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**Level of Deprivation in Sub-Saharan Africa.**

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## **Abstract**

The first of the millennium development goals, halving poverty by 2015, was not achieved in Sub-Saharan Africa. To make matters worse, for the period from 1990 to 2013 the number of poor increased in this region. In this dissertation, I consider the possibility that current measures of poverty are not appropriate for Sub-Saharan African countries. The limitations of current poverty measures include poor data quality and inappropriateness of selected indicators. In addition, I add a third limitation in that most social indicators used to measure poverty are highly correlated with income, therefore making them redundant in capturing other non-income domains associated with deprivation. To this I have used principal component analysis to construct composite deprivation and income-independent deprivation indices which are ultimately used to rank 31 Sub-Saharan African countries for the years of 2000, 2005, 2010, and 2014. The results obtained in this dissertation include large volatility in the ranking of the countries when comparing to those of the universal Multidimensional Poverty Index (MPI) and real gross domestic product per capita. The volatility in rankings signals that a few low-income countries are far better than one would expected given their level of income is low as regards to the level of deprivation experienced by their citizens. This dissertation adds to the debate that human development or well-being should not be regarded as a mere unidimensional economic concept. Policymakers need to look beyond income to formulate policies which will ultimately increase overall well-being in their countries.

## Contents

<b>Level of Deprivation in Sub-Saharan Africa.</b>	<b>2</b>
LIST OF ABBREVIATIONS	4
LIST OF TABLES AND FIGURES	5
1. Introduction	6
2. Literature Review	10
3. Methodology	19
3.1. Methodology followed for the composite deprivation index	19
4. Data and variables	21
4.1. Data	21
4.2. Variables selected for the composite deprivation index	22
5. Results	27
5.1. Principal Component Analysis	27
5.2. Deprivation rankings	30
5.3. Income- independent Deprivation Index	35
5.4. Robustness checks	38
6. Conclusion	46
Acknowledgements	48
References	49

## LIST OF ABBREVIATIONS

AIDS	Acquired Immune Deficiency Syndrome
GDP	Gross Domestic Product
HDI	Human Development Index
HDR	Human Development Report
HIV	Human Immunodeficiency Virus
IDA	Industrial Development Agency
IIAG	Ibrahim Index of African Governance
IID	Income-Independent Deprivation
IRAI	IDA Resource Allocation Index
KMO	Kaiser-Meyer-Olkin
MDGs	Millennium Development Goals
MPI	Multidimensional Poverty Index
PCA	Principal Component Analysis
PPP	Purchase Power Parity
SDGs	Sustainable Development Goals
SD	Standard Deviation
SMC	Squared Multiple Correlations
SSA	Sub-Saharan African
UN	United Nations
UNDP	United Nations Development Program
WDI	World Development Indicators
WHO	World Health Organization
UNICEF	United Nations International Children's Emergency Fund

## LIST OF TABLES AND FIGURES

### Tables

Table 1:	Summary of well-being measures
Table 2:	Classification of SSA economies according to their GNI per capita
Table 3:	Descriptive statistics of the variables used for the composite deprivation index.
Table 4:	KMO and SMC results
Table 5:	The top five least deprived and bottom five most deprived countries; 2000, 2005, 2010 and 2014
Table 6:	The top and bottom five countries according to their income-independent deprivation.
Table 7:	Deprivation ranking, IID and GDP ranking
Table 8:	Compare with universal MPI
Table 9:	Comparison across four measures of poverty/deprivation in 2014

### Figures

Figure 1:	Headcount ratio in SSA between 1990 and 2013
Figure 2:	The eigenvalues of each component after PCA
Figure 3:	Map of Africa
Figure 4:	Deprivation rankings for 31 SSA countries, 2000, 2005, 2010 and 2014.
Figure 5:	Deprivation rankings in 2014 and universal multidimensional poverty ranking for 27 SSA countries

## 1. Introduction

At the beginning of the millennium, 191 United Nations (UN) member states adopted the Millennium Development Goals (MDGs). The overarching goal of reducing poverty in all its forms was refined into eight goals:

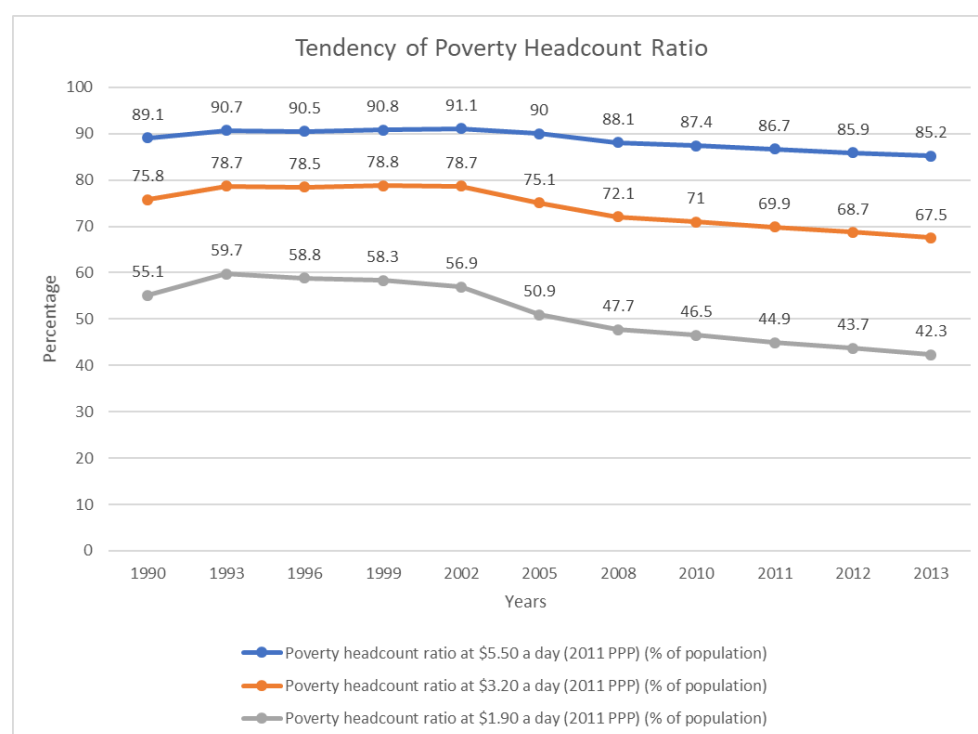
1. eradicating extreme poverty and hunger;
2. achieving universal primary education;
3. promoting gender equality and empowering women;
4. reducing child mortality;
5. improving maternal health;
6. combating HIV/AIDS, malaria and other diseases;
7. ensuring environmental sustainability; and
8. developing a global partnership for development.

The target date for achieving these eight goals was the end of 2015. The first goal, with the operational target of halving the number of people living on \$1 or less per day, was achieved in 2010, five years ahead of the 2015 deadline. Since the MDGs were signed, more than one billion people have escaped extreme poverty, inroads have been made against hunger, and more girls have attended school (United Nations, 2015). However, there is an ongoing debate about whether the MDGs were achieved as successfully as the UN has claimed, as the aggregate achievements conceal failure. In particular, the first MDG has not been achieved in Sub-Saharan African countries (SSA) (United Nations, 2015).

Since the MDGs were signed, Gross Domestic Product (GDP) and income growth in SSA has been mostly offset by population growth, with the result that more people in SSA are living in poverty today than when the goals were signed. According to World Bank data, real GDP (constant 2010 US\$) in SSA has increased from \$634 billion in 1990 to \$1,631 billion in 2013 (World Bank, 2018). The population of the region has increased from 512 million in 1990 to 979 million in 2014. As a result, despite the proportion of people living in extreme poverty fell, the absolute number has increased. The proportion of the population living in poverty in SSA, as measured by the

headcount ratio of people living on \$1.90 a day, changed from \$1 a day to \$1.90 a day since 2015 (2011 purchasing power parity (PPP)), increased from 55.1 per cent in 1990 to 58.3 per cent in 1999, before declining to 42.3 per cent in 2013, and between 1999 and 2013, the proportion fell by 16 per cent (World Bank, 2018). Despite the decline in the proportion of the population living in extreme poverty to 42.3 per cent in 2013, rapid population growth in this region means that there are 389 million people living on less than \$1.90 a day in 2013, up by 113 million since 1990. The following graph shows three types of headcount ratios in SSA from 1990 to 2013. What could possibly explain why achievement in economic growth has failed to lift these impoverished people out of poverty? In the past, an increase in inequality could have been the answer but now it seems that issues with the actual measurement of poverty itself could be the reason (Deaton, 2016).

*Figure 1. Headcount ratio in SSA between 1990 and 2013*



Source: World Bank Data Bank (2018)

In order to eradicate extreme poverty in its entirety, we need both an in-depth understanding of the nature of poverty and an accurate measure. Currently, both income (economic) and non-income indicators are widely used to measure poverty

and well-being, and the specific measurement method depends on how these concepts are defined. In general, if the purpose is to require rapid intervention for the poor in the short term, using income indicators such as GDP or income per capita is applicable to measure poverty. In saying this, if the goal is profoundly and thoroughly to reduce poverty in the long run, non-income indicators are more appropriate (Sumner, 2004).

A possible cause for the failure to achieve the poverty reduction goals in SSA may be attributed to measurement error of poverty itself. In this dissertation, I examine the appropriateness of standard measures of poverty as applied to the SSA context. As an alternative, I construct composite deprivation indices through utilising consumption surveys. These indices capture home production and the distribution of labour income, elements missing from the standard measures that rely heavily on labour market income. Moreover, I address the fundamental flaw of the widely used MPI since it was designed for developing countries in general and not specifically for SSA countries (Alkire and Santos, 2014). This region is unique in the challenges it face, therefore a Region-specific multidimensional poverty measure is needed. Finally, considering that most indicators of well-being and poverty are strongly and significantly correlated with GDP, there is a need to construct a poverty measure that is independent of income so that the role of non-income indicators can be fully captured in assessing the deprivation of countries (McGillivray, 2005).

In this dissertation I address the following research question: Do existing measures of poverty, which are based directly on private income and multidimensional indices that place a large weight on private income, accurately capture the incidence of deprivation experienced in SSA? To answer this question, I utilise four time periods for 31 SSA countries and address the following three secondary aims:

1. Constructing a multidimensional deprivation index by using principal components analysis (PCA).
2. Running a regression of the multidimensional deprivation scores on the natural logarithm of real GDP per capita and saving the residual.



3. Utilising the residual obtained as my income-independent multidimensional deprivation index.

My main findings are as follows. First, I find a clear North-South divide in that the countries lie on the edge of the Sahara Desert (Mali, Chad, Ethiopia, and Niger) suffering deeper multidimensional deprivation than that experienced by South Africa and her surrounding nations (Botswana, Lesotho, Namibia, Swaziland, and Zimbabwe). Secondly, some countries, according to my two multidimensional deprivation indices that differ significantly in terms of ranking when compared to the universal MPI and income-based rankings. Some countries with lower GDP per capita are doing better as regards to non-income deprivation than what one would expect given their level of income. The reason for this might be that they have strong governance, stable political systems, or significant amounts of foreign assistance. Conversely, some countries with high real per capita income, through the sale of natural resources, tend to have lower non-income deprivation than one would expect to see. This finding reiterates that one cannot merely look at income indicators in order to gain a full picture of the state of poverty in one's country since it can be grossly misleading. Therefore, the argument can be made that increasing average national income alone cannot help the poor escape poverty and that initiatives to address overall human well-being are needed.

The dissertation is structured as follows. In section two, I review literature pertaining to measures of well-being and poverty. Section three discusses the methodology used in constructing my indices. In section four, I discuss the data used as well as the variables selected for my multidimensional deprivation index. The results obtained from the indices and the consequent ranking and comparison of the 31 SSA countries round out section five. The dissertation concludes in section six.

## **2. Literature Review**

The definition of poverty directly relates to the concept of human well-being. In order to properly measure poverty and develop correct social policy objectives to reduce poverty, it is necessary to study human well-being first (Rojas, 2004). There is an ongoing debate regarding the best measure to successfully capture the true extent of poverty and well-being. Since the 1950s, the methods used to capture poverty have evolved from a single economic indicator to multidimensional measures; from recognizing basic needs to identifying human rights; and from considering individuals as the 'means' to achieve economic well-being to understanding that they themselves are the 'ends' to be achieved through said well-being. In considering the evolution of our understanding of poverty, it is important to note that the general context and various developmental practices determine the individual characteristics of human well-being and the measurement of poverty in each preceding decade (Sumner, 2004).

In the 1950s, well-being was initially measured by real wages and GDP. The idea was that GDP growth would eventually allow for the elimination of poverty and thereby increase well-being through the 'trickle-down' effect (Bourguignon, Silva and Stern, 2004). During the 1960s, well-being became increasingly more important, and the improvement in the standard of living for a country's citizens was regarded as development itself. Despite the increase and availability of social survey data, many countries still chose to use the GDP growth rate per capita as an indicator for well-being. Towards the end of this decade, the concept of well-being gradually underwent a shift from being seen through the lens of a single indicator to a multi-faceted approach which included poverty. Much of the debate in the 1970s revolved around the idea that well-being should be seen as meeting individuals' basic needs regarding food, shelter, and public goods. Moreover, the availability of new data on education and health for most developing countries reflected this broader definition of well-being (Sumner, 2004).

Following the agreement in the academic community of this new well-being measurement, there was an explosion of research in this 'new' field (see for example,

McGranahan et al. 1985, Hicks and Streeten 1979, UNRISD 1970, ILO 1977, Streeten, 1984). These studies led to what became known as composite measures of well-being which excluded income or economic well-being domains, and therefore strictly measured the results of government social policies and not merely inputs. One of the best-known well-being indices during the 1970s was the physical quality of life index (PQLI), which comprise three domains: life expectancy at birth, infant mortality, and adult literacy (Morris, 1978).

Following of the debt crisis of the 1980s and its significant impact on the developing communities, studies of well-being reverted back to using GDP per capita as a primary measure of well-being. For example, in the Washington consensus, which is the “standard” reform constituted by Washington, D.C. for the crisis-stricken developing countries, saw economic growth as a tool in itself to reduce poverty (Dağdeviren, Hoeven and Weeks, 2004).

Despite this temporary lost ground, the 1980s was also the era that saw the construction of the first income (economic) and non-income composite well-being measures. Amartya Sen (1985), an economist, conducted crucial and influential work which led to the establishment of what we now know as the annual report for well-being published by the United Nations Development Programme (UNDP). In 1990, the first Human Development Report (HDR) was published which introduced the academic and public community to the widely used Human Development Index (HDI) (UNDP, 1990). In order to further extend the concept of quality of life, Sen constructed the ‘capability approach’ which connected an individual’s quality of life with his/her capability function. Capabilities reflects a person's freedom to choose a different lifestyle which then translates into extreme poverty depriving a person of such a vitally important choice.

Sen (2003) indicated that economic growth should not simply be seen as an increase in income but that it was a necessary tool to improve non-income social services and infrastructure such as public healthcare, basic education etc. Nevertheless, not all countries' economic growth has significantly contributed to generating resources

needed for better social infrastructure. The difference in outcomes may be due to whether the achieved growth was seen as having a basic "enhancing" capability. Sen stated that well-being is achieved through a wider set of met conditions such as being fed, healthy, clothed, and educated. Economic growth is a 'means' to enrich people's lives, and merely enlarging the economy itself is insufficient for achieving the necessary 'ends'. In his measurement, the focus from 'means', such as having the income to buy food, moved to 'ends', such as being well-nourished (Sen 2003, Anand and Sen, 2000).

The same year as the first HDR was issued, the World Bank released its own new measure of well-being: the dollar-a-day poverty line. This implied that should an individual live under a dollar a day, he/she is judged to be the poor (World Bank, 1990). The international poverty line has since been changed to \$1.90 a day in 2015 (2011 PPP) (World Bank, 2016).

As noted in the introduction, in the beginning of the millennium, 191 UN member states gathered for a summit and adopted the MDGs and pledged to eradicate poverty in all of its dimensions. The deadline for achievement of the eight MDGs was 2015 and there is still ongoing debate whether any of these goals were truly met as was claimed by the UN. The establishment of the MDGs was by far the strongest push towards not merely raising the income of the poor but to eradicate multidimensional poverty (United Nations 2015). As a continuation of the MGDs, the 17 Sustainable Development Goals (SDGs)<sup>1</sup>, which have been adopted by UN member states in September 2015 at a historic UN Summit, officially came into force on 1 January 2016. The SDGs aim to go further in order to end all forms of poverty through achieving sustainable development. The first SDG is to "end poverty in all its forms everywhere" before the year 2030 (United Nations, 2017).

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<sup>1</sup> The 17 goals are: 1. No Poverty, 2. Zero Hunger, 3. Good Health and Well-Being for People, 4. Quality Education, 5. Gender Equality, 6. Clean Water and Sanitation, 7. Affordable and Clean Energy, 8. Decent Work and Economic Growth, 9. Industry, Innovation, and Infrastructure, 10. Reducing Inequalities, 11. Sustainable Cities and Communities, 12. Responsible Consumption and Production, 13. Climate Action, 14. Life Below Water, 15. Life on Land, 16. Peace, Justice and Strong Institutions, 17. Partnerships for the Goals.

Following the construction of the HDI, Alkire and Foster (2011), introduced a new multidimensional poverty measure called the Multidimensional Poverty Index (MPI). This index was different from the traditional unidimensional and multidimensional poverty measures in that they used micro-level data obtained from household surveys. This data was aggregated to obtain national poverty standards which reflected both the prevalence of multidimensional poverty and the intensity of poverty. The global MPI is divided into three dimensions encompassing ten individual indicators. The health dimension includes the nutritional status and mortality of children; the education dimension contains the years of schooling and school attendance; the standard of living domain includes cooking fuel, sanitation, drinking water, electricity, floor material and assets. If an individual fails to reach a certain threshold in each of these indicators, he/she is considered to be deprived on a multidimensional level. After observing the sum of the deprived indicators, MPI uses a headcount ratio multiplied by the average share of indicators in which a poor individual is perceived to be deprived. If the individual obtains a 'weighted sum' of 0.3 or more, the individual is considered to be in poverty. The MPI provides an extensive picture of people living in poverty, and permits comparisons across countries, regions, and within countries according to race, urban or rural location or according to any other fundamentally important household and community indicators. These abilities have made the MPI a universally accepted and preferred measure of multidimensional poverty.

Over the last six decades, the measure of well-being has evolved from containing purely income (economic) indicators to containing non-income indicators as well. The measurement of poverty and well-being depends on how these concepts are defined. If poverty is defined as the deprivation of materials and a lack of basic needs, it is appropriate to use material well-being indicators such as real GDP growth rate, income per capita, consumption and the headcount ration of \$1.90 a day. If poverty is defined as rights, livelihoods, and the freedom to choose, then the non-income indicators of well-being provide a better insight into the phenomenon of poverty. Measuring poverty by using income indicators has certain advantages comparing to non-income indicators. Data pertaining to income indicators are relatively more up to date, easier to determine, and less expensive to acquire. They are also more objective, tangible, and quantitative in nature. In saying this, there are certainly some disadvantages of

using income indicators. First, if it relies entirely on measuring the economy then non-market activities such as unrecorded informal sector work and housework, as well as damage to the environment, are omitted (Ghosh et al., 2010). Thus, income measures rely on a static number that cannot observe the fluctuation of poverty. For example, if an individual's income has been raised from \$1.80 to \$2 per a day he would be considered 'out of poverty' in terms of absolute numbers, but his life would not have changed much at all. Secondly, the setting of a poverty line is improbably affected by the possibility of mismarking inflation (Deaton, 2016).

On the other hand, non-income indicators used are mainly collected through household survey data. Seeing as this is closer to the individual level, it is deemed more accurate in reflecting the different dimensions of poverty and addresses more directly the 'ends' or outcomes of social policy objectives (being educated and healthy). However, data collection at the household level is challenging and incurs huge costs and takes much longer to collect. At the same time, there are problems with data availability and reliability since the non-income indicators are more subjective and therefore more tenuous. Ultimately, the purpose of the measurement will influence which indicators are more appropriate to use. Overall, if there is a need for rapid intervention to the poor in the short term, it makes more sense to choose income indicators. If the purpose is profoundly and thoroughly reducing poverty in the long run, non-income indicators are more appropriate. Table 1 provides an overview of the most commonly used income – and non-income indicators in determining well-being and poverty.

*Table 1. Summary of well-being indicators*

	<b>Income (economic) measures</b>	<b>Non-income measures</b>
<b>Indicators</b>	Income per capita GDP Growth rate Income or Consumption poverty lines Gini Index Headcount ratio	Education levels Healthcare Standard of living Empowerment
<b>Advantages</b>	Relatively new Easier to determine with less expenditure More objective, tangible, and quantitative data	Closer to the individual level More accurate to reflect the different dimensions of poverty. Undertake the 'ends' of well-being
<b>Disadvantages</b>	Neglect non-market activities subjective and arbitrariness Influenced by inflation	More costs and longer time to collect Issue of data availability and reliability
<b>Purpose</b>	Rapid intervention for the poor in the short term	Profoundly and thoroughly reducing poverty in the long run, non-income indicators

Source: Sumner (2004), Alikire and Foster (2010), World Bank (2018)

Even though a leading way has been made in developing the various concepts and measurements of well-being in theory, the application of it is severely lagging (Sumner, 2004). A dominant view is that the poverty status of people living in SSA has not improved during the last three decades, and that economic development has remained stagnant leading to a decrease in their human well-being and societies at large (McGillivray and Shorrocks, 2005, Fosu, 2014). For example, data from the World Bank indicates that the proportion of poverty as measured by the headcount ratio of \$1.90 a day (2011 PPP) has moved from 55.1 per cent in 1990 to 42.3 per cent in 2013 (World Bank, 2018). Although the proportion has decreased, the absolute number of people living in poverty has increased to 113 million because of the population explosion. The MPI constructed in 2010 reveals a relatively worse poverty situation in SSA than in the rest of the developing community. There is 28 per cent or 458 million of the total population of 1.7 billion people who suffered multidimensional poverty living in SSA in 2010 (Alkire and Santos, 2010), and 26.5 per cent or 282 million of the total population of 1.45 billion individuals in SSA in 2014 (Alkire and Robles, 2017). In saying this, during the same period, there were developing countries such as India and China that did make significant progress towards achieving this goal.

What could possibly account for the disparate success of poverty-reduction observed within the developing community? The answer is complicated and to understand the challenges that this unique and vast unequal continent face one must first delve into the historical explanations of stagnation in poverty alleviation in SSA. If the troubles in the past have not been addressed, there could not have been any real expectation of SSA achieving the first MDG.

There are some possible reasons why SSA has not achieving any significant reduction in poverty. These include geographical constraints such as being located on the edge of the Sahara Desert or climates changes, rampant disease (malaria and HIV), low-productive agricultural structures, barriers to the flow of technology from abroad, corruption, poor governance, civil wars and unending political conflicts (Besley and Burgess, 2003, Addaekorankye, 2014). Good governance, stable political regimes, and economic reforms are crucial to reducing poverty in SSA (Christiansen and Demery, 2003, Muna, 2017).

Sachs et al (2004) counters this claim by pointing out the fact that although some SSA countries do have relatively good governance, the material well-being of their population did not improve as such. This implies that the lack of good governance alone could not explain the poverty crisis in SSA. Considering the meaning of "good governance" is still ambiguous (Manu 2015), it may be the reason why even in the well-governed parts, economic growth can improve the well-being of the poorest, but it cannot lift them out of poverty (Christiansen and Demery, 2003). Sen also argues that whether a country's economic growth improves its basic well-being (such as having access to education and healthcare) depends on its intrinsic capability to do so (Anand and Sen, 2000). Therefore, knowing what we do now, one possible explanation of why economic growth fails to reduce countries' poverty levels can be found in the measurement of poverty itself (Deaton, 2016). Currently, data from household surveys representative of the population is the cornerstone of measuring national or global poverty and inequality. Household surveys play a vital role in gaining the integrant socio-economic data that are used to understand the welfare of populations across the world (Beegle et al., 2016).



Taking the above into consideration, there are problems with applying standardized measures to SSA. First, the availability and quality of data remains problematic especially in SSA without accurate data it is nearly impossible to judge whether the MDGs have been achieved (Sumner, 2004). The quality of household surveys in Africa is often weak, outdated (2012 estimates use surveys from 2003), and intermittent, which over time generates problems of inconsistencies within countries (Deaton, 2016). Meanwhile as a rule, the poorer a country is, the harder it is to know the absolute number of poor people, consequently whether or not their living standards have improved over time (Ravallion and Chen, 1997). It is difficult to obtain data from the poorest areas because the degree of openness and scale for a country affect availability and the quality of the data. In addition, those countries only have weak and little administrative support for surveying (Sumner, 2004). Even the best poverty alleviation and development institutions, policies, or programmes are limited in their efficiency if they fail to reach the poorest countries and individuals (Zeller et al, 2003).

Another possible reason is that a few countries, such as Mali<sup>2</sup> and Mauritania<sup>3</sup> are at war or have only recently finished one. Therefore, data are non-existent or fragmentary for these countries. In this context, accurately measuring poverty is extremely difficult.

The second limitation is that the universal MPI contains structural flaws if it is used in SSA countries. The lack of some critical indicators pertaining to disease (malaria and HIV) in measuring well-being means the universal MPI cannot precisely capture the nature or degree of deprivation. This index is designed for developing countries and applies worldwide (Alkire and Santos, 2014). Thus, some indicators are not applicable if they are applied to the extreme poor found in underdeveloped countries located in SSA. Therefore, some indicators should be added to reflect the unique characteristics of this region. For example, SSA has a very high HIV infection rate that significantly reduces individual productivity (Sachs et al., 2004). The Alkire and Foster (AF) method is deemed a better multidimensional poverty measure because it allows adding the particular, different indicators, dimensions and assigning different weights

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<sup>2</sup> The Northern Mali Conflict, Mali Civil War, or Mali War (2012–present), in Mali.

<sup>3</sup> Insurgency in the Maghreb (2002–present), in Mauritania.

to each dimension to build multidimensional poverty models for specific countries (Alkire and Santos, 2014).

The third limitation is that most indicators of well-being are significantly and highly correlated with GDP or income per capita. That is, the index using income-related indicators cannot tell us more information other than income per capita alone and cannot completely capture the non-income deprivation across countries. A number of studies have suggested this limitation. For example, McGillivray (1991) argued that for the most part, HDI was considered another redundant composite measure because of the positive correlation between these variables and GDP or GNP per capita. In other words, HDI reflected only a little more information than GDP or GNP per capita regarding intercountry well-being. Cahill (2005) updated the data in McGillivray's empirical model, and he verified McGillivray's viewpoint that most information reflected in HDI could be captured in GDP per capita only.

In McGillivray and Sharrock's (2005) study, they observed that the majority of variables of human well-being are strongly related to the income per capita across countries. To measure the non-income well-being achievement across countries, McGillivray regressed the composite of income well-being on the logarithm of purchase power parity GDP per capita and observed the residual term of the regression (McGillivray, 2005). The value of those residuals reflected a non-income or income-independent measure of national well-being achievement. They used the residuals as an income-independent index to rank countries and found that some countries recently have a higher non-income well-being ranking than their income-based ranking, while others have the opposite (McGillivray and Sharrock, 2005). Overall, non-market and centrally planned economies did best in terms of non-income well-being. Countries at the bottom of the rankings were more diverse and did not seem to have common uniform features. Duclos et al (2006) and Rojas (2003) also were in favour of the view that weak correlations could be captured between the welfare indicators and income. Diener and Suh (1996) on the other hand held a different view. According to them, although strong relationships existed between income – and social indicators, quality

of life was more important than simply living in a wealthy country, and the indicators of well-being were still needed (Diener and Suh, 1996).

During the last six decades, the meaning and measurement of well-being and poverty has changed considerably. From single income indicators to multidimensional measures capturing poverty, the subject of well-being has been a rich, theoretical ongoing debate. However, in practical application, it is not satisfactory, especially for SSA countries. This situation is mainly caused by the limitation of data availability, structural flaws, and being high correlated with income. Future studies should be directed towards correcting fundamental flaws in poverty measurement as well as ensuring that data are collected properly and accurately.

### 3. Methodology

#### 3.1. *Methodology followed for the composite deprivation index*

In constructing the composite deprivation index, principal component analysis (PCA) was used. PCA works by extracting uncorrelated and small amount of data from the large dataset with the benefit of retaining most of the originally captured information. Mathematically, there is a  $n \times k$  matrix, presented as  $X$ , which is the poverty dataset with  $k$  indicators of poverty and  $n$  individuals' data where arranged in total  $k$  columns and  $n$  rows. The main idea is to construct a dimension-reduction  $n \times m$  matrix called  $Y_i$ , which contains the linear weighted combination of the original variables and explains as much as possible of the total variance observed in  $X$ . In the  $k \times m$  matrix,  $v$  represents the weights of each indicator used to ultimately construct the extracted principal component  $X$ . This relationship can be expressed as:

$$Y_i = Xv$$

In order to identify vector  $v$  which satisfies the above condition, Greene (1993) proposes that the condition will be fulfilled when:

$$(X'X)v - \lambda v = 0$$

Where  $v$  is a set of eigenvectors of  $X'X$  matrices and  $\lambda$  is a set of eigenvalues representative of the correlation matrix. In general, there is  $k$  number of eigenvectors

that exist in a  $k \times k$  square matrix. Therefore,  $X'X$  is a  $k \times k$  matrix with a total of  $k$  eigenvectors. The  $k$  principal components of the original dataset have  $k$  eigenvectors, and the sum of the square of each weighted combination of the components equal one ( $a_{11}^2 + a_{12}^2 + \dots + a_{1k}^2 = 1$ , where  $a_i$  is the weighted number in a principal component).  $\lambda_i$  is the set of eigenvalues represented by the specific weight of each indicator in each principal component. The eigenvalues are extracted from the largest to the smallest, which also imply the variance explained of the matrix corresponds to the eigenvector. Since standardised variables with a unit variance was used in the correlation matrix, the total numerical value of the combined variance is  $1 * k$  which equals  $k$ . Thus, the proportion of the variance explained for each principal component relative to the variance observed in the original dataset is represented by  $\lambda_i/k$ .

Therefore, it is argued that the first principal component explains the maximum possible variance observed in the original data and the second principal component has the largest amount of remnant variance that is uncorrelated to the first principal component. Each subsequent principal component contains an additional part of the various dimensions represented in the original data, but the interpretation relative to the original data becomes increasingly weaker. Consequently, it follows that those principal components with the smallest eigenvalues capture less information contained within the raw data. The principal components with smallest eigenvalues can therefore be disregarded in order to reduce the dimension of the original dataset, but in doing so it would not increase the amount of useful information that can be accessed.

Against this backdrop, the PCA adopted follows the methodology proposed by McGillivray (2005) in which he developed a non-income composite well-being index, at a macro level. The essence of this method is that it enables one to distinguish between income and non-income factors by extraction, through principal component analysis (PCA)<sup>4</sup>, the maximum possible information from various standard national

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<sup>4</sup>A method explained in the Handbook on Constructing Composite Indicators (OECD 2008) to construct a composite index by applying PCA and saving the first extracted principal component, which represents a weighted summary index of the original indicators.

non-income well-being indicators<sup>5</sup>. This ultimately means that the non-income well-being indicators represent those indicators other than direct measures of income. An important step since Drèze and Sen (1991) questioned the correlations between income and non-income indicators and the results offered as evidence for failure or success of policies aimed at increasing welfare.

Therefore, I first make use of PCA in order to extract the first three principal components and compile the composite deprivation index. Second, I take the composite deprivation index and regress it on the natural log of real GDP. Lastly, I retain the residual,  $\mu_i$ , from this regression and interpret it as *income-independent deprivation* (IID). This estimated function of the composite deprivation index can be expressed as:

$$Q_{it} = \alpha + \beta \ln y_{it} + \mu_{it} \quad (1)$$

Where  $Q_{it}$  is the composite deprivation index for country  $i$  in period  $t$  ( $t=2000, 2005, 2010$  to  $2014$ ); and  $\ln y_{it}$  is the natural log of real GDP for the same country  $i$  in the same time period  $t$ , with  $\mu_{it}$  the residual term. This residual term  $\mu_{it}$  is a purely statistical construct and is defined *inter alia* as deprivation independent of income, which is central to my analysis and by definition orthogonal with respect to  $\ln y_{it}$ .

## 4. Data and variables

### 4.1 Data

Two main datasets, which include associative and internationally comparable information for development were used to construct the composite deprivation index; World Development Indicators (WDI) and the Human Development Index (HDI). Data pertaining to the HIV infection rates for Mauritius was collected from the Mauritian National Statistics website (Ministry of Health and Quality of Life, 2017).

This study analyses multidimensional deprivation for 31 SSA countries and table 2 provides an overview of these countries classified according to their GNI per capita

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<sup>5</sup> McGillivray (2005) uses a method explained in the Handbook on Constructing Composite Indicators (OECD 2008) to construct a composite index of non-economic quality of life by applying PCA and saving the first extracted principal component, which represents a weighted summary index of the original indicators.

into three groups; i.e. low-income, lower-middle-income and upper-middle-income economies for 2016 (World Bank, 2018). The study compares multidimensional deprivation for these SSA countries for the years 2000, 2005, 2010, and 2014.

*Table 2. Classification of SSA economies according to their GNI per capita*

Classification	Countries
LOW-INCOME ECONOMIES (\$1,005 OR LESS)	Benin, Burundi, Chad, Ethiopia, Gambia, Madagascar, Mali, Mozambique, Niger, Rwanda, Senegal, Sierra Leone, Tanzania, Togo, Uganda, Zimbabwe
LOWER-MIDDLE-INCOME ECONOMIES (\$1,006 TO \$3,955)	Cape Verde, Cameroon, Congo, Cote d'Ivoire, Ghana, Kenya, Lesotho, Mauritania, Swaziland, Zambia
UPPER-MIDDLE-INCOME ECONOMIES (\$3,956 TO \$12,235)	Botswana, Equatorial Guinea, Mauritius, Namibia, South Africa

Source: World Bank Country and Lending Groups (2018)

#### *4.2. Variables selected for the composite deprivation index*

It is universally accepted that poverty is a multidimensional phenomenon. According to the World Bank (2016), "Poverty is pronounced deprivation in well-being and comprises many dimensions. It includes low incomes and the inability to acquire the basic goods and services necessary for survival with dignity". The criteria for measuring poverty are therefore broad and include the domains of health, education, living standards (basic infrastructure and amenities), the environment, safety from violence, empowerment and culture. As discussed in section 1, income indicators are not adequate to reflect the true state of the poor, since many of them are often uneducated, disempowered, malnourished or disease ridden. Among countries experiencing this level of chronic multidimensional deprivation there are also inadequate support and policy guidance in respect of these deprivations in all dimensions (Alkire and Foster, 2015). The study of selecting domains for multidimensional deprivation index was guided by the methodology presented by

Alkire and Foster (2014) and ultimately draw upon three of the possible five methods. These include:

- Choosing lists with the public consensus at national and local levels, such as millennium development goals (hereinafter referred to as MDGs) and sustainable development goals (hereinafter referred to as SGDs).
- Determining the dimensions which are taken to be authoritative or regularly used.
- Choosing the dimensions that empirically reflect people's values, and utilising data on consumer preferences and behaviour.

Moreover, Alkire and Foster (2015) states that in selecting the indicators to be presented in each dimension across the countries, the principles of parsimony<sup>6</sup> and accuracy<sup>7</sup> should be adhered to. To further guide the domains this study selected, I followed the United Nations (UN) as well as the World Bank (WB) (United Nations publication, Series F, No. 49 (1989), Series F, No. 18 (1975 and 2015)) which places significant importance on education, health, and developing basic infrastructure pertaining to housing, water and sanitation. These are taken as breakthrough policies required for achieving higher well-being in developing regions.

Against this backdrop, my composite deprivation index includes the following three domains, consisting of various indicators (see table 3 for descriptive statistics).

1. To represent the domain of literacy, the education indicators of expected years of schooling and mean years of schooling, taken from the Human Development Index, were selected.
2. As regards to the development of basic infrastructure, the study used improved water sources (proxied by piped water, public taps or standpipes, tube wells or boreholes, protected dug wells, protected springs, and rainwater collection); improved sanitation (proxied by the proportion of people with access to some types of flush toilets, ventilated improved pit latrine, pit latrine with slab, or

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<sup>6</sup> Choosing as few indicators as possible to easily compare countries and transparency of policy purpose.

<sup>7</sup> When measuring in a country, use as many indicators as possible to easily analysis and guide policy properly.

composting toilet); electricity (proportion of people with access to electricity), clean cooking fuels (the proportion of people with access to clean cooking fuel, excluding wood, dung, grass, cardboard, carbon, charcoal, and kerosene) and communications technology (proxied by the proportion of people with a fixed telephone line) (United Nations, 2018). Together these indicators also reflect the SDGs number 6 and 7. These five indicators play an important role in economic growth and poverty reduction which will be discussed below.

First, inadequate sanitation, unsafe water, and poor personal hygiene are important causes for many diseases and in some cases child deaths observed in developing countries. Improved water sources and sanitation have significant beneficial impacts on the marginalised groups specifically, such as women and children. Women and children spend millions of hours a year to fetch water (WHO and UNICEF, 2017). This drudgery takes their time away from other important activities such as getting educated or partaking in other economic activities. These deficits can cause serious welfare losses in term of reduced productivity, poor health, illiteracy, and environmental degradation. For these reasons, international agencies use sanitation and safe water sources as measures to combat poverty, disease and death (WHO and UNICEF, 2017).

Second, access to electricity cannot only improve people's quality of life but is also seen as a necessary condition for economic growth. Factory operations, cultivating crops, and transport of goods to consumers are all reliant on one or another source of energy. A growing number of countries are dependent on reliable and secure electricity to support economic growth and community prosperity. Third, communications technologies are considered an essential tool for development as it contributes to regional and global integration and promotes the efficiency and transparency of the public sector. Moreover, the quality of an economy's social infrastructure, including electricity and communications, is an important factor in investment decisions for domestic and foreign investors. Lastly, polluting fuels have devastating effects on people's health, the environment and the economy. Nearly 2.9 billion people in developing countries still use polluting fuels for cooking and heating (United Nations, 2018).



3. Objectively measured health. Here, the study used maternal mortality rate, mortality rate of under-fives, HIV infection rate, health expenditure per capita, proportion relative to public spending and the total health expenditure. The mortality rates of child and mother can be considered as a failure of the health system and has ramifications for the entire family concerned. For the most part, the under-five mortality rate could be curbed through implementing a strategic and effective vaccination programme (Alkire and Santos, 2014). Better family planning and accessibility to proper prenatal healthcare could also significantly decrease the maternal mortality rate (United Nation, 2018). By 2016, the HIV infection rates in central and western Africa were 9 per cent whereas in the eastern and southern parts it was as high as 29 per cent (Avert, 2017). HIV infection can significantly reduce an individual's productive capacity and have a psychological impact, such as not being able to integrate into the community and being ostracised.

In general, developing or underdeveloped countries cannot afford to spend more on creating an effective public healthcare system and therefore they fail to improve human well-being. For this reason, private health expenditure accounts for the majority of the total health expenditure in these countries. On the one hand, public health expenditure can improve human well-being, but in saying this, high private health expenditure squeezed from total private expenditure could increase poverty (Deaton, 2015). This could be because the poor are struggling to pay the high cost of healthcare and the private health expenditure is at the expense of daily necessities. Taking this into consideration, these three indicators all representing different aspects of health expenditure are included in the health domain.

*Table 3. Descriptive statistics of the variables used for the composite deprivation index.*

Dimensions	Indicator	Meaning of indicators (yearly)	Data source	Mean	Mini	Max	SD
Health	Maternal mortality rate	Maternal mortality ratio (modelled estimate, per 100,000 live births)	WDI	573.27	39.00	2650.00	361.25
	Mortality rate, under 5	Mortality rate, under-5 (per 1,000 live births)	WDI	100.13	14.70	233.90	44.52
	HIV infection rate	Prevalence of HIV, total (% of population ages 15-49)	WDI, and Ministry of health and quality of life for Mauritius	6.99	0.09	29.80	7.88
	Health expenditure per capita	Health expenditure per capita, PPP (constant 2011 international \$)	WDI	211.73	21.42	1237.30	259.37
	Health expenditure, public	Health expenditure, public (% of GDP)	WDI	2.80	0.91	8.08	1.30
	Health expenditure, total	Health expenditure, total (% of GDP)	WDI	5.83	1.63	13.63	2.12
Literacy	Expected years of schooling	Expected years of schooling (years)	HDI	9.31	2.90	15.20	2.38
	Mean years of schooling	Mean years of schooling (years)	HDI	4.64	1.10	10.30	2.12
Basic housing	Improved water source	Improved water source (% of the population with access)	WDI	67.83	28.90	99.90	16.49
	Improved sanitation	Improved sanitation facilities (% of the population with access)	WDI	33.93	6.60	93.20	22.11
	Electricity	Access to electricity (% of the population)	WDI	34.08	0.41	99.17	24.44
	Clean cooking fuels	Access to clean fuels and technologies for cooking (% of the population)	WDI	20.11	2.00	99.28	23.85
	Communication technologies	Fixed telephone subscriptions	WDI	294040.48	6100.00	4961743.00	812386.74

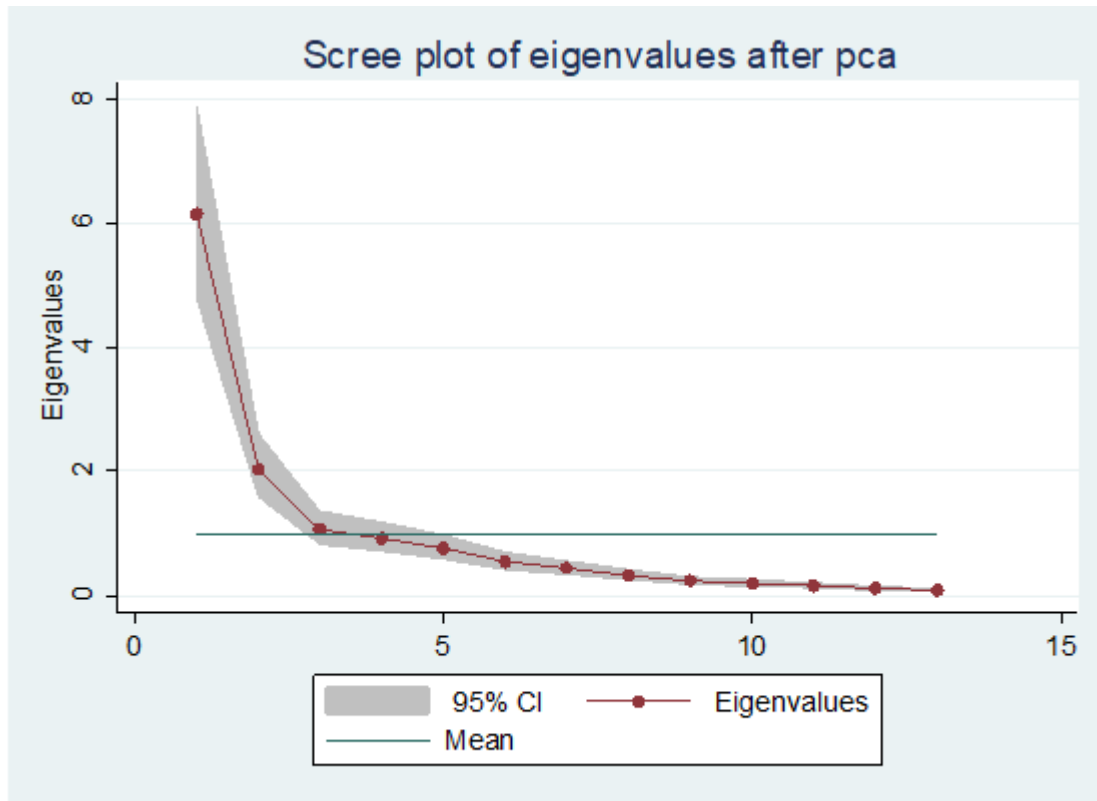
## 5. Results

### 5.1. *Principal Component Analysis*

To construct the composite deprivation index, I made use of PCA to weight the index, which was in accordance with McGillivray's (2005) methodology. This is the most common method used as a weighting technique, except for equal weighting (Klasen, 2000). However, in some cases, the first component is not sufficient to adequately represent the original indicators (Ram, 1982) and more than one component needs to be extracted. Using an adjusted method of Nicoletti et al. (2000), I extracted not only the first component, but also the subsequent components, as to explain sufficient variance representative of the dataset. Extracting the first three component is in line with the Kaiser rule (Kaiser and Rice, 1974) which states that only the components with an eigenvalue greater than 1 should be extracted.

Figure 2 is the scree plot, which shows the eigenvalues of all 13 components of the correlation matrix after PCA. There are three components with eigenvalues greater than one. Together these components explain 71.05 per cent of the total variance observed in the data, which is deemed an acceptable level of explained variance representative of the dataset (see comparative studies such as Vyas and Kumaranayake, 2006, Rossouw and Pacheco, 2012, and Greyling and Tregenna, 2017). In saying this, the eigenvalues represent the contribution of the corresponding eigenvector to the entire matrix after orthogonalization. That is, the larger the size of the eigenvalue is, the greater the proportion of the variance is explained. If the eigenvalues of some components are small (less than one), they only reveal an insignificant amount of information pertaining to the matrix. Accordingly, the first three components include the most significant and useful information to this study. Therefore, the last remaining ten components were dropped in constructing the deprivation index.

Figure 2. The eigenvalues of each component after PCA



I aggregated my three components by allocating a weight to each of them equal to the proportion of the explained variance of the extracted components in the dataset. The weight of each consecutive component decreases in accordance to the explained variance of the component. The benefit of this method is that it gains a higher representative power of the data.

In mathematical terms the aggregation of the extracted components to derive the composite deprivation index is as follows:

$$DI_i = (\sum_{i=1}^{n=3} (C_i w_i)) * 100 \quad (2)$$

where DI is the composite deprivation index,  $C_i$  is the extracted component ( $i=1 \dots n$ ), and  $w_i$  is the weight of the  $i^{th}$  C determined by the explained variance of the extracted component as a percentage of the cumulative variance of the extracted components.

The weighted scores for all three components used in equation (1) was computed by:

$$weight\ score = \sum_{k=3}^n \left( \frac{proportion_n}{cumulative\ proportion} \right) * score_n \quad (3)$$

Where the score of each principal component is in standardized units after PCA of a correlation matrix, and n is the number of the first three components. The proportion of the variance explains in the dataset was 47.27 per cent, 15.63 per cent and 8.16 per cent, respectively and cumulatively it explained 71.05 per cent of the total variance observed in the dataset.

In order to test whether a low-dimensional representation of our data is possible, I made use of the Kaiser-Meyer-Olkin (KMO) and squared multiple correlations (SMC) measures. The KMO value of 0.7913, is middling/meritorious, and none of the SMCs are small enough to warrant exclusion. The test results below in table 4 show that my model is able to capture a low-dimensional reduction of the data which can be interpreted that using PCA is the appropriate method for analysing the data.

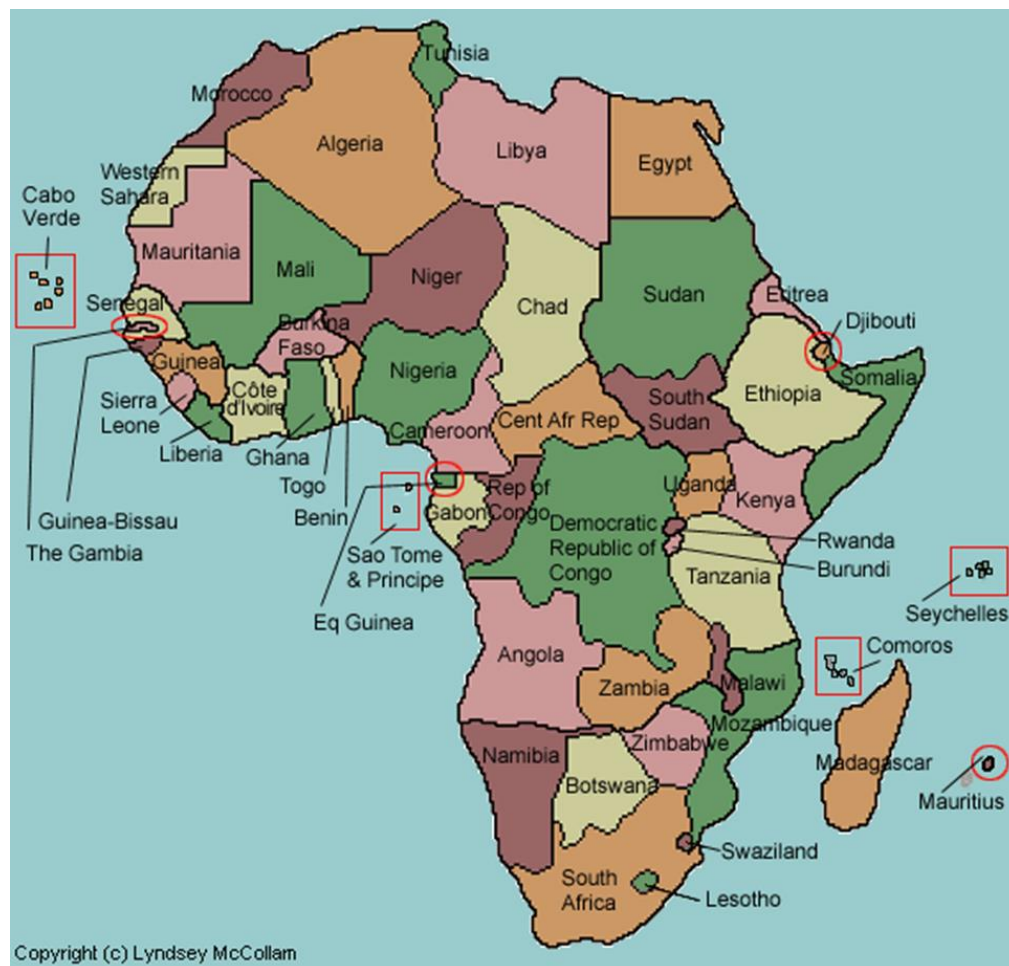
*Table 4. KMO and SMC results*

Multidimensional deprivation variables	KMO test results	SMC test results
Maternal mortality ratio (modelled estimate, per 100,000 live births)	0.8424	0.7093
Mortality rate, under-5 (per 1,000 live births)	0.7897	0.7928
Prevalence of HIV, total (% of population ages 15-49)	0.5218	0.7232
Health expenditure per capita, PPP (constant 2011 international \$)	0.8808	0.6820
Health expenditure, public (% of GDP)	0.5403	0.6633
Health expenditure, total (% of GDP)	0.4012	0.6774
Expected years of schooling (years)	0.8700	0.7973
Mean years of schooling (years)	0.7742	0.8302
Fixed telephone subscriptions	0.7721	0.3607
Improved water source (% of population with access)	0.8617	0.6294
Improved sanitation facilities (% of population with access)	0.8985	0.5782
Access to electricity (% of population)	0.8150	0.7935
Access to clean fuels and technologies for cooking (% of population)	0.9258	0.7389
Overall	0.7913	

## 5.2. Deprivation rankings

In order to make it easier to the reader, I include this map of Africa so that readers can visually place the countries the study makes reference to.

Figure 3. Map of Africa



I utilised equations (1) and (2) to construct the deprivation score encompassing thirteen variables. This allowed me to have the raw deprivation scores for my 31 SSA countries for each of the four-time periods under investigation. The deprivation rankings were then estimated by the raw data being expressed as weighted scores. The higher a country is ranked, the lower its level of deprivation and the more affluent it is. Geographical maps (see figure 4) are used as a visualisation tool to illustrate the deprivation rankings and status of the 31 SSA countries. The darker the colour appears on the map, the higher the level of deprivation.

The initial results indicate that Mauritius, is in the top five least deprived countries for all four-time periods considered. This excellent performance of Mauritius could possibly be explained by her having a small population, a stable political environment, and strong governance. The vigorous development of the tourism sector drives the growth in the service industry. At the same time, Europe and India's preferences in trade also promoted the economic growth and diversification in Mauritius. Another country consistently found in the top-five least deprived nations is Cape Verde, which has profited from a high quality democratic system established in 1991 and reinforced over the years (African Development Bank, 2014). Cape Verde also has good governance, a stable political environment, and good civil liberties at present. In addition, the developed tourism industry (which accounts for 20 per cent of GDP), as well as the service industry (which accounts for 70 per cent of GDP) derived from tourism, has brought significant revenue to Cape Verde. Over the last decade, Cape Verde's successful socio-economic development has been widely acknowledged and ranked second, in 2012, for performance in good governance in Africa (African Development Bank, 2014).

Apart from the above, a few of the top performing countries are located in Southern Africa and display a good performance regarding quality of life in general (Mauritius, South Africa, Botswana, Namibia, Swaziland and Zimbabwe). As was discussed earlier, the industrial development of a country depends on its electrical supply. South Africa's neighbouring states have good rankings in terms of being relatively less deprived and this could possibly be because South Africa provides two-thirds of the continent's electricity, and the development of several surrounding countries, such as Botswana, Lesotho, Mozambique, Namibia, Swaziland, and Zimbabwe depend on South Africa for power (Export Gov, 2017).

It is interesting to note, that several landlocked countries (Mali, Chad, Ethiopia and Niger) are on the edge of the Sahara Desert and seem more inclined to experience larger levels of deprivation. The hostile geographical environment of the Sahara Desert, the world's largest desert, fosters the severe shortage of resources needed for

developing the much-needed agriculture sector. At the same time, the four countries are in internal/external conflict<sup>8</sup>. Moreover, there is a lack of an established and growing tourism industry. Even when travelling to the Sahara Desert, people are more likely to choose Morocco, or countries to the north of the desert, rather than those to the south of it.

*Table 5. The top five least deprived and bottom five most deprived countries; 2000, 2005, 2010 and 2014.*

Ranking	2000	2005	2010	2014
1	South Africa	South Africa	South Africa	South Africa
2	Mauritius	Mauritius	Mauritius	Mauritius
3	Botswana	Botswana	Botswana	Botswana
4	Namibia	Namibia	Swaziland	Swaziland
5	Zimbabwe	Cape Verde	Namibia	Namibia
27	Tanzania	Sierra Leone	Mauritania	Sierra Leone
28	Mali	Mali	Mali	Mali
29	Chad	Ethiopia	Sierra Leone	Madagascar
30	Ethiopia	Niger	Niger	Niger
31	Niger	Chad	Chad	Chad

When considering only the five best and worst performing countries, it is interesting to see their individual rankings have not changed a lot over the last 14 years. A possible explanation could either be a positive one, i.e. all these nations have grown and developed in sync with each other or it could be a negative explanation, i.e. none of them have developed much since the year 2000. As can be seen from table 5, South Africa, Mauritius and Botswana stays the top three for all years whereas Cape Verde, Swaziland, Namibia and Zimbabwe fight it out for fourth and fifth position.

The worst performing countries, as indicated by their ranking at the bottom of the list, are Ethiopia, Mali, Chad, Niger and Sierra Leone. There is some movement in their individual rankings but generally speaking they are the worst offenders when it comes

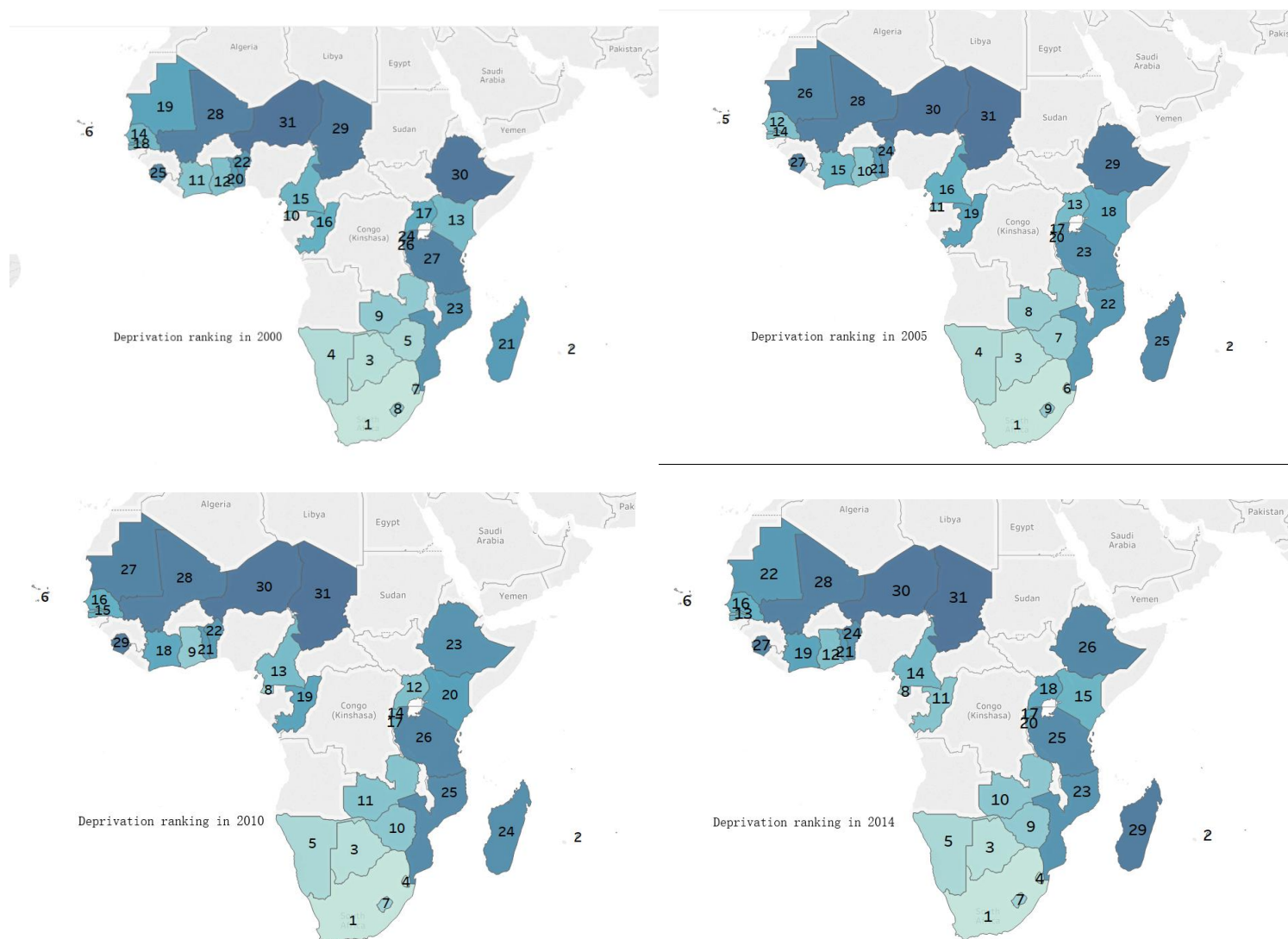
<sup>8</sup> The Tuareg Rebellion of 2007–2009 in Mali and Niger,  
The Eritrean–Ethiopian border conflict (2000–present) in Ethiopia,  
The northern Mali conflict (2012–2015) in Mali  
Chad had not been stable for nearly in past four decades until 2009.



to deprivation. Overall, Chad and Madagascar's deprivation status have deteriorated over the last 14 years. This could be the result of a four decade long armed conflict and social and political instability in Chad. In 2003, the rebels in Chad were mostly inactive but by 2005 opposition parties became very active and were growing rapidly. Chad was plunged into internal armed conflict and bloody violence along its borders prevailed until 2009. This was when government forces declared victory over the rebels and domestic politics stabilised (African Development Bank, 2015).

Countries that experienced the most movements in their rankings throughout the last 14 years are the Republic of the Congo (up five places from 16<sup>th</sup> to 11<sup>th</sup>), Burundi (up six places from 26<sup>th</sup> to 20<sup>th</sup>), Rwanda (up 7 from 24<sup>th</sup> to 17<sup>th</sup>), Madagascar (down 8 from 21<sup>st</sup> to 29<sup>th</sup>) and Cote d'Ivoire (down 8 from 11<sup>th</sup> to 19<sup>th</sup>). Congo's politics has been relatively stable during the last 14 years, and oil exports have contributed a significant proportion to the country's total export earnings (African Development Bank, 2018). Since 2008, Burundi has embarked on extensive economic and social reforms to achieve the goal of stimulating economic growth and regional integration, which has accelerated the modernisation of the country's economy (African Development Bank, 2011). Rwanda's innovative policymakers made tremendous progress in poverty alleviation, such as the sustained implementation of economic structural reforms, a prolonged period of peace and political stability, and unwavering donor support (African Development Bank, 2016). At the same time, the level of deprivation in some countries has been steadily increasing. Local political turmoil may have contributed to the deterioration in the index of deprivation for these countries. Madagascar and Cote d'Ivoire similarly suffered from political instability and civil war. The civil war in Cote d'Ivoire between 2002 and 2011 left the economy in a downward spiral. Cote d'Ivoire has for the greater part relied on their primary industry, especially for exporting coffee and cocoa. Because of a drop in global primary products' prices, Cote d'Ivoire's exports of cocoa and coffee are confronted with more competition in the global market (African Development Bank, 2014). The five years of internal political crisis in Madagascar eased in late 2013 after the presidential and parliament elections (African Development Bank, 2014).

Figure 4. Deprivation rankings for 31 SSA countries, 2000, 2005, 2010 and 2014.



### 5.3. Income-independent Deprivation Index

Since there is agreement that traditional non-income indicators are highly correlated with income (see section 1 and 3 for discussion), I followed the methodology as outlined in section 3.1 and ran a regression of the deprivation index on its natural log of real GDP in order to derive the residual (see equation 1). This residual term  $\mu_{it}$  is a purely statistical construct and is defined inter alia as *deprivation independent of income* (IID), which is central to my analysis and by definition orthogonal with respect to natural log of real GDP. This residual captures all of other domains that cause a person to be seen as being deprived which is not correlated to income. Table 6 shows the top five and bottom five countries according to their level of income-independent deprivation.

*Table 6. The top and bottom five countries according to their income-independent deprivation.*

Ranking	2000	2005	2010	2014
1	South Africa	South Africa	South Africa	South Africa
2	Zimbabwe	Zimbabwe	Lesotho	Lesotho
3	Lesotho	Mauritius	Burundi	Burundi
4	Mauritius	Burundi	Zimbabwe	Swaziland
5	Mozambique	Mozambique	Mauritius	Zimbabwe
27	Chad	Mali	Mali	Mali
28	Mauritania	Mauritania	Mauritania	Tanzania
29	Mali	Congo	Congo	Mauritania
30	Congo	Chad	Chad	Chad
31	Equatorial Guinea	Equatorial Guinea	Equatorial Guinea	Equatorial Guinea

According to the IID ranking, South Africa still retains her position as the country who achieves the best in terms of deprivation. On the other hand, Botswana (down nine places from 3<sup>rd</sup> to 12<sup>th</sup> in 2014) and Namibia (down five places from 5<sup>th</sup> to 10<sup>th</sup> in 2014) has fallen sharply from their initial positions whilst Lesotho, Burundi and Mozambique moved up to round out the top five best performing countries. As regards to the worst performing countries, Congo, Equatorial Guinea and Mauritania are now in the bottom five countries. This is not surprising as the effect of income on multidimensional deprivation is removed and therefore Equatorial Guinea which has the highest PPP GDP per capita for years 2005, 2010 and 2014, fell to last place. Mali, Chad and

Mauritania is consistently ranked as the worst performing countries even after the variation attributable to income has been removed.

Because the income-independent rankings come from the residuals, which includes all other factors except real GDP per capita, it can be regarded as a country's non-income deprivation achievement (or lack thereof). As a result, the rapid decline (improvement) in income-independent rankings for some countries could be due to their non-income deprivation achievement being much worse (better) than what you would expect given their high (low) GDP rankings. For example, Botswana has a very high HIV infection rate, 22.4 per cent in the year 2014 (World Bank, 2014). The infection of HIV poses a significant burden on individuals, families, social communities and the state, and which has a severe impact on their non-income welfare. Namibia was moved out of the top five ranked countries and this could have been due to a very high unemployment rate (37.6 and 28.1 per cent for 2008 and 2014, respectively). There is also large income inequality with the Gini coefficient being 0.63 and 0.61 in 2003 and 2009, respectively (World Bank, 2018).

A special result to this study came to light when I compared Burundi, which has gained sharply in her ranking, and Equatorial Guinea, which has lost in terms of her standing. Firstly, if one uses only GDP to measure the size of the economy then a country's non-market activities, such as unrecorded informal sector workers, are omitted from this calculation. Kuznets (1944) and Clark (1958) state that the nation's income would be seriously underestimated without accounting for income in-kind provided by productive household activities (Chadeau, 1992). Moreover, Ghosh et al. (2010) point out that in many developing countries, the informal sector accounts for a larger proportion of economic activity than the formal sector, but that the productivity of the informal sector is often excluded from the formal statistics (Ghosh et al., 2010). Burundi's economy is not diverse, and primary production is its central sector which accounts for 43 per cent of GDP and employs about 90 per cent of the country's total labour force (African Development Bank and African Development Funds, 2011). One possibility is that the majority of people in Burundi are in self-sufficient informal primary production sectors,

and their output is not counted as they consume it themselves. Thus, these activities are not counted as part of the GDP.

Equatorial Guinea is opposite of Burundi. Equatorial Guinea has the highest PPP national GDP per capita among SSA countries; its real income ranking was higher than that of Spain in 2014, and Equatorial Guinea only had a population of 0.9 million. However, the origin of this high income is dependent on hydrocarbons and oil production and export earnings. The sectors of hydrocarbons, mining and quarries, construction, and manufacturing and communications account for 95.2 per cent of GDP. The non-oil private industry can support a very low proportion of the necessary employment opportunities (African Development Bank, 2013). After adjusting for the variance explained by income in their deprivation levels, Equatorial Guinea fell to the bottom of the list. Hence, considering that some countries have a significant proportion of their economic activity located in the informal sector, it has not been considered in the algorithm of GDP; thus, after removing the influence of the GDP, that part of the economic activity will be highlighted to cause the improvement. Vice versa, if the country's economy is based on an industry or sector that has already been counted as economic activities, it is not hard to imagine that after the removal of the income effect, the rest of the non-income activities will not contribute a significant amount.

Overall, after removing the variation explained by income on deprivation levels, three of the initial top five (middle-high-income) countries (Botswana, Namibia and Equatorial Guinea) experienced a sharp decline in their respective rankings, illustrating an unsatisfactory level of non-income associated deprivation. It is doubtful whether income of these three countries can be equally distributed amongst their citizens and be utilised to improve their social circumstances. It is more likely that majority of income will end up in the hands of the rich and powerful. The results also speak to the well-known theme of 'rich country, poor people'.

#### *5.4. Robustness checks*

In order to check the robustness of my results, I compared my findings with unidimensional economic indicators, i.e. PPP per capita GDP and the universal MPI (Alkire and Foster, 2010). This comparison will also enable me to scrutinize how poverty is measured in SSA and allude to some fundamental flaws in this measurement advising the number of people living in extreme poverty in SSA has increased between 1990 and 2013.

##### *5.4.1 Comparison of deprivation rankings to GDP rankings*

From table 7 it can be seen that when I compare my rankings to those obtained through GDP comparisons, there are no similarities. The significant diversity between rankings are also much more evident. For example, Equatorial Guinea has the highest GDP per capita ranking for 2005, 2010, and 2014, but its deprivation rankings lie between 11<sup>th</sup> and 8<sup>th</sup> place. The results are consistent with the underlying theory that if poverty was merely measured by income indicators, there would be a serious concern regarding the large proportion of uncaptured poverty domains.

Table 7. Deprivation ranking, IID and GDP ranking

	2000			2005			2010			2014		
Countries	Deprivation ranking 2000	IID ranking	GDP ranking	Deprivation ranking 2005	IID ranking	GDP ranking	Deprivation ranking 2010	IID ranking	GDP ranking	Deprivation ranking 2014	IID ranking	GDP ranking
South Africa	1	1	4	1	1	4	1	1	4	1	1	4
Mauritius	2	4	1	2	3	2	2	5	2	2	6	2
Botswana	3	11	3	3	11	3	3	10	3	3	12	3
Namibia	4	10	5	4	14	5	5	16	5	5	10	5
Zimbabwe	5	2	12	7	2	21	10	4	23	9	5	20
Cape Verde	6	6	8	5	9	8	6	9	7	6	8	7
Swaziland	7	21	6	6	18	6	4	8	6	4	4	6
Lesotho	8	3	17	9	6	16	7	2	15	7	2	15
Zambia	9	7	15	8	10	13	11	19	10	10	16	11
Equatorial Guinea	10	31	2	11	31	1	8	31	1	8	31	1
Cote d'Ivoire	11	22	9	15	25	11	18	23	13	19	24	13
Ghana	12	18	13	10	15	12	9	14	11	12	19	9
Kenya	13	19	14	18	21	14	20	25	14	15	17	14
Senegal	14	17	16	12	16	15	16	17	16	16	15	17
Cameroon	15	23	11	16	26	10	13	20	12	14	20	12
Congo	16	30	7	19	29	7	19	29	8	11	26	8
Uganda	17	8	24	13	8	24	12	6	22	18	13	23
Gambia, The	18	15	19	14	12	22	15	12	21	13	7	25
Mauritania	19	28	10	26	28	9	27	28	9	22	29	10
Togo	20	14	23	21	13	25	21	15	27	21	14	28
Madagascar	21	20	22	25	19	23	24	18	24	29	22	27
Benin	22	24	18	24	23	20	22	21	20	24	23	19

Mozambique	23	5	31	22	5	29	25	11	29	23	11	29
Rwanda	24	9	27	17	7	27	14	7	25	17	9	24
Sierra Leone	25	13	26	27	20	26	29	22	26	27	25	22
Burundi	26	12	28	20	4	31	17	3	31	20	3	31
Tanzania	27	25	20	23	24	17	26	26	17	25	28	16
Mali	28	29	21	28	27	19	28	27	19	28	27	21
Chad	29	27	25	31	30	18	31	30	18	31	30	18
Ethiopia	30	16	30	29	17	30	23	13	28	26	18	26
Niger	31	26	29	30	22	28	30	24	30	30	21	30



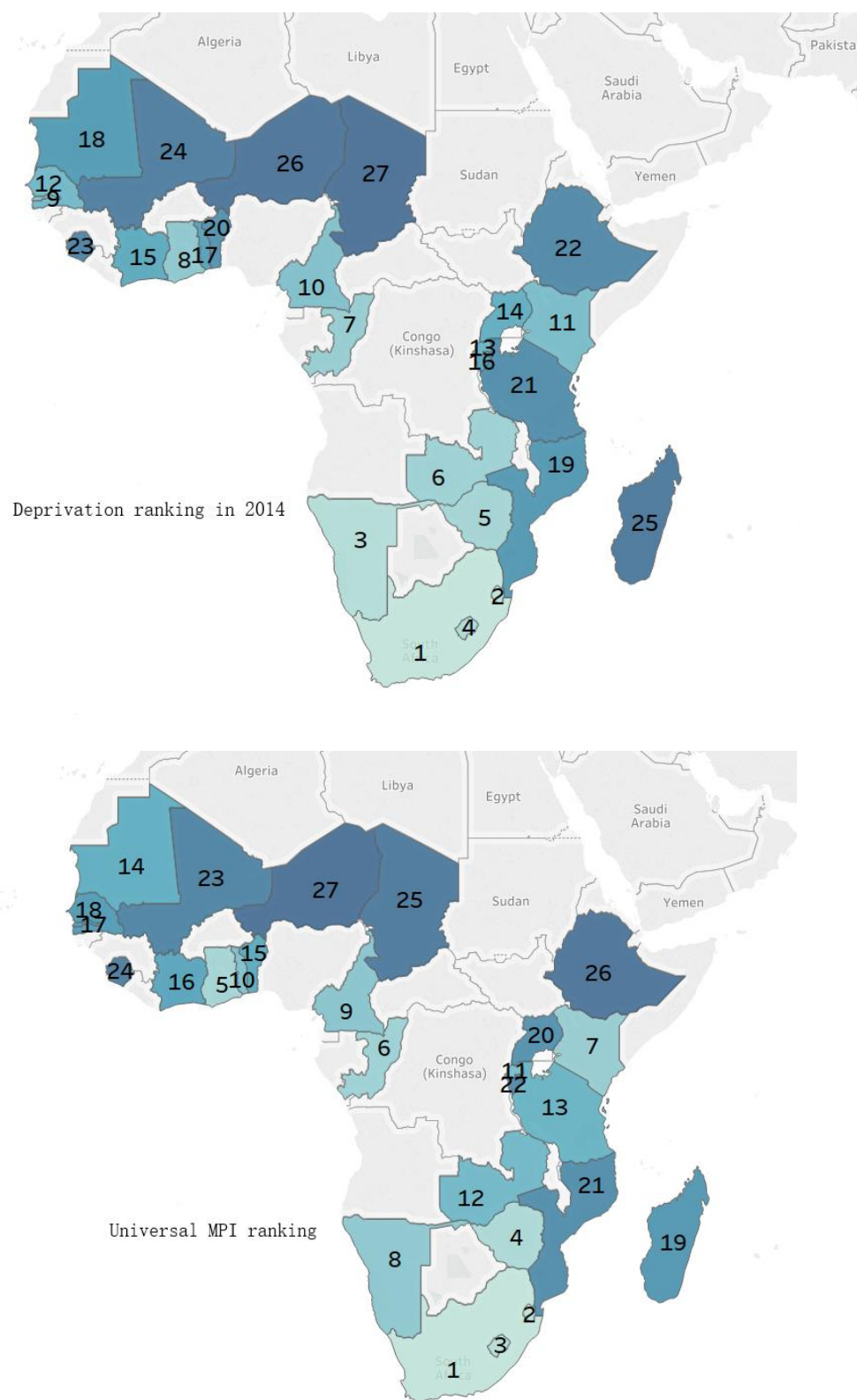
#### 5.4.2 Comparison of deprivation rankings to universal MPI rankings

As regards to the comparing of my findings to those obtained through the universal MPI, it should be noted that I was forced to drop four countries, Botswana, Mauritius, Cape Verde, and Equatorial Guinea, as these countries were missing from the universal MPI. Therefore, only 27 countries were compared by using their respective rankings for 2014. In figure 5, the darker the colour of a country, the higher the level of deprivation in said countries. Although there are small differences in the numerical values of countries' rankings in the two indices, the universal MPI shows similar results the nations close to the Sahara Desert are in a worse state of multidimensional deprivation and that four of the five wealthiest countries are located in southern African, nearly all in coastal regions. On the contrary , Namibia, Togo, Tanzania, Gambia, Madagascar, Burundi, and Senegal show significant differences once I compare the universal MPI and my deprivation index rankings.

*Table 8. Compare with universal MPI*

Countries	Universal MPI Ranking	Deprivation Ranking
Namibia	8	3
Togo	10	17
Tanzania	13	21
Gambia, The	17	9
Senegal	18	12
Burundi	22	16
Madagascar	19	25

Figure 5. Deprivation rankings in 2014 and universal multidimensional poverty ranking for 27 SSA countries



I did a comprehensive comparison between all four poverty/deprivation measures for the year of 2014 by using my deprivation index as the benchmark. A negative change in ranking implies the country's deprivation ranking is lower compared to the others and vice versa. Among all the countries, only South Africa was able to retain their ranking position of being the best according to all measures. The other countries' rankings experienced a significant change and large volatility across all measures. The specific ranking can be seen in table 9.

*Table 9. Comparison across four measure of poverty/deprivation in 2014*

Countries	Deprivation Ranking 2014 ranking	Universal MPI Ranking	GDP	IID	Universal MPI Ranking Change	GDP Ranking Change	IID Ranking Change
South Africa	1	1	1	1	0	0	0
Swaziland	2	2	3	4	0	-1	-2
Namibia	3	8	2	8	-5	1	-5
Lesotho	4	3	11	2	1	-7	2
Zimbabwe	5	4	16	5	1	-11	0
Zambia	6	12	7	13	-6	-1	-7
Congo	7	6	4	23	1	3	-16
Ghana	8	5	5	16	3	3	-8
Gambia, The	9	17	21	6	-8	-12	3
Cameroon	10	9	8	17	1	2	-7
Kenya	11	7	10	14	4	1	-3
Senegal	12	18	13	12	-6	-1	0
Rwanda	13	11	20	7	2	-7	6
Uganda	14	20	19	10	-6	-5	4
Cote d'Ivoire	15	16	9	21	-1	6	-6
Burundi	16	22	27	3	-6	-11	13
Togo	17	10	24	11	7	-7	6
Mauritania	18	14	6	26	4	12	-8
Mozambique	19	21	25	9	-2	-6	10
Benin	20	15	15	20	5	5	0
Tanzania	21	13	12	25	8	9	-4
Ethiopia	22	26	22	15	-4	0	7
Sierra Leone	23	24	18	22	-1	5	1
Mali	24	23	17	24	1	7	0
Madagascar	25	19	23	19	6	2	6
Niger	26	27	26	18	-1	0	8
Chad	27	25	14	27	2	13	0

The four countries of most significance for this study are the Congo, Mauritania, Gambia and Mozambique (Burundi has already been discussed in the previous paragraph) and the reason for their significance lies with the large volatility in their respective rankings. Two of these countries, Congo and Mauritania, have underperformance in either their multidimensional poverty (as measured by the universal MPI) or income-independent deprivation achievement relative to their GDP. Whereas Gambia and Mozambique have overperformance in their multidimensional poverty (as measured by the universal MPI) or income-independent deprivation achievement relative to their GDP.

Being one of the countries in close proximity to the Sahara Desert, also facing a shortage of water, energy and transportation, Mauritania has boosted her per capita income by relying on exporting earnings from iron ore. Foreign aid totalling more than \$500 million was suspended after the coup in August 2008, but international cooperation in the economic backbone sectors of fisheries, mining and oil was unaffected by the introduction of various sanctions. In 2012, Mauritania produced 12 million tons of iron ore, with export earnings exceeding €1 billion (African Development Bank, 2010). Similarly, Congo also relies on oil and gas export earnings to maintain its relatively high GDP status. In 2010, the oil industry accounted for 89 per cent of Congo's total exports (African Development Bank, 2018). However, merely relying on the sale of natural resources and thereby increasing the country's income cannot improve the non-income deprivation experienced. This could be due to large income inequalities prevailing in these African nations.

One of the countries, Gambia, is considered overperforming. It has excellent performance in areas of possible deprivation, which are not associated with income. For example, Gambia's GDP ranks as 21<sup>st</sup> out of a possible 27 countries, which is also below the average. However, the 2011 Ibrahim Index of African Governance<sup>9</sup> ranks Gambia in the middle of the nations of the continent with a rank of 24 out of 53 countries (African Development Bank, 2012). In addition, Gambia has been ranked

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<sup>9</sup> Ibrahim Index of African Governance is a tool to measure all 54 African countries' overall governance performance, which is measured across four key components: safety and rule of law, participation and human right, sustainable economic opportunity, and human development (Ibrahim Index of African Governance (IIAG) 2018).

12<sup>th</sup> using Welfare indicators in the composite Human Development for Ibrahim Index of African Governance. For the Resource Allocation Index (RAI)<sup>10</sup>, Gambia has better portfolio performance, as her index score has increased from 3.1 in 2006 to 3.4 in 2011 computed by AFDB and 3.5 by the World Bank, and the index exceeds the SSA average of 3.2 (African Development Bank, 2012). The other overperforming country, Mozambique, has a significant stable political environment and achieved remarkable economic growth and social progress as a non-oil exporting economy. Mozambique reached the first Millennium Development Goal (MDG) target of halving poverty on 1 February 2015. Meanwhile, Mozambique has large foreign direct investments and high levels of official development assistance (averaging US\$ 89.2 per capita) (African Development Bank, 2011). The two countries' overperformance in terms of non-income deprivation seems derived from their stable governance.

In summary, some countries overperform according to their non-income deprivation. These countries mainly have the following characteristics:

- Excellent social operation and governance with a stable political environment
- A large amount of foreign aid and a rational usage of those funds
- A stable supply of electricity and growing share of the population with access
- Lower population growth
- Developed tourism sector

On the contrary, the nations with large volatility in their rankings are characterised by the following issues:

- Internal/external conflict
- Weak governance and high corruption
- Inability to maintain the basic social operation of the country
- A shortage of resources (electricity, water or food) due to a poor geographical environment

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<sup>10</sup> The World Bank's Industrial Development Agency (IDA) Resource Allocation Index (IRAI) is based on the results of the annual Country Policy and Institutional Assessment (CPIA), which is a set of 16 criteria grouped in four clusters: (a) economic management; (b) structural policies; (c) policies for social inclusion and equity; and (d) public sector management and institutions (World Bank 2018).

- Higher than average per capita income facilitated by export earnings of natural resources such as oil, gas and iron

Overall, the differences in the results strengthen the argument that even though income is essential to human development, it is not directly translatable to higher living standards (Annand and Sen, 1994). Human development or better well-being should be seen as more than a unidimensional economic concept encompassing more dimensions. This does not negate the importance of income in comprising overall well-being, it simply means that one needs to look beyond mere income in order to fully understand how to increase overall well-being.

## **6. Conclusion**

This study was necessary since the current measures of poverty do not include some crucially important indicators, such as the HIV prevalence rate, and most of them do not exclude the effect of income on the level of deprivation. My multidimensional deprivation index filled these caveats through estimating an income-independent deprivation index by adding some specific indicators important to the health sector, i.e. health expenditure (total and private) and the HIV prevalence rate.

In this study, I found large differences between my deprivation ranking scores, the universal MPI and the GDP per capita rankings. These results imply that some countries with lower levels of GDP are doing better in terms of the level of deprivation experienced than one would expect, and vice versa. This finding strengthens the argument against merely relying on unidimensional economic indicators or social indicators that are strongly correlated with income as these cannot portray the complete picture of human deprivation. I also found that countries with lower levels of GDP but overperforming in terms of income-independent deprivations experience characteristics of good governance, stable political environments, lower population growth, a developed tourism sector and high level of foreign aids. On the other hand, countries that have higher levels of GDP and typically rely on export earnings from natural resources, have relatively lower income-independent deprivation rankings compared to their GDP rankings. This reiterates that economic growth cannot simply

increase poor people's non-income deprivation of better basic infrastructure, higher education and better health outcomes.

The following caveats of this study is necessary to mention. First, there are data limitations. Unfortunately, the sample only involved data prior to 2014 as most indicators were not available after this period. Second, choice of variables for the domains of education and health. The study was driven by data availability which ultimately limited my choice of variables. For example, the education domain could have included school attendance or completion rates for primary school and the domain of health could have been more effective if the proportion of the population suffering from malnourishment were included. Third, when working with African data, quality is always a concern. In saying that, the study achieved the best possible results from using data from the most reliable sources.

To summarise, the results of this study serve as justification for future studies focusing on collecting data applicable to non-income domains pertaining to deprivation. Relying on pure income indicators or composite measures that are highly correlated with income does not provide an accurate view of multidimensional deprivation, especially in the African context.

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