İSTANBUL MEDENİYET ÜNİVERSİTESİ

SOSYAL BİLİMLER ENSTİTÜSÜ
İŞLETME ANABİLİM DALI
İŞLETME PROGRAMI

REASSESSING EFFICIENCY IN HUMAN DEVELOPMENT AMONG ECOWAS COUNTRIES

(YÜKSEK LİSANS TEZİ)

Arissou BAWA

Istanbul 2017

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Tez Danışmanı:

Prof. Dr. Ferda HALICIOĞLU

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ONAY

İstanbul Medeniyet Üniversitesi, Sosyal Bilimler Enstitüsü'nde İşletme Yüksek Lisans öğrencisi olan Arissou BAWA'nın hazırladığı ve jüri önünde savunduğu "Reassesing Efficieny in Human Development among ECOWAS Countries" başlıklı tez başarılı kabul edilmiştir.

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beyan ve bu etik ilkeleri ihlal etmiş olmam halinde bütün sonuçlarına katlanacağımı kabul ederim.

Arissou BAWA

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LIST OF ABREVIATIONS

ACDI	: Alternative Composite Human Development Index
GOI	: Government of India
DMUs	: Decision Making Units
DEA	: Data Envelopment Analysis
OLS	: Ordinary Least Squares
SFA	: Stochastic Frontier Analysis
LI	: Longevity Index
EAI	: Educational Attainment Index
GDI	: Gender and Development Index
HPI	: Human Poverty Index
WCI	: Wellbeing Composite Index
CRS	: Constant Returns to Scale
UIS	: UNESCO Institute for Statistics
ECOWAS	: Economic Community of West African States
WAEMU	: West African Economic and Monetary Union

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DEDICATIONS

I dedicate this study to

My mother:

Nanamola Banna

My father:

Abdou-Salam Bawa

And to the entire ***Bawa*** family

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Abstract

Regional economic integration is much beyond the trade liberalization aspect. It also incorporates investments in regional infrastructure, harmonization of regulations and standards, common approaches to macroeconomic policy, management of shared natural resources, and greater labor mobility. The Human Development Index (HDI) is a composite measurement of life expectancy, education, and income per capita indicators, which is used to rank countries into four tiers of human development. A country has got higher HDI score, when the life expectancy at birth is longer, the education period is longer, and the income per capita is higher. Therefore the HDI discusses the measurement of human development based on the three main dimensions such as longevity, education, and standard of living. In this paper, data envelopment analysis (DEA) is used to evaluate the human development (HD) for the Economic Community of West African States (ECOWAS). The aim is to provide complementary information for efficiency measure of HD in ECOWAS countries. ECOWAS region is chosen because of having joint development programs among its member countries. Output-oriented DEA methodology is applied to 15 ECOWAS countries to observe the best practice countries in the regional integration, and provide advices to inefficient ones on the basis of our results. The study will find which country is doing better and what others need to improve to reach an adequate efficiency. The results of the calculations based on DEA fit the HDI values. Both HDI and DEA results yield the same three topmost developed (Capo Verde, Ghana, and Nigeria) and the three lowermost underdeveloped countries (Niger, Guinea, and Burkina Faso).

Keywords: Human Development, Efficiency, Data Envelopment Analysis

Özet

Bölgesel ekonomik entegrasyon, ticaretin serbestleştirilmesinin ötesine geçen bir entegrasyon biçimidir. Böyle bir entegrasyon oluşumu, bölgesel altyapı yatırımları ve ekonomik düzenlemeler, ve standartlarda uyum, makroekonomi politikalar, doğal kaynakların dağıtımı ve yönetimi vede emek dolaşımında yoğun bir işbirliğini kapsar. İnsani Gelişme Endeksi (İGE) yaşam beklentisi, eğitim seviyesi ve kişi başı gelir gibi unsuları içeren dört aşamalı bir endeks olup; ülkelerin gelişmişlik düzeyini belirlemede kullanılır. Bir ülkenin yaşam beklentisi uzadıkça, eğitim süreci arttıkça ve kişi başı geliri yükseldikçe, o ülkeni İGE değeri yükselir. Bu nedenle İGE, yaşam ömrü uzunluğu, eğitim ve hayat standartları gibi unsurları içerdiği için iktisadi kalkınma düzeylerini belirlemede önemli bir ölçüttür. Bu tezin konusu, Batı Afrika Devletler Ekonomik Topluluğu'nun (ECOWAS) İnsani Gelişme (İG) seviyesini, Veri Zarflama Analizi (VZA) ile ortaya koymaktır. ECOWAS ülklerindeki İG düzeyini belirleyen faktörlerin bilinmesi bu ülkelerin iktisadi planlamalarını daha etkin kılacaktır. "Çıktı-odaklı" VZA yöntemi ile ECOWAS bölgesindeki 15 ülkenin en etkin iktisadi planlama yapabilmesi için, bu ülkelerin odaklanması gereken insani gelişim gelişim ölçütlerinin seviyesi ortaya konmaktadır. Bu tez sonuçları ile bölgedeki ülkelerin insani gelişmişlik düzeyleri kantitatif olarak sıralanmışlardır. VZA'ya dayalı kantitatif sonuçlar HDI değerleri ile uyumlu gözükmektedirler. Hem İGE hem de VZA ölçümlerine göre, en gelişmiş üç ülkenin Capo Verde, Gana ve Nijerya; en az gelişmiş üç ülkenin ise Nijer, Gine ve Burkina Faso olduğu tespit edilmiştir.

Anahtar Sözcükler: İnsani Gelişme, Verimlilik, Veri Zarflama Analizi.

Introduction

The year 2015 marked the 25th anniversary of the Human Development Report, which introduced a new approach to the advancement of human development. The term "human development" is well known: it is understood and used in different ways throughout the world. The evaluation of human progress and well-being has, in itself, been converted into an industry in its own: Last year, the Human Development Report Office (HDRO) drew up a list of more than 100 different indices currently used to measure a particular aspect(s) of human development such as well-being, happiness, peace.

This paper aim at contributing to a growing literature that aims to overcome the lack of some measures of socio-economic development, like Gross Domestic Product per habitant or the Human Development Index of the United Nations, by increasing the number of indicators used in the analysis and using new methodological approaches. It explores regional economic integration and its potential impacts on human development, with a focus on Africa and particularly West Africa Region.

After the recent global economic crisis, many countries are reassessing how regional integration can contribute to increase human development. Therefore in this topic efficiency among ECOWAS countries is reassessed in order to overcome some of the limitations of the current Human Development Index (HDI) of the United Nations, to help countries to reach a common and unanimous growth in the region. Regional integration efforts have been ongoing in many regions for several decades, with both theory and experience supporting its potential for human development. The impacts of regional integration on human development are highly dependent on the indicators use in its calculation. They vary from country to country and from community to community, depending on many contextual factors, such as geography and climatic conditions, and factors involving policies that if properly designed and implemented, can shape institutions and capacities in the direction of inclusive growth and human development.

Although West Africa endowed with rich resources, it is subdued recently to the impacts of multiple crises. It has minerals, oil, and a resilient labor force that in difficult circumstances delivers innovation and growth. Yet West Africa also faces multiple challenges. It is highly fragmented, with a large number of landlocked countries and generally has poor transports and communication infrastructures. Before the advent of ECOWAS, the territory of West Africa was constituted at regional level by a group of States from different administrative and colonial systems which defined the borders of the fifteen states in that part of Africa. It covers an area of about 5.1 million km², with more than 300 million inhabitants speaking more than a thousand local languages, including trans-border languages such as *ewe*, *fulfulde*, *hausa*, *mandingo*, *wolof*, *yoruba*, *ibo*, *ga*, etc.

The region's cultural, linguistic and ecological diversity brings both opportunities and challenges for the integration process. The desire to combine forces politically and economically has always been recognized as a step towards the creation of a common prosperity in the region. In this respect, the first integration effort began in 1945 with the creation of the franc CFA, which brought together French speaking countries of the region in a single monetary union. Then in 1964, President of Liberia, William Tubman, proposed an economic union of West Africa that resulted in an agreement signed in 1965 by Côte d'Ivoire, Guinea, Liberia and Sierra Leone. However, these initiatives produced no concrete results until 1975 under the effort of the head of state of Nigeria, General Yakubu Gowon, and his Togolese counterpart, Gnassingbé Eyadéma, a project were put forward and served as a basis for the elaboration in 1975 of the Treaty of Lagos which would give birth to ECOWAS. Originally, the Treaty of Lagos was confined to the economy, but due to the political instability of the region, it was revised and amended in 1993 with the enlargement of its scope and its prerogatives.

ECOWAS aims at promoting economic and political cooperation between its member states. In recent years, the population of West Africa has grown strongly from 70 million to almost 300 million between 1950 and 2010. By the end of 2014, this population represented almost 40 % of that in sub-Saharan Africa. According to UN estimations, the population of the region is projected to

reach 550-600 million by 2050. West Africa is the youngest region in the world. Moreover, with 5% of the world's population and an area covering 40% of sub-Saharan Africa, it is the most densely populated of the continent.

The region has attracted the attention of this study following its constant effort to improve the economic and human development in all its member states. This study will try to find which country is doing better and what others need to improve to reach an adequate efficiency.

Human development efforts gain importance among ECOWAS countries in order to improve their economies and their regional development integration. According to HDI 2015 Report, African countries take place at the lower level of the HDI ranking. They occupy the last 18 places in the HDI rankings, with Niger, DR Congo, Central African Republic and Côte d'Ivoire all ranked behind Afghanistan, which is ranked 171st in the world. These countries have an average HDI of 0.396.

At the regional level, the Economic Community of West African States (ECOWAS) has the lowest average HDI (0.450). Thus, if ECOWAS was a country, it would occupy the 171st place in the HDI classification. This alarming level of the ECOWAS region is our main concern in this topic. This study will find which country is doing better and what others need to improve to reach an adequate efficiency, by using the model of Data Envelopment Analysis (DEA).

The HDI was developed by the Pakistani economist Mahbub ul Haq, working alongside Indian economist Amartya Sen (1989), often framed in terms of whether people are able to "be" and "do" desirable things in their life. It was first introduced by the United Nations Development Program in the 1990 Human Development Report, and it was in response to the need for a measure that could better represent human achievements in several basic capabilities (what people can do and be) than income based indices of growth and development and could provide a credible alternative to them, as mentioned by Kelly and Amburgey (1991), Anand and Sen (1994). The consensus at that time was that the multi-dimensional character of human development was neglected in the typical

measures of economic development, which were based mostly on GDP and GNP.

At the onset, the HDI followed six basic principles as guidelines. According to Ul haq (2003), and Demet and Susanna (2016), that is to (i) measure the basic purpose of human development - to enlarge people's choices; (ii) include a limited number of variables to keep it simple and manageable;(iii) be composite rather than a plethora of separate indices; (iv) cover both social and economic choices; (v) be sufficiently flexible in both coverage and methodology to allow gradual refinements, once better alternatives became available; (vi) not be inhibited by lack of reliable and up-to-date data series.

The HDI was conceived to cover achievements in three basic dimensions - longevity, education and living standard. To capture these three dimensions, the 2009 HDI (as in 2009 HDR) employs four indicators: life expectancy at birth; adult literacy rate; combined gross enrolment for primary, secondary, and tertiary education; and GDP per capita in US$ adjusted by Purchasing Power Parity.

Human Development (HD) and Human Development Index (HDI) are powerful concepts. The former refers to the process of empowerment in the possession of the capacity to build up oneself so as to be able to live a long life, be able to read and write and so participate in the societal affairs effectively and above all be gainfully employed to earn a living. The latter merely establishes how far a country has been able to achieve this for its citizens in numerical qualitative evidence represented by a real number. The fact is that earlier indices of development such as per capita income and its various derivatives have not been able to establish this effectively, especially for comparative purposes.

The HDI has never made a claim to be a comprehensive measure of human development or well-being – but rather a summary alternative to economic measures. "The concept of human development is broader than any measure of human development. Thus although the HDI is a constantly evolving measure, it will never perfectly capture human development in its full sense" UNDP; (2015, p.104).

Among those who criticized the method used in the calculation of HDI are Desai (1991), Sagar and Najam (1998), and Alkire and Foster (2010). One of their critics is that HDI only addresses three factors -income, education and health -which, while being very important, do not cover all those aspects that contribute to increasing the quality of human life. In respect to that this study will reassess the HDI report by using four indicators instead of three.

Verma *et al*. (2003) analyzed the technique of measurement of human development indices and to bring forth the degree of gaps in different regions of the world and also in different states of India. He concluded that human development is a broader term which conveys planning for a tolerable life for human beings. Poverty is a very micro term, which is either confined to income poverty or calorie poverty. Human development indices (Human Poverty Index, the Gender-Related Development Index, and the Gender Empowerment Measure) show critical scenario for developing countries, least developed countries, Sub-Saharan African countries, South Asian Countries and a few other countries of Southeast Asia.

Nayak (2013) also made an attempt to describe evolution and concept of human development which emerged as a new approach to development and the methodological issues relating to its measurement. He provides various changes in the methods of measurement brought out by UNDP, the planning commission GOI (Government of India) and the individual researchers at different points of time since 1990.

Pradhan (2007) identifying the status of human development in India at the global level as well as state level followed two methods namely the Human Development Index and the Alternative Composite Human Development Index (ACDI). According to his study, HDI reflects that a state has high human development, if its value is closer to one and has low human development, if its value is closer to zero. On the contrary, ACDI indicates that a state has high human development, if its score is closer to zero and has low human development, if its score is close to one. He calls for government intervention to improve the status of human development and convergence of regional variations in human development between the states.

Dahl (2013) concluded that, the final aim of development should be to improve the welfare and to flourish each human being on this planet. The term "well-being" is used in a general sense and encompasses work on the measurement of quality of life, social development, human development, sustainable development, and social and economic performance as well. "In broad terms, the human development approach appeared as a means to reallocate human beings at the center of actions related to politics, economy, and society, in such a way, that the central concern is no longer how much is being produced, but rather how this affects people's quality of life" Mariana *et al*.; (2015, p.41).

Data envelopment analysis (DEA) is a nonparametric method in operations research and economics for the estimation of production frontiers. It is used to empirically measure productive efficiency of decision making units (DMUs). Although DEA has a strong link to production theory in economics, the tool is also used for benchmarking in operations management, where a set of measures is selected to benchmark the performance of manufacturing and service operations. In the circumstance of benchmarking, the efficient DMUs, as defined by DEA may not necessarily be form a "production frontier", but rather lead to a "best-practice frontier" as illustrated by Cook *et al*. (2001). DEA is referred to as "balanced benchmarking" by Sherman and Zhu (2013). Non-parametric approaches have the benefit of not assuming a particular functional form or shape for the frontier; however they do not provide a general relationship (equation) relating output and input. There are also parametric approaches which are used for the estimation of production frontiers (see Lovell and Schmidt (1988) for an early survey). These require that the shape of the frontier be guessed beforehand by specifying a particular function relating output to input. One can also combine the relative strengths from each of these approaches in a hybrid method following the example of Tofallis (2001) where the frontier units are first identified by DEA and then a smooth surface is fitted to these. This allows a best-practice relationship between multiple outputs and multiple inputs to be estimated.

Berg (2010) explained how the framework has been adapted from multi-input, multi-output production functions and applied in many industries. DEA develops a function whose form is determined by the most efficient producers.

This method differs from the Ordinary Least Squares (OLS) statistical technique that bases comparisons relative to an average producer. Like Stochastic Frontier Analysis (SFA), DEA identifies a "frontier" which is characterized as an extreme point method that assumes that if a firm can produce a certain level of output utilizing specific input levels, another firm of equal scale should be capable of doing the same. The most efficient producers can form a 'composite producer', allowing the computation of an efficient solution for every level of input or output. Where there is no actual corresponding firm, 'virtual producers' are identified to make comparisons.

Attempts to synthesize DEA and SFA, improving upon their drawbacks, were also made in the literature, via proposing various versions of non-parametric SFA and Stochastic DEA.

In this study, the assessment of HD for the ECOWAS countries is reconsidered in the light of data envelopment analysis (DEA). Accordingly, the aim of the study is to provide complementary information for efficiency measurement of human development for the ECOWAS countries in which the organization has the mission of promoting policies that will improve the economic integration and social well-being of its member countries. However, this study goes beyond and differs from previous studies in different aspects:

- It focuses initially on the HDI of the fifteen countries of the Economic Community of West African States (ECOWAS).
- It uses the Output-Input DEA model to assess the HDI.

The rest of this study is structured as follow: In the first chapter, the study briefly presents literature review; in chapter 2, it explains the methodology used and the output-oriented DEA model. Finally, results and discussions are presented in chapter 4, followed by conclusion, and future work.

Chapter 1: Literature Review

1.1 HDI concept

Measuring inequalities in the world is a difficult task as the parameters to be considered can be varied. It is necessary to stop with the main one of them: the Human Development Index (HDI).

For a long time, many studies have been focusing on economic growth and Gross National Income (GNI) of countries to classify the world between rich and poor countries. This allowed the Third World countries to join together in order to be heard and considered more in the world institutions. From 1970s, the differences between countries in the third world are such that this kind of simplification is no longer possible. How can a country that is full of oil producer, a demographic giant with a population of one billion, been compared with a small African nation devastated by the civil war? In the same way, it soon became apparent that countries with riche resources, whose economy seemed to be flourishing, could hide a dictatorship where almost all the money is diverted by its leaders and where the population hardly sees its life condition improving.

The Human Development Index (or indicator) was thus established by the statisticians of the United Nations in 1990 in order to measure in some way, the degree of well-being of the populations in the world. It is no longer a question of who is the richest but rather where one lives the best. It is inspired by the work of Pakistani and Indian economists, notably the Nobel prize-winning economist Amartya Sen whose work was based on what he called "the economy of well-being". The Index was created to emphasize that people and their capabilities should be the ultimate criteria for assessing the development of a country, not economic growth alone. The HDI can also be used to question national policy choices, asking how two countries with the same level of GNI per capita can end up with different human development outcomes. These contrasts can stimulate debate about government policy priorities. “The concept of human development is broader than any measure of human development. Thus although the HDI is a constantly evolving measure, it will never perfectly capture human development in its full sense” UNDP; (1993, p.104).

How to measure this "well-being"? Three essential criteria were selected:

- Wealth: Let's be honest, it's easier to live well when you have money. This is why one takes the average income of the inhabitants calculated from the Gross Domestic Product divided by the number of inhabitants (All in US dollars). The standard of living dimension is measured by gross national income per capita. The HDI uses the logarithm of income, to reflect the diminishing importance of income with increasing GNI.
- Access to education, a key to a future development: It is an average between the enrollment ratio and the adult literacy rate (being able to read and understand a simple text). It is measured by mean of years of schooling for adults aged 25 years and more and expected years of schooling for children of school entering age
- Health: simply life expectancy which is a good reflection of the health status of a country.

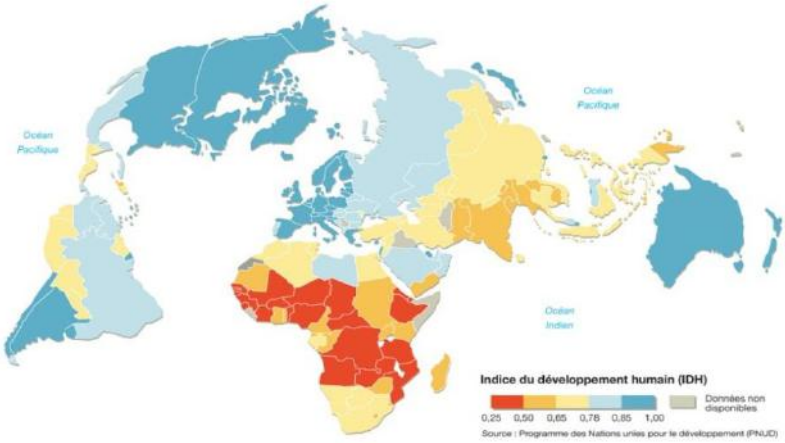
Obviously mixing years, percentages and dollars a year is somewhat complicated and the formula for calculating the index is particularly difficult. The scores for the three HDI dimension indices are then aggregated into a composite index using geometric mean.

It’s included between a number 0 and 1. The closer you get to 1, the better your country’s development is. On the contrary, the closer the number is to zero, the worse the level of well-being. The United Nations Development Program (UNDP) calculates this index annually.

To simplify the calculation, these estimations can be made:

- A GDP per inhabitant of $ 100 is at 0, and a GDP per inhabitant of 40 000 is at 1.
- A country whose life expectancy is 25 years is 0, and 1 for a country where one lives 85 years.
- And that for literacy one goes from 0 (0%) to 1 (100%).

Figure 1.1: world map of Human Development index



Source: UNDP, Human Development Report (2007)

The North-South parts of the world are fairly well represented; while the disastrous situation of much of Sub-Saharan Africa is particularly evident.

A slight analysis of world map (figure 1.1) shows that the first place is not held by the financial giants. Small and prosperous countries which often put forward an important social welfare policy such as Iceland with 0.968 followed by Norway and Australia, are leading the classification. France is 10th with 0.952 ahead of the United States (12th) but behind Japan (8th).

At the bottom of the ranking is the small African country of Sierra Leone, which emerges from a particularly deadly civil war, with an HDI of 0.336, an average life of 41 years, a literacy rate of 34% and an average income of 806 $ per year per inhabitant.

The general evolution of the HDI since 1975 (the date from which reliable data were available to make the calculations) shows a consistent growth for all the world's regions, except sub-Saharan Africa which has stagnated for 40 years around 0.4.

The UNDP website gives more information on this index (HDI). According to UNDP's approach, these three sub-indices are assigned equal weightings as follows:

$$HDI = \frac{LI + EAI + GDPI}{3} \quad (1)$$

The formulas for calculating HDI are different between the period 1990–2010 and the period after 2010. The old method used for calculating HDI includes three sub-indices: longevity index (LI); educational attainment index (EAI); and standard of living.

But like all average parameters, the HDI is not 100% satisfactory. Then, in order to improve and make HDI better, the difference between the situation of men and women in different countries was also taken into account, with the Gender and Development Index (GDI) calculating this situation by separating the sexes. There is also the Human Poverty Index (HPI), which calculates what is missing to achieve a decent standard of living.

To construct the index, fixed minimum and maximum values have been established for each of these indicators:

- Life expectancy at birth: 25 years and 85 years.
- Adult literacy rate: 0% and 100%.
- Combined cross enrolment ratio: 0% and 100%.
- Real GDP per capita (PPP$): $100 and $40,000 (PPP$).

For the components of the HDI, except of the GDP per capita, individual indices are calculated according to the general linear transformation:

$$\text{Index} = (V - \text{min}V)/(\text{max}V - \text{min}V) \quad (2)$$

Where V is the country's actual value for the specific indicator and minV and maxV are fixed minimum and maximum values, respectively, set for the indicator.

For example, if life expectancy at birth in a particular country is 65 years, the index of life expectancy for this country would be:

$$\text{Life Expectancy} = \frac{65\text{-}25}{85\text{-}25} = \frac{40}{60} = 0.667 \quad (3)$$

To construct the income index, a non-linear transformation is applied on GDP per capita (the logarithms of the above values are used), taking into account diminishing returns of higher incomes (utility adjustment). The minimum and maximum values for each component indicator of the HDI are set as follows: 25 and 85 years, respectively, for life expectancy at birth, 0% and 100% for adult literacy rate and combined gross enrolment ratio and USD 100 and USD 40,000 for GDP per capita.

In constructing the HDI there are at least three ignored problems:

- The HDI only synthesizes three sub-indices into a single index and ignores the problem of considering the inputs that generate the sub-indices in each evaluated country;
- The methods synthesizing the three sub-indices into a single index are subjective and changeable, and are short of objective empirical support.
- The HDI cannot tell the policymakers and researchers about whether the inputs, for example labor and capital, generating the normalized sub-indices are over-used.

1.2 Criticism on HDI and the use of DEA as new method for its calculation

The different techniques for calculating human development are proof that there is no universal formula for sustainable development. This calculation has been going on for twenty years and needs to be updated to take account of new conditions. Such a requirement implies questioning the financial and human efforts used to draw up national reports whose purpose seems to be in conformity with a vision of a universal development common to all countries. It is a question of beside economic measures to take into account in the state development of a society, the social welfare as a source of development. As an example: The Justice and Citizenship Commission of the Brazilian Senate (CCJ) approved, an amendment to the Constitution to include the right to happiness. According to the proposed text, article 6 of the Brazilian Federal Constitution said that "the social rights essential to the pursuit of happiness are education, health, food, work, housing, rest, Social security, maternity and child welfare, and assistance to the most deprived ".

Among the "failures of the HDI", there can be cited: the rigor of the statistical sources of the indicators of the HDI can only be questionable. If the measure of human development is based on data from the World Bank for GDP, UNESCO for literacy and schooling and the United Nations Population Division for the expectation of Life at birth, these three institutions use national statistical data (they estimate it when there is none). However, the level of development of statistical systems remains highly variable throughout the world. Only 64 countries in the world, including 4 countries in Africa (Morocco, Tunisia, South Africa, and Egypt) have a statistical system that adheres to the IMF's Special Data Dissemination Standard (SDDS). The reliability of statistical information provided by countries which do not adhere to these standards of excellence, which are costly in any case, can only be questionable. In relation to the initial vision of Amartya Sen defined development as a process of expansion of freedoms. For him the failure to take public freedoms into account in the HDI is another serious flaw. Critical dimensions of political and civic empowerment and freedoms are not considered, as environmental sustainability and vulnerability are. These are the flaws that today call for reform of the HDI.

Ever since the HDI was first published, it has drawn critiques from many researches. Some criticisms were related with the lack of variables while others were related with accuracy measurement methodology, such as the ones mentioned by Mizobuchi (2014). In response to critiques of this kind, the UNDP developed additional complementary tools such as the Human Poverty Index, the Gender-Related Development Index, and the Gender Empowerment Measure. However, although these indices complement the HDI's explanatory power, they have not been widely used. A possible alternative would be to incorporate more dimensions into the HDI itself.

Among the criticisms made on the calculation of HDI, Desai (1991), Sagar and Najam (1998), and Alkire and Foster (2010) have only addressed three factors- income, education and health—which, while being very important, do not cover all those aspects that contribute to increasing the quality of human life. In respect to that our topic will reassess the HDI report by using four indicators instead of three.

Verma *et al*. (2003) analyzed the technique of measurement of human development indices and to bring forth the degree of gaps in different regions of the world and also in different states of India. He concluded that human development is a broader term which conveys planning for a tolerable life for human beings. Poverty is a very micro term, which is either confined to income poverty or calorie poverty. Human development indices (Human Poverty Index, the Gender-Related Development Index, and the Gender Empowerment Measure) show critical scenario for developing countries, least developed countries, Sub-Saharan African countries, South Asian Countries and a few other countries of Southeast Asia.

Nayak (2013) made an attempt to describe the evolution and concept of human development which emerged as a new approach to development and the methodological issues relating to its measurement. He provided various changes in the methods of measurement brought out by UNDP, the planning commission GOI (Government of India) and the individual researchers at different points of time since 1990.

Pradhan (2007) identifying the status of human development in India at the global level as well as state level, followed two methods namely the UNDP, Human Development Index and the Alternative Composite Human Development Index (ACDI). The HDI reflects that a state has high human development, if its value is closer to one and has low human development, if its value is closer to zero. On the contrary, ACDI indicates that a state has high human development, if its score is closer to zero and has low human development, if its score is close to one. He calls for government intervention to improve the status of human development and convergence of regional variations in human development between the states.

However, others argue that the current composition of the HDI is stable and adding new dimensions may affect such stability.

Over time, the detailed composition of each index in the HD family has been subject to change as methodological advances have been incorporated. Recognizing and accepting the valid and valuable critiques, the HDI has been

modified on different occasions. These changes included "broadening the scope of the education component by adding another indicator (gross enrolment ratio) to increase variability since literacy data did not allow for differentiation at the top of the distribution" Raworth and Stewart (2002, p.170). Also, modifications in normalization of component indicators were made by switching from relative maximum and minimum values to fixed goalposts to allow time-series analysis.

Reig-Martínez (2013) calculated human Wellbeing Composite Index (WCI) for 42 countries, belonging to European space and the MENA countries. To attain this goal, different data envelopment analysis (DEA) models are used as an aggregation tool for seven selected socio-economic variables which are income per capita, environmental burden of disease, income inequality, gender gap, education, life expectancy at birth and government effectiveness. He expressed that this study highlights the usefulness of constructing a multi-dimensional index of wellbeing to cover more aspects than those traditionally considered by the HDI and discusses how to go about doing so.

Wu *et al.* (2014) proposed a super-efficiency model to empirically investigate whether the efficiency rankings of the selected 19 OECD countries provide a more reasonable conclusion than the HDI rankings. In the light of the estimated efficiency scores and input slack(s) in the super-efficiency model, they suggested the path of improving the usage efficiency of input resources. They emphasized that compared to the HDI rankings, the efficiency rankings measured by the super-efficiency model have the following two advantages: (1) they consider the inputs that are used to generate the indicators for constructing the HDI, and decide the weights of inputs and outputs endogenously; (2) the input slacks measured by the super-efficiency model can evaluate whether the inputs are over-used and provide the improvement path of each country's input variables.

All of the studies briefly discussed above contribute to the evaluation of human development process from various perspectives either the choice of indicators, the weightings of the elements in the indicator or the measurement methods used.

The HDI has some merits, but it ends up posing more problems than it solves. As mentioned above, a critical issue in estimating the human development index is the fact that equal weights are assumed for its three component indices. This affects to some extent the relative position of the countries in the HDI ranking. Indeed, the relative position of the countries in the HDI ranking can be attributed to two main reasons: one is structural and is related to the data themselves, the other is linked with the particular weighting scheme (equal weights) used in the HDI. Facing this issue, Mahlberg and Obersteiner (2001) introduced the idea of using the DEA approach to assess the relative performance of the countries in terms of human development, as this notion is defined and on the basis of the data given in the Human Development Report of 1998. In line with HDI, in which the component indices are all considered to contribute positively in the HDI, they suggest an output-oriented DEA model by assuming constant returns to scale. In their model, all the individual indicators are considered as outputs and a dummy input (equal to one) is assumed for all the countries. To constrain the flexibility of the model in selecting the weights, they introduce arbitrary bounds on the weight ratios. Then they invert the DEA scores to make them comparable to the HDI.

1.3 Efficiency concept and notion of performance

In recent years, we have seen the development of methodologies to analyze the relative level of performance of institutions by parametric and non-parametric approaches. In modern literature, these new approaches are called "frontier approaches". The frontier represents all the most efficient observations. Any distance from an observation relative to this boundary defines the degree of inefficiency, that is, the difference between the maximum efficiency and the observed efficiency. Efficiency is a productive efficiency that refers to the maximization of production depending on the availability of factors or the minimization of factors while maintaining the level of production constant. To measure the level of productive efficiency of a unit, one must exploit its production technology to link all points by indicating the maximum quantity that can be produced from a volume of available factors, or vice versa.

Performance is at a core place of management studies. It is a very complex notion that can be synonymous with efficiency, profitability, productivity and competitively, according to Mathe and Chague (1999) based on the main criteria of appreciation of efficiency and effectiveness, Performance can be defined by considering several dimensions. Effectiveness is the capacity of an institution to achieve the objectives it has set itself from the resources at its disposal. Its competitiveness and degree of success will constitute the two dimensions allowing appreciating it. On the other hand, Efficiency is appreciated in terms of productivity, cost and efficiency. According to Johnson and Scholes (1997) economies of scale are a source of efficiency.

The production function is generally defined according to the relation between the outputs and the inputs used to obtain them given the production technology. The effective frontier therefore represents then the best practice depending on the technology used. Comparing the input-output factors of an institution with its production boundary informs about its productivity. Also, to measure with sufficient precision the efficiency in HDI, it is important to define indicators used in its calculation.

Productivity is measured for a level of production given by the ratio of output (Y) to input (X). This is the indicator typically used to measure efficiency. This measure does not take into account the diversity of the firm's environment and the variation in the proportions of firms' factors of production over time. In reality, institutions use multiple inputs to produce a multitude of outputs over the same period.

Also, it is risky to use a measurement of partial productivity for possible diverse cases. In order to overcome this shortcoming, economists have introduced the notion of "global productivity" based on a system of weighting by prices or factors in total cost as illustrated by De La Villarmois (2001). The method of calculation always includes the level of weight distributed. Supported by the fact that an institution can consume a multiple of resources to achieve several objectives, economists have innovated the microeconomic theory and a multidimensional approach to measuring efficiency. This measure gives an intuitive interpretation of the notion of efficiency not in terms of input/output

ratio, but in terms of the boundary of the whole of production. The production boundary thus defined serves as a standard for the efficiency of all the units observed.

In the sense of Pareto-Koopmans, a unit is fully effective if, and only if, none of its inputs and outputs can be improved without having a negative impact on its other inputs and outputs. This definition is too restrictive. Farrell (1957) introduced the concept of relative efficiency. According to him, the effectiveness of a unit is measured by the best practices in the sector. Farrell based his assumption on the fact that a firm can be effective in specific context and ineffective in another. He thus laid the foundations for the modern measure of efficiency. It was based on the pioneering work of Koopmans (1951) on the analysis of production and those of Debreu (1951) on the proportions in which resources are to be used. Farrell's innovation lies in applying the efficiency defined by Debreu per unit of production in a sector.

The choice of the orientation of the measure of efficiency is made according to the objective that has been set. If the study wants to answer the question of "how much inputs are reduced while maintaining the current level of production constant ", it opts for a measure of efficiency at orientation input. Conversely, it will choose a measure of output-oriented efficiency if it wants to know "how much to increase outputs without changing the quantities of inputs used".

However, whatever the chosen orientation of the measure of efficiency, Farrell (1957) proposes to divide it into these two components: technical efficiency and allocated efficiency. Technical efficiency reflects a firm's ability to achieve maximum output for a given input level. The allocated efficiency (or price efficiency) reflects the ability of firms to use the prices of their inputs in optimal proportions. A combination of these two types of efficacy provides a measure of economic efficiency or total efficiency.

1.4 DEA Model for Assessing the Human Development

This model focuses on variations in performance between companies, institutions and in some extends countries. The Data Envelopment Analysis

makes no assumptions about functional forms: it is a non-parametric approach for performance evaluation. It is a method initially developed by Charnes, Cooper and Rhodes (1978) to evaluate the relative effectiveness of the decision - making units of non - profit organizations or the public sector that use a similar set of Inputs to produce a set of outputs. It provides an empirical assessment of the capacity of a management unit to transform its inputs into outputs without the need for an explanatory specification of the relationship between inputs and outputs. Its importance can be classified into two ways: the input/output orientated model proposing a minimization of inputs for a given level of outputs; and the output/Input orientated which calls for a maximization of outputs for a given level of inputs. In this study Output/Input oriented model is used.

With the DEA, the benchmark against which the relative performance of companies can be measured is the efficiency frontier. Given a sample of companies, all companies should be able to operate at an optimal level of efficiency, which is determined by the efficient companies in the sample. These efficient companies generally determine the efficiency frontier. Companies that define the efficiency frontier use a minimal amount of inputs to achieve the same amount of production. The distance to the efficiency frontier provides a measure of efficiency or its lack.

DEA advantages: The main advantage of this method is its ability to take into account a multiplicity of inputs and outputs. It is also useful because it takes into account the returns to scale in the calculation of efficiency, integrating the notion of increasing or decreasing efficiency according to size and production levels.

DEA disadvantages: Its results are potentially sensitive to the selection of inputs and outputs, so their relative importance needs to be analyzed before calculation. There is no way to verify whether these results are appropriate or not. The number of efficient companies on efficiency frontier tends to increase with the number of input and output variables. When there is no relationship between inputs and outputs factors, the DEA considers each company to be unique and fully effective, and the efficiency scores are very close to 1, with the method losing then its power of discrimination.

Indeed, ECOWAS countries have very limited information and are very small in size, especially when compared to other countries in Europe and all over the world. Under these conditions, this thesis considers the objective of generating the maximum output for the available information (resources). In addition, these countries are mostly dependent on subsidies and other donations. The study therefore considers it reasonable to assume that they must seek to maximize the supply of services rather than seek to minimize the resources available to them. Moreover, in the particular context of ECOWAS, all the countries seek together an economic development in all aspect.

DEA (Data Envelopment Analysis) is a non-parameter methodology for evaluating the efficiency of homogeneous DMUs (Decision Making Units). It contains solutions for several mutually connected linear programming mathematical models for each of the DMUs. Data Envelopment Analysis (DEA) is used in this paper to reassess the HD of ECOWAS countries. The study utilized the output-oriented DEA model proposed by Mahlberg and Obersteiner (2001) in order to evaluate the human development of 15 ECOWAS countries drawing on the data published by the Human Development Report Office, UNDP (2015). Thus, the purpose of this thesis is to provide complementary information for efficiency measure of HD in ECOWAS countries by employing DEA. The aim is not to propose a new HDI; but to assess the relative HD efficiency of the countries by means of DEA with the recent published data from UNDP.

The DEA method measures the effectiveness of a DMU "θ" in comparison with a set of "n" DMUs in a given sample. The objective is to establish a relative efficiency level ($0 \leq \theta \leq 1$) for each DMU by comparing its inputs and outputs with those of the other DMUs.

The following optimization problem is solved for each individual country in the sample, for the computation of the performance score Zo of each country and weight of each indicator as well as Mahlberg and Obersteiner (2001).

Obective Function =>

$$Zo = \min \sum_{i=0}^{k} (Vi * Xik) \quad (3)$$

Subject To =>

$$\sum (Ur * Yrk) = 1 \quad (4)$$

$$\sum (Ur * Yrj) - \sum (Vi * Xij) \leq 0$$

$$Ur, Vi \geq 0$$

In order to assess countries' efficiency in achieving a certain value of the HD, the study will perform inter-country comparisons and hold their results up to a target. The DEA method allows it to determine this target, which is defined by the best performers in the sample.

A range of DEA models have been developed that measure efficiency and capacity in different ways. These largely fall into the categories of being either input-oriented or output-oriented models.

1.5 Input-Output oriented DEA Model

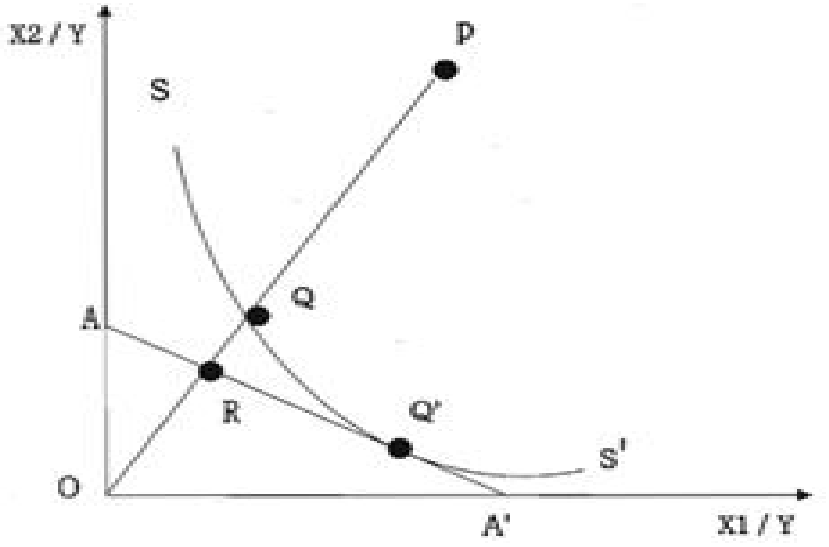
With input-oriented DEA, the linear programming model is configured so as to determine how much input a firm could use in order to achieve the same output level, predetermined by an efficient used input. For the measurement of capacity, the only variables used in the analysis are the fixed factors of production. As these cannot be reduced, the input-oriented DEA approach is less relevant in the estimation of capacity utilization. Modifications to the traditional input-oriented DEA model, however, could be done such that it would be possible to determine the reduction in the levels of the variable inputs conditional on fixed outputs and a desired output level.

Input-output model is also defined as "the ratio models to indicate that an inefficient unit is made efficient through the proportional reduction of its inputs while its outputs proportions are held constant". The input oriented model contracts the inputs as far as possible while controlling the outputs. In an input

oriented model, an inefficient unit is made efficient through the proportional reduction of its inputs, while its outputs proportions are held constant. An inefficient DMU can be made more efficient by projection onto the frontier. Model orientation determines the direction of the projection for inefficient DMUs. In an input orientation, one improves efficiency through the proportional reduction of inputs, whereas an output orientation requires proportional augmentation of the outputs.

As an example for input oriented DEA model (figure 1.3), let us take the case where a firm uses two inputs (X_1, and X_2) to produce a single output (Y). Thus the production function according to Farrell (1957) corresponds to $Y = f(X_1, X_2)$ under an assumption of a Constant Returns to Scale (CRS).

Figure 1.2: Technical Efficiency versus Allocative Efficiency from Input Oriented model



Source: Mariam K., (2007, p:41)

The isoquant **SS'** represents the production possibility frontier, or **$f(X_1/Y, X_2/Y) = 1$**. The convex isoquant which reflects the effective production function, the cost or the profit, is constructed from a number of points so that "no observation is situated neither to the left nor below the isoquant" Amara and Roman (2000). Any firm that is located on this frontier line is technically efficient (**score = 1**) according to Farrell. Such firm is represented by point **Q**. Therefore,

the measurement of the technical efficiency gives answers to the question of how observed activity of a productive unit is located on the border or below its entire production. For this same level of production, any point within the isoquant is technically inefficient. For example, a firm that uses a number of inputs defined at point "**P**" is technically inefficient. The degree of technical efficiency (**TE**$_{\mathbf{I}}$) that measures the distance from the frontier line is represented by the ratio "O**Q/OP**". The distance "**QP**" indicates that it is possible to produce the level "**y**" while reducing the consumption of inputs in the proportion "**QP/OP**". In other words, if for example the ratio "**QP/OP**" is 20%, then the firm can maintain its current level of output while reducing its inputs by 20%. The ratio "**QP/OP**" thus represents the measurement of technical inefficiency. Therefore, if **TE**$_{\mathbf{I}}$**= OQ/OP** and the technical inefficiency is equal to "**QP/OP**", then **TE**$_{\mathbf{I}}$ **= 1 - QP/OP**. The obtained scores vary between zero (0) and unity (1), this unity indicating that the firm has reached full technical efficiency.

Farrell (1957) points out, however, that a technically efficient firm is not necessarily efficient on the allocative level. Allocative efficiency occurs when there is an optimal distribution of goods and services, taking into account consumer's preferences. For example, a firm operating at the "**Q**" point is technically efficient but ineffective on the allocative level. In addition, a firm operating at the point "**P**" is technically inefficient because it is located inside the **SS'** isoquant. But for this same firm, we cannot stalk of allocative efficiency because it is not situated below the isoquant.

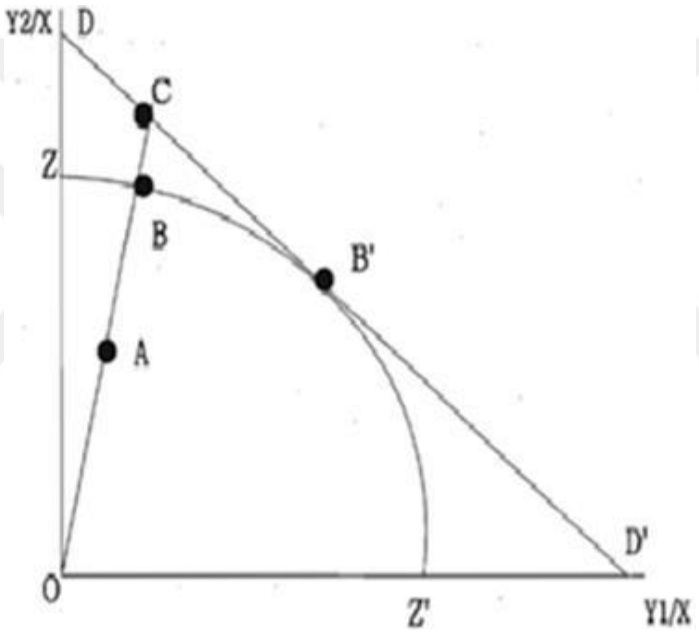
1.6 Output-Input oriented DEA model

In an output-oriented model, an inefficient unit is made efficient through the proportional increase of its outputs, while the inputs proportions remain unchanged. The output oriented model expands the outputs as far as possible while controlling the inputs. Output-oriented models are "...very much in the spirit of neo-classical production functions defined as the maximum achievable output given input quantities" Färe, Grosskopf and Lowell (1994, p.95). While the CCR model yields the same efficiencies regardless of whether it is input or output-oriented, this is not so with the BCC model. Introduced by Banker, Charnes and Cooper (1984), BBC model measures technical efficiency as the convexity

constraint ensures that the composite unit is of similar scale size as the unit being measured. The resulting efficiency is always at least equal to the one given by the CCR model, and those DMUs with the lowest input or highest output levels are rated efficient. Unlike the CCR model, the BCC model allows for variable returns to scale.

In contrast to the previous example, an output orientation model can be defined by the figure represented below.

Figure 1.3: Technical Efficiency versus Allocative Efficiency at Output Oriented Model



Source: Mariam K., (2007, p:44)

As an example of Output oriented model, is that of a firm producing two outputs ($Y_1$and Y_2) from a single input (**X**). The production possibility frontier is represented by the curve **ZZ'**. Point "**B**" represents a technically efficient firm whereas "**A**" is technically inefficient. The degree of technical efficiency (**TE_o**) is measured by the ratio "**OA/OB**". The distance "**AB**" indicates that the level of production can be reduced without changing the quantities of inputs used in the "**AB**/**OA**" proportion. By information on factor prices, we can draw the revenue curve "DD" (isorevenue) and determine the allocative efficiency (**AE_o**). Thus, **AE_o=OB/OC**. The point "**B**" located at the tangency between the isoquant **ZZ'**

and the isorevenue **DD'**, represents the allocative efficiency (score =1). Therefore **EEo**=**TEo** ; **AEo = OA/OB** ; **OB/OC = OA/OC**. The index "**O**" represents the output oriented measurement.

As previously mentioned, the choice of a measurement methodology depends on the initial research objectives. However, whatever orientation chosen, each measurement is subdivided into technical efficiency and allocative efficiency. They all take values within the interval (0, 1). In this case, Farrell formulates the hypothesis of Constant Returns to Scale (CRS). However, the interpretation of one curve is the inversion of the other. For input-output oriented model, the points of technical inefficiency are located inside the isoquant. If factor pricing information is available, an isocost line is drawn showing that cost of production can be reduced till its minimum to achieve allocative efficiency. On the other hand, for the output oriented model, using information on factor prices, we can draw an isorevenue line which will be interpreted as the increase in incomes to achieve allocative efficiency.

In summary, an input-output oriented model, has as objective the minimization of costs. In contrast, the output-input oriented model has as objective the maximization of the incomes. However, it should be noted that minimizing costs is a necessary but not sufficient condition for maximizing revenues. Often, this creates confusion in the interpretation of scale economies (scale efficiency) and economies of scope (scope efficiency). Theoretically, an institution is economically efficient if it produces the level of output while choosing a combination that maximizes revenues and minimizes costs to the extent possible. Through a diversification strategy, large economies reflect the abilities of a firm to offer multiple products at a lower cost than that offered by its peers, each one specializing in the production of a single product. However, the Institution can reduce its average cost by varying the level of production (scale economies) or by classifying the range of products offered (large economies).

During the 1970s and 1980s, Farrell's efficiency model was widely used, and nonparametric approaches have been developed. Lately, some authors have developed new approaches, mainly parametric approaches. The large literature on the possibility frontier models reflects their importance to statisticians and

economists (e.g. Coelli, *et al*. (1998), Lovell and Schmidt (1998), Thanassoulis (2001), Simar and Wilson (2007). Initially, these models were used to estimate the productive activity, or production function, of units operating in a particular sector, as well as the resulting technical performance. In this context, it refers to the volume of production, that is, the quantity of resources used to produce a given quantity of goods and services. The production function is then defined as the optimal allocation of production resources. The production frontier line represents all the most effective observation points. Any distance from an observation to this frontier line, defines a degree of inefficiency, that is, the difference between the maximum efficiency and the observed efficiency. The measured efficiency is a productive efficiency that relates to the maximization of production according to the availability of factors or the minimization of factors while maintaining the level of production constant. To measure the level of productive efficiency of a unit, one must use its production technology to link all points by indicating the maximum quantity that can be produced from a volume of available factors, or vice versa.

The structure of the different parts of this study, are presented as follow: The methodology is described in the first part of the study and the results of the literature search are summed up. Then it is shown the analysis of the DMU by the means of DEA. Finally, the results of this analysis are summarized, put into criticism and conclusions are drawn.

Chapter 2: Methodology

This thesis is written as a theoretical research and it is based on a systematic literature review. The literature sources are from internet where there is access to the updated databases covering thousands of journals worldwide, as well as conference proceedings. Data are driven from variety of publications such as: Journal of the Operational Research Society, The Academy of Management, European Journal of Operational Research, and International Journal of management science, Journal of Operations Management, and the Journal of Econometrics. Some books were also found helpful as a starting point in the research process. The study's inspiration is from the work of Despotis (2005a), titled: measuring human development via data envelopment analysis, the case of Asia and the Pacific. From this review it could be identified a set of key findings, where the literature was either consistent or contradictory.

The review of the literature on the topic helped establishing a better understanding on the components involved in the calculation of HDI and how efficient they are. A starting point was to identify the definitions and key characteristics of HDI concept given by authors who are prominent in the field of human development index, data envelopment analysis, and development. Next step was identifying related and others indicators that can lead to a different HDI results by the use of Data Envelopment Analysis (DEA) model. The criticism regarding this model was also discussed. Instead of a simple rank of the countries according to the HDI, this paper used four indicators data and the indices for 15 countries.

The paper revisits Mahlberg and Obersteiner's formulations and, on the same line as HDI, then develops a simplified index maximizing model to assess the relative performance of the countries in terms of human development. Then it extends its formulation with a post-DEA model to derive global estimates of a new development index, comparable with the HDI, by using optimal common weights for the socioeconomic indicators. With this line of thinking, the study develops a DEA model to estimate the relative efficiency of the countries in converting input to knowledge and life opportunities.

A basic strength of DEA is that it provides a reasonable method to detect inefficiency (a decisional unit is judged inefficient when it performs worse than its peers, even if contemplated under the most favorable idiosyncratic set of weights). The DEA approach possesses important advantages as a basis for the measurement of any aggregate of socio-economic variables:

- First, it can deal with a variety of data dimensions, which is important because of the multi-faceted nature of the composite variable.
- Second, it provides an in-built method of data normalization, as DMUs are ranked between 0 and 1 according to their efficiency.
- And finally, exogenous a priori information is not required to calculate weights, which result from solving individual linear program optimization. The relative weight assigned to each attribute or socio-economic variable is endogenously determined in the performance evaluation model.

In the initial search, over twenty thousands of papers associated with the topic of HDI appeared in the result list. It was then necessary to narrow down the scope of the search by using a set of keywords which were based on the main research question. The search was further restricted by considering papers published after the year 2000. Several articles were chosen using a snowball technique. While scanning the selected papers identified through the databases, some relevant articles appeared from the reference lists that would further explain terms and give clearance over researched topics. All in all, 60 articles were selected for review.

The DEA method used here to reassess efficiency in Human Development among ECOWAS Countries for the year 2015 has already been presented in the previous chapter, therefore the study described in this section the samples or DMUs used, as well as the inputs and outputs chosen for calculations.

In this chapter, the study tried to verify whether the UNDP report for countries in the ECOWAS region is efficient or not. Following the example of Mahlberg and Obersteiner (2001), the DEA model is also applied in this study.

Mahlberg and Obersteiner (2001) formulated DEA on the same line as HDI, and then develop a simplified index maximizing model to assess the relative performance of the countries in terms of human development.

2.1 Selection of Decision Making Units

As sample or decision making units (DMUs) for calculations, 15 countries from the Economic Community of West African States (ECOWAS) were selected for the study. DEA output oriented model is used to measure the efficiency of the UNDP's Human Development Index (HDI) of the year 2015. The total sample for the study, which represents the most homogenous region in Africa during that period, includes only 15 countries following the withdrawal of Mauritania and Sao Tome Principe in the previous years from the union. The study then developed and solved for this purpose a pure DEA model with variable returns to scale. Data are collected from UNDP Report for the year 2015, under the concept of Human Development Index (HDI). HDI is defined as a composite measurement of life expectancy, education, and income per capita indicators, which are used to rank countries into four tiers of human development (Very high Developed, Developed, Developing and Undeveloped). A country has got higher HDI score, when the life expectancy at birth is longer, the education period is longer, and the income per capita is higher. Therefore human development index (HDI) discusses the measurement of human development based on the three main dimensions such as longevity, knowledge, and standard of living. The report is prepared and published every year on the UNDP website.

The homogeneity of DMU, the competitive environment of the ECOWAS region, the socioeconomic aspects and the size of countries under evaluation, is one of the important conditions for the application of the DEA method in this study. All these aspects are respected under ECOWAS countries agreement, which forces all member countries to be governed by the same laws and regulations. These make the region suitable for the study and attracted the researcher interest of verifying whether the UNDP report reflects or not the development signals in that part of Africa continent.

To understand the environment in which countries operate under ECOWAS agreement, the following details are important: The main mission of the ECOWAS is to achieve "collective self-sufficiency" for its member states by creating a single large trading bloc through an economic and trading union. In broad terms, the aim of ECOWAS regional union is to promote economic integration in all fields of economic activity, particularly industry, transport, telecommunications, energy, agriculture, natural resources, commerce, monetary and financial questions, social, and cultural matters, etc..

ECOWAS is made up of fifteen (15) countries (Benin, Burkina Faso, Cape Verde, Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo), with eight (08) French-speaking countries, five (05) English-speaking countries and two (02) Portuguese-speaking country. All countries according to UNDP Report 2015 are classified as Under Developed countries (Table 2.1), despite their high National Income and natural resources available in that region.

Table 2.1: Human Development Report for ECOWAS Countries as for the Year 2015

Countries	Human Development Index (HDI 2015) (Values)
Cape Verde	0,646
Ghana	0,579
Nigeria	0,514
Togo	0,484
Benin	0,480
Senegal	0,466
Cote d'Ivoire	0,462
Gambia	0,441
Liberia	0,430
Guinea Bissau	0,420
Mali	0,419
Sierra Leone	0,413
Guinea	0,411
Burkina Faso	0,402
Niger	0,348

Source: UNDP Report (2015)

2.2 DEA model and Selection of Inputs and Outputs variables

The DEA is a non-parametric approach that uses a linear programming technique. It defines the best practice frontier which allows us to classify countries into best performing units if they are at the frontier and into worse performing units if they lie below. Output-oriented DEA is a part of DEA model, derived from the neo-classical production functions defined as the maximum achievable output given input quantities. In an output-oriented model, an inefficient unit is made efficient through the proportional increase of its outputs, while the inputs proportions remain unchanged.

In this study, since the scores of all indicators (life expectancy at birth, expected years of schooling, mean years of schooling, and GNI per capita) are

preferred to be as high as possible, output-oriented DEA model is applied, accordingly with the idea of Mahlberg and Obersteiner (2001).

The choice of inputs and appropriate outputs is probably the most important task for a successful application of the DEA model since it helps to determine the context of comparison. The same idea is shared by Kao and Liu (2004). In this study, Output oriented DEA model is performed by selecting the inputs and outputs as mentioned in following paragraph.

2.3 Input

Since the objective function of this study leads to the maximization of outputs, a dummy input (equal to one) is assumed for all the countries, as Mahlberg and Obersteiner (2001). Furthermore, the study also solved Charnes, Cooper and Rhodes CCR (1978) output oriented model for all fifteen countries.

2.4 Output

To have the same basis for comparison, four indices used for constructing the HDI were selected as output variables: life expectancy at birth, expected years of schooling, mean years of schooling, and GNI per capita. Data are collected from the ECOWAS countries' database and World databank. Life expectancy at birth, expected years of schooling, mean years of schooling, and GNI per capita are selected as outputs and their scores are preferred to be as high as possible.

Life expectancy at birth (LEB):

Life Expectancy at Birth summarizes a complex set of conditions that exert influence on the ability of people to live a healthy life, a component of paramount importance in the definition of human development. For this study, life expectancy index were taken from the year 2015 United Nations Human Development Report.

Life expectancy at birth is defined as how long, on average, a newborn can expect to live, if current death rates do not change. However, the actual age-specific death rate of any particular birth cohort cannot be known in advance. If

rates are falling, actual life spans will be higher than life expectancy calculated using current death rates. Life expectancy at birth is one of the most frequently used health status indicators. Gains in life expectancy at birth can be attributed to a number of factors, including rising living standards, improved lifestyle and better education, as well as greater access to quality health services. This indicator is presented as a total and as per gender and it is measured in years[1].

The most commonly used measure of life expectancy is at birth (LEB), which can be defined in two ways: while cohort LEB is the mean length of life of an actual birth cohort (all individuals born a given year) and can be computed only for cohorts born many decades ago, so that all their members died, period LEB is the mean length of life of a hypothetical cohort assumed to be exposed since birth until death of all their members to the mortality rates observed at a given year.

GNI per capita (GNI):

This variable represents average purchasing power. In this case, this variable is included in the same format as it appears in the construction of the United Nations HDI. Income per capita is adjusted, taking logarithms, because "achieving a respectable level of human development does not require unlimited income" UNDP (2009, p.355). The effect is to soften the differences in income per capita at high income levels.

GNI per capita is gross national income divided by mid-year population, while Gross National Income (GNI) is gross domestic product (GDP) plus net receipts of primary income (employee compensation and investment income) from abroad. GDP is the sum of value added by all resident producers plus any product taxes (minus subsidies) not included in the valuation of output. Todaro and Smith (2011, p.:44), defined gross national income (GNI) as "the total domestic and foreign output claimed by residents of a country, consisting of gross domestic product (GDP) plus factor incomes earned by foreign residents, minus income earned in the domestic economy by nonresidents".

[1] Shryok and Siegel (1973)

Expected years of schooling (EYS):

It's defined as the number of years during which a child entering infant school can expect to spend in full-time and part-time schooling in the course of their life cycle, based on the school enrolment rates of the time. These expected years are calculated on the young people of less than 30 years old.

Mean years of schooling (MYS):

Average number of years of education received by people ages 25 and older, converted from education attainment levels using official durations of each level. It is developed based on a methodology proposed by Barro and Lee (2013), which has been used as one of two education indicators in UNDP's Human Development Index (HDI). It uses educational attainment data collected in an annual survey from national ministries, and is designed as an internationally comparable measure of a particular country's "stock" of human capital.

All indicators for GNI, LEB, EYS and MYS refer to 2015 UNDP Report. Where Life expectancy at birth is provided by the UN Department of Economic and Social Affairs, the UN Population Division; Mean years of schooling are based on UNESCO Institute for Statistics (UIS) educational attainment data and Barro and Lee (2013) methodology; Expected years of schooling are provided by UIS; and GNI per capita by the World Bank and the International Monetary Fund. For a few countries, mean years of schooling is estimated from nationally representative household surveys and for another few countries GNI was obtained from the UN Statistical Division's database.

2.5 Data

In the midst of growing concerns about identifying an alternative approach to measuring Human Development, the four (4) indicators used are essential to evaluate ECOWAS populations' well-being. This study used the same indicators as those in the 2015 Human Development Report that is published annually by the United Nations Development Program (UNDP), which are used to compute the Human Development Index (HDI). Correspondingly, the

computations of the study are based on data published by the Human Development Report Office (2015) as shown in the following Table.

Table 2.2: Indicators (data) used for DEA calculation

Countries	**X**	**U_1**	**U_2**	**U_3**	**V**
Cape Verde	0,646	73,3	13,5	4,7	6.094
Ghana	0,579	61,4	11,5	7,0	3.852
Nigeria	0,514	52,8	9,0	5,9	5.341
Togo	0,484	59,7	12,2	4,5	1.228
Benin	0,480	59,6	11,1	3,3	1.767
Senegal	0,466	66,5	7,9	2,5	2.188
Côte d'Ivoire	0,462	51,5	8,9	4,3	3.171
Gambia	0,441	60,2	8,8	2,8	1.507
Liberia	0,430	60,9	9,5	4,1	805
Guinea-Bissau	0,420	55,2	9,0	2,8	1.362
Mali	0,419	58,0	8,4	2,0	1.583
Sierra Leone	0,413	50,9	8,6	3,1	1.780
Guinea	0,411	58,8	8,7	2,4	1.096
Burkina Faso	0,402	58,7	7,8	1,4	1.591
Niger	0,348	61,4	5,4	1,5	908

Source: UNDP (2015)

Note:

X = Human Development Index (HDI) (Values)

U_1= Life expectancy at birth (Years)

U_2= Expected years of schooling (Years)

U_3= Mean years of schooling (Years)

V= Gross national income (GNI) per capita (2011 PPP $)

The following optimization problem is solved for each individual country in the sample, for the computation of the performance score Z_O of each country and weight of each indicator as well, accordingly with Mahlberg and Obersteiner (2001). The DEA results are presented in the next chapter (Table 3.5).

Objective Function =>

$$Zo = \min \sum_{i=0}^{k} (Vi * Xik) \quad (3)$$

Subject To =>

$$\sum (Ur * Yrk) = 1 \quad (4)$$

$$\sum (Ur * Yrj) - \sum (Vi * Xij) \leq 0$$

$$Ur, Vi \geq 0$$

Where:

$Zo =$ Performance score,

$X_{ik} =$ *i*-th resource of the *k-th* country

$Y_{rk} =$ *r-th* indicator of the *k-th* country

$X_{ik} =$ *i-th* resource of the country *k*

$Y_{rk} =$ *r-th* indicator of the country *k*

$m =$ Number of resources, $m = 1$

$s =$ Number of indicators, $= 4$,

$n =$ Number of countries, $n = 15$,

$k =$ The country under instigation

$v =$ Weight of the *i-th* resource,

$u =$ Weight of the *r-th* indicator,

$i = 1, \ldots\ldots\ldots\ldots, m$

$j = 1, \ldots\ldots\ldots\ldots, n$

$r = 1, \ldots\ldots\ldots\ldots, s$

Because the study combined the four indicators of the HDI as the output, the resource side consists of the unity vector. The model computes weights so that the country under consideration is determined as best as possible. The weights can

differ from country to country in contrast to the standard definition of the HDI, where the weights are equal for all countries.

All data are considered as outputs and there is a unit input (objective function is maximizing the outputs) for all countries. With the help of LINDO (Linear, Interactive, and Discrete Optimizer) programing, the calculation of DEA values is carried out. LINDO is a software package for linear programming, integer programming, nonlinear programming, stochastic programming and global optimization, programing software.

Below is the example of how the calculation of the DEA and weights for each country is computed. The data of Benin Republic is considered in the following:

Calculation formula of DEA value and weight for Benin:

$$Zmin= 1/(1.7V1+59.6U2+11.1U3+3.3U4)$$

Table 2.3: Calculation of DEA values and weights for Benin

Countries' data
V2-6.094V1-73.3U1-13.5U2-4.7U3>=0
V2-3.852V1-61.4U1-11.5U2-7.0U3>=0
V2-2.918V1-66.5U1-11.3U2-4.7U3>=0
V2-5.341V1-52.8U1-9.0U2-5.9U3>=0
V2-3.560V1-63.1U1-8.5U2-3.8U3>=0
V2-1.228V1-59.7U1-12.2U2-4.5U3>=0
V2-1.767V1-59.6U1-11.1U2-3.3U3>=0
V2-2.188V1-66.5U1-7.9U2-2.5U3>=0
V2-3.171V1-51.5U1-8.9U2-4.3U3>=0
V2-1.507V1-60.2U1-8.8U2-2.8U3>=0
V2-0.805V1-60.9U1-9.5U2-4.1U3>=0
V2-1.362V1-55.2U1-9.0U2-2.8U3>=0
V2-1.583V1-58.0U1-8.4U2-2.0U3>=0
V2-1.780V1-50.9U1-8.6U2-3.1U3>=0
V2-1.096V1-58.8U1-8.7U2-2.4U3>=0
V2-1.591V1-58.7U1-7.8U2-1.4U3>=0
V2-0.908V1-61.4U1-5.4U2-1.5U3>=0
V1, V2, U1, U2, U3>=0.0001

Source: Author's own computations on the basis of data from UNDP (2015)

The following figure shows how the study computed the model for Benin, into LINDO programing for calculation.

BENIN

MIN 1V2

ST

1.767V1+59.6U1+11.1U2+3.3U3=1

V2-6.094V1-73.3U1-13.5U2-4.7U3>=0

V2-3.852V1-61.4U1-11.5U2-7.0U3>=0

V2-2.918V1-66.5U1-11.3U2-4.7U3>=0

V2-5.341V1-52.8U1-9.0U2-5.9U3>=0

V2-3.560V1-63.1U1-8.5U2-3.8U3>=0

V2-1.228V1-59.7U1-12.2U2-4.5U3>=0

V2-1.767V1-59.6U1-11.1U2-3.3U3>=0

V2-2.188V1-66.5U1-7.9U2-2.5U3>=0

V2-3.171V1-51.5U1-8.9U2-4.3U3>=0

V2-1.507V1-60.2U1-8.8U2-2.8U3>=0

V2-0.805V1-60.9U1-9.5U2-4.1U3>=0

V2-1.362V1-55.2U1-9.0U2-2.8U3>=0

V2-1.583V1-58.0U1-8.4U2-2.0U3>=0

V2-1.780V1-50.9U1-8.6U2-3.1U3>=0

V2-1.096V1-58.8U1-8.7U2-2.4U3>=0

V2-1.591V1-58.7U1-7.8U2-1.4U3>=0

V2-0.908V1-61.4U1-5.4U2-1.5U3>=0

V1>=0.0001

V2>=0.0001

U1>=0.0001

U2>=0.0001

U3>=0.0001

END

1) 1.216761

VARIABLE	VALUE	REDUCED COST
V2	1.216761	0.000000
V1	0.000100	0.000000
U1	0.000100	0.000000
U2	0.089508	0.000000
U3	0.000100	0.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2)	0.000000	-1.216216
3)	0.000000	-1.000000
4)	0.180199	0.000000
5)	0.197914	0.000000
6)	0.404789	0.000000
7)	0.448901	0.000000
8)	0.118226	0.000000
9)	0.216761	0.000000
10)	0.502533	0.000000
11)	0.414247	0.000000
12)	0.422644	0.000000
13)	0.359859	0.000000
14)	0.405257	0.000000
15)	0.458739	0.000000
16)	0.441418	0.000000
17)	0.431816	0.000000
18)	0.512433	0.000000
19)	0.727039	0.000000
20)	0.000000	-3.944946
21)	1.216661	0.000000
22)	0.000000	-0.813514
23)	0.089408	0.000000
24)	0.000000	-0.686486

BURKINA FASO

OBJECTIVE FUNCTION VALUE

The same model has been constructed for all ECOWAS countries (including Mauritania and Sao Tome Principe).

As a summary to this chapter, the research question which is mainly based on the reassessment of efficiency in Human Development among ECOWAS Countries, by using the DEA CCR Charnes, Cooper & Rhodes (1978) Output oriented model is solved. A dummy input equal unity has been assumed and four HDI indicators are used as Outputs (life expectancy at birth, expected years of schooling, mean years of schooling, and GNI per capita). The results of the study's calculation are detailed and discussed in the following chapter.

Chapter 3: Results and Discussions

In this chapter, the economic situation in west Arica is first explained and later the study tried to verify which country is efficient in the region and what the score of others are, and following the example of Mahlberg and Obersteiner (2001) the DEA methodology were applied. However the study is not recalculating a new HDI, but it is formulating DEA on the same line as HDI, then develops a simplified index maximizing model to assess the relative performance of the countries in terms of human development.

3.1 Western African economic situation in 2015 and its perspectives in future

3.1.1 Economic growth

In 2015, growth in West Africa was 4.2% compared to 6.1% in 2014. This decline in regional growth was mainly due to lower prices for raw materials, particularly oil. The sharp fall in oil prices, which lost more than half of its value in less than a year, highlighted the fragility of the foundations of West African growth, heavily dependent on the export of raw materials. The slowdown of economic activity has been observed in most ECOWAS countries.

However, disparities exist in terms of economic growth between countries. For example, Côte d'Ivoire (9.5%), Gambia (7%), Senegal (5.4%), Guinea Bissau (4.7%) and Burkina Faso have increased their economic growth in 2015, compared to 8.5%, 0.5%, 4.7%, 2.9% and 4.0% respectively in 2014. Togo (5.8%) and Benin (5.2%) experienced a slight decline in economic activity compared to 2014 and to a lesser extent Mali (4.9%) and Niger (4.4 %) recorded relatively a solid growth in 2015.

The negative effects of the fall in oil prices have affected oil-exporting countries such as Nigeria and to a lesser extent Ghana. Nigeria's GDP growth rate was expected to be 4% in 2015, compared to 6.3 % in 2014. In other hand, Ghana's economic activity resulted in a 0.5 percentage point decline in the Growth rate compared to 2014 to 3.5%.

Countries affected by the Ebola epidemic have had a low activity rates. Indeed, Guinea and Liberia have hardly recovered from the serious health crisis

that has affected the social and production systems of these two countries. Their growth rate in 2015 was 0.9% for each country, compared with 1.1% and 0.7% respectively in 2014. For Sierra Leone, Ebola epidemic has had a severe and more intense effect on economic activity. The GDP growth rate was -21.5% in 2015 against 4.6% in 2014. This decrease is a result of the closure of two iron and ore mills due to the Ebola epidemic.

3.1.2 Inflation

Inflation in the ECOWAS region has increased in 2015. Indeed, the rate of inflation in the region was 8.3% in 2015 against 7% a year before. This overall increase was linked to the expected rise in inflation in Nigeria (9.8% vs. 8% in 2014) and the high inflation rate in Ghana (15.3%).

In the French speaking countries zone, inflation remained under control at 1% below the region norm of 3%. This was due to lower cereals prices and good harvests. Deflationary trends in 2014 and 2015 has attracted attention in some countries such as, Capo Verde (-0.2% and -0.1%), Niger (-0.9% and -1%) and Senegal (-1.1% and -1.3% respectively). The fall in prices could hide a decline in activity that has generated less revenue, which would tend to squeeze demand, especially domestic demand, and thus economic activity.

The following table shows the inflation rate in West African Economic and Monetary Union (WAEMU).

Table.3.1: WAEMU Inflation Statistics, 2014 - 2015

Inflation	2014	2015
Benin	-1.0	0.7
Burkina Faso	-0.4	0.9
Côte d'Ivoire	0.4	1.2
Guinea-Bissau	-1.0	1.3
Mali	0.9	3.6
Niger	-0.9	1.5
Senegal	-0.5	1.5
Togo	0.1	1.9
WAEMU	0.0	1.5

Source: IMF, African Department database (2015)

3.1.3 Public finances

The budget deficit of ECOWAS in 2015, although below the Community norm of 3% of the GDP, would have worsened. Indeed, it would be at 2.2% against 0.4% in 2014.This would be mainly due to the evolution of Nigeria's deficit in 2015, which deteriorated to 1.6% from 0.9% in 2014. The pressure on public finances following the fall in the price of oil explained this negative result. Outside Nigeria, only three countries would have a government deficit below the 3% threshold: Mali (0.03%), Guinea Bissau (2%) and Burkina Faso (2.4%).

The deficit was worsen for other ECOWAS member countries and was beyond the community norm. Compared to 2014, we have in Benin (4.3% vs. 1.9%) and Côte d'Ivoire (3.6% vs. 2.2%). It was remained relatively high in Cape Verde (6% vs. 7.3%), Ghana (5.9% vs. 6.4%), Guinea (5.5% vs. 3.9%), and Niger (9% vs. 5.6%), Senegal (4.8% vs. 5%), Sierra Leone (4% vs. 3.4%) and Togo (3.6% vs. 3.3%). Liberia will record a significant worsening of its fiscal deficit in 2015, to 10.2% against 3.5% the previous year.

Governments seem to face a dilemma while dealing with the public finances situation: financing investment, the engine of growth on the one hand

and balancing public finances on the other. The persistent instability of the fiscal deficit ratio seems to be related to this ambivalence.

Public debt as a share of GDP in ECOWAS reached 21% in 2015, compared with 19.3% in 2014, well below the critical threshold of 70% set in the ECOWAS convergence framework. However, this overall situation hides disparities between countries. Under the HIPC (Highly Indebted Poor Countries) initiative, the majority of countries have had a debt ratio below the 70% threshold. Only Capo Verde (117%) and the Gambia (95.1%), which did not benefit from the HIPC initiative, have a fairly high debt. The situation of the Ghanaian debt has also clearly increased to 72.8%. Nigeria's debt ratio (11.9%) is the lowest, followed by Niger (23.5%) and Benin (25.3%).

In the WAEMU (West African Economic and Monetary Union) zone, the overall deficit represented 3.7% of GDP in 2015 against 3.1% in 2014. This deterioration is due to the sharp increase in total expenditure and net lending in some Member States. The summary of some ECOWAS countries is shown below.

Table. 3.2: ECOWAS Countries Public Finances Situation in 2014 and 2015

Countries	2014	2015
Cape Verde	7.3%	6%
Ghana	6.4%	5.9%
Togo	3.3%	3.6%
Senegal	5%	4.8%
Liberia	3.5%	10.2%
Benin	4.3%	1.9%
Niger	5.6%	9%
Guinea	3.9%	5.5%
Côte d'Ivoire	2.2%	3.6%
Sierra Leone	3.4%	4%

Source: IMF, African Department Database (2015)

3.1.4 Foreign account

The current account balance deficit of ECOWAS was deteriorated in 2015 to 3.1% against 1.6% in 2014. The current account balance of almost all countries in the region is structurally deficient and highly volatile. Only Nigeria (1.9%) and Côte d'Ivoire (0.2%) has continued to have a current account below 5%. The other countries registered a deficit above 5%; the situation in Liberia (41.6%), Niger (19.5 %), Guinea (16.7 %) and The Gambia (13.5 %) were of much concern.

The expected improvement in the economic performance of the euro zone has had a positive impact on the current account balance of ECOWAS countries in 2016 and 2017. The depreciation of the major currencies also contributed to the promotion of exports. However, the dependence of many of these countries on imports and the faster rate of growth of imports relative to exports represent a risk to the balance of the foreign account.

3.2 Results of DEA calculation

The measurement of the human development performance of ECOWAS countries is achieved through the use of indicators utilized in HDI calculation in the following three categories: longevity, knowledge, and standard of living. Applying the basic output oriented DEA model developed by Charnes *et al*. (1978), the study revisited performance indices for each country in the sample.

In accordance to the HDI, the values of DEA measurement are bounded in the interval [0, 1]. Countries that achieve a score of 1 are in correspondence to the so-called “efficient decision making units” in the DEA terminology. Respectively, if the score is less than 1, the country might be considered as “inefficient. The DEA method measures the effectiveness of a DMU "0" in comparison with a set of "n" DMUs in a given sample. The objective is to establish a relative efficiency level ($0 \leq \theta \leq 1$) for each DMU by comparing its inputs and outputs with those of the other DMUs. The scores of output- oriented DEA-model are, by definition, 1 or larger and a value of 1 is assigned to the best performing country.

By transforming the scores of the DEA to the domain between zero and one, makes the DEA scores comparable to the values of the HDI. The transformation is done by inverting the DEA scores. The values of the transformed indicators lie between 0 and 1, as in the values of the HDI. The domain of the HDI, as published in the Human Development Report (as shown in the below table), is between 0 and 1, but even the best performing country does not achieve the highest possible value. To ensure comparability with the DEA values the study has normalized the HDI values as published in 2015.

Table 3.3: HDI Values and the Normalized HDI

Countries	**HDI (2015) (Values)**	**Normalized HDI (Values)**
Cape Verde	0,646	1,000
Ghana	0,579	0,896091301
Nigeria	0,514	0,795
Togo	0,484	0,748231841
Benin	0,480	0,742193161
Senegal	0,466	0,721
Côte d'Ivoire	0,462	0,715
Gambia	0,441	0,682
Liberia	0,430	0,665
Guinea-Bissau	0,420	0,649301951
Mali	0,419	0,648812607
Sierra Leone	0,413	0,639
Guinea	0,411	0,636
Burkina Faso	0,402	0,622504647
Niger	0,348	0,538893047

Source: Author's own computations on the basis of data from UNDP (2015)

To the highest developed country a value of 1 is assigned and to all relatively less developed countries a value of less than 1. Accordingly, the DEA and the inverted DEA scores for each ECOWAS country are given in the table below.

Table 3.4: DEA Values and the Inverted DEA

Countries	DEA Value	Inverted DEA 1/DEA
Cape Verde	1	1
Ghana	1	1
Nigeria	1	1
Togo	1,092632	0,915221227
Senegal	1,103297	0,906374258
Liberia	1,189519	0,840675937
Benin	1,195308	0,836604457
Niger	1,216761	0,821854086
Gambia	1,218441	0,820720905
Guinea	1,247508	0,801598066
Burkina Faso	1,249804	0,80012546
Mali	1,264708	0,79069635
Côte d'Ivoire	1,323843	0,755376582
Guinea-Bissau	1,32858	0,752683316
Sierra Leone	1,440567	0,694171115

Source: Author's own computations on the basis of data from UNDP (2015)

The values of DEA indices show the distance that a country has already moved towards the maximum possible value of 1 and allows comparisons with other countries. The difference between the values achieved by a country and the maximum possible value of 1 show the country's shortfall and indicates how far the country has to go.

All scores and weights obtained from DEA calculation are summarized in the following table.

Table 3.5: DEA Values and the weights of indicators

Countries	DEA Value	1/DEA	Weight of GNI per capita	Weight of life expectancy	Weight of expected years of schooling	Weight of mean years of schooling
Cabo Verde	1	1	0.000100	0.010215	0.000100	0.053037
Ghana	1	1	0.000100	0.010215	0.000100	0.053037
Nigeria	1	1	0.073998	0.002134	0.000100	0.083258
Togo	1,092632	0,915221227	0.000100	0.000100	0.061512	0.054103
Senegal	1,103297	0,906374258	0.000100	0.015019	0.000100	0.000100
Liberia	1,189519	0,840675937	0.000100	0.012157	0.000100	0.063081
Benin	1,195308	0,836604457	0.000100	0.016274	0.000100	0.000100
Niger	1,216761	0,821854086	0.000100	0.000100	0.089508	0.000100
Gambia	1,218441	0,820720905	0.000100	0.016590	0.000100	0.000100
Guinea	1,247508	0,801598066	0.000100	0.016986	0.000100	0.000100
Burkina Faso	1,249804	0,80012546	0.000100	0.017017	0.000100	0.000100
Mali	1,264708	0,79069635	0.000100	0.017221	0.000100	0.000100
Côte d'Ivoire	1,323843	0,755376582	0.000100	0.013533	0.000100	0.070201
Guinea-Bissau	1,32858	0,752683316	0.000100	0.018092	0.000100	0.000100
Sierra Leone	1,440567	0,694171115	0.000100	0.019620	0.000100	0.000100

Source: Author's own computations on the basis of data from UNDP (2015)

3.3 Discussions

The table below (table 3.6) shows that the scores obtain from the normalized HDI and inverted DEA are not the same from one country to another. However both HDI and DEA results yield the same three topmost (capo Verde,

Ghana and Nigeria) but the three lowermost countries have changed. In the normalized HDI the lowermost countries are Guinea, Burkina Faso and Niger, at the same time the inverted DEA shows a different ranking with Cote d'Ivoire, Guinea-Bissau and Sierra Leone as the lowest. It can be observed that Cap Verde (1), Ghana (0,896091301), and Nigeria (0,795) scored the highest first three values among the normalized HDI values, while the same three countries scored maximum value of "1" for inverted DEA scores. Togo (0, 748231841) and Senegal (0,721) took place at the fourth and sixth among the normalized HDI values, while they are respectively fourth and fifth in the normalized DEA values. The countries in the most favorable situation are usually among those that enjoy the highest level of human development as a result not only of their high level of GNI per capita, but also to their social policies applied. For instance, Capo Verde the efficient country among the ECOWAS region, has the highest GNI, LEB and Expected years of schooling, but not the highest Mean year of schooling. Ghana with lower GNI than Nigeria has scored the highest HDI than Nigeria did. This shows that the efficiency of Ghana relies on other three indicators than GNI, where Ghana is doing much better than Nigeria. In the case of Togo, the government free school policy from 2007 has helped to the country to have a good score in Expected years of schooling, but effort need to be made in mean years of schooling, life expectancy. Also much effort must be made for transparency and free corruption to increase Togolese GNI, to allow the country the reach efficiency in the coming years.

Table 3.6: Normalized HDI values and inverted DEA scores for ECOWAS countries

Countries	Normalized HDI values	Countries	Inverted DEA scores 1/DEA
Cape Verde	1,000	Cape Verde	1
Ghana	0,896091301	Ghana	1
Nigeria	0,795	Nigeria	1
Togo	0,748231841	Togo	0,915221227
Benin	0,742193161	Senegal	0,906374258
Senegal	0,721	Liberia	0,840675937
Côte d'Ivoire	0,715	Benin	0,836604457
Gambia	0,682	Niger	0,821854086
Liberia	0,665	Gambia	0,820720905
Guinea-Bissau	0,649301951	Guinea	0,801598066
Mali	0,648812607	Burkina Faso	0,80012546
Sierra Leone	0,639	Mali	0,79069635
Guinea	0,636	Côte d'Ivoire	0,755376582
Burkina Faso	0,622504647	Guinea-Bissau	0,752683316
Niger	0,538893047	Sierra Leone	0,694171115

Source: Author's own computations on the basis of data from UNDP (2015)

In contrast, the countries whose scores have changed in the inverted DEA, such as Niger and Cote d'Ivoire show that the current socioeconomic situation is far from their efficient frontiers. In the case of Niger, the recent political stability and the implementation of development policies, has helped the country to have good scores in LEB, but efforts needs to be made in the other

three indicators to reach efficiency. The lower score of Cote d'Ivoire in LEB and mean years of schooling is the result of the recent civil war and political instability. Normalized HDI values are 0,715 for Cote d'Ivoire, 0,649301951 for Guinea-Bissau, and 0,639 for Sierra Leone while their DEA scores are 0,755376582 for Cote d'Ivoire, 0,752683316 for Guinea-Bissau, and 0,694171115 for Sierra Leone. The largest gap among the ECOWAS countries is found in GNI per capita and mean years of schooling when comparing with the other factors which are life expectancy and expected years of schooling.

On the other hand, both values for the rest of the ECOWAS countries became different, making the main argument changed. The countries that are the lowest in the normalized HDI (Guinea, Burkina Faso and Niger), have all changed their ranking with the inverted DEA becoming the tenth, eighth, eleventh respectively in the order. This shows that the human development was not only the result of the level of GNI per capita, but the social policies applied in those countries.

This analysis examines West Africa's performance against benchmarks and rankings in the business environment, good governance and human development.

Among the 10 economies that have significantly improved their business environment, such us economies that have set up reform in less than 3 months, are Senegal (153rd) and Benin (158th). Significant improvements were observed in Côte d'Ivoire (142nd), Togo (150th) and Niger (160th) according to World Bank (2016), doing business report for measuring regulatory quality and efficiency.

Despite significant improvements, ECOWAS countries' governments should continue to narrow the gap that separate them from the best practices countries in many of the major dimensions to easy the process of doing business, including increasing the access to electricity and setting up an effective system for resolving trade disputes.

With regard to governance assessments in 2015 and according to Mo Ibrahim Foundation, West Africa second in the ranking after Southern Africa, has an average score of 52.4 on a scale of 100 Ranked on the basis of Mo Ibrahim

index, and remains the area that is progressing the most. By 2015, three countries have performed well in the region and are among the top ten, Côte d'Ivoire, Senegal and Togo. However, the challenge of good governance remains to be faced in this area, which has several countries that are poorly classified in terms of global governance.

In terms of human development, with an average development index of 0.460 for West Africa, most of the countries in the region are in the category of countries with "low human development"; only Capo Verde and Ghana are in the "medium human development" category according to UNDP Report (2015).

Corruption reduction is a major concern in the West African region. Cape Verde occupies a prominent place in West Africa, ranking 42nd in the world according to Transparency International, with a score of 57 against an average of 34.73 for West Africa, out of a total from 175 countries in 2014. Ghana and Senegal, ranked 61 and 69 out of 175 respectively in 2014, experienced an improvement in their scores with increases of 3 and 7 points on their respective scores between 2012 and 2014.

Conclusions and Future Work

In conclusion, the study highlights the usefulness of constructing a model of wellbeing to cover more aspects than those traditionally considered by the HDI and discusses how to go about doing so. The human development index is revisited in the light of data envelopment analysis. The point of this study is to give reciprocal data for efficiency measure of HD in ECOWAS nations. Rather than ranking the nations, human development index is benchmarked on the basis of empirical observations of the best practice countries by applying output-oriented DEA. The DEA problem handles a variety of observed quantities of inputs consumed and outputs produced by a number of DMUs to benchmark the performance of individual decision-making units against frontiers of best practices. It measures the efficiency of each unit by its distance from the best practice frontier, which is represented by the best practice units.

The measurement and analysis of development by multiple criteria has the potential to reformulate development policies. Development policies improve from the analysis of less successful countries and examples of best or better practice. The correct measurement of development, as illustrated by the HDI in this paper, is therefore of great importance. Employing more comprehensive measurements enhances the intrinsic relevance of lives and puts less emphasis on measurements of financial opulence, as stated by World Bank (1996).

In this thesis, Data Envelopment Analysis (DEA) is used to reassess the HD in a multiple output setting. The study utilized the output-oriented DEA proposed by Mahlberg and Obersteiner (2001) in order to evaluate the human development of 15 ECOWAS countries drawing on the data published by the Human Development Report Office, UNDP (2015). Thus, the study aimed to provide complementary information for efficiency measure of HD in ECOWAS countries by employing a DEA rather than proposing a new HDI. It rather employs a DEA model for reassessing the efficiency scores with recently published data by UNDP (2015). In this study, ECOWAS countries were selected as the decision making units since the mission of the ECOWAS is to promote

policies that will improve the economic and social well-being of people among their member countries.

Both HDI and DEA results yield the same three topmost (capo Verde, Ghana and Nigeria) but the three lowermost countries have changed. If in the normalized HDI the lowermost countries are Guinea, Burkina Faso and Niger, the inverted DEA shows a different ranking with Cote d'Ivoire, Guinea-Bissau and Sierra Leone as the lowest.

As a future work, relative efficiencies of other countries belonging to other unions or committees should be analyzed in order to shed the light on human development issues. On the other hand, the efficiency of the countries can be analyzed by using other inputs and/or outputs. Finally, the source of inefficiencies in the study's DEA model and the proposals for how to tackle with those issues should be studied as future work.

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APPENDIX

DEA calculation results as shown in LINDO programing

BENIN

MIN 1V2

ST

1.767V1+59.6U1+11.1U2+3.3U3=1

V2-6.094V1-73.3U1-13.5U2-4.7U3>=0

V2-3.852V1-61.4U1-11.5U2-7.0U3>=0

V2-2.918V1-66.5U1-11.3U2-4.7U3>=0

V2-5.341V1-52.8U1-9.0U2-5.9U3>=0

V2-3.560V1-63.1U1-8.5U2-3.8U3>=0

V2-1.228V1-59.7U1-12.2U2-4.5U3>=0

V2-1.767V1-59.6U1-11.1U2-3.3U3>=0

V2-2.188V1-66.5U1-7.9U2-2.5U3>=0

V2-3.171V1-51.5U1-8.9U2-4.3U3>=0

V2-1.507V1-60.2U1-8.8U2-2.8U3>=0

V2-0.805V1-60.9U1-9.5U2-4.1U3>=0

V2-1.362V1-55.2U1-9.0U2-2.8U3>=0

V2-1.583V1-58.0U1-8.4U2-2.0U3>=0

V2-1.780V1-50.9U1-8.6U2-3.1U3>=0

V2-1.096V1-58.8U1-8.7U2-2.4U3>=0

V2-1.591V1-58.7U1-7.8U2-1.4U3>=0

V2-0.908V1-61.4U1-5.4U2-1.5U3>=0

V1>=0.0001

V2>=0.0001

U1>=0.0001

U2>=0.0001

U3>=0.0001

END

OBJECTIVE FUNCTION VALUE

1) **1.216761**

VARIABLE	VALUE	REDUCED COST
V2	1.216761	0.000000
V1	0.000100	0.000000
U1	0.000100	0.000000
U2	0.089508	0.000000
U3	0.000100	0.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2)	0.000000	-1.216216
3)	0.000000	-1.000000
4)	0.180199	0.000000
5)	0.197914	0.000000
6)	0.404789	0.000000
7)	0.448901	0.000000
8)	0.118226	0.000000
9)	0.216761	0.000000
10)	0.502533	0.000000
11)	0.414247	0.000000
12)	0.422644	0.000000
13)	0.359859	0.000000
14)	0.405257	0.000000
15)	0.458739	0.000000
16)	0.441418	0.000000
17)	0.431816	0.000000
18)	0.512433	0.000000
19)	0.727039	0.000000
20)	0.000000	-3.944946
21)	1.216661	0.000000
22)	0.000000	-0.813514
23)	0.089408	0.000000
24)	0.000000	-0.686486

BURKINA FASO

MIN 1V2

ST

1.591V1+58.7U1+7.8U2+1.4U3=1

V2-6.094V1-73.3U1-13.5U2-4.7U3>=0

V2-3.852V1-61.4U1-11.5U2-7.0U3>=0

V2-2.918V1-66.5U1-11.3U2-4.7U3>=0

V2-5.341V1-52.8U1-9.0U2-5.9U3>=0

V2-3.560V1-63.1U1-8.5U2-3.8U3>=0

V2-1.228V1-59.7U1-12.2U2-4.5U3>=0

V2-1.767V1-59.6U1-11.1U2-3.3U3>=0

V2-2.188V1-66.5U1-7.9U2-2.5U3>=0

V2-3.171V1-51.5U1-8.9U2-4.3U3>=0

V2-1.507V1-60.2U1-8.8U2-2.8U3>=0

V2-0.805V1-60.9U1-9.5U2-4.1U3>=0

V2-1.362V1-55.2U1-9.0U2-2.8U3>=0

V2-1.583V1-58.0U1-8.4U2-2.0U3>=0

V2-1.780V1-50.9U1-8.6U2-3.1U3>=0

V2-1.096V1-58.8U1-8.7U2-2.4U3>=0

V2-1.591V1-58.7U1-7.8U2-1.4U3>=0

V2-0.908V1-61.4U1-5.4U2-1.5U3>=0

V1>=0.0001

V2>=0.0001

U1>=0.0001

U2>=0.0001

U3>=0.0001

END

OBJECTIVE FUNCTION VALUE

1) 1.249804

VARIABLE	VALUE	REDUCED COST
V2	1.249804	0.000000
V1	0.000100	0.000000
U1	0.017017	0.000000
U2	0.000100	0.000000
U3	0.000100	0.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2)	0.000000	-1.248722
3)	0.000000	-1.000000
4)	0.202701	0.000000
5)	0.116256	0.000000
6)	0.349262	0.000000
7)	0.174421	0.000000
8)	0.232073	0.000000
9)	0.233951	0.000000
10)	0.116889	0.000000
11)	0.371771	0.000000
12)	0.224047	0.000000
13)	0.212005	0.000000
14)	0.309128	0.000000
15)	0.261597	0.000000
16)	0.382271	0.000000
17)	0.247962	0.000000
18)	0.249804	0.000000
19)	0.204156	0.000000
20)	0.000000	-4.107283
21)	1.249704	0.000000
22)	0.016917	0.000000
23)	0.000000	-3.759966
24)	0.000000	-2.951789

CAPO VERDE

MIN 1V2

ST

6.094V1+73.3U1+13.5U2+4.7U3=1

V2-6.094V1-73.3U1-13.5U2-4.7U3>=0

V2-3.852V1-61.4U1-11.5U2-7.0U3>=0

V2-2.918V1-66.5U1-11.3U2-4.7U3>=0

V2-5.341V1-52.8U1-9.0U2-5.9U3>=0

V2-3.560V1-63.1U1-8.5U2-3.8U3>=0

V2-1.228V1-59.7U1-12.2U2-4.5U3>=0

V2-1.767V1-59.6U1-11.1U2-3.3U3>=0

V2-2.188V1-66.5U1-7.9U2-2.5U3>=0

V2-3.171V1-51.5U1-8.9U2-4.3U3>=0

V2-1.507V1-60.2U1-8.8U2-2.8U3>=0

V2-0.805V1-60.9U1-9.5U2-4.1U3>=0

V2-1.362V1-55.2U1-9.0U2-2.8U3>=0

V2-1.583V1-58.0U1-8.4U2-2.0U3>=0

V2-1.780V1-50.9U1-8.6U2-3.1U3>=0

V2-1.096V1-58.8U1-8.7U2-2.4U3>=0

V2-1.591V1-58.7U1-7.8U2-1.4U3>=0

V2-0.908V1-61.4U1-5.4U2-1.5U3>=0

V1>=0.0001

V2>=0.0001

U1>=0.0001

U2>=0.0001

U3>=0.0001

END

OBJECTIVE FUNCTION VALUE

1) 1.000000

VARIABLE	VALUE	REDUCED COST
V2	1.000000	0.000000
V1	0.000100	0.000000
U1	0.010215	0.000000
U2	0.000100	0.000000
U3	0.053037	0.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2)	0.000000	-1.000000
3)	0.000000	-1.000000
4)	0.000000	0.000000
5)	0.070000	0.000000
6)	0.146291	0.000000
7)	0.152681	0.000000
8)	0.150150	0.000000
9)	0.214871	0.000000
10)	0.187094	0.000000
11)	0.244657	0.000000
12)	0.235516	0.000000
13)	0.159418	0.000000
14)	0.286586	0.000000
15)	0.300451	0.000000
16)	0.314599	0.000000
17)	0.271083	0.000000
18)	0.325182	0.000000
19)	0.292606	0.000000
20)	0.000000	0.000000
21)	0.999900	0.000000
22)	0.010115	0.000000
23)	0.000000	0.000000
24)	0.052937	0.000000

COTE DIVOIRE

MIN 1V2

ST

3.171V1+51.5U1+8.9U2+4.3U3=1

V2-6.094V1-73.3U1-13.5U2-4.7U3>=0

V2-3.852V1-61.4U1-11.5U2-7.0U3>=0

V2-2.918V1-66.5U1-11.3U2-4.7U3>=0

V2-5.341V1-52.8U1-9.0U2-5.9U3>=0

V2-3.560V1-63.1U1-8.5U2-3.8U3>=0

V2-1.228V1-59.7U1-12.2U2-4.5U3>=0

V2-1.767V1-59.6U1-11.1U2-3.3U3>=0

V2-2.188V1-66.5U1-7.9U2-2.5U3>=0

V2-3.171V1-51.5U1-8.9U2-4.3U3>=0

V2-1.507V1-60.2U1-8.8U2-2.8U3>=0

V2-0.805V1-60.9U1-9.5U2-4.1U3>=0

V2-1.362V1-55.2U1-9.0U2-2.8U3>=0

V2-1.583V1-58.0U1-8.4U2-2.0U3>=0

V2-1.780V1-50.9U1-8.6U2-3.1U3>=0

V2-1.096V1-58.8U1-8.7U2-2.4U3>=0

V2-1.591V1-58.7U1-7.8U2-1.4U3>=0

V2-0.908V1-61.4U1-5.4U2-1.5U3>=0

V1>=0.0001

V2>=0.0001

U1>=0.0001

U2>=0.0001

U3>=0.0001

END

OBJECTIVE FUNCTION VALUE

1) **1.323843**

VARIABLE	VALUE	REDUCED COST
V2	1.323843	0.000000
V1	0.000100	0.000000
U1	0.013533	0.000000
U2	0.000100	0.000000
U3	0.070201	0.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2)	0.000000	-1.323665
3)	0.000000	-0.568801
4)	0.000000	-0.431199
5)	0.092559	0.000000
6)	0.193702	0.000000
7)	0.201967	0.000000
8)	0.198700	0.000000
9)	0.284351	0.000000
10)	0.247414	0.000000
11)	0.323843	0.000000
12)	0.311588	0.000000
13)	0.210854	0.000000
14)	0.379245	0.000000
15)	0.397552	0.000000
16)	0.416373	0.000000
17)	0.358665	0.000000
18)	0.430259	0.000000
19)	0.387010	0.000000
20)	0.000000	-0.929911
21)	1.323743	0.000000
22)	0.013433	0.000000
23)	0.000000	-0.856986
24)	0.070101	0.000000

GAMBIA

MIN 1V2

ST

1.507V1+60.2U1+8.8U2+2.8U3=1

V2-6.094V1-73.3U1-13.5U2-4.7U3>=0

V2-3.852V1-61.4U1-11.5U2-7.0U3>=0

V2-2.918V1-66.5U1-11.3U2-4.7U3>=0

V2-5.341V1-52.8U1-9.0U2-5.9U3>=0

V2-3.560V1-63.1U1-8.5U2-3.8U3>=0

V2-1.228V1-59.7U1-12.2U2-4.5U3>=0

V2-1.767V1-59.6U1-11.1U2-3.3U3>=0

V2-2.188V1-66.5U1-7.9U2-2.5U3>=0

V2-3.171V1-51.5U1-8.9U2-4.3U3>=0

V2-1.507V1-60.2U1-8.8U2-2.8U3>=0

V2-0.805V1-60.9U1-9.5U2-4.1U3>=0

V2-1.362V1-55.2U1-9.0U2-2.8U3>=0

V2-1.583V1-58.0U1-8.4U2-2.0U3>=0

V2-1.780V1-50.9U1-8.6U2-3.1U3>=0

V2-1.096V1-58.8U1-8.7U2-2.4U3>=0

V2-1.591V1-58.7U1-7.8U2-1.4U3>=0

V2-0.908V1-61.4U1-5.4U2-1.5U3>=0

V1>=0.0001

V2>=0.0001

U1>=0.0001

U2>=0.0001

U3>=0.0001

END

OBJECTIVE FUNCTION VALUE

1) 1.218441

VARIABLE	VALUE	REDUCED COST
V2	1.218441	0.000000
V1	0.000100	0.000000
U1	0.016590	0.000000
U2	0.000100	0.000000
U3	0.000100	0.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2)	0.000000	-1.217608
3)	0.000000	-1.000000
4)	0.197610	0.000000
5)	0.113346	0.000000
6)	0.340491	0.000000
7)	0.170057	0.000000
8)	0.226254	0.000000
9)	0.228089	0.000000
10)	0.113979	0.000000
11)	0.362444	0.000000
12)	0.218441	0.000000
13)	0.206699	0.000000
14)	0.301384	0.000000
15)	0.255051	0.000000
16)	0.372687	0.000000
17)	0.241758	0.000000
18)	0.243557	0.000000
19)	0.199064	0.000000
20)	0.000000	-4.259065
21)	1.218341	0.000000
22)	0.016490	0.000000
23)	0.000000	-2.785050
24)	0.000000	-1.290698

GHANA

MIN 1V2

ST

3.852V1+61.4U1+11.5U2+7.0U3=1

V2-6.094V1-73.3U1-13.5U2-4.7U3>=0

V2-3.852V1-61.4U1-11.5U2-7.0U3>=0

V2-2.918V1-66.5U1-11.3U2-4.7U3>=0

V2-5.341V1-52.8U1-9.0U2-5.9U3>=0

V2-3.560V1-63.1U1-8.5U2-3.8U3>=0

V2-1.228V1-59.7U1-12.2U2-4.5U3>=0

V2-1.767V1-59.6U1-11.1U2-3.3U3>=0

V2-2.188V1-66.5U1-7.9U2-2.5U3>=0

V2-3.171V1-51.5U1-8.9U2-4.3U3>=0

V2-1.507V1-60.2U1-8.8U2-2.8U3>=0

V2-0.805V1-60.9U1-9.5U2-4.1U3>=0

V2-1.362V1-55.2U1-9.0U2-2.8U3>=0

V2-1.583V1-58.0U1-8.4U2-2.0U3>=0

V2-1.780V1-50.9U1-8.6U2-3.1U3>=0

V2-1.096V1-58.8U1-8.7U2-2.4U3>=0

V2-1.591V1-58.7U1-7.8U2-1.4U3>=0

V2-0.908V1-61.4U1-5.4U2-1.5U3>=0

V1>=0.0001

V2>=0.0001

U1>=0.0001

U2>=0.0001

U3>=0.0001

END

OBJECTIVE FUNCTION VALUE

1) **1.000000**

VARIABLE	VALUE	REDUCED COST
V2	1.000000	0.000000
V1	0.000100	0.000000
U1	0.010215	0.000000
U2	0.000100	0.000000
U3	0.053037	0.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2)	0.000000	-1.000000
3)	0.000000	0.000000
4)	0.000000	-1.000000
5)	0.070000	0.000000
6)	0.146291	0.000000
7)	0.152681	0.000000
8)	0.150150	0.000000
9)	0.214871	0.000000
10)	0.187094	0.000000
11)	0.244657	0.000000
12)	0.235516	0.000000
13)	0.159418	0.000000
14)	0.286586	0.000000
15)	0.300451	0.000000
16)	0.314599	0.000000
17)	0.271083	0.000000
18)	0.325182	0.000000
19)	0.292606	0.000000
20)	0.000000	0.000000
21)	0.999900	0.000000
22)	0.010115	0.000000
23)	0.000000	0.000000
24)	0.052937	0.000000

GUINEA

MIN 1V2

ST

1.096V1+58.8U1+8.7U2+2.4U3=1

V2-6.094V1-73.3U1-13.5U2-4.7U3>=0

V2-3.852V1-61.4U1-11.5U2-7.0U3>=0

V2-2.918V1-66.5U1-11.3U2-4.7U3>=0

V2-5.341V1-52.8U1-9.0U2-5.9U3>=0

V2-3.560V1-63.1U1-8.5U2-3.8U3>=0

V2-1.228V1-59.7U1-12.2U2-4.5U3>=0

V2-1.767V1-59.6U1-11.1U2-3.3U3>=0

V2-2.188V1-66.5U1-7.9U2-2.5U3>=0

V2-3.171V1-51.5U1-8.9U2-4.3U3>=0

V2-1.507V1-60.2U1-8.8U2-2.8U3>=0

V2-0.805V1-60.9U1-9.5U2-4.1U3>=0

V2-1.362V1-55.2U1-9.0U2-2.8U3>=0

V2-1.583V1-58.0U1-8.4U2-2.0U3>=0

V2-1.780V1-50.9U1-8.6U2-3.1U3>=0

V2-1.096V1-58.8U1-8.7U2-2.4U3>=0

V2-1.591V1-58.7U1-7.8U2-1.4U3>=0

V2-0.908V1-61.4U1-5.4U2-1.5U3>=0

V1>=0.0001

V2>=0.0001

U1>=0.0001

U2>=0.0001

U3>=0.0001

END

OBJECTIVE FUNCTION VALUE

1) 1.247508

VARIABLE	VALUE	REDUCED COST
V2	1.247508	0.000000
V1	0.000100	0.000000
U1	0.016986	0.000000
U2	0.000100	0.000000
U3	0.000100	0.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2)	0.000000	-1.246599
3)	0.000000	-1.000000
4)	0.202328	0.000000
5)	0.116043	0.000000
6)	0.348620	0.000000
7)	0.174101	0.000000
8)	0.231647	0.000000
9)	0.233522	0.000000
10)	0.116676	0.000000
11)	0.371088	0.000000
12)	0.223636	0.000000
13)	0.211616	0.000000
14)	0.308561	0.000000
15)	0.261118	0.000000
16)	0.381569	0.000000
17)	0.247508	0.000000
18)	0.249347	0.000000
19)	0.203783	0.000000
20)	0.000000	-4.727728
21)	1.247408	0.000000
22)	0.016886	0.000000
23)	0.000000	-2.654592
24)	0.000000	-1.7081

GUINEA-BISSOU

MIN 1V2

ST

1.362V1+55.2U1+9.0U2+2.8U3=1

V2-6.094V1-73.3U1-13.5U2-4.7U3>=0

V2-3.852V1-61.4U1-11.5U2-7.0U3>=0

V2-2.918V1-66.5U1-11.3U2-4.7U3>=0

V2-5.341V1-52.8U1-9.0U2-5.9U3>=0

V2-3.560V1-63.1U1-8.5U2-3.8U3>=0

V2-1.228V1-59.7U1-12.2U2-4.5U3>=0

V2-1.767V1-59.6U1-11.1U2-3.3U3>=0

V2-2.188V1-66.5U1-7.9U2-2.5U3>=0

V2-3.171V1-51.5U1-8.9U2-4.3U3>=0

V2-1.507V1-60.2U1-8.8U2-2.8U3>=0

V2-0.805V1-60.9U1-9.5U2-4.1U3>=0

V2-1.362V1-55.2U1-9.0U2-2.8U3>=0

V2-1.583V1-58.0U1-8.4U2-2.0U3>=0

V2-1.780V1-50.9U1-8.6U2-3.1U3>=0

V2-1.096V1-58.8U1-8.7U2-2.4U3>=0

V2-1.591V1-58.7U1-7.8U2-1.4U3>=0

V2-0.908V1-61.4U1-5.4U2-1.5U3>=0

V1>=0.0001

V2>=0.0001

U1>=0.0001

U2>=0.0001

U3>=0.0001

END

OBJECTIVE FUNCTION VALUE

1) 1.328580

VARIABLE	VALUE	REDUCED COST
V2	1.328580	0.000000
V1	0.000100	0.000000
U1	0.018092	0.000000
U2	0.000100	0.000000
U3	0.000100	0.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2)	0.000000	-1.327899
3)	0.000000	-1.000000
4)	0.215490	0.000000
5)	0.123564	0.000000
6)	0.371293	0.000000
7)	0.185383	0.000000
8)	0.246689	0.000000
9)	0.248674	0.000000
10)	0.124197	0.000000
11)	0.395200	0.000000
12)	0.238125	0.000000
13)	0.225331	0.000000
14)	0.328580	0.000000
15)	0.278040	0.000000
16)	0.406344	0.000000
17)	0.263545	0.000000
18)	0.265495	0.000000
19)	0.216945	0.000000
20)	0.000000	-4.285402
21)	1.328480	0.000000
22)	0.017992	0.000000
23)	0.000000	-1.548913
24)	0.000000	-0.981884

LIBERIA

MIN 1V2

ST

0.805V1+60.9U1+9.5U2+4.1U3=1

V2-6.094V1-73.3U1-13.5U2-4.7U3>=0

V2-3.852V1-61.4U1-11.5U2-7.0U3>=0

V2-2.918V1-66.5U1-11.3U2-4.7U3>=0

V2-5.341V1-52.8U1-9.0U2-5.9U3>=0

V2-3.560V1-63.1U1-8.5U2-3.8U3>=0

V2-1.228V1-59.7U1-12.2U2-4.5U3>=0

V2-1.767V1-59.6U1-11.1U2-3.3U3>=0

V2-2.188V1-66.5U1-7.9U2-2.5U3>=0

V2-3.171V1-51.5U1-8.9U2-4.3U3>=0

V2-1.507V1-60.2U1-8.8U2-2.8U3>=0

V2-0.805V1-60.9U1-9.5U2-4.1U3>=0

V2-1.362V1-55.2U1-9.0U2-2.8U3>=0

V2-1.583V1-58.0U1-8.4U2-2.0U3>=0

V2-1.780V1-50.9U1-8.6U2-3.1U3>=0

V2-1.096V1-58.8U1-8.7U2-2.4U3>=0

V2-1.591V1-58.7U1-7.8U2-1.4U3>=0

V2-0.908V1-61.4U1-5.4U2-1.5U3>=0

V1>=0.0001

V2>=0.0001

U1>=0.0001

U2>=0.0001

U3>=0.0001

END

OBJECTIVE FUNCTION VALUE

1) 1.189519

VARIABLE	VALUE	REDUCED COST
V2	1.189519	0.000000
V1	0.000100	0.000000
U1	0.012157	0.000000
U2	0.000100	0.000000
U3	0.063081	0.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2)	0.000000	-1.188817
3)	0.000000	-0.924283
4)	0.000000	-0.075717
5)	0.083202	0.000000
6)	0.174037	0.000000
7)	0.181524	0.000000
8)	0.178562	0.000000
9)	0.255532	0.000000
10)	0.222395	0.000000
11)	0.290998	0.000000
12)	0.280035	0.000000
13)	0.189519	0.000000
14)	0.340812	0.000000
15)	0.357277	0.000000
16)	0.374159	0.000000
17)	0.322338	0.000000
18)	0.386675	0.000000
19)	0.347853	0.000000
20)	0.000000	-4.967244
21)	1.189419	0.000000
22)	0.012057	0.000000
23)	0.000000	-2.054802
24)	0.062981	0.000000

MALI

MIN 1V2

ST

1.583V1+58.0U1+8.4U2+2.0U3=1

V2-6.094V1-73.3U1-13.5U2-4.7U3>=0

V2-3.852V1-61.4U1-11.5U2-7.0U3>=0

V2-2.918V1-66.5U1-11.3U2-4.7U3>=0

V2-5.341V1-52.8U1-9.0U2-5.9U3>=0

V2-3.560V1-63.1U1-8.5U2-3.8U3>=0

V2-1.228V1-59.7U1-12.2U2-4.5U3>=0

V2-1.767V1-59.6U1-11.1U2-3.3U3>=0

V2-2.188V1-66.5U1-7.9U2-2.5U3>=0

V2-3.171V1-51.5U1-8.9U2-4.3U3>=0

V2-1.507V1-60.2U1-8.8U2-2.8U3>=0

V2-0.805V1-60.9U1-9.5U2-4.1U3>=0

V2-1.362V1-55.2U1-9.0U2-2.8U3>=0

V2-1.583V1-58.0U1-8.4U2-2.0U3>=0

V2-1.780V1-50.9U1-8.6U2-3.1U3>=0

V2-1.096V1-58.8U1-8.7U2-2.4U3>=0

V2-1.591V1-58.7U1-7.8U2-1.4U3>=0

V2-0.908V1-61.4U1-5.4U2-1.5U3>=0

V1>=0.0001

V2>=0.0001

U1>=0.0001

U2>=0.0001

U3>=0.0001

END

OBJECTIVE FUNCTION VALUE

1) 1.264708

VARIABLE	VALUE	REDUCED COST
V2	1.264708	0.000000
V1	0.000100	0.000000
U1	0.017221	0.000000
U2	0.000100	0.000000
U3	0.000100	0.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2)	0.000000	-1.263793
3)	0.000000	-1.000000
4)	0.205121	0.000000
5)	0.117638	0.000000
6)	0.353430	0.000000
7)	0.176495	0.000000
8)	0.234838	0.000000
9)	0.236737	0.000000
10)	0.118271	0.000000
11)	0.376204	0.000000
12)	0.226710	0.000000
13)	0.214526	0.000000
14)	0.312808	0.000000
15)	0.264708	0.000000
16)	0.386826	0.000000
17)	0.250910	0.000000
18)	0.252773	0.000000
19)	0.206575	0.000000
20)	0.000000	-4.093415
21)	1.264608	0.000000
22)	0.017121	0.000000
23)	0.000000	-2.884138
24)	0.000000	-2.172414

NIGER

MIN 1V2

ST

0.908V1+61.4U1+5.4U2+1.5U3=1

V2-6.094V1-73.3U1-13.5U2-4.7U3>=0

V2-3.852V1-61.4U1-11.5U2-7.0U3>=0

V2-2.918V1-66.5U1-11.3U2-4.7U3>=0

V2-5.341V1-52.8U1-9.0U2-5.9U3>=0

V2-3.560V1-63.1U1-8.5U2-3.8U3>=0

V2-1.228V1-59.7U1-12.2U2-4.5U3>=0

V2-1.767V1-59.6U1-11.1U2-3.3U3>=0

V2-2.188V1-66.5U1-7.9U2-2.5U3>=0

V2-3.171V1-51.5U1-8.9U2-4.3U3>=0

V2-1.507V1-60.2U1-8.8U2-2.8U3>=0

V2-0.805V1-60.9U1-9.5U2-4.1U3>=0

V2-1.362V1-55.2U1-9.0U2-2.8U3>=0

V2-1.583V1-58.0U1-8.4U2-2.0U3>=0

V2-1.780V1-50.9U1-8.6U2-3.1U3>=0

V2-1.096V1-58.8U1-8.7U2-2.4U3>=0

V2-1.591V1-58.7U1-7.8U2-1.4U3>=0

V2-0.908V1-61.4U1-5.4U2-1.5U3>=0

V1>=0.0001

V2>=0.0001

U1>=0.0001

U2>=0.0001

U3>=0.0001

END

OBJECTIVE FUNCTION VALUE

1) 1.195308

VARIABLE	VALUE	REDUCED COST
V2	1.195308	0.000000
V1	0.000100	0.000000
U1	0.016274	0.000000
U2	0.000100	0.000000
U3	0.000100	0.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2)	0.000000	-1.193811
3)	0.000000	-1.000000
4)	0.193854	0.000000
5)	0.111200	0.000000
6)	0.334021	0.000000
7)	0.166837	0.000000
8)	0.221962	0.000000
9)	0.223766	0.000000
10)	0.111833	0.000000
11)	0.355564	0.000000
12)	0.214307	0.000000
13)	0.202786	0.000000
14)	0.295671	0.000000
15)	0.250222	0.000000
16)	0.365617	0.000000
17)	0.237182	0.000000
18)	0.238950	0.000000
19)	0.195308	0.000000
20)	0.000000	-5.010019
21)	1.195208	0.000000
22)	0.016174	0.000000
23)	0.000000	-7.053420
24)	0.000000	-2.909283

NIGERIA

MIN 1V2

ST

5.341V1+52.8U1+9.0U2+5.9U3=1

V2-6.094V1-73.3U1-13.5U2-4.7U3>=0

V2-3.852V1-61.4U1-11.5U2-7.0U3>=0

V2-2.918V1-66.5U1-11.3U2-4.7U3>=0

V2-5.341V1-52.8U1-9.0U2-5.9U3>=0

V2-3.560V1-63.1U1-8.5U2-3.8U3>=0

V2-1.228V1-59.7U1-12.2U2-4.5U3>=0

V2-1.767V1-59.6U1-11.1U2-3.3U3>=0

V2-2.188V1-66.5U1-7.9U2-2.5U3>=0

V2-3.171V1-51.5U1-8.9U2-4.3U3>=0

V2-1.507V1-60.2U1-8.8U2-2.8U3>=0

V2-0.805V1-60.9U1-9.5U2-4.1U3>=0

V2-1.362V1-55.2U1-9.0U2-2.8U3>=0

V2-1.583V1-58.0U1-8.4U2-2.0U3>=0

V2-1.780V1-50.9U1-8.6U2-3.1U3>=0

V2-1.096V1-58.8U1-8.7U2-2.4U3>=0

V2-1.591V1-58.7U1-7.8U2-1.4U3>=0

V2-0.908V1-61.4U1-5.4U2-1.5U3>=0

V1>=0.0001

V2>=0.0001

U1>=0.0001

U2>=0.0001

U3>=0.0001

END

OBJECTIVE FUNCTION VALUE

1) 1.000000

VARIABLE	VALUE	REDUCED COST
V2	1.000000	0.000000
V1	0.073998	0.000000
U1	0.002134	0.000000
U2	0.000100	0.000000
U3	0.083258	0.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2)	0.000000	-1.000000
3)	0.000000	0.000000
4)	0.000000	0.000000
5)	0.249746	0.000000
6)	0.000000	-1.000000
7)	0.284706	0.000000
8)	0.405873	0.000000
9)	0.466221	0.000000
10)	0.487272	0.000000
11)	0.296572	0.000000
12)	0.526039	0.000000
13)	0.468187	0.000000
14)	0.547417	0.000000
15)	0.591756	0.000000
16)	0.500723	0.000000
17)	0.592752	0.000000
18)	0.639685	0.000000
19)	0.676379	0.000000
20)	0.073898	0.000000
21)	0.999900	0.000000
22)	0.002034	0.000000
23)	0.000000	0.000000
24)	0.083158	0.000000

SENEGAL

MIN 1V2

ST

2.188V1+66.5U1+7.9U2+2.5U3=1

V2-6.094V1-73.3U1-13.5U2-4.7U3>=0

V2-3.852V1-61.4U1-11.5U2-7.0U3>=0

V2-2.918V1-66.5U1-11.3U2-4.7U3>=0

V2-5.341V1-52.8U1-9.0U2-5.9U3>=0

V2-3.560V1-63.1U1-8.5U2-3.8U3>=0

V2-1.228V1-59.7U1-12.2U2-4.5U3>=0

V2-1.767V1-59.6U1-11.1U2-3.3U3>=0

V2-2.188V1-66.5U1-7.9U2-2.5U3>=0

V2-3.171V1-51.5U1-8.9U2-4.3U3>=0

V2-1.507V1-60.2U1-8.8U2-2.8U3>=0

V2-0.805V1-60.9U1-9.5U2-4.1U3>=0

V2-1.362V1-55.2U1-9.0U2-2.8U3>=0

V2-1.583V1-58.0U1-8.4U2-2.0U3>=0

V2-1.780V1-50.9U1-8.6U2-3.1U3>=0

V2-1.096V1-58.8U1-8.7U2-2.4U3>=0

V2-1.591V1-58.7U1-7.8U2-1.4U3>=0

V2-0.908V1-61.4U1-5.4U2-1.5U3>=0

V1>=0.0001

V2>=0.0001

U1>=0.0001

U2>=0.0001

U3>=0.0001

END

OBJECTIVE FUNCTION VALUE

1) 1.103297

VARIABLE	VALUE	REDUCED COST
V2	1.103297	0.000000
V1	0.000100	0.000000
U1	0.015019	0.000000
U2	0.000100	0.000000
U3	0.000100	0.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2)	0.000000	-1.102256
3)	0.000000	-1.000000
4)	0.178916	0.000000
5)	0.102665	0.000000
6)	0.308288	0.000000
7)	0.154034	0.000000
8)	0.204890	0.000000
9)	0.206568	0.000000
10)	0.103298	0.000000
11)	0.328199	0.000000
12)	0.197863	0.000000
13)	0.187220	0.000000
14)	0.272951	0.000000
15)	0.231017	0.000000
16)	0.337499	0.000000
17)	0.218980	0.000000
18)	0.220623	0.000000
19)	0.180371	0.000000
20)	0.000000	-3.682265
21)	1.103198	0.000000
22)	0.014919	0.000000
23)	0.000000	-4.792181
24)	0.000000	-1.944361

SIERRE LEONE

MIN 1V2

ST

1.780V1+50.9U1+8.6U2+3.1U3=1

V2-6.094V1-73.3U1-13.5U2-4.7U3>=0

V2-3.852V1-61.4U1-11.5U2-7.0U3>=0

V2-2.918V1-66.5U1-11.3U2-4.7U3>=0

V2-5.341V1-52.8U1-9.0U2-5.9U3>=0

V2-3.560V1-63.1U1-8.5U2-3.8U3>=0

V2-1.228V1-59.7U1-12.2U2-4.5U3>=0

V2-1.767V1-59.6U1-11.1U2-3.3U3>=0

V2-2.188V1-66.5U1-7.9U2-2.5U3>=0

V2-3.171V1-51.5U1-8.9U2-4.3U3>=0

V2-1.507V1-60.2U1-8.8U2-2.8U3>=0

V2-0.805V1-60.9U1-9.5U2-4.1U3>=0

V2-1.362V1-55.2U1-9.0U2-2.8U3>=0

V2-1.583V1-58.0U1-8.4U2-2.0U3>=0

V2-1.780V1-50.9U1-8.6U2-3.1U3>=0

V2-1.096V1-58.8U1-8.7U2-2.4U3>=0

V2-1.591V1-58.7U1-7.8U2-1.4U3>=0

V2-0.908V1-61.4U1-5.4U2-1.5U3>=0

V1>=0.0001

V2>=0.0001

U1>=0.0001

U2>=0.0001

U3>=0.0001

END

OBJECTIVE FUNCTION VALUE

1) 1.440567

VARIABLE	VALUE	REDUCED COST
V2	1.440567	0.000000
V1	0.000100	0.000000
U1	0.019620	0.000000
U2	0.000100	0.000000
U3	0.000100	0.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2)	0.000000	-1.440079
3)	0.000000	-1.000000
4)	0.233671	0.000000
5)	0.133953	0.000000
6)	0.402613	0.000000
7)	0.200966	0.000000
8)	0.267467	0.000000
9)	0.269605	0.000000
10)	0.134586	0.000000
11)	0.428506	0.000000
12)	0.258139	0.000000
13)	0.244275	0.000000
14)	0.356233	0.000000
15)	0.301415	0.000000
16)	0.440567	0.000000
17)	0.285698	0.000000
18)	0.287801	0.000000
19)	0.235125	0.000000
20)	0.000000	-3.530660
21)	1.440467	0.000000
22)	0.019520	0.000000
23)	0.000000	-1.115324
24)	0.000000	-0.235756

TOGO

MIN 1V2

ST

1.228V1+59.7U1+12.2U2+4.5U3=1

V2-6.094V1-73.3U1-13.5U2-4.7U3>=0

V2-3.852V1-61.4U1-11.5U2-7.0U3>=0

V2-2.918V1-66.5U1-11.3U2-4.7U3>=0

V2-5.341V1-52.8U1-9.0U2-5.9U3>=0

V2-3.560V1-63.1U1-8.5U2-3.8U3>=0

V2-1.228V1-59.7U1-12.2U2-4.5U3>=0

V2-1.767V1-59.6U1-11.1U2-3.3U3>=0

V2-2.188V1-66.5U1-7.9U2-2.5U3>=0

V2-3.171V1-51.5U1-8.9U2-4.3U3>=0

V2-1.507V1-60.2U1-8.8U2-2.8U3>=0

V2-0.805V1-60.9U1-9.5U2-4.1U3>=0

V2-1.362V1-55.2U1-9.0U2-2.8U3>=0

V2-1.583V1-58.0U1-8.4U2-2.0U3>=0

V2-1.780V1-50.9U1-8.6U2-3.1U3>=0

V2-1.096V1-58.8U1-8.7U2-2.4U3>=0

V2-1.591V1-58.7U1-7.8U2-1.4U3>=0

V2-0.908V1-61.4U1-5.4U2-1.5U3>=0

V1>=0.0001

V2>=0.0001

U1>=0.0001

U2>=0.0001

U3>=0.0001

END

OBJECTIVE FUNCTION VALUE

1) 1.092632

VARIABLE	VALUE	REDUCED COST
V2	1.092632	0.000000
V1	0.000100	0.000000
U1	0.000100	0.000000
U2	0.061512	0.000000
U3	0.054103	0.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2)	0.000000	-1.091473
3)	0.000000	-0.907987
4)	0.000000	-0.092013
5)	0.136323	0.000000
6)	0.214004	0.000000
7)	0.357525	0.000000
8)	0.092632	0.000000
9)	0.225175	0.000000
10)	0.464563	0.000000
11)	0.307067	0.000000
12)	0.393670	0.000000
13)	0.280278	0.000000
14)	0.381882	0.000000
15)	0.461769	0.000000
16)	0.390644	0.000000
17)	0.421643	0.000000
18)	0.531068	0.000000
19)	0.673084	0.000000
20)	0.000000	-4.547378
21)	1.092532	0.000000
22)	0.000000	-7.044091
23)	0.061412	0.000000
24)	0.054003	0.00000

ÖZGEÇMİŞ

KİŞİSEL BİLGİLER

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EĞİTİM

Derece	Kurum	Mezuniyet Yılı
Lisans	University of Juba, Economics, TOGO	2013
Yüksek Lisans	İMÜ,Sosyal Bilimler Enstitüsü, İŞLETME (YL) (TEZLİ) (İNGİLİZCE)	2017

İŞ TECRÜBESİ

Tarih	Kurum	Görev
2014	Office du Baccalaureat du Togo	Typing & Controling the Students Marks into the Computer System
2011	BEC.CO.LTD Khartum- Sudan For Building and Multi Activities	Assistant Accountant

YABANCI DİLLER

Fransızca, İngilizce, Arapça; başlangıç düzeyinde Turkce.

HOBİLER

Yelkencilik, binicilik, okçuluk, pul koleksiyonu, ev dekorasyonu.