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Diversification and Sophistication as drivers of structural transformation for Africa: the economic complexity index of African countries§

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Abstract

African countries have achieved impressive growth performance during the recent years despite the multiple crises the western world is experiencing. However, this growth has not been inclusive for several reasons. It has been driven mainly by the extractive industry at the detriment of the industrial and manufacturing sectors. These sectors contribution has even stagnated during the last fifteen years to least than 10% of the continent's GDP. Because much of the efforts were put in the extractive industry, and the industrial sector including the manufacturing were neglected for long time, it has resulted that most African countries productive structure have remained weakly sophisticated and diversified. The productive structures have not benefited from the recent growth observed across the continent.

Since Adam smith (1776), it is recognized that the level of wealth of a nation depends mainly on the lever of knowledge that the society holds. This is translated in the nation's productive structure and the products it make. By exporting mainly commodities and raw materials that do not require any advanced technology, African countries have not yet been able to structurally transform their economies. Yet, it is acknowledges in the literature that development and growth are a process of structural transformation whereby resources were transform from lower productivity activities to higher productivity activities. And this transformation has not yet been observed in African societies.

This paper attempted to measure the level of complexity of African economies by adopting the same approach recently introduced by Hidalgo et al. (2007) and Hidalgo and Hausmann (2009). We generated a large database that includes detailed information related to technology intensiveness of African countries exports, their revealed comparative advantages, indicators related to diversity, ubiquity, and economic and product complexity. We found that not only African economies are not complex. Their exports are weakly diversified and weakly sophisticated. This could contribute to explain why the recent growth has not been inclusive. This study is a starting point and could be extended to deeper macro-econometric analysis which will provide policy recommendations to African countries on which areas they should focus their efforts in order to really transform their economies and create sustainable prosperity for the majority of their population.

Key words: Exports, revealed comparative advantage, technology intensity, sophistication, diversification, economic complexity

JEL classification: F10, O10, O14, O55

I. Introduction

Despite the turbulences the western world has been experiencing since 2008, African countries continue to demonstrate some resilience. After decades of economic stagnation, most African countries have recently achieved sustainable economic growth over the past decade, and some are even among the world's fastest growth performers. It is estimated that Africa has achieved an average growth rate of about 5% in 2012-2013, and forecasts indicate that it will remain the same level at 5.3%, in 2014 (African Economic Outlook, 2013 and African Development Report 2012). This good performance of African economies is the results of two major factors: (i) government reforms undertaken by governments and (ii) a significant increase in the exploitation and export of natural resources as a result of the recent high commodity prices.

Yet, this sustained growth has not been inclusive and its impact on poverty reduction has been very modest. It has not been to generate enough jobs well remunerated for the majority of the population. One can explain it by the fact that this growth has been mainly driven by the extractive industry (oil and mining), a sector which is capital intensive.

On the other hand, while the extractive industry was experiencing a boom, the agricultural sector was left behind. Yet this sector employs about 60% of the labor force and contributes to only 25% of the continent GDP. In addition to be subject to climate change issues, the agricultural sector has low productivity and does not provide well-paid jobs. As a consequent, the majority of the active population lives under the poverty line. However, it is known that employment is the cornerstone of any economic development. The well-paid jobs, people can improve their living conditions and be able to get out of poverty (World Bank, 2012). But, in Africa, the majority of the active population cannot afford this opportunity because they are constrained to work in low productivity sectors such as the agricultural sector, where the jobs are not well remunerated. The mining industry which has experienced the boom has not been able to fill this need and therefore, the recent growth performance driven by this sector has not benefited to the majority of African people.

Furthermore, the manufacturing industry has remained weakly developed and its contribution to GDP averaged less than 10% in 2012. In the recent years, this sector has not really contributed to growth in the continent. It contribution has even slowed down between 2006-2011 for about one percent point. The decline is more pronounced in some countries such as South Africa with about 5% decline (from 17.5% to 13.4%), Ghana more than 3% (10% to 7%), Lesotho with a decrease of more than 8% (from 21% to 13%), Madagascar from 14% to 8%, and Zimbabwe with the worst decline of 13% from 28% to 15% (AEO, 2013).

Yet, experience around the world has shown that the manufacturing plays a crucial role in the process of structural transformation of a nation. For instance, emerging markets have long time benefited from their cheap labor force by attracting foreign investments and this has boosted their manufacturing sector. More specifically, it has been observed that the manufacturing was the main driver that creates well-paid jobs for a substantial proportion of the society and this has

contributed to improving the living conditions of the middle class of the emerging countries (World economic Forum, 2012).

It is worth noting that the manufacturing is traditionally known as the major engine of growth, since it can generate sustained and well-paid jobs unlike the agriculture. It has been observed that the level of development of the manufacturing is closely related to the level of prosperity of a nation. In comparison to the other sectors, this sector is more capable to make sophisticated products with high value added and therefore generate greater prosperity. In addition, the output from this sector reflects also the quantity of knowledge embodies in the society. However, the manufacturing has long time been neglected in Africa for benefit of the extractive industry. This situation could help to understand why the strong growth recorded by many African countries has not generated tangible impacts on poverty reduction.

Understanding export structure is essential to determine the real gains of export earning on economic development. Following the hike in commodity prices, especially oil and the mining products, exports have provided substantial foreign exchange revenues for many African countries. However, as stated previously, these revenues have not benefited to the majority of the population. It is known in the literature that what you export matters (Hausmann, Hwang and Rodrik, 2005). What a country exports determines it development pattern. Exports that are technology intensive generate greater economic development outcomes. On the opposite, exports that are intensive in raw materials seem to generate relatively small development outcomes (Lall et al., 2005).

It is the complexity of exports that generates a real impact on a nation's economic development complexity rather than their monetary value. The reason is that the knowledge embodies in exports reflects what is available in the society. In a recent series of papers, Hidalgo et al. (2007), Hausmann and Hidlago (2009), Hausmann et al. (2011) demonstrated that economic development is a process of learning how to make goods and therefor how to make export products that are more and more complex. These authors showed that the manufacturing and industrial sectors, which reflect also the level of complexity of an economy, are the drivers of economic development. An economy that has a diversified and sophisticated productive structure will gain greater benefits in terms of economic development through its exports. They showed that the complexity of the productive structure not only help in explaining the level of income variations between nations, but also contributes to predict the future of a nation's economic growth.

However, as mentioned previously, the manufacturing and industrial sectors have long time been marginalized in African countries development strategies. Currently, the manufacturing and industrial sectors are weakly developed in Africa. Could this situation contribute to explain why the recent growth performance has not resulted into a real improvement of the living conditions of the majority of African populations?

A weak diversification and sophistication of exports hinder economic growth and development. A number of studies have demonstrated that specializing in the export of raw materials including petroleum products, is detrimental to long-term growth ((Sala-i-Martin, 2004, Sachs et Warner, 2001). By specializing in these areas, the country mobilizes most of its productive resources away from high value-added activities such as industry, manufacturing and the services. Yet, export products reflect the knowledge available in the society. In other words, it appears that the export structure of a country reflects the level of wealth and therefore the level of development of the society.

The main objective of this study is to analyze the productive structures of African countries as well as the degree of the economic complexity of the countries. This will help to determine how countries can successfully carry out a real structural transformation.

Firstly, we will try to analyze African countries productive structures through their export structures. The reason is that due to lack of data on countries productive structure, we focused on exports. This analysis will help to understand African countries export diversification/concentration but also their technology intensiveness. Secondly, we will be interested in assessing African countries economic complexity, in other words, the knowledge indirectly embodies in their exports. To do so, we will focus especially on the relationship between export diversity and ubiquity. These two notions are then used to compute the economic complexity index following the recent approach developed by Hidalgo and Hausmann (2009), Hausmann et al. (2011). Finally, with the new dataset we have generated, we conclude by highlighting the prospects for future research that could help African policy makers to adopt adequate structural transformation strategy.

II. Analysis of African countries export structures

We first analyze African countries productive structures through their export composition. According to Abdon et al. (2012), economic development is not only a continuous improvement of the same product basket, but more importantly, it is a process that requires the accumulation of a series of more and more complex productive capability with higher productivity.

The pace of economic development of a society is closely related to the state of its productive structure. It has been observed that development is slower in countries where the productive structure is oriented toward low-productivity activities with small wages which including raw materials and agriculture. In contract, development seems faster in countries where the productivity is higher and the workers are highly remunerated. Then, what happened in Africa during the last fifteen years with sustained high growth rates? Why the recent growth in Africa has not been inclusive? We will try to provide some answers to these questions. Although Africa has experienced strong economic growth during the recent years, it has not really

changed the productive structures of African countries. To demonstrate this, we analyzed the evolution of the structure of African exports during the last fifteen years.

What is the composition of the export basket of each African country? To answer to this question, we first analyze exports diversification/concentration, then, we analyze the composition of the export basket in terms of technology intensiveness or in other words, technology sophistication.

2.1 Analysis of the state of export diversification/concentration

Development and growth are known as a process of structural transformation where resources are transferred from lower productivity activities to higher productivity activities (Lewis, 1995; Rostow, 1959, Kuznets (1966), Kaldor (1967). In that regard diversification plays an important role in the process of structural transformation. It is observed that rich countries have very diversified productive structure while low-income countries tend to have weakly diversified structures (Hausmann and Hidalgo, 2012). Therefore, would diversification lead to structural transformation and then growth? Has the recent economic growth in African been accompanied by a diversification of countries productive structures?

We mean by diversification, the capability of a country to produce and export a variety of products that require a certain complexity on their manufacturing. A country with low diversified and sophisticated export basket is considered not diversified. It exports are rather concentrated in a small number of products, especially raw materials. Therefore, we use as a measure of diversification, the number of products a country exports with revealed comparative advantage (RCA > 1). In particular, we analyze the number of products where African countries held a comparative advantage during the period 1995-2011. These number are reported in Table 1.

In addition, we use and alternative measure of diversification/concentration which is the Herfindahl-Hirschman Index (HHI). This index measures the diversity of the export basket of a given countries and the value is between 0 and 1. The higher the value the less diversified is the countries. If the index equal one, it means that the country's export basket includes only one single product. Table 1 also reports the average values of HHI for all African countries from 1995-2011.

From 1995-2011, results show that African countries kept comparative advantage in the export of on average 11 products. A priori, this indicates that African economies are weakly diversified. In addition, we found that countries with higher GDP per capita are not necessarily those with greater diversified export basket.

Table 1: Number of export products with RCA > 1 and diversification measures

Country	*Total number of product exports with RCA>1*	*HH index*	*Entropy*
North Africa			
Algeria	6	0,323924	0,597202
Egypt	20	0,082904	1,47915
Libya	7	0,654811	0,376983
Mauritania	5	0,296624	0,626555
Morocco	33	0,048715	1,53876
Sudan	8	0,326512	0,771208
Tunisia	28	0,060313	1,54278
Average Region	***15***		
Central Africa			
Angola	1	0,85424	0,162309
Cameroon	12	0,190619	1,02411
Central African Republic	7	0,269931	0,833997
Chad	1	0,636214	0,371226
Congo	4	0,583799	0,488931
Dem. Rep. of the Congo	9	0,289438	0,800367
Equatorial Guinea	2	0,622823	0,349974
Gabon	4	0,576841	0,44797
Sao Tome and Principe	1	0,370148	0,827969
Average Region	***5***		
West Africa			
Benin	8	0,302233	0,916759
Burkina Faso	10	0,382005	0,827145
Cape Verde	4	0,166674	1,07485
Côte d'Ivoire	22	0,155283	1,17088
Gambia	6	0,221013	1,08271
Ghana	16	0,185466	1,11237
Guinea	8	0,358164	0,751617
Guinea-Bissau	2	0,56994	0,456946
Liberia	2	0,451801	0,504037
Mali	6	0,418347	0,663732
Niger	7	0,176449	1,02594
Nigeria	1	0,754836	0,312198
Senegal	18	0,08366	1,41202
Sierra Leone	5	0,203701	1,15297
Togo	11	0,108589	1,3199

Average Region	***8***		
East Africa			
Burundi	5	0,389441	0,720354
Comoros	1	0,44319	0,561236
Djibouti	8	0,077299	1,51922
Eritrea	3	0,173894	1,25786
Ethiopia	9	0,261329	0,848781
Kenya	28	0,073514	1,56018
Madagascar	24	0,081789	1,34219
Malawi	11	0,380916	0,81492
Mauritius	22	0,127946	1,15396
Mozambique	11	0,225926	1,04271
Rwanda	17	0,29164	0,774009
Uganda	3	0,212715	1,1698
Seychelles	4	0,331789	0,746837
Somalia	6	0,292437	0,825419
United Republic of Tanzania	24	0,074871	1,42787
Zambia	10	0,354821	0,878931
Zimbabwe	25	0,087004	1,47503
Average Region	***12***		
Southern Africa			
Botswana	6	0,522905	0,582587
Lesotho	10	0,183938	0,929468
Namibia	24	0,11894	1,28445
South Africa	40	0,032258	1,79084
Swaziland	21	0,08914	1,44114
Average Region	***20***		
Average Africa	***11***		

LIC: low income country/LMIC: low middle income country/UMIC: upper middle income country/HIC: high income country

Source: Data collected from UNCTAD 2013, computation done by the authors

At the regional level, Southern Africa is relatively more diversified than the rest of the continent, with an average of 20 products for which the region held a comparative advantage from 1995-2011. It comes out that South Africa has the most diversified economy in the continent, with 40 products where it held a comparative advantage from 1995-2011. This is also reflected in its low HHI of about 0.03, the lowest value in the continent. Namibia and Swaziland are also diversified economies with respectively 24 and 21 products where they held comparative advantage during these 15 years. Their HHI were respectively 0.12 and 0.09. On the opposite, Botswana, a country rich with natural resources, namely diamonds, is not diversified enough. It kept a comparative advantage for only six products and its HHI was relatively high of 0.52.

In comparison of the continent average, North African countries are relatively diversified, exporting about 15 products with comparative advantage during the fifteen years. The most diversified economies in the region are Morocco (33 products), followed by Tunisia (28 products), and Egypt (20 products). This is also reflected through their HHI values: 0.05 (Morocco), 0.06 (Tunisia), and 0.08 (Egypt). On the other hand, the less diversified countries in this region are also the oil or gas rich countries namely Algeria (6 products), Libya (7 products), and Sudan (8 products). The concentration of their exports is also reflected through their high HHI: 0.65 for Libya, 0.32 for Algeria and 0.33 for Sudan.

The Eastern African countries have on average a comparative advantage on only 12 products during 1995-2011. But, this region is heterogeneous in terms of their productive structures diversity. The most diversified economy in the region are respectively Kenya (28 products), Zimbabwe (25 products), Madagascar and Tanzania (24 products), and Mauritius (22 products). The low level of their HHI confirms this fact for countries such as Kenya (0.073), Tanzania (0.075), Djibouti (0.077), and Zimbabwe (0.087). In contract, Comoros (1 product), Eritrea and Rwanda (3 products), Seychelles (4 products) have highly concentrated export baskets and this is also confirmed with their respective HHI.

West African countries exported on average 8 products for which they held a comparative advantage between 1995 and 2011. At the country level, Côte d'Ivoire leads with 22 products where it held a comparative advantage during that period. It is followed by Senegal with 18 products, Ghana and 16 products. On the opposite, Nigeria, the oil-richest country in the region, concentrated its exports on only one product (oil) where it held a comparative advantage from 1995 to 2011. This is also confirmed in it high HHI of 0.75.

Finally, we can notice that the Central African region is the least diversified one in the continent. This is confirmed by the high values of HHI which are close to one for countries in the region. The oil-rich countries such as Angola, Chad, São Tomé and Principe have concentrated their economies on one single product or two products for Equatorial Guinea. But a country such as Cameroon tried to diversify by exporting a dozen of products with comparative advantage between 1995-2011.

2.2 Analysis of technological intensiveness of African exports

In this subsection, we are interested in the technological intensiveness of African countries export baskets. The concept of technological intensity used here comes from Lall (2000). It does not include only innovation in R&D but it also refers to the ability of an economy to make some improvements over time and achieve economies of scale. Products that require highly advanced technology will therefore be exported by countries with the human and physical capital as well as the technological and institutional capabilities. Following Lall (2000), exports are classified according to their technological intensiveness in three different categories as following:

(1) Commodities and primary products which include fresh fruit, meat, cocoa, tea, wood, coal, crude petroleum, gas
(2) Manufactured products which in turn are divided into three subcategories including:
    a. Resource based products:
       - prepared meat/fruits, beverages, wood products, vegetable oils,
       - other resource based products: ore concentrates, petroleum/rubber products, cement, cut gems, glass
    b. low technology manufactures:
        - textile/fashion cluster, textile fabrics, clothing, headfear, footwear, leather manufactures, travel goods
        - other low technology: pottery, simple metal parts/structures, furniture, jewelry, toys, plastic products
    c. Medium technology manufactures:
        - Passenger vehicle and parts, commercial vehicles, motorcycles and parts
        - Synthetic fibres, chemicals and paints, fertilizers, plastics, iron, pipes/tubes
        - Medium technology engineering industries: engines, motors, industrial machinery, pumps, switchgear, ships, watches
    d. High technology manufactures:
        - electronics and electrical products: office/data processing/telecommunications equipment, TVs, transitors, turbines, power generating equipment
        - other high technology: pharmaceuticals, aerospace, optical/measuring instruments, cameras
(3) other transactions: electricity, cinema film, printed matter, special transactions, gold, art, coins, pets

It comes out from this classification (see Table 2) that between 1995 and 2011, African countries exports account on average for 57% of raw material and 19% of manufactured products based

on natural resources. This means that most African exports are based on processing that does not involve any technology or innovation. It also comes out that less than 10% of the continent total exports are based on low technology manufacturing, and only 7% used medium technology processing. The share of high technology manufactures in total exports remained marginal between 1995 and 2011 to average less than 3%.

A more detailed analysis showed that Southern Africa recorded an average of 11% of medium technology manufactures, 4% of high technology manufacture which are largely above the continent's average. In this region, South Africa recorded an average of 24% of medium technology, 4% of high technology manufactures in its total exports between 1995-2011. Swaziland and Botswana accounted for respectively 15% and 9% of medium technology in their total exports.

In Northern Africa, diversified countries like Tunisia, Morocco and Egypt have export structures that are relatively technology-intensive. Almost 20% of Tunisian exports were based on medium technology and 5% on high technology. In Morocco, 13% and 8% of exports were respectively based on medium-tech and high-tech. On the opposite, energy-rich countries such as Libya, Algeria and Sudan almost do not exploit any technology: 98% of Algerian exports do not use any technology, and the rate is 96% in Libya and 93% in Sudan.

In West Africa, exports account on average for 9% of medium-tech and 3% of high-tech. the case of Liberia is quite interesting with 54% of its exports based on medium-tech. Indeed, this country exported ships, boats and floating structures and maintained a comparative advantage for these products throughout the period from 1995-2011. Another country such as Niger uses extensively high-tech in its production processing. In this country, 25% of exports are v=based on high-tech manufacturing. When we look more deeply in the country's export basket, it appears that the country specialized in the export of energy products, especially uranium, thorium and radioactive materials. Another case if Côte d'Ivoire which tried to keep its productive structure relatively technology intensive. On average, between 1995-2011, about 17% and 6% of the country's total exports were based on medium-tech and high-tech respectively. But, the last ten years political crisis has slow down the pace of growth of the country's industrial activities.

In eastern Africa, countries such as Comoros, Djibouti, and Eritrea had relatively recorded technology intensive exports. An average of 20%, 17% and 10% of exports of respectively Comoros, Djibouti, and Eritrea were based on medium-tech. on the other hand, and average of 5%, 6% and 11% of exports from these respective countries were based on high-tech manufacturing. Exports from Zimbabwe and Seychelles accounted for respectively 13% and 10% of medium technology.

The less diversified region in the continent in terms of technology-intensiveness is the Central African region which paradoxically is immensely endowed with natural resources. Only Sao Tome and Principe recorded a productive structure that is relatively technology intensive with

13% of total exports based on medium-tech and 8% on high-tech. Countries with abundant energy resources (hydraulic and fossil fuel energy) such as Angola, Cameroon, Congo Rep., The Dem. Rep. of Congo and Equatorial Guinea export mainly unprocessed products.

Table 2 : Income group and average Share in Total exports from 1995-2011

			Average Share in Total exports from 1995-2011				
Region/Country	**Average GDP PPP 1995-2011**	**Income Group**	**Raw material**	**Natural Resources**	**Low Technology**	**Medium Technology**	**High Technology**
North Africa							
Algeria	6160,35	UMIC	97,06	1,04	0,37	0,48	0,05
Egypt	4428,19	LMIC	53,45	12,04	19,29	8,09	1,28
Lybia	8938,9	UMIC	94,57	1,10	1,29	2,45	0,06
Mauritania	1813,36	LMIC	93,57	0,99	0,59	0,59	0,51
Morocco	3316,43	LMIC	27,85	17,74	32,57	13,28	7,68
Sudan	1352,88	LIMC	87,68	5,38	1,68	0,95	0,59
Tunisia	6530,03	UMIC	15,97	13,80	44,79	19,82	5,31
Average			***73,30***	***6,58***	***10,82***	***4,98***	***1,91***
Central Africa							
Angola	3262,15	UMIC	94,98	4,33	0,05	0,24	0,07
Cameroon	1785,85	LMIC	69,66	24,62	1,58	2,01	0,61
Central African Rep	702,404	LIC	25,17	68,25	1,44	3,33	0,76
Chad	977,87	LIC	93,42	1,61	0,69	0,92	2,42
Congo, Rep.	3195,88	LMIC	84,49	12,46	0,39	1,88	0,28
Congo, Demo. Rep.	299,946	LIC	34,64	60,60	1,20	0,59	0,54
Equatorial Guinea	16013,5	HIC	86,03	11,04	0,08	2,18	0,10
Gabon	12954,1	UMIC	82,38	15,01	0,30	1,11	0,91
Sao Tome&Principe	987,737	LMIC	64,24	7,01	7,25	12,97	8,30
Average			***70,56***	***22,77***	***1,44***	***2,80***	***1,55***
West Africa							
Benin	1206,72	LIC	77,58	11,01	5,58	2,60	0,85
Burkina Faso	970,508	LIC	74,84	5,73	5,08	3,76	1,17
Cape Verde	2456,86	LMIC	33,48	9,43	32,65	17,33	5,60
Cote d'Ivoire	1721,5	LMIC	69,49	14,33	5,21	8,35	1,06
Gambia	1567,16	LIC	47,68	36,59	5,45	6,53	3,65
Ghana	1175,07	LMIC	58,67	25,41	2,31	2,06	1,96
Guinea	843,864	LIC	80,67	12,58	0,61	1,02	0,78

Guinea Bissau	1016,9	LIC	94,50	1,94	0,60	1,76	1,06
Liberia	334,176	LIC	22,11	18,44	0,37	54,96	0,21
Mali	891,313	LIC	53,93	1,81	1,98	4,07	1,90
Niger	581,249	LIC	55,79	7,21	4,71	4,46	**25,10**
Nigeria	1638,25	LMIC	96,80	0,66	0,89	1,18	0,12
Senegal	1468,77	LMIC	53,60	26,78	5,20	**10,05**	2,38
Sierra leone	819,192	LMIC	35,28	36,16	7,86	**13,16**	4,30
Togo	830,879	LIC	58,81	18,88	10,54	7,14	0,85
Average			***60,88***	***15,13***	***5,94***	***9,23***	***3,40***
East Africa							
Burundi	458,92	LIC	70,12	6,27	1,90	4,77	1,34
Comoros	1063,21	LIC	56,29	16,78	1,74	19,25	5,36
Djibouti	1887,6	LMIC	47,02	14,36	9,37	17,35	5,70
Eritrea	534,674	LIC	29,36	14,90	15,44	10,41	10,88
Ethiopia	614,668	LIC	82,32	3,28	7,55	0,70	0,43
Kenya	1296,97	LIC	58,92	16,93	13,91	6,14	2,76
Madagascar	819,045	LIC	44,92	12,20	37,08	2,38	1,13
Malawi	644,692	LIC	78,63	9,94	7,81	2,38	1,18
Mauritius	9591,15	UMIC	4,26	27,29	56,08	4,26	3,73
Mozambique	589,256	LIC	41,53	40,21	2,15	4,14	1,06
Uganda	765,62	LIC	72,69	8,53	4,67	4,07	3,61
Rwanda	856,587	LIC	82,02	2,63	2,87	3,07	1,20
Seychelles	17708,1	UMIC	53,60	26,78	5,20	10,05	2,38
Somalia	0	LIC	77,16	7,94	1,67	2,31	1,26
Tanzania	982,234	LIC	64,75	12,79	4,80	3,46	1,24
Zambia	1115,36	LMIC	15,37	72,27	5,97	3,35	0,36
Zimbabwe	527,343	LIC	53,18	20,48	9,01	**12,64**	1,36
Average			***54,83***	***18,45***	***11,01***	***6,51***	***2,64***
Southern Africa							
Botswana	10354	UMIC	16,49	63,23	6,73	9,21	1,61
Lesotho	1242,31	LMIC	3,08	14,71	76,10	0,91	5,34
Namibia	4901,59	UMIC	37,64	35,70	**10,85**	**6,18**	6,19
South Africa	8049,15	UMIC	23,65	30,26	**10,69**	**24,55**	4,32
Swaziland	4209,4	LMIC	6,11	55,80	18,70	15,29	3,42
Average			***17,39***	***39,94***	***24,61***	***11,23***	***4,18***
Average Africa			***57,31***	***18,82***	***9,68***	***7,10***	***2,76***

Source: Data collected from UNCTAD, 2013

UMIC: upper middle income country; LMIC: low middle income country; LIC: low income country; HIC: High income country

In conclusion, by classifying exports by their technology intensiveness, we confirmed that African countries are mainly specialized in the export of unmanufactured products that do not require any kind of technology or are based on low technology manufacturing. Only few countries have been able to integrate advanced technology in the processing of export products. But, are the productive structures of countries with relatively technology intensive exports also very diversified? In the next section, we discuss in more detail the relationship between diversification and sophistication.

III. Analyzing African countries export structure

The notion of sophistication is closely related to the economic complexity of a nation. We will discuss the state of the economic complexity of exports of African countries following the new approach introduced by Hidalgo and Hausmann (2009), Hausmann et al. (2011). This approach consists in exploiting the relationship that exists between diversity and ubiquity.

3.1 Analyzing the state of African countries exports concentration/diversification

The concept of product sophistication we discussed previously refers not only to technological intensiveness but also to the economic complexity of the product. In this subsection, we will rather discuss the economic complexity of the productive structure of African countries. According to Hausmann et al. (2011), the complexity of the productive structure is reflected through the number of products the country can make and the amount of knowledge these products require in their manufacturing processing.

The economic complexity of a productive structure is not limited to only its diversity, but depends also on the amount of knowledge required to manufacture the products. If the manufacturing of a given product requires a substantial technological knowledge, it is obvious that the product cannot be made everywhere and by everybody. Only a limited number of countries will be able to make such product. However, it should be noticed that some rare natural resources such as precious stones, diamonds are available in very few places around the world. For these products, scarcity does not really mean a greater complexity in their manufacturing, but it reflects the geographical availability of such products. In sum, the scarcity of a product can be explained either by the complexity required in its processing, or either its geographical availability. But in this paper, we focus on the economic complexity of the product.

Hausmann et al. (2011) defined the ubiquity of a product as the number of countries that make such product. Ubiquity reflects indirectly the amount of knowledge required to make a given product. Products that require large volume of knowledge, i.e. those that are less ubiquitous, can be manufactured only by a limited number of countries. Some goods require in their manufacturing processing, the human capital as well as the organizations that possess relevant

knowledge for their manufacturing. On the opposite, standard or ubiquitous products are more likely to require a few capabilities and therefore can be made by many countries. Capabilities is what is required to make a given product.

These authors established a linkage between ubiquity and diversity. To do so, they defined measures to quantify these two elements by using the revealed comparative advantages (RCA) of a country for a given product. As mentioned previously, the diversity of a country is the number of products the country holds a comparative advantage for a given period (year). In other words:

$$Diversity_{ct,0} = K_{ct,0} = \sum_{p} M_{cpt} \qquad (1)$$

With

$$M_{cpt} = \begin{cases} 1 & if\ RCA \geq 1 \\ 0 & if\ RCA < 1 \end{cases}$$

The revealed comparative advantage is defined as follows:

$$RCA_{pct} = \frac{x_{pct}/X_{ct}}{x_{wpt}/X_{wt}}$$

with:

x_{pct} is the export of product c by country p at time t.

X_{ct} is the total exports of country c at time t ;

x_{wpt} is the world total exports of product p at time t

X_{wt} is the world total exports at time t.

The ubiquity of a given product is defined using also the RCA as follows:

$$Ubiquity_{pt,0} = K_{pt,0} = \sum_{c} M_{cpt} \qquad (2)$$

The index 0 indicates that we are using the observed values of the two variables.

Diversity and ubiquity are crude approximation of the variety of capabilities available in a nation or required by a product; and the two are interdependent as shown in the above equations. According to Hausmann et al. (2011), these two variables are not an exact measure of complexity. In addition, one can use the information on one variable to correct the information on the other variable and vice-versa. In other words, diversity can be used to correct the information on ubiquity and vice-versa. For this purpose, they use the method of refection

which consists in computing recursively the average of the two variables named K_{pt} and K_{ct} . during the first iteration, we compute the value of $K_{pt,1}$ and $K_{ct,1}$ as following:

$$K_{ct,1} = \frac{1}{K_{ct,0}} \sum_{p} M_{cpt} K_{pt,0}$$

$$K_{pt,1} = \frac{1}{K_{pt,0}} \sum_{p} M_{cpt} K_{ct,0}$$

In order to reach convergence and a more accurate value of the complexity, we repeat these iterations for an infinite number of times N with $N \geq 1$:

$$K_{ct,N} = \frac{1}{K_{ct,0}} \sum_{p} M_{cpt} K_{pt,N-1} \qquad (3)$$

$$K_{pt,N} = \frac{1}{K_{pt,0}} \sum_{p} M_{cpt} K_{ct,N-1} \qquad (4)$$

For a given period t, each country is characterized by the vector $\overline{K_{ct}} = (K_{ct,0}, K_{ct,1}, \ldots., K_{ct,N})$ and each product characterized by the vector $\overline{K_{pt}} = (K_{pt,0}, K_{pt,1}, \ldots., K_{pt,N})$. According to Hidalgo and Hausmann (2009), for countries, even variables of K_{ct} i.e. $(K_{ct,0}, K_{ct,2}, \ldots.)$are generalized measures of diversification while odd variables $(K_{ct,1}, K_{ct,3}, \ldots.)$ are generalized measures of ubiquity of their exports. On the other hand, for products, even variables of K_{pt} are related to their ubiquity and the ubiquity of other related products, whereas odd variables of K_{pt} are related to the diversity of countries exporting such products.

The diagram below summarizes the method of reflection by reporting the first three iterations.

Diagram 1 : details of the method of reflection: iteration 1 to 2.		
Number of iterations	**Pays (c)**	**Produits (p)**
0	$K_{ct,0}$: Diversity : number of products exported with RCA by country c. This also indicates how many products are exported by country c with RCA.	$K_{pt,0}$: Ubiquity : number of countries exporting product p with RCA. This indicates how many countries export product p with RCA.
1	$K_{ct,1}$: Average ubiquity of the products exported by country c with RCA. It indicates how common are the products exported with RCA	$K_{pt,1}$: Average diversity of the countries exporting product p with RCA. It shows how diversified are the countries exporting product p with RCA

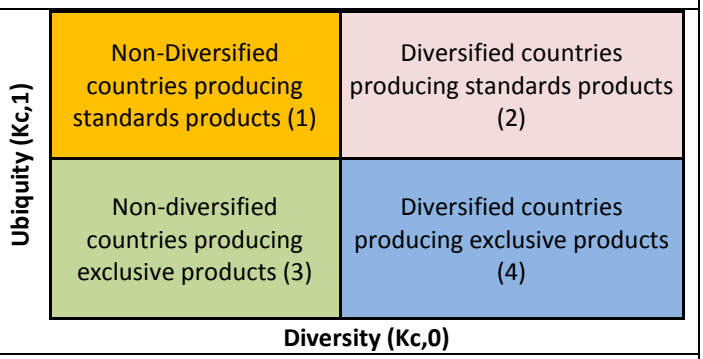
2	$K_{ct,2}$: average diversity of countries with similar export basket as country c. It also indicates how diversified are the countries exporting similar products with RCA as those exported by country c.	$K_{pt,2}$: Average ubiquity of the products exported with RCA by countries exporting product p with RCA. It also indicates how ubiquitous are the products exported by product's p exporters.
Source : Hidalgo and Hausmann (2009)		

3.2 Correlation between diversity and ubiquity

It is possible to retreive relevant information from $K_{ct,0}$ and $K_{ct,1}$. In fact, these two variables measure respectively the diversity of country c and the average ubiquity of the country's c export basket. As mentioned previously, these two variables are interrelated. In the following diagram, Hausmann and Hidalgo (2009) classified countries into four main categories according to the empirically observed averages of $K_{ct,0}$ and $K_{ct,1}$ as following:

- Category (1) which includes non-diversified countries producing standard products (high ubiquity)
- Category (2): diversified countries producing standard products
- Category (3) non-diversified countries producing exclusive products
- Category (4): diversified countries producing exclusive products (less ubiquity)

Diagram 1 : Diversity and Ubiquity

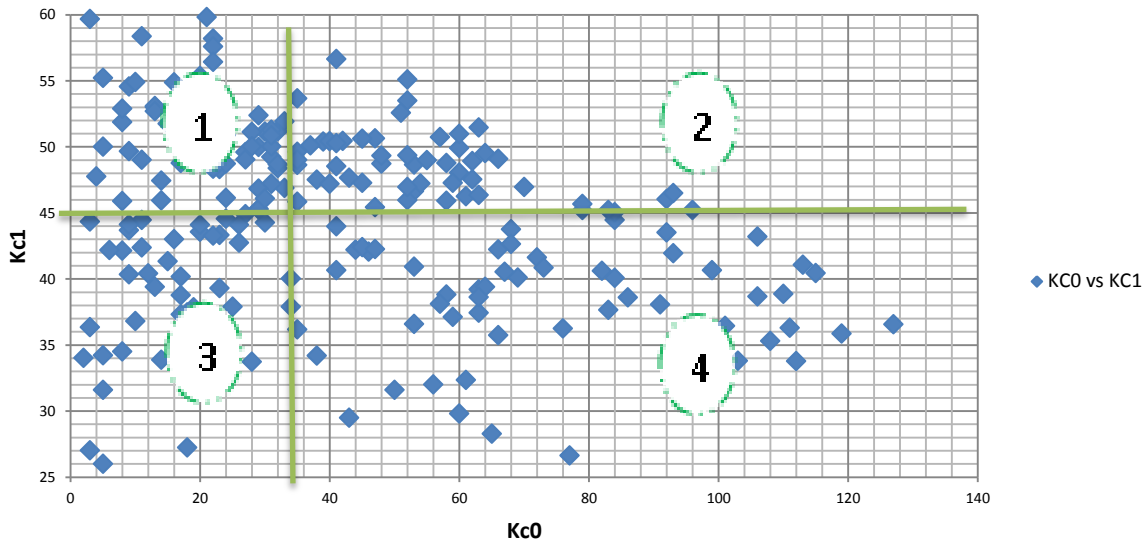


Source : Hidalgo and Hausmann 2009

Hausmann and Hidalgo (2009), using a dataset of 2000 for 128 countries found a negative correlation between ubiquity and diversity. We replicated this exercise using a dataset of 2012 for 217 countries. Figure 1 shows a negative and statistically significant correlation of -0.323 between the two variables. Countries in category (1) are mainly developing countries while

those in category (4) are mostly developed countries. The Figure shows clearly that the most diversified countries tend to export products that are exclusive and very complex to make.

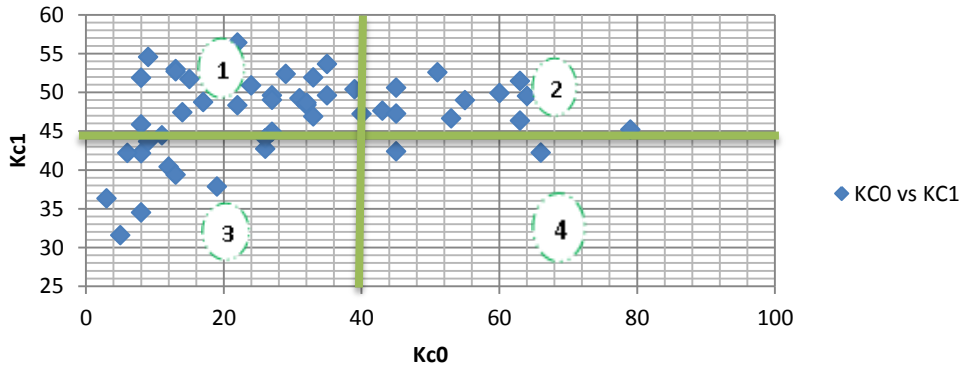
Figure 1 : Countries position in the Kc0 et Kc1 space (2012)



Source : Data collected from UNCAD 2013, computation done by the authors

Let's now analyze the case of African countries in the diagram. Figure 2 reports only data for African countries. we can see that most African countries (75%) belongs to the first category or the second one while only two countries are in the fourth category. These two countries are South Africa and Swaziland. This means that a minority of African countries exports are diversified and sophisticated.

Figure 2 : Position des pays africains dans l'espace Kc0 et Kc1



Source : Authors

In addition, we can observe that diversified countries in Africa have export basket that are mainly composed of ubiquitous products. In conclusion, diversified countries in Africa tend to produce goods that are not exclusive and can be made by many countries in the world.

3.3 Trend in the diversity and ubiquity of African countries

Table 3 reports how African countries from one period to the other regarding their ubiquity and diversity categories. It shows that the majority of African countries remained in the category of non-diversified countries producing standard goods (category 1). In 2008 for example, 26 African countries belong to category 1 and this number rose in 2010 to 28 countries but decreased to 24 in 2012. The number of diversified countries producing standard goods was 16 in 2008, it went up to 17 in 2010 but decreased to 13 in 2012. Yet, there is a significant number of countries that are non-diversified but produce exclusive products. Their number was 9 in 2008, 7 in 2010 and 11 in 2012. But only two African countries belong to the fourth category (Swaziland and South Africa) and they remained the same during all the period.

This table shows clearly that most African countries are not diversified and most of them export ubiquitous products. It is therefore crucial for African policymakers to determine and implement adequate economic policy reforms that could help countries to migrate from category 1 and 2 to category 4.

We also draw the trend of the average diversity and ubiquity of the continent. Figure 3 shows that on average, African countries have diversified their exports. We can observe an upward trend in their diversification trend between 1995 and 2012. In addition, this diversification is accompanied by a downward trend in the average ubiquity of the continent. Figure 4 shows that between 1995 and 2012, we can observe two phases in the evolution of the continent average ubiquity. From 1995 to 2002, ubiquity tends to increase while diversity was also increasing. But, from 2004 to 2012, the average ubiquity trend decreased slightly was increasing at a high speed. This means that African economies put efforts to diversify their exports but still have some difficulties to make them less ubiquitous. In order to observe a real change in their productive structure, countries will need to put their efforts to make less ubiquitous products while keeping diversifying their exports.

Table 3: Migration of African countries according to their ubiquity diversity categories (number of countries between 2008 to 2012.

Catégorie	2008	2010	2012
1	Cape Verde, Comoros, Seychelles, Botswana, Somalia, Rwanda, Central African Republic, Guinea-Bissau, Burundi, Zambia, Gambia, Burkina Faso, Mali, Côte d'Ivoire, Niger, Ethiopia, DRC, Malawi, Cameroon, Mozambique, Gabon, Sudan, Guinea, Mauritania, Chad **(26)**	Cape Verde, Comoros, Botswana, Lesotho, Seychelles, Guinea-Bissau Rwanda, Gambia, Ethiopia, Central African Rep., Niger, Cameroon, Burkina Faso, Zambia, Côte d'Ivoire, Benin, Somalia, Burundi, Malawi, Mali, Liberia, Mozambique, DRC, Sudan, Mauritania, Guinea, Gabon, Nigeria **(28)**	Comoros, Seychelles, Guinea-Bissau, Cape verde, Rwanda, Mali, Botswana, Côte d'Ivoire, Benin, Gambia, Burkina Faso, Ethiopia, Cameroon, Burundi, Malawi, Sierra Leone, Ghana, Niger, DRC, Mozambique, Liberia, Mauritania, Gabon **(24)**
2	Tunisia, Mauritius, Sierra Leone, Egypt, Namibia, Kenya, Morocco, Togo, Eritrea, Senegal, Uganda, Zimbabwe, Madagascar, Tanzania, Djibouti, Ghana **(16)**	Tunisia, Mauritius, Sierra Leone, Egypt, Eritrea, Madagascar, Djibouti, Togo, Uganda, Morroco, Namibia, Senegal, Ghana, Zimbabwe, Tanzania **(17)**	Tunisia, Mauritius, Egypt, Uganda, Djibouti, Madagascar, Kenya, Togo, Senegal, Namibia, Morocco, Tanzania, Zimbabwe **(13)**
3	STP, Lesotho, Liberia, Congo, Algeria, Lybia, Angola, Nigeria, Equatorial Guinea **(9)**	STP, Chad, Congo, Algeria, Lybia, Equatorial Guinea, Angola **(7)**	Somalia, STP, Central African rep., Lesotho, Eritrea, Zambia, Chad, Congo, Nigeria, Algeria, Lybia, Equatorial Guinea, Angola **(11)**
4	Swaziland, South Africa **(2)**	Swaziland, South Africa **(2)**	Swaziland, South Africa **(2)**

Source : authors

Figure 3: Trend of the average diversity of African countries

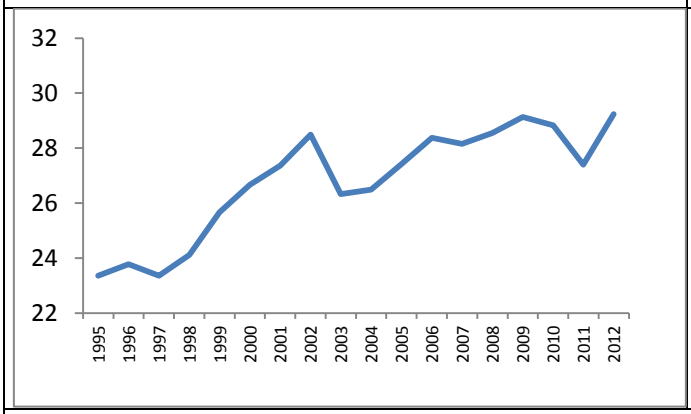
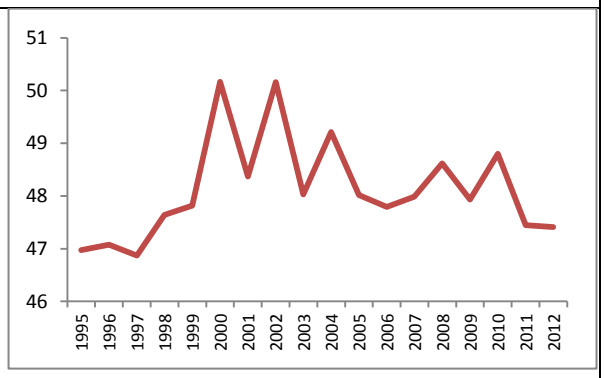


Figure 4: Trend of the average ubiquity of African countries



Source: Authors

IV. Economic complexity of African countries productive structures

In this section, we first present the methodology used to measure the economic complexity of a nation. Then we discuss the empirical results of the index of economic complexity we generate.

4.1 How economic complexity is measured

Why some countries have succeeded their economic development while others still have not? And why some countries are more diversified and are able to produce more complex goods than other cannot? In his volume on the "wealth of nations", Adam smith pointed out that in any society, there are two important factors that determine its level of prosperity. The first one is related to people skills, their ability, dexterity and knowledge they bring in their work. In other words, it is the technical knowledge, technical competence, human and physical capital, as well as the institutions available in the society. All these points refer to the capabilities available in the society.

The second element refers to the proportion of active population in the society. But, according to Smith, the first element (capabilities) predominantly explains the level of wealth of a nation than the second. In this regards, natural resources for instance are not enough to determine by themselves the level of prosperity of the nation.

The capabilities available in a society are the key element in determining its level of development. In other words, it is the knowledge a society holds that determines its level of development. Therefore, there is causal relationship between knowledge and development. According to the empirical results of Hausmann et al. (2011), the most prosperous economies are

also those that are more complex with high volume of knowledge or capabilities. Indeed, they found a positive correlation between the level of complexity and the income per capita of nations. In this subsection, we follow their approach and try to assess the level of complexity of African economies.

Although for a long time it was not possible to quantify the level of complexity of nations, it is only recently that Hausmann and Hidalgo (2009), Hausmann et al. (2011) introduced a new approach based on international trade data to assess the level of countries and products economic complexity. They used diversity and ubiquity as defined previously to approximate the level of capabilities available in a society.

Their approach is based on the method of reflection which consists in approximating the real value economic complexity by using recursively the information on ubiquity and diversity. Since we saw in the previous section that the two variables are interdependent, the authors suggested to use the information from one to correct the other and so on. It consists to calculate the average values of ubiquity and use this information to compute correct the value of ubiquity etc. in other words, one has to compute recursively equation (1) to (4) defined previously. The initial values of the iterative process are given in equation (1) and (2) which depend on the revealed comparative advantages of the countries.

The economic complexity index is computed at the country level as well as at the product level. At the country level, this consists in computing the mean values of ubiquity of products that the country exports with comparative advantage, the average diversity of countries that export the product and so on. At the product level, it consists in computing the average diversity of countries that export the product with comparative advantage, and the average value of ubiquity of other products exported by the countries with comparative advantage.

The iterations continue until there is no more variation between $K_{ct,N}$ and $K_{pt,N}$. In other words, the process ends when there is convergence with: $K_{ct,N} = K_{ct,N-2}$ at the country level and : $K_{pt,N} = K_{pt,N-2}$ at the product level. When the convergence is reached at the $\bar{N}$ iteration, we then compute the complexity index as a standardized variable as following:

$$ECI = \frac{K_{c,\bar{N}} - \overline{K_{c,\bar{N}}}}{Stdev(K_{c,\bar{N}})}$$

With $\overline{K_{c,\bar{N}}}$ the average of $K_{c,\bar{N}}$ and $Stdev(K_{c,\bar{N}})$ its standard deviation. We used Microsoft Excel to run the iterations. The data used come from UNCTAD 2013 for 217 starting from 1995 to 2012. Some countries do not appear for some years but overall, 217 countries were included in the analysis. In comparison with de index generated by Hausmann et al. (2011), several African countries were not included in their analysis. To fill this gap, we included all the African countries, except those who do not have any data from 1995 to 2011, such as South Sudan and Sudan. But the country Sudan included in the analysis is the all Sudan before the split in 2011. Other countries were also excluded due to outliers (Somalia, Central African Republic).

Table 4 reports our results of the ECI for only African Countries, but these data are available for the 217 countries from 1995 to 2012. We reported only data for 2010 and 2011. We also reported the ECI for 2008 and we compared them with the estimates obtained by Hausmann et al. (2011), see Table 6 in the Annex. There are some differences between those from Hausmann et al. (2011) and those we obtained. Several reasons may explain these differences. First we are not using the same level of disaggregated products, Hausmann et al. (2011) used SITC 4 with four digits which contains about 1024 groups of products. On our side, we used SITC4 with three digits (3 level of disaggregated) which contains 255 groups of products. These reasons could explain the differences in the results.

Table 4: African countries economic complexity index

Country	ECI 2010	ECI Ranking 2010	Country	ECI 2011	ECI Ranking 2011
Sao Tome and Principe	0.979958065	1	Sao Tome and Principe	0,76117368	1
Swaziland	0.532098652	2	Swaziland	0,56418819	2
Tunisia	0.519072442	3	Tunisia	0,52343681	3
Mauritius	0.111452084	4	Comoros	0,38958973	4
Sierra Leone	0.074890921	5	Mauritius	0,3823277	5
Cape Verde	0.040977651	6	Lesotho	0,28216247	6
South Africa	0.039649515	7	Djibouti	0,06689906	7
Kenya	-0.000367561	8	Sierra Leone	-0,0457	8
Egypt	-0.020159264	9	Kenya	-0,04943877	9
Eritrea	-0.029183107	10	Madagascar	-0,05578601	10
Madagascar	-0.064769568	11	Cape Verde	-0,06217205	11
Djibouti	-0.077833342	12	Uganda	-0,0950711	12
Comoros	-0.083197201	13	Egypt	-0,11159232	13
Botswana	-0.108476019	14	Eritrea	-0,16766804	14
Togo	-0.117926941	15	Morocco	-0,19192871	15
Lesotho	-0.135236377	16	South Africa	-0,19851204	16
Rwanda	-0.144141252	17	Somalia	-0,21650782	17
Seychelles	-0.159320544	18	Botswana	-0,21990025	18
Uganda	-0.1763468	19	Zambia	-0,22254378	19
Morocco	-0.178729435	20	Seychelles	-0,22644785	20
Namibia	-0.218806621	21	Senegal	-0,26024342	21
Senegal	-0.255950805	22	Namibia	-0,26775318	22
Guinea-Bissau	-0.278229088	23	Togo	-0,2855283	23
Gambia	-0.357974415	24	Guinea-Bissau	-0,28897688	24
Ethiopia	-0.364138914	25	Cameroon	-0,29786491	25
Central African Republic	-0.442427933	26	Gambia	-0,31308458	26
Niger	-0.487383762	27	Liberia	-0,33038877	27
Cameroon	-0.497498342	28	Central African Republic	-0,33879208	28

Ghana	-0.513117065	29	Tanzania	-0,35890956	29
Zimbabwe	-0.533104162	30	Rwanda	-0,38025326	30
Tanzania	-0.588970954	31	Burundi	-0,47634018	31
Burkina Faso	-0.590862218	32	Zimbabwe	-0,51879026	32
Zambia	-0.592922821	33	Mali	-0,5236711	33
Côte d'Ivoire	-0.648659752	34	Ethiopia	-0,56129131	34
Benin	-0.814348551	35	Benin	-0,5662097	35
Somalia	-0.826867471	36	Côte d'Ivoire	-0,61728005	36
Burundi	-0.905652575	37	Burkina Faso	-0,644955	37
Chad	-0.93965742	38	Malawi	-0,69490835	38
Malawi	-0.981270609	39	Niger	-0,71085102	39
Mali	-1.02817686	40	Ghana	-0,73105427	40
Liberia	-1.184176994	41	Congo	-0,99327593	41
Mozambique	-1.229537379	42	Mozambique	-1,08003403	42
Dem. Rep. of the Congo	-1.316084253	43	Mauritania	-1,10201117	43
Sudan (…2011)	-1.339693052	44	Chad	-1,31936933	44
Congo	-1.385222277	45	Sudan (…2011)	-1,36664225	45
Mauritania	-1.550788362	46	Gabon	-1,46621402	46
Guinea	-1.606547339	47	Dem. Rep. of the Congo	-1,55462709	47
Gabon	-1.63122214	48	Guinea	-1,61111028	48
Nigeria	-1.877263761	49	Libya	-1,9813128	49
Algeria	-1.958563914	50	Nigeria	-2,03623276	50
Libya	-2.466619251	51	Algeria	-2,31587735	51
Equatorial Guinea	-2.802639472	52	Equatorial Guinea	-3,43312622	52
Angola	-4.21782164	53	Angola	-4,57955087	53

Source : computation done by the authors using data from UNCTAD 2013

4.2 Interpretation of the empirical results of ECI for African countries

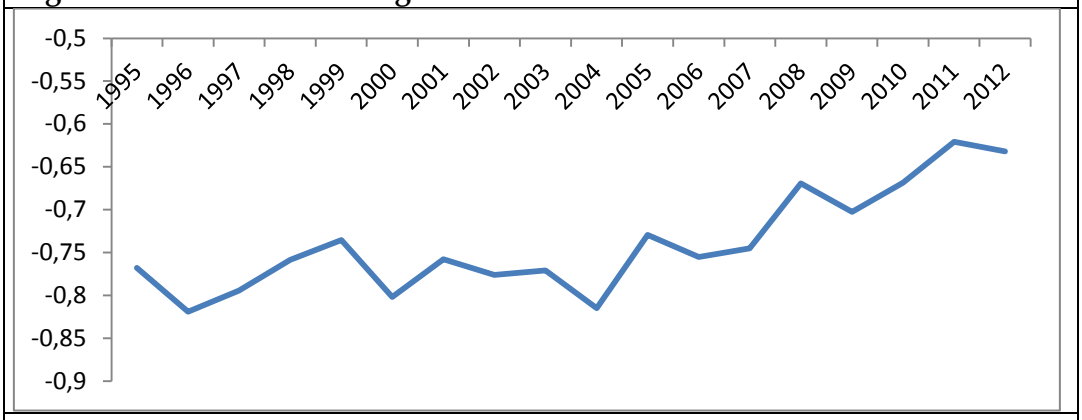
Table 4 presents the economic complexity index ECI for only African countries for 2010 and 2011. It comes out that in 2011, the ten most complex economies in Africa were: Sao Tome and Principe, Swaziland, Tunisia, Comoros, Mauritius, Lesotho, Djibouti, Sierra Leone, Kenya and Madagascar. Among these countries, four are small islands and Cape Verde, another small island developing state was ranked 11th out of the 52 countries in 2011. In comparison to 2010, most of these ten countries were among the ten first ones, except Comoros (13th), Lesotho (16), Djibouti (12th), and Madagascar (11th). Egypt, ranked 9th in 2010 became 13th in 2011. South Africa went from 7th in 2010 to 16th in 2010. Cape Verde was 6th in 2010 but regressed to 11th in 2011.

Among the less complex economic, the five less complex economies are fossil fuel rich countries and the list involves the same countries in 2010 and 2011: Angola, Equatorial Guinea, Algeria, Nigeria, and Libya. In addition, the following five also countries immensely endowed with natural resources: Guinea, Democratic Rep. of Congo, Gabon, Sudan and Chad in 2011.

Is there any relationship between a country's natural resource endowment and its economic complexity? Hausmann et al. (2011) found that for the Middle East and North Africa, the worst performers were Kuwait, Iran and Libya, which are also oil rich countries. Natural resource, especially oil endowment may affect negatively the process of complexification of countries productive structures. A huge endowment of oil may negatively impact the productive structure of a nation through its industry and manufacturing. This may be related to the issue of the Dutch Disease which many African countries have experienced when exploiting their oil reserves. We will check in the second part of this study if there any relationship between countries ECI and their natural resources endowment.

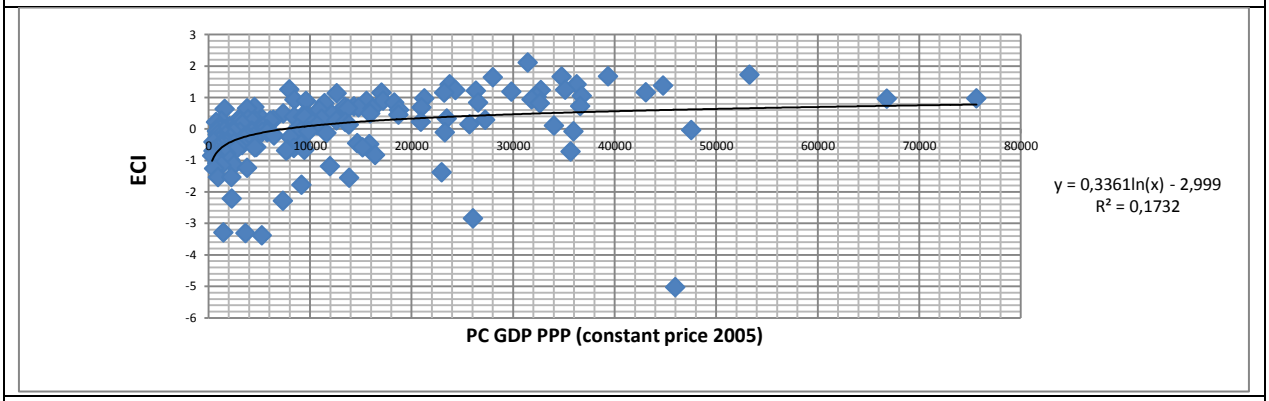
Figure 5 presents the trend in the average ECI of all African countries from 1995 to 2012. On average, the ECI is negative in Africa but has improved since 1995. Between 1995 and 2005, the trend was a bit stable but since 2005, we can observe an upward trend in the average ECI. This means that African countries on average have improved the complexity of their economies. This improvement can be directly attributed more to their effort to diversify their exports than their efforts to make them less ubiquitous. This positive trend gives hope that the average ECI could reach positive values in the next few years if countries continue in the same vein.

Figure 5 : Trend of the average ECI of African countries from 1995-2012



We also tried to analyze the relationship between ECI and other key indicators such as countries GDP pc PPP, the HHI and Kc0. It comes out from the Figure 3 that there is a negative relationship between ECI and PC GDP PPP. Rich countries tend to have high ECI and poor countries tend to have low ECI. This means that countries with more complex productive structures tend to have high income.

Figure 6: Relationship between ECI and GDP pc PPP



Source: Authors using data from UNCTAD 2013 for 217 countries around the world

We also found a positive relationship between ECI and diversity (Figure 7). Complex countries tend to be also diversified. This is also confirmed by the negative relationship between ECI and the HH index (Figure 8). High HHI comes with low ECI, in other words, when the productive structure is concentrated on few products, the country tends to have low ECI which means low complexity.

Figure 7: relationship between ECI and Kc0

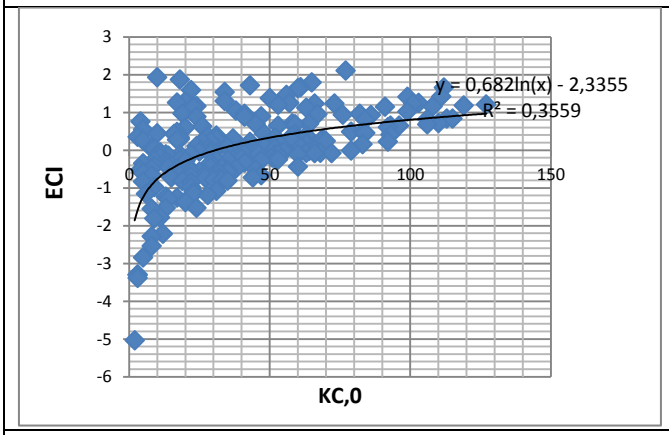
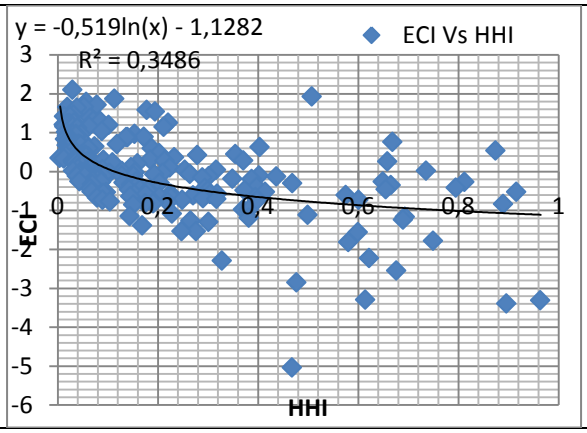


Figure 8: relationship between ECI and HHI



Source: Authors using data from UNCTAD 2013 for 217 countries around the world

V. Conclusion and the way forward

African countries have experienced strong economic growth in the recent years despite the economic downturns the world has been experienced since 2008. However, this growth has mainly been driven by the primary sector, especially the oil and mining industry. As a consequence, the recent economic growth has not been inclusive and poverty and inequality remains huge challenges in the continent. It has also been done at the detriment of the industrial sector, particularly the manufacturing. It has not also been able to generate jobs to the majority of the active population who remains in the agriculture and cannot afford decent living conditions.

From our analysis, it came out that African countries have not been able to diversify their productive structures and make sophisticated products during the last fifteen years. Three quarters of their exports do not necessitate any advanced technology and less than 3% were based on high-tech. Over the last fifteen years, countries specialized in the export of very few products, with an average of 11 products across the continent, and these products are mostly raw material. In other words, African countries exports are not diversified but are ubiquitous.

We also found that African economies are not complex. The most complex economies include many small islands while the less complex economies are oil or gas rich countries. yet, the recent growth was mainly driven by resource rich countries. This situation could explain why most of the continent's exports were not diversified and did not require high-tech.

In conclusion, following Hausmann et al. (2011), we generated a large dataset with many variables including technology intensiveness, diversity, ubiquity, the economic complexity index of each African countries we have adequate data, and other additional data such as product complexity index, countries untapped potential, etc…. This is the first time these kinds of data are generated for many African countries. This gives an opportunity to conduct deeper economic analysis at the country level or at the regional or continental level. Such analysis could help in given adequate policy guidance to African policymakers on how they can achieve an effective structural transformation for the coming years.

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Annex

Table 6 : ECI for 2008 : Comparison with Hausmann et al. (2011) results (Africa)

Hausnmann results 2008 (using 1024 products)					ECI Application results 2008 (using 255 products)			
country	Rank (world)	Rank (Africa)	ECI		Country	Rank (world)	Rank (Africa)	ECI
Tunisia	47	1	0.273881		Tunisia	43	1	0.324904
South Africa	55	2	0.109421		Mauritius	52	2	0.174194
Egypt	62	3	-0.046469		Namibia	57	3	0.034383
Namibia	72	4	-0.304709		Egypt	59	4	0.006994
Kenya	73	5	-0.308719		Kenya	67	5	-0.100220
Senegal	74	6	-0.314649		South Africa	68	6	-0.150483
Mauritius	77	7	-0.345299		Uganda	70	7	-0.181506
Zimbabwe	80	8	-0.358059		Botswana	73	8	-0.217507
Morocco	83	9	-0.442449		Senegal	75	9	-0.261320
Uganda	87	10	-0.527829		Morocco	76	10	-0.274040
Madagascar	90	11	-0.635338		Zimbabwe	78	11	-0.297512
Botswana	93	12	-0.664258		Madagascar	79	12	-0.343429
Cote d'Ivoire	99	13	-0.915968		Mali	83	13	-0.454036
Ghana	100	14	-0.919498		Zambia	87	14	-0.510833
Tanzania	95	15	-0.678358		Côte d'Ivoire	88	15	-0.558469
Ethiopia	103	16	-0.936418		Ghana	92	16	-0.622064
Zambia	105	17	-0.978238		Ethiopia	100	17	-0.750647
Malawi	106	18	-1.071798		Malawi	101	18	-0.795748
Mozambique	109	19	-1.129298		Cameroon	103	19	-0.864850
Mali	111	20	-1.143398		Mozambique	105	20	-0.978886
Liberia	112	21	-1.169398		Gabon	106	21	-1.049413
Algeria	115	22	-1.242498		Sudan	109	22	-1.155015
Libya	119	23	-1.332498		Liberia	110	23	-1.156028
Gabon	120	24	-1.409598		Congo	113	24	-1.383061
Nigeria	121	25	-1.449098		Guinea	114	25	-1.422781
Cameroon	122	26	-1.453798		Algeria	118	26	-1.756306
Guinea	123	27	-1.501798		Mauritania	119	27	-1.760883
Congo	125	28	-1.768698		Angola	121	28	-2.004031
Angola	126	29	-1.805297		Libya	123	29	-2.201500
Sudan	127	30	-1.811398		Nigeria	124	30	-2.598900
Mauritania	128	31	-1.960798		Nigeria	124	31	-2.598900

Table 6 : ECI for 2008 : Comparison with Hausmann et al. (2011) results (world)

Hausnmann results 2008			ECI Application results 2008		
country	**Rank**	**ECI**	**Country**	**ECI**	**Rank**
Japan	1	2,3661	Japan	2,38676114	1
Germany	2	2,0125	Switzerland	1,85358111	2
Switzerland	3	1,9709	Germany	1,83355355	3
Sweden	4	1,8912	Singapore	1,78974419	4
Austria	5	1,8356	Korea, Republic of	1,71002427	5
Finland	6	1,7431	Czech Republic	1,61897551	6
Singapore	7	1,6732	Sweden	1,59072915	7
Czech Rep.	8	1,6514	United Kingdom	1,55804269	8
United Kingdom	9	1,584	Slovenia	1,53570744	9
Slovenia	10	1,5428	Italy	1,52638729	10
France	11	1,493	France	1,48561119	11
Korea, Rep.	12	1,4915	Finland	1,39357149	12
United States	13	1,4671	China	1,38053209	13
Hungary	14	1,4502	Hungary	1,37875458	14
Slovak Rep.	15	1,3929	Israel	1,36339686	15
Italy	16	1,3208	Slovakia	1,31972356	16
Denmark	17	1,2777	Mexico	1,27250866	17
Ireland	18	1,2459	United States	1,22415118	18
Israel	19	1,1731	Denmark	1,21832804	19
Mexico	20	1,1561	Panama	1,0897834	20
Belarus	21	1,1241	Thailand	1,04882414	21
Belgium	22	1,0917	Ireland	1,00912963	22
Netherlands	23	1,0485	Spain	1,00433125	23
Hong Kong	24	1,0277	Poland	0,98202171	24
Poland	25	1,025501	Belgium	0,94791421	25
Croatia	26	0,9906605	Romania	0,93487899	26
Romania	27	0,9349405	Portugal	0,77036031	27
Spain	28	0,9335905	Malaysia	0,7676975	28
China	29	0,8922805	Netherlands	0,74674872	29
Panama	30	0,8294906	Croatia	0,71232968	30
Thailand	31	0,8136506	Bosnia and Herzegovina	0,69092598	31
Estonia	32	0,7882406	Belarus	0,68319353	32
Norway	33	0,7827406	Turkey	0,6719125	33
Malaysia	34	0,7595006	Latvia	0,63240042	34
Portugal	35	0,6881307	Estonia	0,62233887	35
Lithuania	36	0,6762407	Serbia	0,62184574	36
Serbia	37	0,6348307	Lebanon	0,58376495	37
Bosnia& Herzegovina	38	0,5868907	Costa Rica	0,56120165	38
Latvia	39	0,5836007	Lithuania	0,5284494	39
Bulgaria	40	0,5791108	Bulgaria	0,51520406	40
Canada	41	0,5659508	Greece	0,41671308	41

Ukraine	42	0,5503308	Ukraine	0,36610454	42
Turkey	43	0,4190609	**Tunisia**	0,32490413	43
Lebanon	44	0,3861409	Viet Nam	0,31318414	44
Russia	45	0,3141809	El Salvador	0,29356316	45
Jordan	46	0,305741	India	0,26218412	46
Tunisia	47	0,273881	Colombia	0,2504017	47
New Zealand	48	0,269411	Brazil	0,22361036	48
Costa Rica	49	0,256631	Jordan	0,21693255	49
Moldova	50	0,243531	Kyrgyzstan	0,21366808	50
India	51	0,230391	Philippines	0,17792988	51
Brazil	52	0,229891	**Mauritius**	0,17419361	52
Greece	53	0,194861	New Zealand	0,16667876	53
Colombia	54	0,179321	Uruguay	0,11465556	54
South Africa	55	0,1094211	Albania	0,07132791	55
Uruguay	56	0,0846501	Syrian Arab Republic	0,05376042	56
Argentina	57	0,0797291	**Namibia**	0,03438289	57
Albania	58	0,0625361	Indonesia	0,03345399	58
Philippines	59	0,0063412	**Egypt**	0,00699368	59
El Salvador	60	0,0005425	Canada	-0,01553334	60
Indonesia	61	-0,0322018	Dominican Republic	-0,02652509	61
Egypt	62	-0,0464688	Argentina	-0,02728284	62
Macedonia	63	-0,0489198	Sri Lanka	-0,04453156	63
Dominican Rep	64	-0,0928668	Norway	-0,05518205	64
Guatemala	65	-0,1317787	Guatemala	-0,06387802	65
United Arab Emirates	66	-0,1332287	Pakistan	-0,06978626	66
Viet Nam	67	-0,2108787	**Kenya**	-0,10021996	67
Saudi Arabia	68	-0,2139987	**South Africa**	-0,1504834	68
Kyrgyzstan	69	-0,2689486	Cambodia	-0,1736487	69
Georgia	70	-0,3015686	**Uganda**	-0,1815056	70
Sri Lanka	71	-0,3020286	Georgia	-0,19494428	71
Namibia	72	-0,3047086	Bangladesh	-0,21210433	72
Kenya	73	-0,3087186	**Botswana**	-0,21750697	73
Senegal	74	-0,3146486	Paraguay	-0,22648361	74
Syrian	75	-0,3235486	**Senegal**	-0,26132036	75
Trinidad& Tobago	76	-0,3354186	**Morocco**	-0,27403981	76
Mauritius	77	-0,3452986	Cuba	-0,2773566	77
Australia	78	-0,3504386	**Zimbabwe**	-0,29751159	78
Chile	79	-0,3514286	**Madagascar**	-0,34342945	79
Zimbabwe	80	-0,3580586	Honduras	-0,34558045	80
Jamaica	81	-0,3823086	Jamaica	-0,37754946	81
Pakistan	82	-0,4363886	United Republic of Tanzania	-0,44965732	82
Morocco	83	-0,4424485	**Mali**	-0,45403564	83
Qatar	84	-0,4514385	Nicaragua	-0,48830727	84
Cuba	85	-0,4679685	Mongolia	-0,49952733	85
Paraguay	86	-0,5151384	Chile	-0,50186327	86
Uganda	87	-0,5278285	**Zambia**	-0,51083344	87
Honduras	88	-0,5585985	**Côte d'Ivoire**	-0,55846908	88

Peru	89	-0,6246184	Lao People's Dem. Rep.	-0,56114152	89
Madagascar	90	-0,6353384	Ecuador	-0,59320831	90
Oman	91	-0,6395784	Peru	-0,6070149	91
Kazakhstan	92	-0,6442184	**Ghana**	-0,62206389	92
Botswana	93	-0,6642584	United Arab Emirates	-0,62403019	93
Ecuador	94	-0,6654984	Australia	-0,62422191	94
Tanzania	95	-0,6783583	Uzbekistan	-0,63465388	95
Uzbekistan	96	-0,7016183	Bolivia (Plurinational State of)	-0,63921843	96
Nicaragua	97	-0,7106183	Russian Federation	-0,6466987	97
Cambodia	98	-0,7399983	Tajikistan	-0,66270899	98
Cote d'Ivoire	99	-0,9159682	Turkmenistan	-0,66576115	99
Ghana	100	-0,9194981	**Ethiopia**	-0,75064734	100
Lao PDR	101	-0,9338781	**Malawi**	-0,79574799	101
Bolivia	102	-0,9357182	Venezuela	-0,80059264	102
Ethiopia	103	-0,9364182	**Cameroon**	-0,86484979	103
Bangladesh	104	-0,9437981	Yemen	-0,95413873	104
Zambia	105	-0,9782382	**Mozambique**	-0,97888611	105
Malawi	106	-1,071798	**Gabon**	-1,04941315	106
Yemen	107	-1,079798	Kazakhstan	-1,06043495	107
Tajikistan	108	-1,105598	Oman	-1,08698009	108
Mozambique	109	-1,129298	**Sudan (…2011)**	-1,15501457	109
Venezuela	110	-1,141998	**Liberia**	-1,15602768	110
Mali	111	-1,143398	Azerbaijan	-1,31791721	111
Liberia	112	-1,169398	Papua New Guinea	-1,36308684	112
Kuwait	113	-1,214898	**Congo**	-1,3830605	113
Mongolia	114	-1,223798	**Guinea**	-1,42278112	114
Algeria	115	-1,242498	Saudi Arabia	-1,43763313	115
Turkmenistan	116	-1,256798	Trinidad and Tobago	-1,46791457	116
Iran	117	-1,277998	Iran (Islamic Republic of)	-1,50723595	117
Azerbaijan	118	-1,278098	**Algeria**	-1,75630623	118
Libya	119	-1,332498	**Mauritania**	-1,76088305	119
Gabon	120	-1,409598	Kuwait	-1,99362036	120
Nigeria	121	-1,449098	**Angola**	-2,00403126	121
Cameroon	122	-1,453798	Qatar	-2,1325608	122
Guinea	123	-1,501798	**Libya**	-2,20150001	123
Papua New Guinea	124	-1,639798	**Nigeria**	-2,5989001	124
Congo	125	-1,768698			
Angola	126	-1,805297			
Sudan	127	-1,811398			
Mauritania	128	-1,960798			

Source : data are from Hausmann et al. (2011) and from the authors