37     | 0    | 1    |
|                           | Protocol              | 54  | 0.56 | 0.50     | 0    | 1    |
|                           |                       |     |      |          |      |      |
| Aggregated Dimensions     |                       | Obs | Mean | Std Dev. | Min  | Max  |
|                           | Trade_d               | 54  | 0.38 | 0.12     | 0.11 | 0.73 |
|                           | Productive_d          | 54  | 0.20 | 0.13     | 0.05 | 1.00 |
|                           | Macro_d               | 54  | 0.40 | 0.13     | 0.02 | 0.81 |
|                           | Infrastructure_d      | 54  | 0.22 | 0.17     | 0.01 | 0.90 |
|                           | Movement_d            | 54  | 0.44 | 0.31     | 0.01 | 1.00 |

Table 10 Descriptive statistics - SADC

| Trade dimension           | Obs | Mean | Std. Dev. | Min  | Max  |
|---------------------------|-----|------|-----------|------|------|
| Tariff                    | 16  | 0.88 | 0.27      | 0    | 1    |
| Trade                     | 16  | 0.16 | 0.24      | 0    | 1    |
| Exports                   | 16  | 0.24 | 0.25      | 0    | 1    |
| Imports                   | 16  | 0.24 | 0.28      | 0    | 1    |
|                           |     |      |           |      |      |
| Productive dimension      | Obs | Mean | Std. Dev. | Min  | Max  |
| Intermediates imports     | 16  | 0.38 | 0.37      | 0    | 1    |
| Intermediates exports     | 16  | 0.15 | 0.24      | 0    | 1    |
| TCI                       | 16  | 0.25 | 0.23      | 0    | 1    |
|                           |     |      |           |      |      |
| Macroeconomic dimension   | Obs | Mean | Std. Dev. | Min  | Max  |
| Inflation                 | 16  | 0.78 | 0.30      | 0    | 1    |
| Currency                  | 16  | 0.32 | 0.31      | 0    | 1    |
| Investment                | 16  | 0.16 | 0.29      | 0    | 1    |
|                           |     |      |           |      |      |
| Infrastructural dimension | Obs | Mean | Std. Dev. | Min  | Max  |
| AfDB Infrastructure       | 16  | 0.26 | 0.31      | 0    | 1    |
| Connections               | 16  | 0.17 | 0.24      | 0    | 1    |
|                           |     |      |           |      |      |
| Free movement of people   | Obs | Mean | Std. Dev. | Min  | Max  |
| Required                  | 16  | 0.80 | 0.28      | 0    | 1    |
| Arrival                   | 16  | 0.27 | 0.37      | 0    | 1    |
| Protocol                  | 16  | 0.44 | 0.51      | 0    | 1    |
|                           |     |      |           |      |      |
| Aggregated Dimensions     | Obs | Mean | Std. Dev. | Min  | Max  |
| Trade_d                   | 16  | 0.34 | 0.18      | 0.01 | 0.59 |
| Productive_d              | 16  | 0.24 | 0.23      | 0.06 | 0.99 |
| Macro_d                   | 16  | 0.42 | 0.18      | 0.09 | 0.72 |
| Infrastructure_d          | 16  | 0.21 | 0.23      | 0.02 | 0.89 |
| Movement_d                | 16  | 0.49 | 0.23      | 0.22 | 1.00 |

Table 11 Descriptive statistics - ECOWAS

| Trade dimension           |                       | Obs | Mean  | Std. Dev. | Min  | Max  |
|---------------------------|-----------------------|-----|-------|-----------|------|------|
|                           | Tariff                | 15  | 0.921 | 0.26      | 0    | 1    |
|                           | Trade                 | 15  | 0.266 | 0.30      | 0    | 1    |
|                           | Exports               | 15  | 0.295 | 0.30      | 0    | 1    |
|                           | Imports               | 15  | 0.353 | 0.30      | 0    | 1    |
| Productive dimension      |                       | Obs | Mean  | Std. Dev. | Min  | Max  |
|                           | Intermediates imports | 15  | 0.14  | 0.25      | 0    | 1    |
|                           | Intermediates exports | 15  | 0.14  | 0.25      | 0    | 1    |
|                           | TCI                   | 15  | 0.41  | 0.31      | 0    | 1    |
| Macroeconomic dimension   |                       | Obs | Mean  | Std. Dev. | Min  | Max  |
|                           | Inflation             | 15  | 0.552 | 0.21      | 0    | 1    |
|                           | Currency              | 15  | 0.133 | 0.35      | 0    | 1    |
|                           | Investment            | 15  | 0.831 | 0.31      | 0    | 1    |
| Infrastructural dimension |                       | Obs | Mean  | Std. Dev. | Min  | Max  |
|                           | AfDB Infrastructure   | 15  | 0.305 | 0.24      | 0    | 1    |
|                           | Connections           | 15  | 0.292 | 0.26      | 0    | 1    |
| Free movement of people   |                       | Obs | Mean  | Std. Dev. | Min  | Max  |
|                           | Required              | 15  | 1.000 | 0.00      | 1    | 1    |
|                           | Arrival               | 15  | 1.000 | 0.00      | 1    | 1    |
|                           | Protocol              | 15  | 0.200 | 0.41      | 0    | 1    |
| Aggregated Dimensions     |                       | Obs | Mean  | Std. Dev. | Min  | Max  |
|                           | Trade_d               | 15  | 0.438 | 0.16      | 0.20 | 0.77 |
|                           | Productive_d          | 15  | 0.220 | 0.20      | 0.00 | 0.72 |
|                           | Macro_d               | 15  | 0.469 | 0.18      | 0.25 | 0.86 |
|                           | Infrastructure_d      | 15  | 0.298 | 0.17      | 0.07 | 0.66 |
|                           | Movement_d            | 15  | 0.733 | 0.14      | 0.67 | 1.00 |

Table 12 Descriptive statistics – CEN-SAD

| Trade dimension           | Obs | Mean | Std. Dev. | Min  | Max  |
|---------------------------|-----|------|-----------|------|------|
| Tariff                    | 29  | 0.78 | 0.27      | 0    | 1    |
| Trade                     | 29  | 0.21 | 0.26      | 0    | 1    |
| Exports                   | 29  | 0.19 | 0.26      | 0    | 1    |
| Imports                   | 29  | 0.24 | 0.27      | 0    | 1    |
|                           |     |      |           |      |      |
| Productive dimension      | Obs | Mean | Std. Dev. | Min  | Max  |
| Intermediates imports     | 29  | 0.12 | 0.19      | 0    | 1    |
| Intermediates exports     | 29  | 0.11 | 0.20      | 0    | 1    |
| TCI                       | 29  | 0.46 | 0.26      | 0    | 1    |
|                           |     |      |           |      |      |
| Macroeconomic dimension   | Obs | Mean | Std. Dev. | Min  | Max  |
| Inflation                 | 29  | 0.47 | 0.32      | 0    | 1    |
| Currency                  | 29  | 0.13 | 0.24      | 0    | 1    |
| Investment                | 29  | 0.78 | 0.24      | 0    | 1    |
|                           |     |      |           |      |      |
| Infrastructural dimension | Obs | Mean | Std. Dev. | Min  | Max  |
| AfDB Infrastructure       | 29  | 0.27 | 0.26      | 0    | 1    |
| Connections               | 29  | 0.34 | 0.25      | 0    | 1    |
|                           |     |      |           |      |      |
| Free movement of people   | Obs | Mean | Std. Dev. | Min  | Max  |
| Required                  | 29  | 0.61 | 0.36      | 0    | 1    |
| Arrival                   | 29  | 0.28 | 0.38      | 0    | 1    |
| Protocol                  | 29  | 0.62 | 0.49      | 0    | 1    |
|                           |     |      |           |      |      |
| Aggregated Dimensions     | Obs | Mean | Std. Dev. | Min  | Max  |
| Trade_d                   | 29  | 0.38 | 0.16      | 0.03 | 0.78 |
| Productive_d              | 29  | 0.26 | 0.15      | 0.03 | 0.62 |
| Macro_d                   | 29  | 0.44 | 0.15      | 0.19 | 0.94 |
| Infrastructure_d          | 29  | 0.30 | 0.21      | 0.06 | 0.80 |
| Movement_d                | 29  | 0.51 | 0.31      | 0.00 | 1.00 |

Table 13 Descriptive statistics - COMESA

| Trade dimension           | Obs | Mean  | Std Dev. | Min  | Max  |
|---------------------------|-----|-------|----------|------|------|
| Tariff                    | 21  | 0.856 | 0.287    | 0    | 1    |
| Trade                     | 21  | 0.301 | 0.295    | 0    | 1    |
| Exports                   | 21  | 0.322 | 0.263    | 0    | 1    |
| Imports                   | 21  | 0.289 | 0.284    | 0    | 1    |
|                           |     |       |          |      |      |
| Productive dimension      | Obs | Mean  | Std Dev. | Min  | Max  |
| Intermediates imports     | 21  | 0.202 | 0.238    | 0    | 1    |
| Intermediates exports     | 21  | 0.246 | 0.299    | 0    | 1    |
| TCI                       | 21  | 0.507 | 0.292    | 0    | 1    |
|                           |     |       |          |      |      |
| Macroeconomic dimension   | Obs | Mean  | Std Dev. | Min  | Max  |
| Inflation                 | 21  | 0.117 | 0.217    | 0    | 1    |
| Currency                  | 21  | 0.155 | 0.240    | 0    | 1    |
| Investment                | 21  | 0.778 | 0.294    | 0    | 1    |
|                           |     |       |          |      |      |
| Infrastructural dimension | Obs | Mean  | Std Dev. | Min  | Max  |
| AfDB Infrastructure       | 21  | 0.311 | 0.316    | 0    | 1    |
| Connections               | 21  | 0.322 | 0.250    | 0    | 1    |
|                           |     |       |          |      |      |
| Free movement of people   | Obs | Mean  | Std Dev. | Min  | Max  |
| Required                  | 21  | 0.319 | 0.382    | 0    | 1    |
| Arrival                   | 21  | 0.549 | 0.414    | 0    | 1    |
| Protocol                  | 21  | 0.286 | 0.463    | 0    | 1    |
|                           |     |       |          |      |      |
| Aggregated Dimensions     | Obs | Mean  | Std Dev. | Min  | Max  |
| Trade_d                   | 21  | 0.445 | 0.166    | 0.15 | 0.95 |
| Productive_d              | 21  | 0.328 | 0.212    | 0.07 | 0.83 |
| Macro_d                   | 21  | 0.365 | 0.148    | 0.12 | 0.67 |
| Infrastructure_d          | 21  | 0.317 | 0.180    | 0.07 | 0.66 |
| Movement_d                | 21  | 0.385 | 0.361    | 0.00 | 1.00 |

Table 14 Descriptive statistics - ECCAS

| Trade dimension           | Obs | Mean | Std. Dev. | Min  | Max  |
|---------------------------|-----|------|-----------|------|------|
| Tariff                    | 11  | 0.55 | 0.39      | 0    | 1    |
| Trade                     | 11  | 0.28 | 0.31      | 0    | 1    |
| Exports                   | 11  | 0.27 | 0.32      | 0    | 1    |
| Imports                   | 11  | 0.22 | 0.33      | 0    | 1    |
|                           |     |      |           |      |      |
| Productive dimension      | Obs | Mean | Std. Dev. | Min  | Max  |
| Intermediates imports     | 11  | 0.19 | 0.30      | 0    | 1    |
| Intermediates exports     | 11  | 0.36 | 0.37      | 0    | 1    |
| TCI                       | 11  | 0.41 | 0.30      | 0    | 1    |
|                           |     |      |           |      |      |
| Macroeconomic dimension   | Obs | Mean | Std. Dev. | Min  | Max  |
| Inflation                 | 11  | 0.75 | 0.29      | 0    | 1    |
| Currency                  | 11  | 0.00 | 0.00      | 0.00 | 0.00 |
| Investment                | 11  | 0.58 | 0.28      | 0    | 1    |
|                           |     |      |           |      |      |
| Infrastructural dimension | Obs | Mean | Std. Dev. | Min  | Max  |
| AfDB Infrastructure       | 11  | 0.48 | 0.32      | 0    | 1    |
| Connections               | 11  | 0.27 | 0.32      | 0    | 1    |
|                           |     |      |           |      |      |
| Free movement of people   | Obs | Mean | Std. Dev. | Min  | Max  |
| Required                  | 11  | 0.42 | 0.31      | 0    | 1    |
| Arrival                   | 11  | 0.09 | 0.30      | 0    | 1    |
| Protocol                  | 11  | 0.82 | 0.40      | 0    | 1    |
|                           |     |      |           |      |      |
| Aggregated Dimensions     | Obs | Mean | Std. Dev. | Min  | Max  |
| Trade_d                   | 11  | 0.36 | 0.22      | 0.08 | 0.89 |
| Productive_d              | 11  | 0.32 | 0.22      | 0.08 | 0.87 |
| Macro_d                   | 11  | 0.68 | 0.25      | 0.00 | 0.92 |
| Infrastructure_d          | 11  | 0.37 | 0.26      | 0.00 | 0.83 |
| Movement_d                | 11  | 0.47 | 0.25      | 0.06 | 1.00 |

Table 15 Descriptive statistics - IGAD

| Trade dimension           |                       | Obs | Mean | Std. Dev. | Min  | Max  |
|---------------------------|-----------------------|-----|------|-----------|------|------|
|                           | Tariff                | 8   | 0.78 | 0.34      | 0    | 1    |
|                           | Trade                 | 8   | 0.37 | 0.41      | 0    | 1    |
|                           | Exports               | 8   | 0.36 | 0.41      | 0    | 1    |
|                           | Imports               | 8   | 0.24 | 0.33      | 0    | 1    |
| Productive dimension      |                       | Obs | Mean | Std. Dev. | Min  | Max  |
|                           | Intermediates imports | 8   | 0.27 | 0.33      | 0    | 1    |
|                           | Intermediates exports | 8   | 0.25 | 0.44      | 0    | 1    |
|                           | TCI                   | 8   | 0.47 | 0.36      | 0    | 1    |
| Macroeconomic dimension   |                       | Obs | Mean | Std. Dev. | Min  | Max  |
|                           | Inflation             | 8   | 0.33 | 0.36      | 0    | 1    |
|                           | Currency              | 8   | 0.25 | 0.46      | 0    | 1    |
|                           | Investment            | 8   | 0.73 | 0.32      | 0    | 1    |
| Infrastructural dimension |                       | Obs | Mean | Std. Dev. | Min  | Max  |
|                           | AfDB Infrastructure   | 8   | 0.48 | 0.41      | 0    | 1    |
|                           | Connections           | 8   | 0.48 | 0.34      | 0    | 1    |
| Free movement of people   |                       | Obs | Mean | Std. Dev. | Min  | Max  |
|                           | Required              | 8   | 0.50 | 0.42      | 0    | 1    |
|                           | Arrival               | 8   | 0.45 | 0.39      | 0    | 1    |
|                           | Protocol              | 8   | 0.75 | 0.46      | 0    | 1    |
| Aggregated Dimensions     |                       | Obs | Mean | Std. Dev. | Min  | Max  |
|                           | Trade_d               | 8   | 0.44 | 0.17      | 0.23 | 0.74 |
|                           | Productive_d          | 8   | 0.32 | 0.34      | 0.04 | 0.91 |
|                           | Macro_d               | 8   | 0.42 | 0.19      | 0.25 | 0.85 |
|                           | Infrastructure_d      | 8   | 0.48 | 0.31      | 0.04 | 1.00 |
|                           | Movement_d            | 8   | 0.54 | 0.37      | 0.06 | 1.00 |

Table 16 Descriptive statistics - EAC

| Trade dimension            | Obs | Mean  | Std. Dev. | Min   | Max   |
|----------------------------|-----|-------|-----------|-------|-------|
| Tariff                     | 6   | 1.000 | 0.000     | 1     | 1     |
| Trade                      | 6   | 0.473 | 0.432     | 0     | 1     |
| Exports                    | 6   | 0.393 | 0.363     | 0     | 1     |
| Imports                    | 6   | 0.448 | 0.415     | 0     | 1     |
|                            |     |       |           |       |       |
| Productive dimension       | Obs | Mean  | Std. Dev. | Min   | Max   |
| Intermediates imports      | 6   | 0.482 | 0.361     | 0     | 1     |
| Intermediates exports      | 6   | 0.458 | 0.449     | 0     | 1     |
| TCI                        | 6   | 0.360 | 0.434     | 0     | 1     |
|                            |     |       |           |       |       |
| Macroeconomic dimension    | Obs | Mean  | Std. Dev. | Min   | Max   |
| Inflation                  | 6   | 0.500 | 0.408     | 0     | 1     |
| Currency                   | 6   | 0.820 | 0.402     | 0     | 1     |
| Investment                 | 6   | 0.000 | 0.000     | 0     | 0     |
|                            |     |       |           |       |       |
| Infrastructural dimension  | Obs | Mean  | Std. Dev. | Min   | Max   |
| AfDB                       | 6   | 0.572 | 0.361     | 0     | 1     |
| Infrastructure Connections | 6   | 0.537 | 0.372     | 0     | 1     |
|                            |     |       |           |       |       |
| Free movement of people    | Obs | Mean  | Std. Dev. | Min   | Max   |
| Required                   | 6   | 0.833 | 0.408     | 0     | 1     |
| Arrival                    | 6   | 0.500 | 0.474     | 0     | 1     |
| Protocol                   | 6   | 0.667 | 0.516     | 0     | 1     |
|                            |     |       |           |       |       |
| Aggregated Dimensions      | Obs | Mean  | Std. Dev. | Min   | Max   |
| Trade_d                    | 6   | 0.440 | 0.270     | 0.117 | 0.829 |
| Productive_d               | 6   | 0.434 | 0.374     | 0.003 | 0.910 |
| Macro_d                    | 6   | 0.660 | 0.362     | 0.000 | 0.991 |
| Infrastructure_d           | 6   | 0.555 | 0.339     | 0.000 | 1.000 |
| Movement_d                 | 6   | 0.664 | 0.191     | 0.410 | 1.000 |

Table 17 Descriptive statistics - AMU

| Trade dimension           |                       | Obs      | Mean  | Std.<br>Dev. | Min   | Max   |
|---------------------------|-----------------------|----------|-------|--------------|-------|-------|
|                           | Tariff                | 5        | 0.579 | 0.427        | 0     | 1     |
|                           | Trade                 | 5        | 0.557 | 0.448        | 0     | 1     |
|                           | Exports               | 5        | 0.306 | 0.408        | 0     | 1     |
|                           | Imports               | 5        | 0.488 | 0.428        | 0     | 1     |
| Productive dimension      |                       | Obs      | Mean  | Std.<br>Dev. | Min   | Max   |
|                           | Intermediates imports | 5        | 0.445 | 0.418        | 0     | 1     |
|                           | Intermediates exports | 5        | 0.407 | 0.386        | 0     | 1     |
|                           | TCI                   | 5        | 0.496 | 0.428        | 0     | 1     |
|                           |                       |          |       |              |       |       |
| Macroeconomic dimension   |                       | Obs      | Mean  | Std.<br>Dev. | Min   | Max   |
|                           | Inflation             | 5        | 0.743 | 0.423        | 0     | 1     |
|                           | Currency              | 5        | 0.400 | 0.365        | 0     | 1     |
|                           | Investment            | Constant |       |              |       |       |
|                           |                       |          |       |              |       |       |
| Infrastructural dimension |                       | Obs      | Mean  | Std.<br>Dev. | Min   | Max   |
|                           | AfDB Infrastructure   | 5        | 0.633 | 0.382        | 0     | 1     |
|                           | Connections           | 5        | 0.384 | 0.392        | 0     | 1     |
|                           |                       |          |       |              |       |       |
| Free movement of people   |                       | Obs      | Mean  | Std.<br>Dev. | Min   | Max   |
|                           | Required              | 5        | 0.333 | 0.471        | 0     | 1     |
|                           | Arrival               | 5        | 0.200 | 0.447        | 0     | 1     |
|                           | Protocol              | 5        | 0.200 | 0.447        | 0     | 1     |
|                           |                       |          |       |              |       |       |
| Aggregated Dimensions     |                       | Obs      | Mean  | Std.<br>Dev. | Min   | Max   |
|                           | Trade_d               | 5        | 0.481 | 0.198        | 0.253 | 0.790 |
|                           | Productive_d          | 5        | 0.449 | 0.330        | 0.000 | 0.796 |
|                           | Macro_d               | 5        | 0.571 | 0.310        | 0.167 | 0.998 |
|                           | Infrastructure_d      | 5        | 0.509 | 0.325        | 0.000 | 0.906 |
|                           | Movement_d            | 5        | 0.222 | 0.349        | 0.000 | 0.833 |

## Empirical results: Correlation structures

Green High correlation >.3 Red Negative correlation <.3

Table 18 Pearson Correlation Coefficients-Africa

|    |                      | Free Movement |       |       | Productive |       |       | Trade |       |       |       |       | Macroeconomic |      |      | Infrastructure |      |
|----|----------------------|---------------|-------|-------|------------|-------|-------|-------|-------|-------|-------|-------|---------------|------|------|----------------|------|
|    |                      | 1             | 2     | 3     | 4          | 5     | 6     | 7     | 8     | 9     | 10    | 11    | 12            | 13   | 14   | 15             | 16   |
| 1  | Required             | 1.00          |       |       |            |       |       |       |       |       |       |       |               |      |      |                |      |
| 2  | Arrival              | 0.90          | 1.00  |       |            |       |       |       |       |       |       |       |               |      |      |                |      |
| 3  | Protocol             | 0.13          | 0.09  | 1.00  |            |       |       |       |       |       |       |       |               |      |      |                |      |
| 4  | Intermediates import | -0.14         | -0.22 | -0.32 | 1.00       |       |       |       |       |       |       |       |               |      |      |                |      |
| 5  | Intermediates export | -0.15         | -0.22 | -0.27 | 0.75       | 1.00  |       |       |       |       |       |       |               |      |      |                |      |
| 6  | TCI                  | 0.08          | 0.07  | -0.02 | 0.22       | 0.28  | 1.00  |       |       |       |       |       |               |      |      |                |      |
| 7  | Trade                | -0.09         | -0.15 | -0.25 | 0.79       | 0.93  | 0.43  | 1.00  |       |       |       |       |               |      |      |                |      |
| 8  | Tariff               | -0.05         | -0.10 | -0.04 | 0.15       | 0.12  | -0.19 | 0.14  | 1.00  |       |       |       |               |      |      |                |      |
| 9  | Exports              | 0.06          | -0.11 | -0.18 | 0.41       | 0.16  | -0.23 | 0.15  | 0.11  | 1.00  |       |       |               |      |      |                |      |
| 10 | Imports              | -0.08         | -0.15 | 0.01  | 0.25       | -0.03 | -0.42 | -0.06 | 0.18  | 0.66  | 1.00  |       |               |      |      |                |      |
| 11 | ACFTA                | 0.04          | -0.10 | 0.35  | 0.03       | 0.06  | 0.01  | 0.15  | 0.14  | 0.19  | 0.01  | 1.00  |               |      |      |                |      |
| 12 | Currency             | 0.09          | -0.02 | 0.17  | -0.22      | -0.08 | -0.06 | -0.10 | -0.04 | -0.23 | -0.25 | 0.30  | 1.00          |      |      |                |      |
| 13 | Inflation            | 0.30          | 0.19  | -0.09 | -0.06      | -0.11 | 0.02  | -0.03 | -0.08 | 0.10  | 0.01  | 0.31  | 0.11          | 1.00 |      |                |      |
| 14 | Investment           | -0.18         | -0.15 | -0.31 | 0.09       | 0.14  | 0.14  | 0.16  | -0.03 | -0.15 | -0.22 | -0.06 | -0.11         | 0.00 | 1.00 |                |      |
| 15 | Infrastructure       | -0.02         | -0.03 | -0.47 | 0.29       | 0.31  | 0.28  | 0.35  | 0.09  | 0.09  | -0.11 | -0.08 | -0.13         | 0.07 | 0.58 | 1.00           |      |
| 16 | Connections          | -0.04         | -0.10 | -0.27 | 0.69       | 0.68  | 0.38  | 0.76  | 0.04  | 0.08  | -0.21 | 0.21  | -0.04         | 0.08 | 0.32 | 0.28           | 1.00 |

Table 19 Pearson Correlation Coefficients - SADC

|    |                      | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12    | 13    | 14    | 15    |
|----|----------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------|-------|-------|-------|
|    |                      |        |        |        |        |        |        |        |        |        |        |        |       |       |       |       |
| 1  | Required             | 1.000  |        |        |        |        |        |        |        |        |        |        |       |       |       |       |
| 2  | Arrival              | 0.446  | 1.000  |        |        |        |        |        |        |        |        |        |       |       |       |       |
| 3  | Protocol             | -0.358 | -0.057 | 1.000  |        |        |        |        |        |        |        |        |       |       |       |       |
| 4  | Intermediates import | -0.053 | -0.463 | -0.247 | 1.000  |        |        |        |        |        |        |        |       |       |       |       |
| 5  | Intermediates export | -0.141 | -0.372 | -0.186 | 0.620  | 1.000  |        |        |        |        |        |        |       |       |       |       |
| 6  | TCI                  | 0.040  | -0.103 | -0.218 | 0.310  | 0.803  | 1.000  |        |        |        |        |        |       |       |       |       |
| 7  | Trade                | -0.091 | -0.384 | -0.289 | 0.721  | 0.972  | 0.778  | 1.000  |        |        |        |        |       |       |       |       |
| 8  | Tariff               | 0.224  | -0.402 | -0.462 | 0.302  | 0.179  | 0.090  | 0.234  | 1.000  |        |        |        |       |       |       |       |
| 9  | Exports              | -0.006 | -0.485 | -0.245 | 0.266  | 0.060  | -0.228 | 0.135  | 0.387  | 1.000  |        |        |       |       |       |       |
| 10 | Imports              | -0.045 | -0.412 | 0.053  | 0.265  | -0.167 | -0.406 | -0.031 | 0.323  | 0.610  | 1.000  |        |       |       |       |       |
| 11 | Currency             | 0.293  | 0.164  | 0.314  | -0.063 | 0.056  | 0.222  | 0.007  | -0.226 | -0.388 | -0.368 | 1.000  |       |       |       |       |
| 12 | Inflation            | 0.490  | 0.223  | -0.511 | -0.001 | 0.071  | -0.127 | 0.116  | 0.063  | 0.212  | 0.195  | -0.226 | 1.000 |       |       |       |
| 13 | Investment           | 0.303  | -0.017 | -0.269 | -0.038 | 0.207  | 0.370  | 0.199  | 0.227  | -0.236 | -0.336 | 0.254  | 0.192 | 1.000 |       |       |
| 14 | Infrastructure       | 0.255  | 0.094  | -0.484 | 0.053  | 0.347  | 0.430  | 0.360  | 0.258  | -0.066 | -0.204 | -0.323 | 0.384 | 0.405 | 1.000 |       |
| 15 | Connections          | 0.063  | -0.266 | -0.209 | 0.626  | 0.961  | 0.845  | 0.952  | 0.215  | -0.029 | -0.212 | 0.151  | 0.073 | 0.332 | 0.386 | 1.000 |

Table 20 Pearson Correlation Coefficients - ECOWAS

|                        | 1 | 2 | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14     | 15    |
|------------------------|---|---|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------|
| 1 Required             | . |   |        |        |        |        |        |        |        |        |        |        |        |        |       |
| 2 Arrival              | . | . |        |        |        |        |        |        |        |        |        |        |        |        |       |
| 3 Protocol             | . | . | 1.000  |        |        |        |        |        |        |        |        |        |        |        |       |
| 4 Intermediates import | . | . | 0.031  | 1.000  |        |        |        |        |        |        |        |        |        |        |       |
| 5 Intermediates export | . | . | -0.157 | 0.161  | 1.000  |        |        |        |        |        |        |        |        |        |       |
| 6 TCI                  | . | . | 0.020  | 0.594  | 0.229  | 1.000  |        |        |        |        |        |        |        |        |       |
| 7 Trade                | . | . | -0.022 | 0.746  | 0.720  | 0.499  | 1.000  |        |        |        |        |        |        |        |       |
| 8 Tariff               | . | . | 0.159  | 0.168  | 0.128  | 0.215  | 0.194  | 1.000  |        |        |        |        |        |        |       |
| 9 Exports              | . | . | 0.243  | 0.399  | -0.081 | 0.413  | 0.186  | 0.278  | 1.000  |        |        |        |        |        |       |
| 10 Imports             | . | . | 0.377  | 0.156  | -0.306 | -0.286 | 0.015  | -0.537 | -0.053 | 1.000  |        |        |        |        |       |
| 11 Currency            | . | . | -0.127 | -0.092 | 0.081  | -0.453 | 0.065  | -0.494 | -0.036 | 0.481  | 1.000  |        |        |        |       |
| 12 Inflation           | . | . | 0.136  | 0.120  | -0.612 | 0.018  | -0.460 | 0.016  | 0.351  | 0.125  | -0.356 | 1.000  |        |        |       |
| 13 Investment          | . | . | 0.294  | -0.062 | -0.088 | -0.091 | -0.119 | 0.125  | -0.131 | 0.070  | -0.032 | 0.208  | 1.000  |        |       |
| 14 Infrastructure      | . | . | -0.208 | 0.016  | 0.078  | 0.099  | 0.023  | 0.219  | -0.129 | -0.376 | 0.162  | -0.251 | -0.132 | 1.000  |       |
| 15 Connections         | . | . | 0.119  | 0.882  | 0.366  | 0.606  | 0.849  | 0.203  | 0.537  | 0.104  | 0.029  | -0.142 | -0.044 | -0.049 | 1.000 |

Table 21 Pearson Correlation Coefficients – CEN-SAD

|                        | 1      | 2      | 3      | 4     | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13    | 14    | 15    |
|------------------------|--------|--------|--------|-------|--------|--------|--------|--------|--------|--------|--------|--------|-------|-------|-------|
| 1 Required             | 1.000  |        |        |       |        |        |        |        |        |        |        |        |       |       |       |
| 2 Arrival              | 0.725  | 1.000  |        |       |        |        |        |        |        |        |        |        |       |       |       |
| 3 Protocol             | 0.246  | 0.173  | 1.000  |       |        |        |        |        |        |        |        |        |       |       |       |
| 4 Intermediates import | -0.031 | -0.228 | -0.263 | 1.000 |        |        |        |        |        |        |        |        |       |       |       |
| 5 Intermediates export | -0.116 | -0.258 | -0.401 | 0.356 | 1.000  |        |        |        |        |        |        |        |       |       |       |
| 6 TCI                  | -0.163 | -0.112 | 0.062  | 0.018 | 0.129  | 1.000  |        |        |        |        |        |        |       |       |       |
| 7 Trade                | -0.098 | -0.292 | -0.410 | 0.775 | 0.779  | 0.031  | 1.000  |        |        |        |        |        |       |       |       |
| 8 Tariff               | -0.057 | -0.200 | -0.002 | 0.103 | 0.096  | -0.270 | 0.165  | 1.000  |        |        |        |        |       |       |       |
| 9 Exports              | 0.379  | 0.072  | 0.039  | 0.405 | 0.052  | -0.094 | 0.258  | 0.198  | 1.000  |        |        |        |       |       |       |
| 10 Imports             | 0.210  | -0.213 | 0.035  | 0.242 | -0.124 | -0.285 | 0.134  | 0.040  | 0.283  | 1.000  |        |        |       |       |       |
| 11 Currency            | 0.042  | -0.320 | -0.139 | 0.115 | 0.180  | -0.290 | 0.173  | 0.265  | 0.283  | 0.494  | 1.000  |        |       |       |       |
| 12 Inflation           | 0.491  | 0.289  | 0.191  | 0.016 | -0.374 | -0.031 | -0.207 | -0.015 | 0.348  | 0.129  | -0.071 | 1.000  |       |       |       |
| 13 Investment          | -0.403 | -0.195 | -0.282 | 0.096 | 0.146  | -0.072 | 0.286  | -0.056 | -0.166 | -0.138 | -0.023 | -0.076 | 1.000 |       |       |
| 14 Infrastructure      | -0.360 | -0.191 | -0.501 | 0.103 | 0.275  | -0.159 | 0.331  | 0.037  | -0.120 | -0.303 | 0.020  | -0.315 | 0.679 | 1.000 |       |
| 15 Connections         | -0.031 | -0.270 | -0.327 | 0.762 | 0.540  | 0.038  | 0.844  | 0.018  | 0.422  | 0.155  | 0.202  | -0.038 | 0.448 | 0.384 | 1.000 |

Table 22 Pearson Correlation Coefficients - COMESA

|                        | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13    | 14     | 15    |
|------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------|--------|-------|
| 1 Required             | 1.000  |        |        |        |        |        |        |        |        |        |        |        |       |        |       |
| 2 Arrival              | 0.760  | 1.000  |        |        |        |        |        |        |        |        |        |        |       |        |       |
| 3 Protocol             | 0.472  | 0.646  | 1.000  |        |        |        |        |        |        |        |        |        |       |        |       |
| 4 Intermediates import | -0.120 | -0.147 | -0.009 | 1.000  |        |        |        |        |        |        |        |        |       |        |       |
| 5 Intermediates export | -0.252 | -0.287 | 0.097  | 0.716  | 1.000  |        |        |        |        |        |        |        |       |        |       |
| 6 TCI                  | 0.306  | 0.324  | 0.236  | 0.196  | 0.266  | 1.000  |        |        |        |        |        |        |       |        |       |
| 7 Trade                | -0.213 | -0.243 | -0.057 | 0.831  | 0.797  | 0.426  | 1.000  |        |        |        |        |        |       |        |       |
| 8 Tariff               | 0.022  | -0.166 | -0.230 | 0.118  | 0.015  | -0.228 | 0.125  | 1.000  |        |        |        |        |       |        |       |
| 9 Exports              | 0.308  | -0.061 | -0.009 | 0.510  | 0.331  | 0.237  | 0.368  | 0.270  | 1.000  |        |        |        |       |        |       |
| 10 Imports             | 0.365  | 0.320  | 0.234  | 0.269  | -0.115 | 0.217  | 0.003  | -0.232 | 0.270  | 1.000  |        |        |       |        |       |
| 11 Currency            | 0.242  | 0.264  | 0.377  | -0.057 | -0.148 | 0.182  | -0.027 | 0.048  | 0.076  | 0.368  | 1.000  |        |       |        |       |
| 12 Inflation           | 0.491  | 0.346  | 0.176  | -0.545 | -0.454 | 0.188  | -0.367 | -0.111 | -0.113 | -0.102 | 0.169  | 1.000  |       |        |       |
| 13 Investment          | -0.454 | -0.242 | -0.305 | -0.088 | 0.119  | 0.053  | 0.278  | -0.043 | -0.397 | -0.369 | -0.144 | -0.061 | 1.000 |        |       |
| 14 Infrastructure      | -0.086 | -0.357 | -0.328 | -0.116 | 0.198  | 0.073  | 0.114  | 0.045  | -0.004 | -0.294 | -0.205 | -0.039 | 0.457 | 1.000  |       |
| 15 Connections         | -0.037 | -0.042 | 0.131  | 0.398  | 0.274  | 0.244  | 0.628  | -0.023 | 0.104  | -0.044 | 0.184  | 0.048  | 0.214 | -0.204 | 1.000 |

Table 23 Pearson Correlation Coefficients - ECCAS

|                        | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9     | 10     | 11    | 12    | 13 | 14    | 15 |
|------------------------|--------|--------|--------|--------|--------|--------|--------|--------|-------|--------|-------|-------|----|-------|----|
| 1 Required             | 1      |        |        |        |        |        |        |        |       |        |       |       |    |       |    |
| 2 Arrival              | 0.631  | 1      |        |        |        |        |        |        |       |        |       |       |    |       |    |
| 3 Protocol             | 0.110  | 0.149  | 1      |        |        |        |        |        |       |        |       |       |    |       |    |
| 4 Intermediates import | 0.103  | -0.133 | -0.548 | 1      |        |        |        |        |       |        |       |       |    |       |    |
| 5 Intermediates export | -0.129 | 0.148  | -0.221 | 0.492  | 1      |        |        |        |       |        |       |       |    |       |    |
| 6 TCI                  | 0.274  | 0.059  | 0.034  | 0.209  | -0.174 | 1      |        |        |       |        |       |       |    |       |    |
| 7 Trade                | 0.146  | -0.110 | -0.093 | 0.593  | 0.531  | 0.219  | 1      |        |       |        |       |       |    |       |    |
| 8 Tariff               | -0.179 | -0.337 | 0.503  | -0.439 | -0.060 | 0.219  | 0.062  | 1      |       |        |       |       |    |       |    |
| 9 Exports              | 0.416  | 0.382  | -0.092 | 0.287  | 0.532  | 0.090  | 0.737  | -0.127 | 1     |        |       |       |    |       |    |
| 10 Imports             | 0.015  | -0.210 | 0.270  | -0.146 | -0.191 | -0.175 | 0.161  | 0.019  | 0.158 | 1      |       |       |    |       |    |
| 11 Currency            | 0.650  | 0.496  | 0.360  | 0.106  | 0.138  | 0.020  | 0.144  | -0.303 | 0.300 | 0.240  | 1     |       |    |       |    |
| 12 Inflation           | 0.422  | 0.063  | -0.225 | 0.067  | 0.214  | -0.087 | 0.206  | -0.080 | 0.370 | 0.238  | 0.530 | 1     |    |       |    |
| 13 Investment          |        |        |        |        |        |        |        |        |       |        |       |       | 1  |       |    |
| 14 Infrastructure      | 0.010  | 0.178  | -0.002 | -0.116 | 0.082  | 0.428  | -0.108 | -0.039 | 0.244 | 0.261  | 0.152 | 0.209 |    | 1     |    |
| 15 Connections         | 0.138  | -0.111 | -0.452 | 0.733  | 0.542  | 0.505  | 0.673  | -0.135 | 0.559 | -0.153 | 0.141 | 0.373 |    | 0.351 | 1  |

Table 24 Pearson Correlation Coefficients - IGAD

|                        | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8      | 9      | 10     | 11     | 12     | 13     | 14    | 15 |
|------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------|----|
| 1 Required             | 1      |        |        |        |        |        |        |        |        |        |        |        |        |       |    |
| 2 Arrival              | 0.930  | 1      |        |        |        |        |        |        |        |        |        |        |        |       |    |
| 3 Protocol             | 0.492  | 0.601  | 1      |        |        |        |        |        |        |        |        |        |        |       |    |
| 4 Intermediates import | 0.269  | 0.096  | 0.474  | 1      |        |        |        |        |        |        |        |        |        |       |    |
| 5 Intermediates export | 0.341  | 0.049  | 0.308  | 0.769  | 1      |        |        |        |        |        |        |        |        |       |    |
| 6 TCI                  | 0.652  | 0.472  | 0.304  | 0.398  | 0.721  | 1      |        |        |        |        |        |        |        |       |    |
| 7 Trade                | 0.103  | -0.220 | 0.086  | 0.731  | 0.886  | 0.362  | 1      |        |        |        |        |        |        |       |    |
| 8 Tariff               | -0.283 | -0.430 | -0.327 | 0.052  | 0.266  | 0.246  | 0.296  | 1      |        |        |        |        |        |       |    |
| 9 Exports              | 0.631  | 0.448  | 0.243  | 0.395  | 0.510  | 0.584  | 0.458  | 0.435  | 1      |        |        |        |        |       |    |
| 10 Imports             | 0.509  | 0.646  | 0.326  | 0.012  | -0.262 | -0.046 | -0.389 | -0.825 | -0.269 | 1      |        |        |        |       |    |
| 11 Currency            | -0.213 | -0.248 | 0.000  | 0.179  | 0.013  | -0.376 | 0.215  | 0.045  | -0.223 | 0.167  | 1      |        |        |       |    |
| 12 Inflation           | 0.565  | 0.353  | -0.203 | -0.002 | 0.342  | 0.539  | 0.288  | 0.050  | 0.617  | -0.112 | -0.612 | 1      |        |       |    |
| 13 Investment          | -0.616 | -0.601 | -0.333 | -0.250 | -0.286 | -0.724 | 0.104  | -0.036 | -0.243 | -0.429 | 0.000  | -0.056 | 1      |       |    |
| 14 Infrastructure      | 0.405  | 0.262  | 0.396  | 0.333  | 0.638  | 0.702  | 0.464  | 0.471  | 0.788  | -0.520 | -0.461 | 0.510  | -0.164 | 1     |    |
| 15 Connections         | 0.264  | 0.044  | 0.007  | 0.022  | 0.463  | 0.194  | 0.580  | -0.081 | 0.314  | -0.200 | -0.048 | 0.575  | 0.336  | 0.394 | 1  |

Table 25 Pearson Correlation Coefficients - EAC

|                        | 1      | 2      | 3      | 4      | 5      | 6      | 7      | 8 | 9      | 10     | 11    | 12    | 13 | 14    | 15 |
|------------------------|--------|--------|--------|--------|--------|--------|--------|---|--------|--------|-------|-------|----|-------|----|
| 1 Required             | 1      |        |        |        |        |        |        |   |        |        |       |       |    |       |    |
| 2 Arrival              | -0.258 | 1      |        |        |        |        |        |   |        |        |       |       |    |       |    |
| 3 Protocol             | -0.316 | -0.204 | 1      |        |        |        |        |   |        |        |       |       |    |       |    |
| 4 Intermediates import | 0.398  | -0.520 | 0.507  | 1      |        |        |        |   |        |        |       |       |    |       |    |
| 5 Intermediates export | 0.499  | -0.948 | 0.242  | 0.639  | 1      |        |        |   |        |        |       |       |    |       |    |
| 6 TCI                  | 0.378  | -0.878 | 0.447  | 0.556  | 0.935  | 1      |        |   |        |        |       |       |    |       |    |
| 7 Trade                | 0.497  | -0.874 | 0.427  | 0.741  | 0.970  | 0.956  | 1      |   |        |        |       |       |    |       |    |
| 8 Tariff               |        |        |        |        |        |        |        | 1 |        |        |       |       |    |       |    |
| 9 Exports              | 0.530  | -0.690 | 0.446  | 0.888  | 0.807  | 0.805  | 0.886  |   | 1      |        |       |       |    |       |    |
| 10 Imports             | -0.017 | 0.892  | -0.011 | -0.177 | -0.760 | -0.649 | -0.616 |   | -0.296 | 1      |       |       |    |       |    |
| 11 Currency            | 0.600  | 0.344  | -0.316 | -0.088 | -0.093 | -0.186 | -0.067 |   | -0.179 | 0.308  | 1     |       |    |       |    |
| 12 Inflation           | 1.000  | -0.253 | -0.335 | 0.399  | 0.490  | 0.361  | 0.485  |   | 0.526  | -0.013 | 0.594 | 1     |    |       |    |
| 13 Investment          |        |        |        |        |        |        |        |   |        |        |       |       | 1  |       |    |
| 14 Infrastructure      | 0.776  | -0.385 | 0.305  | 0.554  | 0.647  | 0.708  | 0.754  |   | 0.725  | -0.063 | 0.436 | 0.758 |    | 1     |    |
| 15 Connections         | 0.707  | -0.545 | -0.023 | 0.425  | 0.726  | 0.579  | 0.701  |   | 0.443  | -0.486 | 0.591 | 0.696 |    | 0.708 | 1  |

Table 26 Pearson Correlation Coefficients - AMU

|    |                      | 1      | 2       | 3       | 4      | 5       | 6      | 7       | 8      | 9       | 10      | 11 | 12     | 13      | 14    | 15 |
|----|----------------------|--------|---------|---------|--------|---------|--------|---------|--------|---------|---------|----|--------|---------|-------|----|
| 1  | Required             | 1      |         |         |        |         |        |         |        |         |         |    |        |         |       |    |
| 2  | Arrival              | -0.395 | 1       |         |        |         |        |         |        |         |         |    |        |         |       |    |
| 3  | Protocol             | -0.395 | 1.000   | 1       |        |         |        |         |        |         |         |    |        |         |       |    |
| 4  | Intermediates import | -0.154 | -0.595  | -0.595  | 1      |         |        |         |        |         |         |    |        |         |       |    |
| 5  | Intermediates export | -0.331 | -0.588  | -0.588  | 0.249  | 1       |        |         |        |         |         |    |        |         |       |    |
| 6  | TCI                  | 0.025  | -0.648  | -0.648  | 0.940  | 0.191   | 1      |         |        |         |         |    |        |         |       |    |
| 7  | Trade                | -0.377 | -0.695  | -0.695  | 0.752  | 0.815   | 0.697  | 1       |        |         |         |    |        |         |       |    |
| 8  | Tariff               | 0.801  | -0.758  | -0.758  | 0.064  | 0.234   | 0.285  | 0.156   | 1      |         |         |    |        |         |       |    |
| 9  | Exports              | -0.471 | -0.419  | -0.419  | 0.809  | 0.463   | 0.572  | 0.757   | -0.270 | 1       |         |    |        |         |       |    |
| 10 | Imports              | -0.395 | 0.669   | 0.669   | -0.005 | -0.567  | -0.238 | -0.395  | -0.845 | 0.246   | 1       |    |        |         |       |    |
| 11 | Currency             |        |         |         |        |         |        |         |        |         |         |    |        |         |       |    |
| 12 | Inflation            | -0.722 | 0.340   | 0.340   | 0.400  | -0.061  | 0.403  | 0.297   | -0.583 | 0.275   | 0.289   |    | 1      |         |       |    |
| 13 | Investment           | 0.4841 | -0.1021 | -0.1021 | 0.3667 | -0.6275 | 0.5654 | -0.1824 | 0.2925 | -0.1964 | -0.0145 |    | 0.2371 | 1       |       |    |
| 14 | Infrastructure       | 0.618  | -0.928  | -0.928  | 0.473  | 0.348   | 0.495  | 0.428   | 0.772  | 0.329   | -0.499  |    | -0.585 | 0.1573  | 1     |    |
| 15 | Connections          | -0.428 | -0.548  | -0.548  | 0.857  | 0.570   | 0.668  | 0.865   | -0.129 | 0.981   | 0.064   |    | 0.281  | -0.1609 | 0.409 | 1  |

## Empirical results: Eligibility tests

Table 27 Statistical test results - Africa

|                                                                     | Trade  | Productive | Macroeconomic | Infrastructure | Movement | Dimensions |
|---------------------------------------------------------------------|--------|------------|---------------|----------------|----------|------------|
| Test scale = mean (unstandardized items)                            |        |            |               |                |          |            |
| Average interitem covariance:                                       | 0.007  | 0.012      | 0.004         | 0.004          | 0.054    | 0.006      |
| Number of items in the scale:                                       | 5      | 3          | 3             | 3              | 3        | 5          |
| Scale reliability coefficient:                                      | 0.450  | 0.674      | 0.194         | 0.248          | 0.571    | 0.500      |
|                                                                     |        |            |               |                |          |            |
| Determinant of the correlation matrix                               | 0.454  | 0.396      | 0.976         | 0.913          | 0.192    | 0.378      |
|                                                                     |        |            |               |                |          |            |
| Bartlett test of sphericity (H0: variables are not intercorrelated) |        |            |               |                |          |            |
| Chi-square                                                          | 39.838 | 47.334     | 1.245         | 4.671          | 84.36    | 49.091     |
| Degrees of freedom                                                  | 10     | 3          | 3             | 3              | 3        | 10         |
| p-value                                                             | 0      | 0          | 0.742         | 0.198          | 0        | 0          |
|                                                                     |        |            |               |                |          |            |
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy                     | 0.449  | 0.545      | 0.498         | 0.482          | 0.502    | 0.461      |

Table 28 Statistical test results - SADC

|                                                                     | Trade | Productive | Macroeconomic | Infrastructure | Movement | Dimensions |
|---------------------------------------------------------------------|-------|------------|---------------|----------------|----------|------------|
| Test scale = mean (unstandardized items)                            |       |            |               |                |          |            |
| Average interitem covariance:                                       | 0.019 | 0.042      | 0.009         | 0.028          | 0.037    | 0.014      |
| Number of items in the scale:                                       | 4     | 3          | 3             | 2              | 3        | 5          |
| Scale reliability coefficient:                                      | 0.611 | 0.758      | 0.252         | 0.544          | 0.471    | 0.694      |
|                                                                     |       |            |               |                |          |            |
| Determinant of the correlation matrix                               | 0.481 | 0.183      | 0.826         | 0.851          | 0.688    | 0.199      |
|                                                                     |       |            |               |                |          |            |
| Bartlett test of sphericity (H0: variables are not intercorrelated) |       |            |               |                |          |            |
| Chi-square                                                          | 9.38  | 22.351     | 2.524         | 2.182          | 4.925    | 20.204     |
| Degrees of freedom                                                  | 6     | 3          | 3             | 1              | 3        | 10         |
| p-value                                                             | 0.153 | 0          | 0.471         | 0.14           | 0.177    | 0.027      |
|                                                                     |       |            |               |                |          |            |
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy                     | 0.59  | 0.471      | 0.378         | 0.5            | 0.477    | 0.637      |

Table 29 Statistical test results - ECOWAS

|                                                                     | Trade | Productive | Macroeconomic | Infrastructure | Movement | Dimensions |
|---------------------------------------------------------------------|-------|------------|---------------|----------------|----------|------------|
| Test scale = mean (unstandardized items)                            |       |            |               |                |          |            |
| Average interitem covariance:                                       | 0.165 | 0.025      | 0.016         | 0.003          |          | 0.007      |
| Number of items in the scale:                                       | 4     | 3          | 3             | 2              |          | 5          |
| Scale reliability coefficient:                                      | 0.490 | 0.601      | 0.401         | 0.094          |          | 0.624      |
|                                                                     |       |            |               |                |          |            |
| Determinant of the correlation matrix                               | 0.601 | 0.613      | 0.834         | 0.998          |          | 0.203      |
|                                                                     |       |            |               |                |          |            |
| Bartlett test of sphericity (H0: variables are not intercorrelated) |       |            |               |                |          |            |
| Chi-square                                                          | 6.034 | 5.959      | 2.208         | 0.03           |          | 18.346     |
| Degrees of freedom                                                  | 6     | 3          | 3             | 1              |          | 10         |
| p-value                                                             | 0.419 | 0.114      | 0.53          | 0.862          |          | 0.049      |
|                                                                     |       |            |               |                |          |            |
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy                     | 0.49  | 0.541      | 0.495         | 0.5            |          | 0.622      |

Table 30 Statistical test results – CEN-SAD

|                                                                     | Trade | Productive | Macroeconomic | Infrastructure | Movement | Dimensions |
|---------------------------------------------------------------------|-------|------------|---------------|----------------|----------|------------|
| Test scale = mean (unstandardized items)                            |       |            |               |                |          |            |
| Average interitem covariance:                                       | 0.008 | 0.007      | 0.003         | 0.025          | 0.059    | 0.011      |
| Number of items in the scale:                                       | 4     | 3          | 3             | 2              | 3        | 5          |
| Scale reliability coefficient:                                      | 0.464 | 0.337      | 0.103         | 0.554          | 0.606    | 0.630      |
|                                                                     |       |            |               |                |          |            |
| Determinant of the correlation matrix                               | 0.809 | 0.858      | 0.988         | 0.854          | 0.446    | 0.401      |
|                                                                     |       |            |               |                |          |            |
| Bartlett test of sphericity (H0: variables are not intercorrelated) |       |            |               |                |          |            |
| Chi-square                                                          | 5.483 | 4          | 0.316         | 4.226          | 21.157   | 23.319     |
| Degrees of freedom                                                  | 6     | 3          | 3             | 1              | 3        | 10         |
| p-value                                                             | 0.484 | 0.261      | 0.959         | 0.04           | 0        | 0.01       |
|                                                                     |       |            |               |                |          |            |
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy                     | 0.596 | 0.497      | 0.482         | 0.5            | 0.532    | 0.597      |

Table 31 Statistical test results - COMESA

|                                                                     | Trade  | Productive | Macroeconomic | Infrastructure | Movement | Dimensions |
|---------------------------------------------------------------------|--------|------------|---------------|----------------|----------|------------|
| Test scale = mean (unstandardized items)                            |        |            |               |                |          |            |
| Average interitem covariance:                                       | 0.0102 | 0.0293     | 0.0075        | 0.0161         | 0.1084   | 0.0061     |
| Number of items in the scale:                                       | 4      | 3          | 3             | 2              | 3        | 5          |
| Scale reliability coefficient:                                      | 0.369  | 0.647      | 0.287         | 0.332          | 0.825    | 0.404      |
| Determinant of the correlation matrix                               | 0.656  | 0.453      | 0.95          | 0.958          | 0.246    | 0.343      |
| Bartlett test of sphericity (H0: variables are not intercorrelated) |        |            |               |                |          |            |
| Chi-square                                                          | 7.52   | 14.41      | 0.93          | 0.79           | 25.49    | 18.74      |
| Degrees of freedom                                                  | 6      | 3          | 3             | 1              | 3        | 10         |
| p-value                                                             | 0.276  | 0.002      | 0.818         | 0.375          | 0        | 0.044      |
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy                     |        |            |               |                |          |            |
|                                                                     | 0.42   | 0.54       | 0.54          | 0.50           | 0.63     | 0.431      |

Table 32 Statistical test results - ECCAS

|                                                                     | Trade  | Productive | Macroeconomic                      | Infrastructure | Movement | Dimensions |
|---------------------------------------------------------------------|--------|------------|------------------------------------|----------------|----------|------------|
| Test scale = mean (unstandardized items)                            |        |            |                                    |                |          |            |
| Average interitem covariance:                                       | 0.0188 | 0.0182     | 0.0449                             | 0.0359         | 0.0300   | 0.0129     |
| Number of items in the scale:                                       | 4      | 3          | 2                                  | 2              | 3        | 5          |
| Scale reliability coefficient:                                      | 0.4387 | 0.3828     | 0.692                              | 0.5194         | 0.5112   | 0.5897     |
| Determinant of the correlation matrix                               | 0.413  | 0.648      | matrix has zero values on diagonal | 0.877          | 0.589    | 0.309      |
| Bartlett test of sphericity (H0: variables are not intercorrelated) |        |            |                                    |                |          |            |
| Chi-square                                                          | 6.93   | 3.54       |                                    | 1.12           | 4.33     | 8.81       |
| Degrees of freedom                                                  | 6      | 3          |                                    | 1              | 3        | 10         |
| p-value                                                             | 0.328  | 0.316      |                                    | 0.291          | 0.228    | 0.55       |
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy                     |        |            |                                    |                |          |            |
|                                                                     | 0.47   | 0.38       |                                    | 0.50           | 0.52     | 0.55       |

Table 33 Statistical test results - IGAD

|                                                                     | Trade  | Productive | Macroeconomic | Infrastructure | Movement | Dimensions |
|---------------------------------------------------------------------|--------|------------|---------------|----------------|----------|------------|
| Test scale = mean (unstandardized items)                            |        |            |               |                |          |            |
| Average interitem covariance:                                       | 0.021  | 0.046      | 0.011         | 0.030          | 0.051    | 0.012      |
| Number of items in the scale:                                       | 4      | 3          | 3             | 2              | 3        | 5          |
| Scale reliability coefficient:                                      | 0.613  | 0.773      | 0.292         | 0.545          | 0.587    | 0.662      |
| Determinant of the correlation matrix                               | 0.374  | 0.202      | 0.746         | 0.85           | 0.685    | 0.145      |
| Bartlett test of sphericity (H0: variables are not intercorrelated) |        |            |               |                |          |            |
| Chi-square                                                          | 11.638 | 19.447     | 3.568         | 2.031          | 4.601    | 22.193     |
| Degrees of freedom                                                  | 6      | 3          | 3             | 1              | 3        | 10         |
| p-value                                                             | 0.071  | 0          | 0.312         | 0.154          | 0.203    | 0.014      |
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy                     | 0.556  | 0.554      | 0.352         | 0.5            | 0.588    | 0.431      |

Table 34 Statistical test results - EAC

|                                                                     | Trade  | Productive | Macroeconomic | Infrastructure | Movement | Dimensions |
|---------------------------------------------------------------------|--------|------------|---------------|----------------|----------|------------|
| Test scale = mean (unstandardized items)                            |        |            |               |                |          |            |
| Average interitem covariance:                                       | 0.0979 | 0.1244     | 0.0974        | 0.0952         | 0.0222   | 0.0453     |
| Number of items in the scale:                                       | 3      | 3          | 2             | 2              | 3        | 5          |
| Scale reliability coefficient:                                      | 0.8177 | 0.8835     | 0.7449        | 0.8288         | 0.2526   | 0.8084     |
| Determinant of the correlation matrix                               | 0.071  | 0.073      | 0.648         | 0.499          | 0.758    | 0.001      |
| Bartlett test of sphericity (H0: variables are not intercorrelated) |        |            |               |                |          |            |
| Chi-square                                                          | 8.40   | 8.28       | 1.52          | 2.44           | 0.88     | 18.32      |
| Degrees of freedom                                                  | 3      | 3          | 1             | 1              | 3        | 10         |
| p-value                                                             | 0.039  | 0.04       | 0.218         | 0.119          | 0.831    | 0.05       |
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy                     | 0.39   | 0.61       | 0.50          | 0.50           | 0.36     | 0.26       |

Table 35 Statistical test results - AMU

|                                                                     | Trade  | Productive | Macroeconomic | Infrastructure | Movement | Dimensions |
|---------------------------------------------------------------------|--------|------------|---------------|----------------|----------|------------|
| Test scale = mean (unstandardized items)                            |        |            |               |                |          |            |
| Average interitem covariance:                                       | 0.3523 | 0.0801     | 0.0366        | 0.0612         | 0.1222   | 0.0470     |
| Number of items in the scale:                                       | 4      | 3          | 2             | 2              | 3        | 5          |
| Scale reliability coefficient:                                      | 0.4879 | 0.7295     | 0.3801        | 0.5808         | 0.8115   | 0.832      |
| Determinant of the correlation matrix                               | 0.004  | 0.107      | 0.832         | 0.739          | .        | 0          |
| Bartlett test of sphericity (H0: variables are not intercorrelated) |        |            |               |                |          |            |
| Chi-square                                                          | 10.16  | 4.84       | 0.46          | 0.65           | .        | .          |
| Degrees of freedom                                                  | 6      | 3          | 1             | 3              | .        | 10         |
| p-value                                                             | 0.118  | 0.184      | 0.498         | .884           | .        | .          |
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy                     | 0.23   | 0.51       | 0.50          | 0.40           | .        | .          |

## Empirical results: PCA and weightings

Table 36 Results of PCA and weights derived for indicators and dimensions - Africa

|           |            |            |            |            | Eigenvalues  |        |             |             |             | Loadings     |        |        |        |                | Weights |
|-----------|------------|------------|------------|------------|--------------|--------|-------------|-------------|-------------|--------------|--------|--------|--------|----------------|---------|
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1  | Comp2       | Comp3       | Unexplained |              | Comp 1 | Comp 2 | Comp 3 |                |         |
| Comp1     | 1.781      | 0.572      | 0.356      | 0.356      | Tariff       | 0.313  | 0.351       | 0.851       | 0.036       | Tariff       | 0.417  | 0.386  | 0.801  | Tariff         | 0.249   |
| Comp2     | 1.209      | 0.323      | 0.242      | 0.598      | Trade        | 0.183  | 0.633       | -0.137      | 0.440       | Trade        | 0.244  | 0.696  | -0.129 | Trade          | 0.144   |
| Comp3     | 0.886      | 0.045      | 0.177      | 0.775      | Exports      | 0.655  | -0.171      | -0.253      | 0.143       | Exports      | 0.875  | -0.188 | -0.238 | Exports        | 0.221   |
| Comp4     | 0.841      | 0.557      | 0.168      | 0.943      | Imports      | 0.612  | -0.407      | 0.059       | 0.130       | Imports      | 0.817  | -0.447 | 0.055  | Imports        | 0.224   |
| Comp5     | 0.283      | .          | 0.057      | 1.000      | ACFTA        | 0.255  | 0.531       | -0.435      | 0.375       | ACFTA        | 0.340  | 0.584  | -0.409 | ACFTA          | 0.161   |
|           |            |            |            |            |              |        |             |             |             |              |        |        |        |                |         |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1  | Comp2       | Unexplained |             |              | Comp 1 | Comp 2 |        |                |         |
| Comp1     | 1.894      | 1.030      | 0.631      | 0.631      | Intermedia~M | 0.651  | -0.306      | 0.117       |             | Intermedia~M | 0.896  | -0.284 |        | Intermedia~M   | 0.320   |
| Comp2     | 0.864      | 0.622      | 0.288      | 0.919      | Intermedia~X | 0.665  | -0.213      | 0.124       |             | Intermedia~X | 0.915  | -0.198 |        | Intermedia~X   | 0.318   |
| Comp3     | 0.242      | .          | 0.081      | 1.000      | TCI          | 0.367  | 0.928       | 0.001       |             | TCI          | 0.505  | 0.863  |        | TCI            | 0.362   |
|           |            |            |            |            |              |        |             |             |             |              |        |        |        |                |         |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1  | Comp2       | Unexplained |             |              | Comp 1 | Comp 2 |        |                |         |
| Comp1     | 1.157      | 0.161      | 0.386      | 0.386      | Inflation    | 0.519  | 0.683       | 0.224       |             | Inflation    | 0.558  | 0.682  |        | Inflation      | 0.360   |
| Comp2     | 0.997      | 0.150      | 0.332      | 0.718      | Currency     | 0.703  | 0.002       | 0.428       |             | Currency     | 0.756  | 0.002  |        | Currency       | 0.266   |
| Comp3     | 0.846      | .          | 0.282      | 1.000      | Investment   | -0.487 | 0.730       | 0.195       |             | Investment   | -0.523 | 0.729  |        | Investment     | 0.374   |
|           |            |            |            |            |              |        |             |             |             |              |        |        |        |                |         |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1  | Unexplained |             |             |              | Comp 1 |        |        |                |         |
| Comp1     | 1.284      | 0.266      | 0.428      | 0.428      | Infrastruc~e | 0.707  | 0.358       |             |             | Infrastruc~e | 0.801  |        |        | Infrastructure | 0.500   |
| Comp2     | 1.018      | 0.319      | 0.339      | 0.767      | Connections  | 0.707  | 0.358       |             |             | Connections  | 0.801  |        |        | Connections    | 0.500   |
|           |            |            |            |            |              |        |             |             |             |              |        |        |        |                |         |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1  | Comp2       | Unexplained |             |              | Comp 1 | Comp 2 |        |                |         |
| Comp1     | 1.921      | 0.945      | 0.640      | 0.640      | Required     | 0.700  | -0.091      | 0.051       |             | Required     | 0.970  | -0.090 |        | Required       | 0.327   |
| Comp2     | 0.976      | 0.874      | 0.325      | 0.966      | Arrival      | 0.696  | -0.137      | 0.051       |             | Arrival      | 0.965  | -0.135 |        | Arrival        | 0.328   |
| Comp3     | 0.103      | .          | 0.034      | 1.000      | Protocol     | 0.161  | 0.986       | 0.000       |             | Protocol     | 0.224  | 0.975  |        | Protocol       | 0.345   |
|           |            |            |            |            |              |        |             |             |             |              |        |        |        |                |         |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1  | Comp2       | Comp3       | Unexplained |              | Comp 1 | Comp 2 | Comp 3 |                |         |
| Comp1     | 1.950      | 0.867      | 0.390      | 0.390      | Trade_d      | 0.224  | -0.521      | 0.729       | 0.118       | Trade_d      | 0.313  | -0.542 | 0.700  | Trade_d        | 0.223   |
| Comp2     | 1.083      | 0.161      | 0.217      | 0.607      | Productive_d | 0.571  | -0.258      | -0.093      | 0.284       | Productive_d | 0.798  | -0.268 | -0.089 | Productive_d   | 0.181   |
| Comp3     | 0.922      | 0.119      | 0.184      | 0.791      | Macro_d      | 0.254  | 0.790       | 0.369       | 0.072       | Macro_d      | 0.355  | 0.823  | 0.354  | Macro_d        | 0.235   |
| Comp4     | 0.803      | 0.561      | 0.161      | 0.952      | Infrastruc~d | 0.647  | 0.161       | 0.014       | 0.157       | Infrastruc~d | 0.903  | 0.167  | 0.013  | Infrastruc~d   | 0.213   |
| Comp5     | 0.242      | .          | 0.048      | 1.000      | Movement_d   | -0.375 | 0.109       | 0.568       | 0.415       | Movement_d   | -0.524 | 0.113  | 0.546  | Movement_d     | 0.148   |

Table 37 Results of PCA and weights derived for indicators and dimensions - SADC

|           |            |            |            |            | Eigenvectors |        |        |             |  |  | Loadings     |        |        |  |  |                | Weights |
|-----------|------------|------------|------------|------------|--------------|--------|--------|-------------|--|--|--------------|--------|--------|--|--|----------------|---------|
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1  | Comp2  | Unexplained |  |  | Comp1        | Comp2  |        |  |  |                |         |
| Comp1     | 1.929      | 0.862      | 0.482      | 0.482      | Tariff       | 0.505  | 0.284  | 0.422       |  |  | Tariff       | 0.702  | 0.293  |  |  | Tariff         | 0.193   |
| Comp2     | 1.068      | 0.433      | 0.267      | 0.749      | Trade        | 0.198  | 0.864  | 0.128       |  |  | Trade        | 0.275  | 0.893  |  |  | Trade          | 0.291   |
| Comp3     | 0.635      | 0.267      | 0.159      | 0.908      | Exports      | 0.615  | -0.149 | 0.247       |  |  | Exports      | 0.854  | -0.154 |  |  | Exports        | 0.251   |
| Comp4     | 0.368      | .          | 0.092      | 1.000      | Imports      | 0.572  | -0.389 | 0.207       |  |  | Imports      | 0.795  | -0.402 |  |  | Imports        | 0.265   |
|           |            |            |            |            |              |        |        |             |  |  |              |        |        |  |  |                |         |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1  | Comp2  | Unexplained |  |  | Comp1        | Comp2  |        |  |  |                |         |
| Comp1     | 2.178      | 1.475      | 0.726      | 0.726      | Intermedia~M | 0.494  | 0.468  |             |  |  | Intermedia~M | 0.729  |        |  |  | Intermedia~M   | 0.244   |
| Comp2     | 0.703      | 0.583      | 0.234      | 0.960      | Intermedia~X | 0.652  | 0.074  |             |  |  | Intermedia~X | 0.962  |        |  |  | Intermedia~X   | 0.425   |
| Comp3     | 0.120      | .          | 0.040      | 1.000      | TCI          | 0.575  | 0.281  |             |  |  | TCI          | 0.848  |        |  |  | TCI            | 0.330   |
|           |            |            |            |            |              |        |        |             |  |  |              |        |        |  |  |                |         |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1  | Comp2  | Unexplained |  |  | Comp1        | Comp2  |        |  |  |                |         |
| Comp1     | 1.260      | 0.071      | 0.420      | 0.420      | Inflation    | -0.255 | 0.795  | 0.167       |  |  | Inflation    | -0.287 | 0.866  |  |  | Inflation      | 0.340   |
| Comp2     | 1.189      | 0.638      | 0.396      | 0.816      | Currency     | 0.780  | -0.168 | 0.201       |  |  | Currency     | 0.875  | -0.183 |  |  | Currency       | 0.326   |
| Comp3     | 0.551      | .          | 0.184      | 1.000      | Investment   | 0.572  | 0.584  | 0.183       |  |  | Investment   | 0.642  | 0.636  |  |  | Investment     | 0.334   |
|           |            |            |            |            |              |        |        |             |  |  |              |        |        |  |  |                |         |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1  | Comp2  | Unexplained |  |  | Comp1        | Comp2  |        |  |  |                |         |
| Comp1     | 1.387      | 0.775      | 0.694      | 0.694      | Infrastruc~e | 0.707  | 0.306  |             |  |  | Infrastruc~e | 0.833  |        |  |  | Infrastructure | 0.500   |
| Comp2     | 0.613      | .          | 0.306      | 1.000      | Connections  | 0.707  | 0.306  |             |  |  | Connections  | 0.833  |        |  |  | Connections    | 0.500   |
|           |            |            |            |            |              |        |        |             |  |  |              |        |        |  |  |                |         |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1  | Comp2  | Unexplained |  |  | Comp1        | Comp2  |        |  |  |                |         |
| Comp1     | 1.601      | 0.656      | 0.534      | 0.534      | Required     | 0.690  | 0.022  | 0.239       |  |  | Required     | 0.872  | 0.021  |  |  | Required       | 0.299   |
| Comp2     | 0.944      | 0.489      | 0.315      | 0.848      | Arrival      | 0.556  | 0.625  | 0.137       |  |  | Arrival      | 0.703  | 0.607  |  |  | Arrival        | 0.339   |
| Comp3     | 0.455      | .          | 0.152      | 1.000      | Protocol     | -0.464 | 0.780  | 0.080       |  |  | Protocol     | -0.588 | 0.758  |  |  | Protocol       | 0.362   |
|           |            |            |            |            |              |        |        |             |  |  |              |        |        |  |  |                |         |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1  | Comp2  | Unexplained |  |  | Comp1        | Comp2  |        |  |  |                |         |
| Comp1     | 2.391      | 1.052      | 0.478      | 0.478      | Trade_d      | 0.459  | -0.390 | 0.294       |  |  | Trade_d      | 0.709  | -0.452 |  |  | Trade_d        | 0.189   |
| Comp2     | 1.338      | 0.722      | 0.268      | 0.746      | Productive_d | 0.556  | 0.167  | 0.224       |  |  | Productive_d | 0.859  | 0.193  |  |  | Productive_d   | 0.208   |
| Comp3     | 0.616      | 0.208      | 0.123      | 0.869      | Macro_d      | 0.087  | 0.723  | 0.282       |  |  | Macro_d      | 0.135  | 0.837  |  |  | Macro_d        | 0.193   |
| Comp4     | 0.408      | 0.160      | 0.082      | 0.951      | Infrastruc~d | 0.497  | 0.400  | 0.196       |  |  | Infrastruc~d | 0.768  | 0.463  |  |  | Infrastruc~d   | 0.216   |
| Comp5     | 0.247      | .          | 0.049      | 1.000      | Movement_d   | -0.476 | 0.370  | 0.276       |  |  | Movement_d   | -0.736 | 0.428  |  |  | Movement_d     | 0.194   |

Table 38 Results of PCA and weights derived for indicators and dimensions - ECOWAS

|           |            |            |            |            | Eigenvalues  |        |         |             |             |  | Loadings     |        |         |        |                | Weights |
|-----------|------------|------------|------------|------------|--------------|--------|---------|-------------|-------------|--|--------------|--------|---------|--------|----------------|---------|
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1  | Comp2   | Comp3       | Unexplained |  | Comp1        | Comp2  | Comp3   |        |                |         |
| Comp1     | 1.685      | 0.572      | 0.421      | 0.421      | Tariff       | 0.675  | -0.142  | -0.047      | 0.208       |  | Tariff       | 0.876  | -0.149  | -0.042 | Tariff         | 0.220   |
| Comp2     | 1.112      | 0.308      | 0.278      | 0.699      | Trade        | 0.286  | 0.666   | -0.665      | 0.013       |  | Trade        | 0.372  | 0.702   | -0.597 | Trade          | 0.274   |
| Comp3     | 0.805      | 0.407      | 0.201      | 0.900      | Exports      | 0.395  | 0.504   | 0.735       | 0.020       |  | Exports      | 0.513  | 0.532   | 0.659  | Exports        | 0.272   |
| Comp4     | 0.398      | .          | 0.100      | 1.000      | Imports      | -0.553 | 0.531   | 0.124       | 0.158       |  | Imports      | -0.718 | 0.560   | 0.111  | Imports        | 0.234   |
|           |            |            |            |            |              |        |         |             |             |  |              |        |         |        |                |         |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1  | Comp2   | Unexplained |             |  | Comp1        | Comp2  |         |        |                |         |
| Comp1     | 1.70211    | 0.805905   | 0.5674     | 0.5674     | Intermedia~M | 0.6484 | -0.3229 | 0.1909      |             |  | Intermedia~M | 0.8459 | -0.3057 |        | Intermedia~M   | 0.311   |
| Comp2     | 0.8962     | 0.494505   | 0.2987     | 0.8661     | Intermedia~X | 0.3657 | 0.9264  | 0.003248    |             |  | Intermedia~X | 0.4772 | 0.877   |        | Intermedia~X   | 0.384   |
| Comp3     | 0.401695   | .          | 0.1339     | 1          | TCI          | 0.6677 | -0.1938 | 0.2075      |             |  | TCI          | 0.8711 | -0.1835 |        | TCI            | 0.305   |
|           |            |            |            |            |              |        |         |             |             |  |              |        |         |        |                |         |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1  | Comp2   | Unexplained |             |  | Comp1        | Comp2  |         |        |                |         |
| Comp1     | 1.426      | 0.454      | 0.475      | 0.475      | Currency     | -0.609 | 0.501   | 0.228       |             |  | Currency     | -0.727 | 0.494   |        | Currency       | 0.322   |
| Comp2     | 0.972      | 0.371      | 0.324      | 0.800      | Investment   | 0.384  | 0.864   | 0.064       |             |  | Investment   | 0.458  | 0.852   |        | Investment     | 0.390   |
| Comp3     | 0.601      | .          | 0.201      | 1.000      | Inflation    | 0.695  | -0.038  | 0.310       |             |  | Inflation    | 0.830  | -0.038  |        | Inflation      | 0.288   |
|           |            |            |            |            |              |        |         |             |             |  |              |        |         |        |                |         |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1  | Comp2   | Unexplained |             |  | Comp1        | Comp2  |         |        |                |         |
| Comp1     | 1.049      | 0.099      | 0.525      | 0.525      | Infrastruc~e | -0.707 | 0.707   | 0.000       |             |  | Infrastruc~e | -0.724 | 0.690   |        | Infrastructure | 0.500   |
| Comp2     | 0.951      | .          | 0.475      | 1.000      | Connections  | 0.707  | 0.707   | 0.000       |             |  | Connections  | 0.724  | 0.690   |        | Connections    | 0.500   |
|           |            |            |            |            |              |        |         |             |             |  |              |        |         |        |                |         |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1  | Comp2   | Unexplained |             |  | Comp1        | Comp2  |         |        |                |         |
|           |            |            |            |            |              |        |         |             |             |  |              |        |         |        | Required       | 0.333   |
|           |            |            |            |            |              |        |         |             |             |  |              |        |         |        | Arrival        | 0.333   |
|           |            |            |            |            |              |        |         |             |             |  |              |        |         |        | Protocol       | 0.333   |
|           |            |            |            |            |              |        |         |             |             |  |              |        |         |        |                |         |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1  | Comp2   | Unexplained |             |  | Comp1        | Comp2  |         |        |                |         |
| Comp1     | 2.298      | 0.923      | 0.460      | 0.460      | Trade_d      | 0.537  | 0.348   | 0.170       |             |  | Trade_d      | 0.814  | 0.408   |        | Trade_d        | 0.226   |
| Comp2     | 1.375      | 0.650      | 0.275      | 0.735      | Productive_d | 0.592  | -0.109  | 0.179       |             |  | Productive_d | 0.897  | -0.127  |        | Productive_d   | 0.224   |
| Comp3     | 0.725      | 0.378      | 0.145      | 0.880      | Macro_d      | -0.208 | 0.577   | 0.443       |             |  | Macro_d      | -0.315 | 0.677   |        | Macro_d        | 0.152   |
| Comp4     | 0.347      | 0.092      | 0.069      | 0.949      | Infrastruc~d | 0.561  | -0.077  | 0.268       |             |  | Infrastruc~d | 0.851  | -0.090  |        | Infrastruc~d   | 0.199   |
| Comp5     | 0.255      | .          | 0.051      | 1.000      | Movement_d   | 0.056  | 0.727   | 0.267       |             |  | Movement_d   | 0.084  | 0.852   |        | Movement_d     | 0.200   |

Table 39 Results of PCA and weights derived for indicators and dimensions – CEN-SAD

|           |            |            |            |            | Eigenvectors |        |        |             |             | Loadings     |        |        |        |                | Weights |
|-----------|------------|------------|------------|------------|--------------|--------|--------|-------------|-------------|--------------|--------|--------|--------|----------------|---------|
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1  | Comp2  | Comp3       | Unexplained |              | Comp1  | Comp2  | Comp3  |                |         |
| Comp1     | 1.559      | 0.586      | 0.390      | 0.390      | Tariff       | 0.399  | 0.709  | 0.517       | 0.047       | Tariff       | 0.498  | 0.699  | 0.465  | Tariff         | 0.285   |
| Comp2     | 0.973      | 0.164      | 0.243      | 0.633      | Trade        | 0.509  | 0.199  | -0.797      | 0.043       | Trade        | 0.635  | 0.196  | -0.717 | Trade          | 0.286   |
| Comp3     | 0.809      | 0.150      | 0.202      | 0.835      | Exports      | 0.609  | -0.129 | 0.108       | 0.396       | Exports      | 0.761  | -0.128 | 0.097  | Exports        | 0.181   |
| Comp4     | 0.659      | .          | 0.165      | 1.000      | Imports      | 0.459  | -0.665 | 0.292       | 0.173       | Imports      | 0.573  | -0.656 | 0.263  | Imports        | 0.248   |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1  | Comp2  | Unexplained |             |              | Comp1  | Comp2  |        |                |         |
| Comp1     | 1.384      | 0.396      | 0.461      | 0.461      | Intermedia~M | 0.661  | -0.340 | 0.281       |             | Intermedia~M | 0.778  | -0.338 |        | Intermedia~M   | 0.303   |
| Comp2     | 0.989      | 0.361      | 0.330      | 0.791      | Intermedia~X | 0.701  | -0.036 | 0.318       |             | Intermedia~X | 0.825  | -0.036 |        | Intermedia~X   | 0.287   |
| Comp3     | 0.627      | .          | 0.209      | 1.000      | TCI          | 0.266  | 0.940  | 0.029       |             | TCI          | 0.313  | 0.935  |        | TCI            | 0.409   |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1  | Comp2  | Unexplained |             |              | Comp1  | Comp2  |        |                |         |
| Comp1     | 1.093      | 0.070      | 0.364      | 0.364      | Currency     | 0.445  | 0.733  | 0.235       |             | Currency     | 0.465  | 0.741  |        | Currency       | 0.362   |
| Comp2     | 1.023      | 0.139      | 0.341      | 0.705      | Investment   | 0.497  | -0.681 | 0.256       |             | Investment   | 0.520  | -0.688 |        | Investment     | 0.351   |
| Comp3     | 0.884      | .          | 0.295      | 1.000      | Inflation    | -0.745 | -0.016 | 0.393       |             | Inflation    | -0.779 | -0.017 |        | Inflation      | 0.287   |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1  | Comp2  | Unexplained |             |              | Comp1  | Comp2  |        |                |         |
| Comp1     | 1.384      | 0.768      | 0.692      | 0.692      | Infrastruc~e | 0.707  | 0.707  | 0.000       |             | Infrastruc~e | 0.832  | 0.555  |        | Infrastructure | 0.500   |
| Comp2     | 0.616      | .          | 0.308      | 1.000      | Connections  | 0.707  | -0.707 | 0.000       |             | Connections  | 0.832  | -0.555 |        | Connections    | 0.500   |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1  | Comp2  | Unexplained |             |              | Comp1  | Comp2  |        |                |         |
| Comp1     | 1.831      | 0.933      | 0.610      | 0.610      | Required     | 0.674  | -0.183 | 0.139       |             | Required     | 0.912  | -0.174 |        | Required       | 0.316   |
| Comp2     | 0.898      | 0.627      | 0.299      | 0.910      | Arrival      | 0.658  | -0.292 | 0.131       |             | Arrival      | 0.891  | -0.277 |        | Arrival        | 0.319   |
| Comp3     | 0.271      | .          | 0.090      | 1.000      | Protocol     | 0.336  | 0.939  | 0.002       |             | Protocol     | 0.455  | 0.890  |        | Protocol       | 0.366   |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1  | Comp2  | Comp3       | Unexplained |              | Comp1  | Comp2  | Comp3  |                |         |
| Comp1     | 2.110      | 0.921      | 0.422      | 0.422      | Trade_d      | 0.446  | 0.289  | 0.648       | 0.146       | Trade_d      | 0.647  | 0.315  | 0.580  | Trade_d        | 0.208   |
| Comp2     | 1.189      | 0.387      | 0.238      | 0.660      | Productive_d | 0.324  | -0.652 | 0.435       | 0.120       | Productive_d | 0.471  | -0.711 | 0.390  | Productive_d   | 0.215   |
| Comp3     | 0.802      | 0.300      | 0.160      | 0.820      | Macro_d      | 0.394  | 0.635  | -0.131      | 0.178       | Macro_d      | 0.573  | 0.693  | -0.118 | Macro_d        | 0.200   |
| Comp4     | 0.502      | 0.106      | 0.100      | 0.921      | Infrastruc~d | 0.573  | -0.058 | -0.192      | 0.275       | Infrastruc~d | 0.832  | -0.063 | -0.172 | Infrastruc~d   | 0.177   |
| Comp5     | 0.397      | .          | 0.079      | 1.000      | Movement_d   | -0.461 | 0.291  | 0.581       | 0.180       | Movement_d   | -0.670 | 0.318  | 0.520  | Movement_d     | 0.200   |

Table 40 Results of PCA and weights derived for indicators and dimensions - COMESA

|           |            |            |            |            | Eigenvector<br>s |        |             |             |             |  | Loadings         |        |        |        |                    | Weight<br>s |
|-----------|------------|------------|------------|------------|------------------|--------|-------------|-------------|-------------|--|------------------|--------|--------|--------|--------------------|-------------|
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable         | Comp1  | Comp2       | Comp3       | Unexplained |  |                  | Comp1  | Comp2  | Comp3  |                    |             |
| Comp1     | 1.533      | 0.299      | 0.383      | 0.383      | Tariff           | 0.407  | -0.592      | 0.533       | 0.087       |  | Tariff           | 0.504  | -0.658 | 0.476  | Tariff             | 0.256       |
| Comp2     | 1.234      | 0.435      | 0.309      | 0.692      | Trade            | 0.573  | -0.031      | -0.749      | 0.048       |  | Trade            | 0.709  | -0.034 | -0.670 | Trade              | 0.267       |
| Comp3     | 0.799      | 0.365      | 0.200      | 0.892      | Exports          | 0.690  | 0.175       | 0.226       | 0.192       |  | Exports          | 0.854  | 0.194  | 0.202  | Exports            | 0.227       |
| Comp4     | 0.434      | .          | 0.109      | 1.000      | Imports          | 0.176  | 0.786       | 0.322       | 0.108       |  | Imports          | 0.218  | 0.873  | 0.288  | Imports            | 0.250       |
|           |            |            |            |            |                  |        |             |             |             |  |                  |        |        |        |                    |             |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable         | Comp1  | Comp2       | Unexplained |             |  |                  | Comp1  | Comp2  |        |                    |             |
| Comp1     | 1.843      | 0.966      | 0.614      | 0.614      | Intermedia~M     | 0.651  | -0.311      | 0.134       |             |  | Intermedia~M     | 0.884  | -0.291 |        | Intermedia~M       | 0.318       |
| Comp2     | 0.877      | 0.597      | 0.292      | 0.907      | Intermedia~X     | 0.667  | -0.200      | 0.144       |             |  | Intermedia~X     | 0.906  | -0.188 |        | Intermedia~X       | 0.315       |
| Comp3     | 0.280      | .          | 0.093      | 1.000      | TCI              | 0.362  | 0.929       | 0.002       |             |  | TCI              | 0.491  | 0.870  |        | TCI                | 0.367       |
|           |            |            |            |            |                  |        |             |             |             |  |                  |        |        |        |                    |             |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable         | Comp1  | Comp2       | Unexplained |             |  |                  | Comp1  | Comp2  |        |                    |             |
| Comp1     | 1.254      | 0.315      | 0.418      | 0.418      | Currency         | 0.657  | 0.051       | 0.456       |             |  | Currency         | 0.736  | 0.049  |        | Currency           | 0.248       |
| Comp2     | 0.940      | 0.134      | 0.313      | 0.731      | Investment       | -0.507 | 0.768       | 0.123       |             |  | Investment       | -0.568 | 0.745  |        | Investment         | 0.400       |
| Comp3     | 0.806      | .          | 0.269      | 1.000      | Inflation        | 0.558  | 0.638       | 0.227       |             |  | Inflation        | 0.625  | 0.619  |        | Inflation          | 0.352       |
|           |            |            |            |            |                  |        |             |             |             |  |                  |        |        |        |                    |             |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable         | Comp1  | Comp2       | Unexplained |             |  |                  | Comp1  | Comp2  |        |                    |             |
| Comp1     | 1.204      | 0.409      | 0.602      | 0.602      | Infrastruc~e     | -0.707 | 0.707       | 0.000       |             |  | Infrastruc~e     | -0.776 | 0.631  |        | Infrastructur<br>e | 0.500       |
| Comp2     | 0.796      | .          | 0.398      | 1.000      | Connections      | 0.707  | 0.707       | 0.000       |             |  | Connections      | 0.776  | 0.631  |        | Connections        | 0.500       |
|           |            |            |            |            |                  |        |             |             |             |  |                  |        |        |        |                    |             |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable         | Comp1  | Unexplained |             |             |  |                  | Comp1  |        |        |                    |             |
| Comp1     | 2.260      | 1.721      | 0.753      | 0.753      | Required         | 0.575  | 0.254       |             |             |  | Required         | 0.864  |        |        | Required           | 0.330       |
| Comp2     | 0.538      | 0.336      | 0.179      | 0.933      | Arrival          | 0.621  | 0.130       |             |             |  | Arrival          | 0.933  |        |        | Arrival            | 0.385       |
| Comp3     | 0.202      | .          | 0.067      | 1.000      | Protocol         | 0.534  | 0.356       |             |             |  | Protocol         | 0.803  |        |        | Protocol           | 0.285       |
|           |            |            |            |            |                  |        |             |             |             |  |                  |        |        |        |                    |             |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable         | Comp1  | Comp2       | Comp3       | Unexplained |  |                  | Comp1  | Comp2  | Comp3  |                    |             |
| Comp1     | 1.817      | 0.453      | 0.364      | 0.364      | Trade_d          | 0.631  | -0.169      | 0.117       | 0.222       |  | Trade_d          | 0.851  | -0.197 | 0.122  | Trade_d            | 0.181       |
| Comp2     | 1.364      | 0.261      | 0.273      | 0.636      | Productive_<br>d | 0.657  | 0.011       | 0.179       | 0.181       |  | Productive_<br>d | 0.885  | 0.013  | 0.188  | Productive_<br>d   | 0.191       |
| Comp3     | 1.103      | 0.695      | 0.221      | 0.857      | Macro_d          | -0.226 | 0.669       | 0.394       | 0.125       |  | Macro_d          | -0.304 | 0.782  | 0.414  | Macro_d            | 0.204       |
| Comp4     | 0.408      | 0.101      | 0.082      | 0.939      | Infrastruc~d     | 0.336  | 0.693       | -0.085      | 0.133       |  | Infrastruc~d     | 0.453  | 0.809  | -0.089 | Infrastruc~d       | 0.202       |
| Comp5     | 0.307      | .          | 0.061      | 1.000      | Movement_d       | -0.083 | -0.210      | 0.890       | 0.054       |  | Movement_<br>d   | -0.111 | -0.246 | 0.935  | Movement_d         | 0.221       |

Table 41 Results of PCA and weights derived for indicators and dimensions - ECCAS

|           |            |            |            |            | Eigenvectors |         |             |             |             | Loadings     |          |         |          |                |  | Weights |
|-----------|------------|------------|------------|------------|--------------|---------|-------------|-------------|-------------|--------------|----------|---------|----------|----------------|--|---------|
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1   | Comp2       | Unexplained |             |              | Comp1    | Comp2   |          |                |  |         |
| Comp1     | 1.80191    | 0.770091   | 0.4505     | 0.4505     | Tariff       | -0.0493 | 0.9356      | 0.09245     |             | Tariff       | -0.06615 | 0.9504  |          | Tariff         |  | 0.320   |
| Comp2     | 1.03182    | 0.105304   | 0.258      | 0.7084     | Trade        | 0.6774  | 0.0891      | 0.165       |             | Trade        | 0.9093   | 0.09048 |          | Trade          |  | 0.295   |
| Comp3     | 0.926514   | 0.686753   | 0.2316     | 0.9401     | Exports      | 0.6829  | -0.1431     | 0.1386      |             | Exports      | 0.9167   | -0.1453 |          | Exports        |  | 0.304   |
| Comp4     | 0.239761   | .          | 0.0599     | 1          | Imports      | 0.269   | 0.3103      | 0.7703      |             | Imports      | 0.3611   | 0.3152  |          | Imports        |  | 0.081   |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1   | Comp2       | Unexplained |             |              | Comp1    | Comp2   |          |                |  |         |
| Comp1     | 1.49327    | 0.374751   | 0.4978     | 0.4978     | Intermedia~M | 0.7173  | 0.2434      | 0.1655      |             | Intermedia~M | 0.8765   | 0.2574  |          | Intermedia~M   |  | 0.320   |
| Comp2     | 1.11852    | 0.730309   | 0.3728     | 0.8706     | Intermedia~X | 0.6943  | -0.3292     | 0.159       |             | Intermedia~X | 0.8484   | -0.3482 |          | Intermedia~X   |  | 0.322   |
| Comp3     | 0.38821    | .          | 0.1294     | 1          | TCI          | 0.0592  | 0.9124      | 0.0637      |             | TCI          | 0.07232  | 0.9649  |          | TCI            |  | 0.358   |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1   | Unexplained |             |             |              | Comp1    |         |          |                |  |         |
| Comp1     | 1.53032    | 1.06064    | 0.7652     | 0.7652     | Inflation    | 0.7071  | 0.2388      |             |             | Currency     | 0.8747   |         |          | Currency       |  | 0.500   |
| Comp2     | 0.469678   | .          | 0.2348     | 1          | Currency     | 0.7071  | 0.2388      |             |             | Inflation    | 0.8747   |         |          | Inflation      |  | 0.500   |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1   | Comp2       | Unexplained |             |              | Comp1    | Comp2   |          |                |  |         |
| Comp1     | 1.35089    | 0.701788   | 0.6754     | 0.6754     | Infrastruc~e | 0.7071  | 0.7071      | 0           |             | Infrastruc~e | 0.8219   | 0.5697  |          | Infrastructure |  | 0.500   |
| Comp2     | 0.649106   | .          | 0.3246     | 1          | Connections  | 0.7071  | -0.7071     | 0           |             | Connections  | 0.8219   | -0.5697 |          | Connections    |  | 0.500   |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1   | Comp2       | Unexplained |             |              | Comp1    | Comp2   |          |                |  |         |
| Comp1     | 1.68006    | 0.728262   | 0.56       | 0.56       | Required     | 0.6788  | -0.2164     | 0.1813      |             | Required     | 0.8799   | -0.2111 |          | Required       |  | 0.311   |
| Comp2     | 0.9518     | 0.583661   | 0.3173     | 0.8773     | Arrival      | 0.6866  | -0.1519     | 0.1861      |             | Arrival      | 0.8899   | -0.1482 |          | Arrival        |  | 0.309   |
| Comp3     | 0.368139   | .          | 0.1227     | 1          | Protocol     | 0.2605  | 0.9644      | 0.000759    |             | Protocol     | 0.3376   | 0.9409  |          | Protocol       |  | 0.380   |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1   | Comp2       | Comp3       | Unexplained |              | Comp1    | Comp2   | Comp3    |                |  |         |
| Comp1     | 2.0468     | 0.640347   | 0.4094     | 0.4094     | Trade_d      | 0.4511  | 0.125       | 0.7761      | 0.07756     | Trade_d      | 0.6454   | 0.1482  | 0.6957   | Trade_d        |  | 0.217   |
| Comp2     | 1.40646    | 0.602941   | 0.2813     | 0.6907     | Productive_d | 0.5763  | -0.2901     | 0.0032      | 0.2017      | Productive_d | 0.8245   | -0.3441 | 0.002853 | Productive_d   |  | 0.188   |
| Comp3     | 0.803516   | 0.364415   | 0.1607     | 0.8514     | Macro_d      | 0.338   | 0.5465      | -0.5197     | 0.1291      | Macro_d      | 0.4835   | 0.6482  | -0.4659  | Macro_d        |  | 0.205   |
| Comp4     | 0.439101   | 0.134979   | 0.0878     | 0.9392     | Infrastruc~d | 0.5898  | -0.1865     | -0.3129     | 0.1604      | Infrastruc~d | 0.8438   | -0.2212 | -0.2805  | Infrastruc~d   |  | 0.197   |
| Comp5     | 0.304122   | .          | 0.0608     | 1          | Movement_d   | 0.048   | 0.7528      | 0.1722      | 0.1744      | Movement_d   | 0.06869  | 0.8928  | 0.1543   | Movement_d     |  | 0.194   |

Table 42 Results of PCA and weights derived for indicators and dimensions - IGAD

| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1   | Comp2       | Unexplained |  |  | Comp1        | Comp2   |         |  |                |       |
|-----------|------------|------------|------------|------------|--------------|---------|-------------|-------------|--|--|--------------|---------|---------|--|----------------|-------|
| Comp1     | 2.3597     | 1.4358     | 0.5899     | 0.5899     | Tariff       | 0.5675  | -0.4043     | 0.0889      |  |  | Tariff       | 0.8718  | -0.3886 |  | Tariff         | 0.277 |
| Comp2     | 0.9239     | 0.3406     | 0.2310     | 0.8209     | Trade        | 0.4281  | 0.5609      | 0.2769      |  |  | Trade        | 0.6576  | 0.5391  |  | Trade          | 0.220 |
| Comp3     | 0.5833     | 0.4502     | 0.1458     | 0.9667     | Exports      | 0.4349  | 0.5583      | 0.2657      |  |  | Exports      | 0.6681  | 0.5366  |  | Exports        | 0.224 |
| Comp4     | 0.1331     | .          | 0.0333     | 1.0000     | Imports      | -0.5527 | 0.4586      | 0.0849      |  |  | Imports      | -0.8490 | 0.4408  |  | Imports        | 0.279 |
|           |            |            |            |            |              |         |             |             |  |  |              |         |         |  |                |       |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1   | Unexplained |             |  |  | Comp1        |         |         |  |                |       |
| Comp1     | 2.2717     | 1.6686     | 0.7572     | 0.7572     | Intermedia~M | 0.5535  | 0.3041      |             |  |  | Intermedia~M | 0.8342  |         |  | Intermedia~M   | 0.306 |
| Comp2     | 0.6030     | 0.4778     | 0.2010     | 0.9582     | Intermedia~X | 0.6382  | 0.0748      |             |  |  | Intermedia~X | 0.9619  |         |  | Intermedia~X   | 0.407 |
| Comp3     | 0.1253     | .          | 0.0418     | 1.0000     | TCI          | 0.5352  | 0.3494      |             |  |  | TCI          | 0.8066  |         |  | TCI            | 0.286 |
|           |            |            |            |            |              |         |             |             |  |  |              |         |         |  |                |       |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1   | Comp2       | Unexplained |  |  | Comp1        | Comp2   |         |  |                |       |
| Comp1     | 1.6146     | 0.6146     | 0.5382     | 0.5382     | Currency     | 0.7042  | -0.0908     | 0.1911      |  |  | Currency     | 0.8948  | -0.0909 |  | Currency       | 0.309 |
| Comp2     | 1.0000     | 0.6146     | 0.3333     | 0.8715     | Investment   | 0.0642  | 0.9959      | 0.0016      |  |  | Investment   | 0.0816  | 0.9959  |  | Investment     | 0.382 |
| Comp3     | 0.3854     | .          | 0.1285     | 1.0000     | Inflation    | -0.7071 | 0.0000      | 0.1927      |  |  | Inflation    | -0.8985 | 0.0000  |  | Inflation      | 0.309 |
|           |            |            |            |            |              |         |             |             |  |  |              |         |         |  |                |       |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1   | Comp2       | Unexplained |  |  | Comp1        | Comp2   |         |  |                |       |
| Comp1     | 1.3940     | 0.7880     | 0.6970     | 0.6970     | Infrastruc~e | 0.7071  | 0.7071      | 0.0000      |  |  | Infrastruc~e | 0.7071  | 0.7071  |  | Infrastructure | 0.500 |
| Comp2     | 0.6060     | .          | 0.3030     | 1.0000     | Connections  | 0.7071  | -0.7071     | 0.0000      |  |  | Connections  | 0.7071  | -0.7071 |  | Connections    | 0.500 |
|           |            |            |            |            |              |         |             |             |  |  |              |         |         |  |                |       |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1   | Unexplained |             |  |  | Comp1        |         |         |  |                |       |
| Comp1     | 2.3678     | 1.7961     | 0.7893     | 0.7893     | Required     | 0.6036  | 0.1374      |             |  |  | Required     | 0.9287  |         |  | Required       | 0.364 |
| Comp2     | 0.5717     | 0.5112     | 0.1906     | 0.9798     | Arrival      | 0.6269  | 0.0696      |             |  |  | Arrival      | 0.9646  |         |  | Arrival        | 0.393 |
| Comp3     | 0.0605     | .          | 0.0202     | 1.0000     | Protocol     | 0.4927  | 0.4252      |             |  |  | Protocol     | 0.7581  |         |  | Protocol       | 0.243 |
|           |            |            |            |            |              |         |             |             |  |  |              |         |         |  |                |       |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1   | Comp2       | Unexplained |  |  | Comp1        | Comp2   |         |  |                |       |
| Comp1     | 2.5920     | 1.2062     | 0.5184     | 0.5184     | Trade_d      | 0.5380  | 0.1970      | 0.1960      |  |  | Trade_d      | 0.8662  | 0.2319  |  | Trade_d        | 0.202 |
| Comp2     | 1.3858     | 0.8149     | 0.2772     | 0.7956     | Productive_d | 0.5558  | 0.0161      | 0.1988      |  |  | Productive_d | 0.8949  | 0.0190  |  | Productive_d   | 0.201 |
| Comp3     | 0.5709     | 0.2584     | 0.1142     | 0.9098     | Macro_d      | -0.1504 | 0.7772      | 0.1042      |  |  | Macro_d      | -0.2421 | 0.9150  |  | Macro_d        | 0.225 |
| Comp4     | 0.3125     | 0.1737     | 0.0625     | 0.9722     | Infrastruc~d | 0.4690  | 0.3893      | 0.2197      |  |  | Infrastruc~d | 0.7551  | 0.4583  |  | Infrastruc~d   | 0.196 |
| Comp5     | 0.1388     | .          | 0.0278     | 1.0000     | Movement_d   | 0.3987  | -0.4531     | 0.3034      |  |  | Movement_d   | 0.6419  | -0.5334 |  | Movement_d     | 0.175 |

Table 43 Results of PCA and weights derived for indicators and dimensions - EAC

|           |            |            |            |            | Eigenvectors |         |             |             |  | Loadings     |         |         |  |                | Weights |
|-----------|------------|------------|------------|------------|--------------|---------|-------------|-------------|--|--------------|---------|---------|--|----------------|---------|
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1   | Unexplained |             |  |              | Comp1   |         |  |                |         |
|           |            |            |            |            |              |         |             |             |  |              |         |         |  | Tariff         | 0       |
| Comp1     | 2.23087    | 1.50534    | 0.7436     | 0.7436     | Trade        | 0.6584  | 0.03281     |             |  | Trade        | 0.9835  |         |  | Trade          | 0.434   |
| Comp2     | 0.725528   | 0.681923   | 0.2418     | 0.9855     | Exports      | 0.5872  | 0.2307      |             |  | Exports      | 0.8771  |         |  | Exports        | 0.345   |
| Comp3     | 0.0436054  | .          | 0.0145     | 1          | Imports      | -0.4708 | 0.5056      |             |  | Imports      | -0.7031 |         |  | Imports        | 0.222   |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1   | Comp2       | Unexplained |  |              | Comp1   | Comp2   |  |                |         |
| Comp1     | 2.43337    | 1.92594    | 0.8111     | 0.8111     | Intermedia~M | 0.5082  | 0.8549      | 0.0006436   |  | Intermedia~M | 0.7928  | 0.609   |  | Intermedia~M   | 0.340   |
| Comp2     | 0.507434   | 0.448239   | 0.1691     | 0.9803     | Intermedia~X | 0.6178  | -0.2776     | 0.03204     |  | Intermedia~X | 0.9638  | -0.1977 |  | Intermedia~X   | 0.329   |
| Comp3     | 0.0591953  | .          | 0.0197     | 1          | TCI          | 0.6     | -0.4383     | 0.02651     |  | TCI          | 0.9359  | -0.3122 |  | TCI            | 0.331   |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1   | Unexplained |             |  |              | Comp1   |         |  |                |         |
| Comp1     | 1.59952    | 1.19903    | 0.7998     | 0.7998     | Inflation    | 0.7071  | 0.2002      |             |  | Inflation    | 0.8943  |         |  | Inflation      | 0.500   |
| Comp2     | 0.400485   | .          | 0.2002     |            | Currency     | 0.7071  | 0.2002      |             |  | Currency     | 0.8943  |         |  | Currency       | 0.500   |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1   | Comp2       | Unexplained |  |              | Comp1   | Comp2   |  |                |         |
| Comp1     | 1.708      | 1.41599    | 0.854      | 0.854      | Infrastruc~e | 0.7071  | 0.7071      | 0           |  | Infrastruc~e | 0.9241  | 0.3821  |  | Infrastructure | 0.500   |
| Comp2     | 0.292004   | .          | 0.146      | 1          | Connections  | 0.7071  | -0.7071     | 0           |  | Connections  | 0.9241  | -0.3821 |  | Connections    | 0.500   |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1   | Comp2       | Unexplained |  |              | Comp1   | Comp2   |  |                |         |
| Comp1     | 1.32543    | 0.129112   | 0.4418     | 0.4418     | Required     | -0.7663 | -0.1836     | 0.1813      |  | Required     | -0.8823 | -0.2008 |  | Required       | 0.325   |
| Comp2     | 1.19632    | 0.718066   | 0.3988     | 0.8406     | Arrival      | 0.2323  | 0.8142      | 0.1354      |  | Arrival      | 0.2675  | 0.8905  |  | Arrival        | 0.343   |
| Comp3     | 0.478252   | .          | 0.1594     | 1          | Protocol     | 0.5989  | -0.5508     | 0.1616      |  | Protocol     | 0.6895  | -0.6024 |  | Protocol       | 0.332   |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1   | Comp2       | Unexplained |  |              | Comp1   | Comp2   |  |                |         |
| Comp1     | 2.95818    | 1.75952    | 0.5916     | 0.5916     | Trade_d      | 0.5256  | -0.2353     | 0.1166      |  | Trade_d      | 0.9039  | -0.2576 |  | Trade_d        | 0.213   |
| Comp2     | 1.19866    | 0.4359     | 0.2397     | 0.8314     | Productive_d | 0.4814  | -0.5045     | 0.00951     |  | Productive_d | 0.8279  | -0.5523 |  | Productive_d   | 0.238   |
| Comp3     | 0.762763   | 0.685505   | 0.1526     | 0.9839     | Macro_d      | 0.3756  | 0.5125      | 0.268       |  | Macro_d      | 0.6459  | 0.5611  |  | Macro_d        | 0.176   |
| Comp4     | 0.0772579  | 0.0741195  | 0.0155     | 0.9994     | Infrastruc~d | 0.5512  | 0.0591      | 0.09698     |  | Infrastruc~d | 0.9481  | 0.06468 |  | Infrastruc~d   | 0.217   |
| Comp5     | 0.0031384  | .          | 0.0006     | 1          | Movement_d   | 0.2172  | 0.6512      | 0.3521      |  | Movement_d   | 0.3737  | 0.7129  |  | Movement_d     | 0.156   |

Table 44 Results of PCA and weights derived for indicators and dimensions - AMU

|           |            |            |            |            | Eigenvectors |         |         |             |  |  | Loadings     |         |         |  |                | Weights |
|-----------|------------|------------|------------|------------|--------------|---------|---------|-------------|--|--|--------------|---------|---------|--|----------------|---------|
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1   | Comp2   | Unexplained |  |  | Comp1        | Comp2   |         |  |                |         |
| Comp1     | 2.0086     | 0.2421     | 0.5021     | 0.5021     | Tariff       | 0.6587  | -0.1099 | 0.1072      |  |  | Tariff       | 0.9335  | -0.1461 |  | Tariff         | 0.236   |
| Comp2     | 1.7665     | 1.5465     | 0.4416     | 0.9438     | Trade        | 0.2594  | 0.6878  | 0.0291      |  |  | Trade        | 0.3676  | 0.9142  |  | Trade          | 0.257   |
| Comp3     | 0.2200     | 0.2149     | 0.0550     | 0.9987     | Exports      | -0.1503 | 0.7175  | 0.0453      |  |  | Exports      | -0.2130 | 0.9536  |  | Exports        | 0.253   |
| Comp4     | 0.0050     | .          | 0.0013     | 1.0000     | Imports      | -0.6901 | -0.0026 | 0.0433      |  |  | Imports      | -0.9781 | -0.0035 |  | Imports        | 0.253   |
|           |            |            |            |            |              |         |         |             |  |  |              |         |         |  |                |         |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1   | Comp2   | Unexplained |  |  | Comp1        | Comp2   |         |  |                |         |
| Comp1     | 2.0341     | 1.1261     | 0.6780     | 0.6780     | Intermedia~M | 0.6812  | -0.1715 | 0.0293      |  |  | Intermedia~M | 0.9716  | -0.1634 |  | Intermedia~M   | 0.330   |
| Comp2     | 0.9080     | 0.8501     | 0.3027     | 0.9807     | Intermedia~X | 0.2886  | 0.9564  | 0.0001      |  |  | Intermedia~X | 0.4116  | 0.9113  |  | Intermedia~X   | 0.340   |
| Comp3     | 0.0579     | .          | 0.0193     | 1.0000     | TCI          | 0.6728  | -0.2365 | 0.0285      |  |  | TCI          | 0.9596  | -0.2254 |  | TCI            | 0.330   |
|           |            |            |            |            |              |         |         |             |  |  |              |         |         |  |                |         |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1   | Comp2   | Unexplained |  |  | Comp1        | Comp2   |         |  |                |         |
| Comp1     | 1.2371     | 0.4743     | 0.6186     | 0.6186     | Inflation    | 0.7071  | 0.7071  | 0.0000      |  |  | Inflation    | 0.7865  | 0.6176  |  | Inflation      | 0.500   |
| Comp2     | 0.7629     | .          | 0.3814     | 1.0000     | Investment   | 0.7071  | -0.7071 | 0.0000      |  |  | Investment   | 0.7865  | -0.6176 |  | Investment     | 0.500   |
|           |            |            |            |            |              |         |         |             |  |  |              |         |         |  |                |         |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1   | Comp2   | Unexplained |  |  | Comp1        | Comp2   |         |  |                |         |
| Comp1     | 1.4094     | 0.8188     | 0.7047     | 0.7047     | Infrastruc~e | 0.7071  | 0.7071  | 0.0000      |  |  | Infrastruc~e | 0.8395  | 0.5434  |  | Infrastructure | 0.500   |
| Comp2     | 0.5906     | .          | 0.2953     | 1.0000     | Connections  | 0.7071  | -0.7071 | 0.0000      |  |  | Connections  | 0.8395  | -0.5434 |  | Connections    | 0.500   |
|           |            |            |            |            |              |         |         |             |  |  |              |         |         |  |                |         |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1   | Comp2   | Unexplained |  |  | Comp1        | Comp2   |         |  |                |         |
| Comp1     | 1.7994     | 0.6270     | 0.5998     | 0.5998     | Required     | 0.7298  | 0.1579  | 0.0125      |  |  | Required     | 0.9789  | 0.1710  |  | Required       | 0.332   |
| Comp2     | 1.1724     | 1.1442     | 0.3908     | 0.9906     | Arrival      | 0.6593  | -0.4200 | 0.0110      |  |  | Arrival      | 0.8844  | -0.4547 |  | Arrival        | 0.333   |
| Comp3     | 0.0282     | .          | 0.0094     | 1.0000     | Protocol     | 0.1809  | 0.8937  | 0.0048      |  |  | Protocol     | 0.2426  | 0.9677  |  | Protocol       | 0.335   |
|           |            |            |            |            |              |         |         |             |  |  |              |         |         |  |                |         |
| Component | Eigenvalue | Difference | Proportion | Cumulative | Variable     | Comp1   | Comp2   | Unexplained |  |  | Comp1        | Comp2   |         |  |                |         |
| Comp1     | 2.7799     | 1.5764     | 0.5560     | 0.5560     | Trade_d      | 0.5835  | 0.0510  | 0.0505      |  |  | Trade_d      | 0.9728  | 0.0559  |  | Trade_d        | 0.238   |
| Comp2     | 1.2035     | 0.2626     | 0.2407     | 0.7967     | Productive_d | 0.5758  | 0.1203  | 0.0611      |  |  | Productive_d | 0.9600  | 0.1319  |  | Productive_d   | 0.236   |
| Comp3     | 0.9409     | 0.8651     | 0.1882     | 0.9848     | Macro_d      | 0.0860  | 0.6787  | 0.4251      |  |  | Macro_d      | 0.1434  | 0.7445  |  | Macro_d        | 0.144   |
| Comp4     | 0.0758     | 0.0758     | 0.0152     | 1.0000     | Infrastruc~d | 0.5661  | -0.2956 | 0.0041      |  |  | Infrastruc~d | 0.9438  | -0.3243 |  | Infrastruc~d   | 0.250   |
| Comp5     | 0.0000     | .          | 0.0000     | 1.0000     | Movement_d   | 0.0151  | 0.6595  | 0.4759      |  |  | Movement_d   | 0.0252  | 0.7235  |  | Movement_d     | 0.132   |

## Weights assigned through PCA

Table 45 Weights of indicators and dimensions for Africa and RECs

|                           | Weights by region |       |        |         |        |       |       |       |       |
|---------------------------|-------------------|-------|--------|---------|--------|-------|-------|-------|-------|
| Indicators                | Africa            | SADC  | ECOWAS | CEN-SAD | COMESA | ECCAS | IGAD  | EAC   | AMU   |
| Tariff                    | 0.249             | 0.165 | 0.220  | 0.285   | 0.256  | 0.320 | 0.277 | 0.000 | 0.236 |
| Trade                     | 0.144             | 0.292 | 0.274  | 0.286   | 0.267  | 0.295 | 0.220 | 0.434 | 0.257 |
| Exports                   | 0.221             | 0.268 | 0.272  | 0.181   | 0.227  | 0.304 | 0.224 | 0.345 | 0.253 |
| Imports                   | 0.224             | 0.276 | 0.234  | 0.248   | 0.250  | 0.081 | 0.279 | 0.222 | 0.253 |
| ACFTA                     | 0.161             | 0.000 | 0.000  | 0.000   | 0.000  | 0.000 | 0.000 | 0.000 | 0.000 |
|                           |                   |       |        |         |        |       |       |       |       |
| Intermediates import      | 0.320             | 0.247 | 0.311  | 0.303   | 0.318  | 0.320 | 0.306 | 0.340 | 0.330 |
| Intermediates export      | 0.318             | 0.407 | 0.384  | 0.287   | 0.315  | 0.322 | 0.407 | 0.329 | 0.340 |
| TCI                       | 0.362             | 0.346 | 0.305  | 0.409   | 0.367  | 0.358 | 0.286 | 0.331 | 0.330 |
|                           |                   |       |        |         |        |       |       |       |       |
| Inflation                 | 0.360             | 0.338 | 0.288  | 0.287   | 0.352  | 0.500 | 0.309 | 0.500 | 0.500 |
| Currency                  | 0.266             | 0.327 | 0.322  | 0.362   | 0.248  | 0.500 | 0.382 | 0.500 | 0.000 |
| Investment                | 0.374             | 0.335 | 0.390  | 0.351   | 0.400  | 0.000 | 0.309 | 0.000 | 0.500 |
|                           |                   |       |        |         |        |       |       |       |       |
| AfDB Infrastructure Index | 0.500             | 0.500 | 0.500  | 0.500   | 0.500  | 0.500 | 0.500 | 0.500 | 0.500 |
| Connections               | 0.500             | 0.500 | 0.500  | 0.500   | 0.500  | 0.500 | 0.500 | 0.500 | 0.500 |
|                           |                   |       |        |         |        |       |       |       |       |
| Required                  |                   |       |        |         |        |       |       |       |       |
| Arrival                   | 0.327             | 0.307 | 0.333  | 0.316   | 0.330  | 0.311 | 0.364 | 0.325 | 0.332 |
| Protocol                  | 0.328             | 0.354 | 0.333  | 0.319   | 0.385  | 0.309 | 0.393 | 0.343 | 0.333 |
|                           |                   |       |        |         |        |       |       |       |       |
| Dimensions                | Weights by region |       |        |         |        |       |       |       |       |

|                        |           |           |       |       |       |       |           |           |           |
|------------------------|-----------|-----------|-------|-------|-------|-------|-----------|-----------|-----------|
| <b>Trade</b>           | 0.22<br>3 | 0.20<br>4 | 0.226 | 0.208 | 0.181 | 0.217 | 0.20<br>2 | 0.21<br>3 | 0.23<br>8 |
| <b>Productive</b>      | 0.18<br>1 | 0.19<br>4 | 0.224 | 0.215 | 0.191 | 0.188 | 0.20<br>1 | 0.23<br>8 | 0.23<br>6 |
| <b>Macroeconomic</b>   | 0.23<br>5 | 0.17<br>3 | 0.152 | 0.200 | 0.204 | 0.205 | 0.22<br>5 | 0.17<br>6 | 0.14<br>4 |
| <b>Infrastructural</b> | 0.21<br>3 | 0.19<br>4 | 0.199 | 0.177 | 0.202 | 0.197 | 0.19<br>6 | 0.21<br>7 | 0.25<br>0 |
| <b>Free Movement</b>   | 0.14<br>8 | 0.23<br>5 | 0.200 | 0.200 | 0.221 | 0.194 | 0.17<br>5 | 0.15<br>6 | 0.13<br>2 |

## Rankings using PCA weights vs Equal weights - African level

Figure 6 Comparing rankings using PCA and equal weights

| Country              | PCA weights | Equal weights | Change in ranking | PCA weights | Equal weights | Change in ranking | PCA weights | Equal weights | Change in ranking | PCA weights | Equal weights | Change in ranking | PCA weights | Equal weights | Change in ranking | PCA weights | Equal weights | Change in ranking |
|----------------------|-------------|---------------|-------------------|-------------|---------------|-------------------|-------------|---------------|-------------------|-------------|---------------|-------------------|-------------|---------------|-------------------|-------------|---------------|-------------------|
| South Africa         | 1           | 1             | 0                 | 4           | 3             | 1                 | 1           | 1             | 0                 | 25          | 29            | -4                | 1           | 1             | 0                 | 45          | 45            |                   |
| Kenya                | 2           | 2             | 0                 | 18          | 13            | 5                 | 7           | 7             | 0                 | 38          | 38            | 0                 | 8           | 8             | 0                 | 10          | 10            |                   |
| Rwanda               | 3           | 3             | 0                 | 13          | 14            | -1                | 33          | 33            | 0                 | 4           | 2             | 2                 | 23          | 23            | 0                 | 6.5         | 6.5           |                   |
| Mauritius            | 5           | 11            | -6                | 33          | 35            | -2                | 32          | 31            | 1                 | 2           | 3             | -1                | 6           | 6             | 0                 | 29          | 25.5          | 3.5               |
| Ghana                | 8           | 4             | 4                 | 10          | 9             | 1                 | 16          | 17            | -1                | 40          | 33            | 7                 | 18          | 18            | 0                 | 8           | 8             |                   |
| Togo                 | 9           | 5             | 4                 | 20          | 20            | 0                 | 25          | 26            | -1                | 18          | 15            | 3                 | 31          | 31            | 0                 | 6.5         | 6.5           |                   |
| Morocco              | 4           | 13            | -9                | 39          | 39            | 0                 | 8           | 8             | 0                 | 1           | 1             | 0                 | 4           | 4             | 0                 | 48          | 48            |                   |
| Djibouti             | 10          | 6             | 4                 | 12          | 15            | -3                | 21          | 22            | -1                | 39          | 42            | -3                | 29          | 29            | 0                 | 2           | 2             |                   |
| Mauritania           | 13          | 7             | 6                 | 29          | 27            | 2                 | 51          | 51            | 0                 | 7           | 6             | 1                 | 42          | 42            | 0                 | 4           | 4             |                   |
| Senegal              | 7           | 8             | -1                | 9           | 7             | 2                 | 15          | 16            | -1                | 9           | 9             | 0                 | 20          | 20            | 0                 | 14          | 14            |                   |
| Mozambique           | 14          | 9             | 5                 | 22          | 29            | -7                | 14          | 13            | 1                 | 43          | 41            | 2                 | 36          | 36            | 0                 | 5           | 5             |                   |
| Egypt                | 6           | 15            | -9                | 21          | 19            | 2                 | 10          | 10            | 0                 | 3           | 4             | -1                | 2           | 2             | 0                 | 47          | 47            |                   |
| Uganda               | 15          | 10            | 5                 | 15          | 12            | 3                 | 18          | 18            | 0                 | 42          | 44            | -2                | 27          | 27            | 0                 | 9           | 9             |                   |
| Comoros              | 20          | 16            | 4                 | 51          | 52            | -1                | 39          | 40            | -1                | 29          | 30            | -1                | 25          | 25            | 0                 | 2           | 2             |                   |
| Zimbabwe             | 12          | 14            | -2                | 5           | 5             | 0                 | 17          | 15            | 2                 | 33          | 36            | -3                | 13          | 13            | 0                 | 17          | 18            | -1                |
| Burkina Faso         | 16          | 17            | -1                | 14          | 16            | -2                | 27          | 25            | 2                 | 6           | 7             | -1                | 34          | 34            | 0                 | 16          | 16.5          | -0.5              |
| Mali                 | 18          | 20            | -2                | 17          | 17            | 0                 | 40          | 38            | 2                 | 5           | 5             | 0                 | 28          | 28            | 0                 | 21          | 21            |                   |
| Cabo Verde           | 22          | 21            | 1                 | 43          | 43            | 0                 | 41          | 43            | -2                | 8           | 8             | 0                 | 12          | 12            | 0                 | 19          | 19            |                   |
| Somalia              | 31          | 23            | 8                 | 54          | 54            | 0                 | 24          | 24            | 0                 | 32          | 35            | -3                | 52          | 52            | 0                 | 2           | 2             |                   |
| Seychelles           | 11          | 12            | -1                | 32          | 34            | -2                | 42          | 42            | 0                 | 36          | 39            | -3                | 3           | 3             | 0                 | 12          | 12            |                   |
| Côte d'Ivoire        | 17          | 22            | -5                | 6           | 6             | 0                 | 6           | 6             | 0                 | 17          | 14            | 3                 | 11          | 11            | 0                 | 40          | 40            |                   |
| Tunisia              | 24          | 26            | -2                | 52          | 51            | 1                 | 4           | 3             | 1                 | 16          | 25            | -9                | 5           | 5             | 0                 | 39          | 39            |                   |
| The Gambia           | 19          | 19            | 0                 | 8           | 8             | 0                 | 43          | 44            | -1                | 12          | 10            | 2                 | 26          | 26            | 0                 | 20          | 20            |                   |
| Gabon                | 23          | 24            | -1                | 26          | 24            | 2                 | 38          | 39            | -1                | 11          | 11            | 0                 | 16          | 16            | 0                 | 33          | 32            | 1                 |
| Rep. of the Congo    | 27          | 27            | 0                 | 11          | 11            | 0                 | 54          | 54            | 0                 | 15          | 13            | 2                 | 38          | 38            | 0                 | 22          | 22            |                   |
| Guinea-Bissau        | 35          | 30            | 5                 | 46          | 46            | 0                 | 31          | 32            | -1                | 22          | 19            | 3                 | 45          | 45            | 0                 | 18          | 15            | 3                 |
| Madagascar           | 37          | 31            | 6                 | 38          | 40            | -2                | 46          | 46            | 0                 | 34          | 37            | -3                | 39          | 39            | 0                 | 12          | 12            |                   |
| Namibia              | 25          | 28            | -3                | 2           | 2             | 0                 | 9           | 9             | 0                 | 44          | 45            | -1                | 21          | 21            | 0                 | 46          | 46            |                   |
| Guinea               | 33          | 32            | 1                 | 27          | 25            | 2                 | 47          | 47            | 0                 | 26          | 26            | 0                 | 41          | 41            | 0                 | 23          | 23            |                   |
| Sao Tome & Principe  | 26          | 25            | 1                 | 24          | 22            | 2                 | 12          | 14            | -2                | 24          | 24            | 0                 | 30          | 30            | 0                 | 34.5        | 34.5          |                   |
| Chad                 | 32          | 33            | -1                | 28          | 28            | 0                 | 26          | 27            | -1                | 23          | 21            | 2                 | 51          | 51            | 0                 | 26          | 27.5          | -1.5              |
| Lesotho              | 29          | 37            | -8                | 3           | 4             | -1                | 53          | 53            | 0                 | 45          | 46            | -1                | 46          | 46            | 0                 | 25          | 25.5          | -0.5              |
| Niger                | 36          | 35            | 1                 | 19          | 18            | 1                 | 50          | 50            | 0                 | 14          | 12            | 2                 | 50          | 50            | 0                 | 24          | 24            |                   |
| Utd Rep. of Tanzania | 28          | 29            | -1                | 35          | 36            | -1                | 20          | 19            | 1                 | 27          | 28            | -1                | 22          | 22            | 0                 | 30          | 27.5          | 2.5               |
| Benin                | 21          | 18            | 3                 | 31          | 31            | 0                 | 35          | 35            | 0                 | 21          | 18            | 3                 | 24          | 24            | 0                 | 12          | 12            |                   |
| Malawi               | 42          | 36            | 6                 | 30          | 30            | 0                 | 29          | 28            | 1                 | 51          | 51            | 0                 | 33          | 33            | 0                 | 15          | 16.5          | -1.5              |
| Botswana             | 34          | 40            | -6                | 7           | 10            | -3                | 13          | 11            | 2                 | 37          | 40            | -3                | 19          | 19            | 0                 | 43.5        | 43            | 0.5               |
| Equatorial Guinea    | 30          | 34            | -4                | 25          | 23            | 2                 | 36          | 36            | 0                 | 20          | 17            | 3                 | 35          | 35            | 0                 | 37          | 37            |                   |
| Central African Rep. | 45          | 41            | 4                 | 47          | 47            | 0                 | 30          | 30            | 0                 | 28          | 27            | 1                 | 47          | 47            | 0                 | 27.5        | 29.5          | -2                |
| Zambia               | 41          | 39            | 2                 | 16          | 26            | -10               | 5           | 5             | 0                 | 52          | 52            | 0                 | 14          | 14            | 0                 | 38          | 38            |                   |
| Algeria              | 43          | 44            | -1                | 50          | 49            | 1                 | 23          | 21            | 2                 | 13          | 22            | -9                | 9           | 9             | 0                 | 50.5        | 50.5          |                   |
| Nigeria              | 38          | 38            | 0                 | 34          | 33            | 1                 | 2           | 2             | 0                 | 35          | 31            | 4                 | 15          | 15            | 0                 | 41          | 41            |                   |
| Libya                | 44          | 43            | 1                 | 36          | 37            | -1                | 34          | 34            | 0                 | 41          | 34            | 7                 | 7           | 7             | 0                 | 54          | 54            |                   |
| Eswatini             | 39          | 42            | -3                | 1           | 1             | 0                 | 48          | 48            | 0                 | 48          | 48            | 0                 | 40          | 40            | 0                 | 43.5        | 43            | 0.5               |
| Cameroon             | 46          | 46            | 0                 | 48          | 48            | 0                 | 11          | 12            | -1                | 19          | 16            | 3                 | 17          | 17            | 0                 | 49          | 49            |                   |
| Liberia              | 47          | 49            | -2                | 45          | 45            | 0                 | 22          | 23            | -1                | 49          | 49            | 0                 | 48          | 48            | 0                 | 27.5        | 29.5          | -2                |
| Ethiopia             | 40          | 45            | -5                | 23          | 21            | 2                 | 52          | 52            | 0                 | 10          | 20            | -10               | 10          | 10            | 0                 | 52          | 52            |                   |
| D. Rep. of the Congo | 48          | 47            | 1                 | 42          | 41            | 1                 | 45          | 41            | 4                 | 46          | 43            | 3                 | 43          | 43            | 0                 | 32          | 32            |                   |
| Angola               | 49          | 48            | 1                 | 37          | 38            | -1                | 3           | 4             | -1                | 53          | 53            | 0                 | 32          | 32            | 0                 | 34.5        | 34.5          |                   |
| Sudan                | 50          | 50            | 0                 | 53          | 53            | 0                 | 19          | 20            | -1                | 47          | 47            | 0                 | 37          | 37            | 0                 | 36          | 36            |                   |
| Sierra Leone         | 51          | 51            | 0                 | 40          | 32            | 8                 | 37          | 37            | 0                 | 30          | 23            | 7                 | 49          | 49            | 0                 | 42          | 43            | -1                |
| Burundi              | 52          | 52            | 0                 | 41          | 42            | -1                | 44          | 45            | -1                | 31          | 32            | -1                | 44          | 44            | 0                 | 50.5        | 50.5          |                   |
| South Sudan          | 54          | 53            | 1                 | 44          | 44            | 0                 | 49          | 49            | 0                 | 54          | 54            | 0                 | 54          | 54            | 0                 | 31          | 32            | -1                |
| Eritrea              | 53          | 54            | -1                | 49          | 50            | -1                | 28          | 29            | -1                | 50          | 50            | 0                 | 53          | 53            | 0                 | 53          | 53            |                   |

Figure 7 Comparing rankings using PCA and equal weights (ARII 18 variables)

| Country              | Regional integration |               |                   | Trade integration |               |                   | Productive integration |               |                   | Macroeconomic integration |               |                   | Infrastructural integration |               |                   | Free movement of people |               |                   |
|----------------------|----------------------|---------------|-------------------|-------------------|---------------|-------------------|------------------------|---------------|-------------------|---------------------------|---------------|-------------------|-----------------------------|---------------|-------------------|-------------------------|---------------|-------------------|
|                      | PCA weights          | Equal weights | Change in ranking | PCA weights       | Equal weights | Change in ranking | PCA weights            | Equal weights | Change in ranking | PCA weights               | Equal weights | Change in ranking | PCA weights                 | Equal weights | Change in ranking | PCA weights             | Equal weights | Change in ranking |
| Rwanda               | 1                    | 2             | -1                | 13                | 13            | 0                 | 33                     | 33            | 0                 | 3                         | 2             | 1                 | 15                          | 15            | 0                 | 6.5                     | 6.5           |                   |
| South Africa         | 2                    | 1             | 1                 | 3                 | 3             | 0                 | 1                      | 1             | 0                 | 33                        | 34            | -1                | 1                           | 1             | 0                 | 45                      | 45            |                   |
| Ghana                | 3                    | 3             | 0                 | 8                 | 8             | 0                 | 16                     | 17            | -1                | 13                        | 13            | 0                 | 11                          | 11            | 0                 | 8                       | 8             |                   |
| Mozambique           | 4                    | 5             | -1                | 18                | 20            | -2                | 14                     | 13            | 1                 | 20                        | 20            | 0                 | 16                          | 16            | 0                 | 5                       | 5             |                   |
| Kenya                | 5                    | 4             | 1                 | 15                | 12            | 3                 | 7                      | 7             | 0                 | 40                        | 40            | 0                 | 4                           | 4             | 0                 | 10                      | 10            |                   |
| Togo                 | 6                    | 6             | 0                 | 19                | 19            | 0                 | 25                     | 26            | -1                | 27                        | 26            | 1                 | 13                          | 12            | 1                 | 6.5                     | 6.5           |                   |
| Mauritania           | 7                    | 8             | -1                | 22                | 22            | 0                 | 51                     | 51            | 0                 | 8                         | 8             | 0                 | 48                          | 48            | 0                 | 4                       | 4             |                   |
| Djibouti             | 8                    | 7             | 1                 | 14                | 14            | 0                 | 21                     | 22            | -1                | 48                        | 48            | 0                 | 40                          | 40            | 0                 | 2                       | 2             |                   |
| Burkina Faso         | 9                    | 12            | -3                | 29                | 29            | 0                 | 27                     | 25            | 2                 | 10                        | 10            | 0                 | 18                          | 18            | 0                 | 13                      | 14.5          | -1                |
| Mali                 | 10                   | 13            | -3                | 16                | 15            | 1                 | 40                     | 38            | 2                 | 6                         | 6             | 0                 | 17                          | 17            | 0                 | 19                      | 19            |                   |
| Uganda               | 11                   | 10            | 1                 | 12                | 11            | 1                 | 18                     | 18            | 0                 | 44                        | 44            | 0                 | 39                          | 39            | 0                 | 9                       | 9             |                   |
| Zimbabwe             | 12                   | 9             | 3                 | 9                 | 10            | -1                | 17                     | 15            | 2                 | 43                        | 43            | 0                 | 10                          | 9             | 1                 | 15                      | 16            |                   |
| Senegal              | 13                   | 14            | -1                | 7                 | 7             | 0                 | 15                     | 16            | -1                | 17                        | 16            | 1                 | 35                          | 35            | 0                 | 12                      | 12            |                   |
| Egypt                | 14                   | 11            | 3                 | 20                | 18            | 2                 | 10                     | 10            | 0                 | 2                         | 3             | -1                | 3                           | 2             | 1                 | 47                      | 47            |                   |
| Comoros              | 15                   | 15            | 0                 | 51                | 51            | 0                 | 39                     | 40            | -1                | 38                        | 38            | 0                 | 38                          | 37            | 1                 | 2                       | 2             |                   |
| Rep. of the Congo    | 16                   | 18            | -2                | 10                | 9             | 1                 | 54                     | 54            | 0                 | 19                        | 19            | 0                 | 19                          | 19            | 0                 | 20                      | 20            |                   |
| Mauritius            | 17                   | 17            | 0                 | 28                | 28            | 0                 | 32                     | 31            | 1                 | 4                         | 4             | 0                 | 30                          | 29            | 1                 | 27                      | 23.5          | 3                 |
| Guinea               | 18                   | 19            | -1                | 21                | 21            | 0                 | 47                     | 47            | 0                 | 16                        | 15            | 1                 | 20                          | 20            | 0                 | 21                      | 21            |                   |
| Somalia              | 19                   | 23            | -4                | 54                | 54            | 0                 | 24                     | 24            | 0                 | 41                        | 41            | 0                 | 52                          | 52            | 0                 | 2                       | 2             |                   |
| Gabon                | 20                   | 21            | -1                | 40                | 40            | 0                 | 38                     | 39            | -1                | 18                        | 17            | 1                 | 6                           | 5             | 1                 | 29                      | 30            |                   |
| Morocco              | 21                   | 20            | 1                 | 32                | 33            | -1                | 8                      | 8             | 0                 | 1                         | 1             | 0                 | 21                          | 21            | 0                 | 48                      | 48            |                   |
| Niger                | 22                   | 26            | -4                | 17                | 17            | 0                 | 50                     | 50            | 0                 | 24                        | 23            | 1                 | 22                          | 22            | 0                 | 22                      | 22            |                   |
| Chad                 | 23                   | 24            | -1                | 23                | 23            | 0                 | 26                     | 27            | -1                | 32                        | 31            | 1                 | 26                          | 26            | 0                 | 24                      | 25.5          | -1                |
| Côte d'Ivoire        | 24                   | 16            | 8                 | 5                 | 5             | 0                 | 6                      | 6             | 0                 | 25                        | 25            | 0                 | 7                           | 8             | -1                | 40                      | 40            |                   |
| Namibia              | 25                   | 22            | 3                 | 2                 | 2             | 0                 | 9                      | 9             | 0                 | 46                        | 46            | 0                 | 9                           | 14            | -5                | 46                      | 46            |                   |
| The Gambia           | 26                   | 32            | -6                | 25                | 25            | 0                 | 43                     | 44            | -1                | 7                         | 7             | 0                 | 37                          | 38            | -1                | 18                      | 18            |                   |
| Botswana             | 27                   | 25            | 2                 | 6                 | 6             | 0                 | 13                     | 11            | 2                 | 45                        | 45            | 0                 | 2                           | 3             | -1                | 42.5                    | 43            | -0                |
| Benin                | 28                   | 27            | 1                 | 26                | 26            | 0                 | 35                     | 35            | 0                 | 30                        | 29            | 1                 | 14                          | 13            | 1                 | 36.5                    | 36            | 0                 |
| Cabo Verde           | 29                   | 29            | 0                 | 41                | 41            | 0                 | 41                     | 43            | -2                | 12                        | 11            | 1                 | 32                          | 33            | -1                | 17                      | 17            |                   |
| Central African Rep. | 30                   | 30            | 0                 | 45                | 45            | 0                 | 30                     | 30            | 0                 | 34                        | 33            | 1                 | 23                          | 23            | 0                 | 25.5                    | 27.5          |                   |
| Eswatini             | 31                   | 28            | 3                 | 1                 | 1             | 0                 | 48                     | 48            | 0                 | 51                        | 51            | 0                 | 5                           | 7             | -2                | 42.5                    | 43            | -0                |
| Malawi               | 32                   | 33            | -1                | 24                | 24            | 0                 | 29                     | 28            | 1                 | 37                        | 37            | 0                 | 43                          | 43            | 0                 | 14                      | 14.5          | -0                |
| Lesotho              | 33                   | 37            | -4                | 4                 | 4             | 0                 | 53                     | 53            | 0                 | 49                        | 49            | 0                 | 44                          | 46            | -2                | 23                      | 23.5          | -0                |
| Madagascar           | 34                   | 34            | 0                 | 34                | 34            | 0                 | 46                     | 46            | 0                 | 39                        | 39            | 0                 | 47                          | 47            | 0                 | 11                      | 11            |                   |
| Guinea-Bissau        | 35                   | 35            | 0                 | 43                | 44            | -1                | 31                     | 32            | -1                | 31                        | 30            | 1                 | 51                          | 51            | 0                 | 16                      | 13            |                   |
| Liberia              | 36                   | 36            | 0                 | 44                | 43            | 1                 | 22                     | 23            | -1                | 52                        | 52            | 0                 | 24                          | 24            | 0                 | 25.5                    | 27.5          |                   |
| Nigeria              | 37                   | 31            | 6                 | 47                | 48            | -1                | 2                      | 2             | 0                 | 15                        | 14            | 1                 | 12                          | 10            | 2                 | 41                      | 41            |                   |
| Sao Tome & Principe  | 38                   | 38            | 0                 | 38                | 38            | 0                 | 12                     | 14            | -2                | 21                        | 21            | 0                 | 41                          | 41            | 0                 | 32.5                    | 32.5          |                   |
| Angola               | 39                   | 39            | 0                 | 31                | 32            | -1                | 3                      | 4             | -1                | 42                        | 42            | 0                 | 42                          | 42            | 0                 | 32.5                    | 32.5          |                   |
| Utd Rep. of Tanzania | 40                   | 41            | -1                | 49                | 49            | 0                 | 20                     | 19            | 1                 | 26                        | 32            | -6                | 36                          | 36            | 0                 | 28                      | 25.5          | 2                 |
| Seychelles           | 41                   | 43            | -2                | 27                | 27            | 0                 | 42                     | 42            | 0                 | 47                        | 47            | 0                 | 27                          | 27            | 0                 | 36.5                    | 36            | 0                 |
| D. Rep. of the Congo | 42                   | 45            | -3                | 35                | 35            | 0                 | 45                     | 41            | 4                 | 23                        | 22            | 1                 | 49                          | 49            | 0                 | 30                      | 30            |                   |
| Sierra Leone         | 43                   | 44            | -1                | 33                | 31            | 2                 | 37                     | 37            | 0                 | 9                         | 9             | 0                 | 25                          | 25            | 0                 | 44                      | 43            |                   |
| Zambia               | 44                   | 40            | 4                 | 11                | 16            | -5                | 5                      | 5             | 0                 | 50                        | 50            | 0                 | 34                          | 34            | 0                 | 38                      | 38            |                   |
| Equatorial Guinea    | 45                   | 47            | -2                | 39                | 39            | 0                 | 36                     | 36            | 0                 | 29                        | 28            | 1                 | 45                          | 44            | 1                 | 35                      | 36            |                   |
| Tunisia              | 46                   | 42            | 4                 | 50                | 50            | 0                 | 4                      | 3             | 1                 | 22                        | 24            | -2                | 28                          | 28            | 0                 | 39                      | 39            |                   |
| Ethiopia             | 47                   | 46            | 1                 | 37                | 37            | 0                 | 52                     | 52            | 0                 | 11                        | 12            | -1                | 8                           | 6             | 2                 | 52                      | 52            |                   |
| Libya                | 48                   | 48            | 0                 | 30                | 30            | 0                 | 34                     | 34            | 0                 | 5                         | 5             | 0                 | 29                          | 30            | -1                | 54                      | 54            |                   |
| Sudan                | 49                   | 49            | 0                 | 53                | 52            | 1                 | 19                     | 20            | -1                | 35                        | 35            | 0                 | 46                          | 45            | 1                 | 34                      | 34            |                   |
| Algeria              | 50                   | 50            | 0                 | 48                | 47            | 1                 | 23                     | 21            | 2                 | 14                        | 18            | -4                | 31                          | 31            | 0                 | 50.5                    | 50.5          |                   |
| Cameroon             | 51                   | 51            | 0                 | 46                | 46            | 0                 | 11                     | 12            | -1                | 28                        | 27            | 1                 | 33                          | 32            | 1                 | 49                      | 49            |                   |
| Burundi              | 52                   | 52            | 0                 | 36                | 36            | 0                 | 44                     | 45            | -1                | 36                        | 36            | 0                 | 50                          | 50            | 0                 | 50.5                    | 50.5          |                   |
| South Sudan          | 53                   | 53            | 0                 | 42                | 42            | 0                 | 49                     | 49            | 0                 | 54                        | 54            | 0                 | 54                          | 54            | 0                 | 31                      | 30            |                   |
| Eritrea              | 54                   | 54            | 0                 | 52                | 53            | -1                | 28                     | 29            | -1                | 53                        | 53            | 0                 | 53                          | 53            | 0                 | 53                      | 53            |                   |

Figure 8 Statistical test comparing rankings using PCA and equal weights

```
. ktau rI_eq rI

    Number of obs =      54
    Kendall's tau-a =      0.8658
    Kendall's tau-b =      0.8658
    Kendall's score =     1239
    SE of score =     134.041

Test of Ho: rI_eq and rI are independent
    Prob > |z| =      0.0000 (continuity corrected)

. ktau rTrade_d_eq rTrade_d

    Number of obs =      54
    Kendall's tau-a =      0.9357
    Kendall's tau-b =      0.9357
    Kendall's score =     1339
    SE of score =     134.041

Test of Ho: rTrade_d_eq and rTrade_d are independent
    Prob > |z| =      0.0000 (continuity corrected)

. ktau rProductive_d_eq rProductive_d

    Number of obs =      54
    Kendall's tau-a =      0.9720
    Kendall's tau-b =      0.9720
    Kendall's score =     1391
    SE of score =     134.041

Test of Ho: rProductive_d_eq and rProductive_d are independent
    Prob > |z| =      0.0000 (continuity corrected)

. ktau rMacro_d_eq rMacro_d

    Number of obs =      54
    Kendall's tau-a =      0.9064
    Kendall's tau-b =      0.9064
    Kendall's score =     1297
    SE of score =     134.041

Test of Ho: rMacro_d_eq and rMacro_d are independent
    Prob > |z| =      0.0000 (continuity corrected)

. ktau rInfrastructure_d_eq rInfrastructure_d

    Number of obs =      54
    Kendall's tau-a =      1.0000
    Kendall's tau-b =      1.0000
    Kendall's score =     1431
    SE of score =     134.041

Test of Ho: rInfrastructure_d_eq and rInfrastructure_d are independent
    Prob > |z| =      0.0000 (continuity corrected)

. ktau rMovement_d_eq rMovement_d

    Number of obs =      54
    Kendall's tau-a =      0.9755
    Kendall's tau-b =      0.9859
    Kendall's score =     1396
    SE of score =     133.915 (corrected for ties)

Test of Ho: rMovement_d_eq and rMovement_d are independent
    Prob > |z| =      0.0000 (continuity corrected)
```

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## **Annex: Evolution in the choice of variables and dimensions**

There were six dimensions proposed in the initial version of ARII 2019. In addition to the five dimensions that make up the final ARII 2019, there was also a social dimension that included 3 variables: mean years of schooling, gender equality and net migration within RECs. The inclusion of a social dimension was motivated by consultative meetings at the conceptual phase of the integration index: the rationale behind a social dimension is that for regional integration to be successful, favourable social arrangements have to be in place. The dimension was included, and results disseminated for initial validation. However, the dimension was subsequently removed as the variables in this dimension lack a regional component.

The rationale behind each dimension is well-documented in the ARII report and not reproduced here. Only changes that were made in the construction of the index are briefly outlined.

The variable AfCFTA was added to the trade dimension in the course of the making of ARII. The establishment of a free trade area is a stepping-stone in the advancement of regional integration. A country's adherence to this agreement is an important signal to stakeholders as to its economic future. Although, constantly changing, the variable was included and updated numerous times as more countries ratified the agreement.

The infrastructural dimension went through several changes. The variable net electricity trade (source from the Africa Energy Commission report) was initially included but a robust sensitivity analysis recommended its removal in order to improve the overall validity of the dimension.

The cost of mobile roaming was also included in initial computations of the infrastructural dimension. Such a variable is highly significant for regional integration; modernization of African economies but removed because of the low quality of the data and its incompleteness.

The variable Single African Air Transport Market is an initiative aiming at opening the African skies and there are currently 28 countries that signed the agreement. It was initially included but failed to pass the statistical tests. This is comprehensible as what really matters for integration is the implementation of such an agreement.

## Disclaimer

This *Methodological Note* has been prepared to accompany the ARII 2019 report and to explain the methodology used and to facilitate the interpretation of the empirical results obtained. The interpretations of the results and findings expressed herein are those of the author and do not necessarily reflect the views of the United Nations Economic Commission for Africa and its partners. Nor do they represent opinions of its officials or member States.

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S. B. Sufrauj for ECA team